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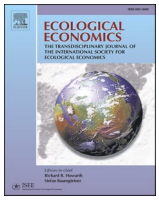

Mangroves and economic development in Tobago: Incorporating payment horizons, choice certainty and ex-post interviews in discrete choice experiments

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ABSTRACT

Governments have long faced potential trade-offs between economic development and protecting nature. This is particularly true for tropical and sub-tropical islands where most mangroves are found. Motivated by Trinidad and Tobago's central government's prior hotel development plans, we employ a discrete choice experiment (DCE) to investigate residents' preferences for mangrove ecosystem services (ES) in the Bon Accord Lagoon and Buccoo Bay, Tobago. Preferences were investigated in the context of a trade-off between conserving mangroves and promoting economic development through a hypothetical hotel project in the study area. We use a Hierarchical Bayesian Logit Model, exploring two distinct payment horizons, 5 and 25-years, undertaken independently and also merged in models that allow for choice certainty and individual characteristics. We find that respondents have consistent willingness-to-pay (WTP) for mangrove ES and exhibit general insensitivity to the payment horizons due to perceived disbenefits associated with mangrove loss from hotel development. The DCE and ex-post (follow-up) interviews suggest that there is strong public support for policies aimed at long-term protection of mangroves.

1. Introduction

There is increasing recognition that mangroves, intertidal trees or shrubs found in the tropics and sub-tropics, provide a variety of benefits or ecosystem services (ES), to people from local through to global scales (Friess, 2016; Barbier, 2017) and over short and long time periods. These benefits classified by the Millenium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005), include provisioning, for example wood and timber; regulating, for example storm protection and erosion control; supporting, for example marine habitats; and cultural services, for example recreation (Kathiresan, 2012; Spalding et al., 2014; Das, 2022). Yet despite the benefits mangroves provide they are being lost globally at a rate of around 0.2 to 0.7 % annually since the 2000s. Although this is at a lower rate than the approximate 2.1 % annually from the early 1980s to early 2000s (Valiela et al., 2001; Friess et al., 2019; Bryan-Brown et al., 2020), the loss is compounded by fragmentation, which is the break-up of mangrove connectivity into sub-parts through alternative land uses (Bryan-Brown et al., 2020). Drivers of loss and fragmentation include natural disasters, particularly storms; land-use conversion for urban expansion; aquaculture, including shrimp farming; and tourism development (Lugo, 2002; FAO, 2007; Polidoro et al., 2010; Tuholske et al., 2017).

Trinidad and Tobago (T&T), located in the Caribbean benefits from a tropical climate and estuarine conditions from the Orinoco and Amazon Rivers in South America, both of which promote mangrove growth. But in common with much of the Caribbean and Central American region,

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the country is experiencing fragmentation and loss of mangrove connectivity (Juman and Hassanali, 2013; Mohammadi et al., 2020; Bryan-Brown et al., 2020). This is in part due to the continuing development of the tourism sector, particularly the traditional "Caribbean beach holiday" (Oxford Business Group, 2015). Tourism contributes 37 % of GDP and 50 % of employment in Tobago (Hassanali, 2017), driving economic growth and development, but historically at the expense of mangrove marinescapes.

Mangrove area use in Tobago has been contentious. In the 1970s rapid infrastructural growth for housing and the tourism sector in southwest (SW) Tobago negatively affected the Bon Accord/Buccoo mangroves (Juman and Hassanali, 2013). Additionally, in the 1970s a constructed sewage treatment facility with an effluent drain through the mangroves into the lagoon became a vector for saltwater intrusion further inland and in the 2010s mangrove fragmentation occurred for housing and resort development (Juman and Hassanali, 2013). More recently the government experienced a backlash against continued tourism development from 2017 to 2019, when negative publicity in the media linked to potential mangrove loss, raised by Non-Governmental Organisations (NGOs) and scientists, contributed to the cancellation of plans to build a 750–1000 room hotel at the Bon Accord Lagoon and adjoining Buccoo mangrove site (LoopTT, 2018; Doodnath, 2019). It is estimated that Tobago lost a potential revenue stream of up to US$80 million annually and 2000 jobs from the cancellation (Polo, 2018; Doodnath, 2019). Despite this, more hotels are planned at different coastal locations across the island, and airport expansion adjacent to the Kilgwyn/Friendship mangrove site is underway (see VisitTobago, 2022).

Tobago's experiences, and future plans, suggest that it is timely to consider this potential area of socio-environmental conflict.[3] In this paper the overarching aim is to determine to what extent Tobago's population prefers protecting and enhancing mangroves over tourism-driven economic growth, or growth over mangroves. To achieve this aim we use a discrete choice experiment (DCE) to investigate residents' preferences for mangrove ES and economic development in the Bon Accord Lagoon and Buccoo, Tobago. We contribute to the environmental valuation literature in three ways. First, we estimate the willingness-to-pay (WTP) of Tobago's residents for a mangrove conservation programme using a Hierarchical Bayesian Logit Model, exploring methodological treatments in two distinct payment horizons, 5- and 25-years. This allows us to estimate the trade-offs across mangroves and economic development with a time sensitivity component. Second, self-reported choice certainty is included to measure respondent understanding and confidence in their choice selection and is integrated into the choice model. Finally, using "follow-up" or "ex-post" interviews we investigated the individual WTP findings of each alternative in a selected choice task for ten previous DCE respondents. Ex-post interviews were conducted to assess whether the individual's WTP values were acceptable compared to the mean estimates from the models, as individual WTP values can deviate from the mean. This was done with in-depth interviews to explore behaviour and thinking on respondents' choices.

2. The evolution of valuation

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[4] introduced the concept of 'nature's contribution to people,' which builds on the ES concept and the diversity of ES values that span intrinsic, instrumental and relational (Pascual et al., 2017; Dean et al., 2021). Intrinsic values are the inherent values of nature for itself such as genetic and species diversity (IPBES, 2013; Pascual et al., 2017); instrumental values are nature's services to people and usually have an economic value such as food, energy and climate regulation (Pascual et al., 2017; Abdurrahim et al., 2023); and relational values are the meaningful relationships between people and nature such as health, way of life and sense of place (Chan et al., 2018; Himes et al., 2023).

As an economic valuation technique DCEs can inform policy makers on ES values by respondents who are affected by land use changes (Breeze et al., 2015). Additionally, integrating economic valuation with other valuation techniques such as biophysical (e.g. state and transition models and spreadsheet type methods also known as 'matrix models' that combine expert opinion in tabular format, spatial land cover data and other empirical data to make a matrix score of ES in case study areas (see Burkhard et al., 2009, 2012)), synthesising (e.g. Bayesian belief networks and multicriteria decision analysis) and socio-cultural (e.g. participatory mapping and narrative methods), have been recommended in the ecological economics paradigm and by IPBES for being more pluralistic as the combination of various techniques offer a diverse rather than one-dimensional valuation standpoint where time and cost constraints allow (Pascual et al., 2017; Jacobs et al., 2018; Costanza, 2020).

Though Stated Preference (SP) methods have an established history in environmental valuation, mangrove DCE studies are limited in number. For example, the systematic literature review by Himes-Cornell et al. (2018a) identified one paper Mashayekhi et al. (2016), between 2007 and 2016 that employed Choice Modelling. DCEs undertaken in T&T include Beharry-Borg and Scarpa (2010) and Alemu et al. (2019), but not on mangroves. Brander et al. (2012) identified four mangrove economic valuation studies in Trinidad from 1975 to 2004 but none used SP approaches. However, there are two mangrove contingent valuation (CV) studies in T&T, and both employ one-off volunteer payments (see Allen et al., 2003; Pemberton and Mader-Charles, 2005). DCEs with payment horizons and choice certainty are growing in the environmental valuation literature. However, existing approaches often use classical estimation (e.g. Ready et al., 2010; Lew, 2018; Ardeshiri et al., 2019; Regier et al., 2019). In contrast, Bayesian approaches offer the ability to incorporate prior information and model individual-level preferences flexibly (Scarpa et al., 2008; Gorton et al., 2023). These features make Bayesian approaches particularly suited to our study context (as discussed in Section 2.1) and to model payment horizons and choice certainty. Therefore, using the case of mangroves in Tobago, our paper explores DCEs with these techniques and the implications on policy.

2.1. Hierarchical Bayes choice modelling

Our valuation study examines people's WTP to avoid the environmental consequences of hotel development. It does so while seeking to incorporate alternative payment horizons and choice uncertainty. The context of the study is that there have been a range of development initiatives over the past 50 years, some of which have received recent negative publicity. As such, we required a modelling framework that was: i) flexible in the sense of allowing for extensions of "standard" approaches, ii) could employ relevant prior knowledge and iii) would allow for diverse preferences (Ferecatu and Öncüler, 2016; Goeken et al., 2021; Nazneen et al., 2023; Gao et al., 2024).

The Hierarchical-Bayes (HB) modelling approach is one which meets all of these criteria (Gelman et al., 2013). Essentially, HB can incorporate many structures while offering a "middle ground" between estimating the preferences for all individuals separately (Mohammadi et al., 2020) or, alternatively, estimating the one set of preferences shared by everybody.

[3] Socio-environmental conflicts are the disputes between social actors, over costs and benefits that arise from transformation or potential human induced transformation of nature, and is influenced by power dynamics, ethics, culture, knowledge and overarching principles and goals shaping society (Özkaynak et al., 2023).

[4] IPBES is the largest intergovernmental organisation mandated with synthesising knowledge and improve the interface between science and policy on biodiversity and ES (IPBES, 2019).

We acknowledge that the HB approach is not exclusively optimal; similar non-Bayesian models, such as the "Mixed Logit," and "Latent Class Logit," (Greene and Hensher, 2003) exist. Some practitioners favour the Latent Class approach which categorises individuals into discrete classes rather than the continuous distribution used in HB. However, whether continuous or discrete approaches to treating preferences should be the default is an ongoing debate (Guo and Shen, 2022). The assumption of distinct preference clusters may not be apt in our context where the sample is diverse, covering a broad spectrum of people with varying socio-demographic backgrounds and economic activities (Howai, 2023; Peters et al., 2023). These include for example local fishers, tourism sector workers, business owners, administrative and professionals representing both coastal residents near the study site and residents located further inland. Therefore, rather than forming several homogenous groups preferences are likely to vary continuously across the diverse population.

Our preference for employing the Hierarchical Bayesian Logit is rooted in its practical versatility and that it allows the integration of prior information into the estimation process. With regard to the latter, this integration can be pivotal when reliable prior information is available. In the context of DCEs, most are rich with prior information, derived from their design process that involves selections of specific attributes and their levels, encompassing both monetary and non-monetary factors. These design choices are influenced by existing knowledge, that is not only useful in design but also in estimation (e.g. Gelo and Turpie, 2021). In our study the pre-DCE design interviews used a payment range of 10 to 50 TTD, but participants suggested they would have broad willingness-to-pay at various levels up to 100 TTD, which was used to set the payment levels of the experiment. That the hotel development proposal evaluated had been the subject of negative publicity was also relevant in influencing respondents' WTP.

Previous studies have recorded the impact of negative publicity on WTP findings such as in contingent valuation where consumers are willing to pay higher premiums to avoid the baseline of products deemed harmful to health (e.g. Donovan and Hesseln, 2004); and in discrete choice studies on environmental beliefs leading to negative preferences for economic development and large WTPs to reduce negative environmental effects (e.g. Aanesen et al., 2023). There is also reason to believe that there is high public aversion to future hotel building in our study site based on the pre-DCE interviews. While these might on one hand increase real WTPs, they might also induce protest responses whereby payment levels are ignored within a hypothetical context or induce other hypothetical sources of bias (Staples et al., 2020; Penn and Hu, 2021). This in turn might further inflate estimates to be larger than what people can plausibly pay. Our HB approach (outlined in Section 3.3) enables a parameterisation that can be informative in relation to the total amount that people are willing to pay by incorporating a total WTP prior parameter, denoted as 'ω' in the model estimation but is non-informative (i.e. objective) regarding the distribution of mean estimates across specific attributes in the DCE. In other words ω constrains total WTP and we do not impose assumptions on which attributes respondents are prepared to pay for.

While the HB approach is highly versatile and facilitate model extensions, it is not our claim that HB techniques are essential for integrating payment horizons and/or investigating uncertainty. In theory, any "classical" estimation platform that offers sufficient user flexibility could allow the user to define a model consistent with ours (though not have the ability to incorporate priors). However, this does not negate the usefulness of the HB approach because Bayesian platforms typically necessitate the specification of all components explicitly in the modelling process (in a way not commonly demanded by classical statistical software). While this requirement may complicate the estimation process, it simultaneously grants the user substantial flexibility to define custom structures and distributions. The non-standard model discussed in Section 3.3, incorporates elements like time and uncertainty. The mathematical structure aligns closely with the required coding.

2.2. Payment horizons, choice uncertainty and ex-post interviews

2.2.1. Payment horizons

Time horizons in DCEs have explored choice temporal (in)sensitivity and choice temporal stability or consistency. Temporal (in)sensitivity and temporal stability differ where the latter is concerned with an identical DCE implemented in two or more different time periods at a research area (e.g. Bliem et al., 2012; Price et al., 2017; Williams, 2022). We apply the temporal (in)sensitivity approach, this is the variation in acquiring environmental goods over payment and/or benefit horizons. Payment horizons refer to different lengths of payment periods such as one-off, five years and 25 year annual payments (e.g. Lew, 2018; Ardeshiri et al., 2019; Howard et al., 2021). Benefit horizons refer to the commencement of environmental goods such as immediately, in two years' and four years' time from now (e.g. Viscusi et al., 2008; Meyer, 2013b; Meyer, 2013a) up to the maximum duration that the benefits would be received (Marre et al., 2015).

We focus on investigating payment horizons in economic valuation and this approach has benefits. First, public policy usually involves an intertemporal dimension as benefits and costs change over time, and understanding public preferences over payment horizons can assist policy makers through the provision of more thorough valuation of different policy alternatives (Howard et al., 2021). Second, various segments of a target population such as by those in support and not in support of paying levies for conservation may exhibit preference heterogeneity in WTP results that can be explored over time horizons (e.g. Ardeshiri et al., 2019). Finally, measuring intertemporal preferences and values through discounting of future benefits and costs is an important application (Lew, 2018; West et al., 2020). Discounting suggests that generally the value of goods and services are worth more today than receiving them at a future time period and though not applied in our study, the analyst can compare costs and benefits of potential conservation programmes across different time horizons (Guerriero and Pacelli, 2019).

Through the investigation of two payment horizons our first expectation is that respondents' WTP for mangrove ES over 25-years will be less likely to drastically decrease from the WTP for mangrove ES over 5-years. Alternatively, WTP for mangrove ES over 5-years will be less likely to drastically increase over the 25-years. Previous studies suggest that the WTP of individuals that support environmental conservation are less likely to be influenced by the duration of payment horizons (see Ardeshiri et al., 2019), and motived by existence and bequest values (Marre et al., 2015) as compared to those not in support of environmental conservation. In our study based on the literature and pre-DCE interviews which highlighted historical and ongoing land-use challenges centred around mangrove fragmentation, loss and proposed future uses of Tobago's mangrove for ecotourism and sustainable development (Howai, 2023) we speculate that these factors may encourage preferences towards environmental conservation and was demonstrated in the attitudinal questions to mangrove conservation in Appendix C.

2.2.2. Choice uncertainty

There is evidence in DCEs that respondents exhibit a degree of uncertainty about their choices (Fraser et al., 2021). Consequently, this may bring about a differential "noise" in choice responses that reflect their level of uncertainty (Balcombe and Fraser, 2011). Factors such as choice task complexity, attention, design and respondent socio-demographic characteristics influences choices and affect true preferences. Investigating choice uncertainty has generally taken two forms (Mattmann et al., 2019). First, stated measures of choice uncertainty are useful in controlling for differential noise which is the random error variation in respondents' choices (e.g. Lundhede et al., 2009; Ready et al., 2010). Second, focusing on factors that influence choice uncertainty such as socio-demographic and other personal characteristics that can help explain differences in respondents' choices in test-retest DCEs

where the same sample is surveyed repeatedly over a time period (e.g. Rigby et al., 2016; Brouwer et al., 2017).

Studies have found that an advantage of self-reported choice uncertainty is the mitigation of hypothetical bias or the difference between stated WTP and true WTP to reduce the exaggerated public WTP (Ready et al., 2010; Zheng et al., 2022). Exaggerated public WTP occurs where respondents overstate WTP in a hypothetical scenario thus inflating the WTP for the population. However, the respondents may spend less if it were a non-hypothetical payment scenario. True WTP is unknown but certainty levels using a response certainty rating or scale are calibrated in models to bring the stated WTP closer to the true WTP (Ku and Wu, 2018). Respondent stated choice certainty has been observed to measure the respondents' confidence in selected choice task alternatives (e.g. Pelletier et al., 2022) which is useful in our study. We further incorporate choice certainty in the analysis for the merged choice model to derive mean estimates, determine the level of agreement in choice certainty across the two payment horizons and investigate the effect of design characteristics on choice certainty using a random effects model.

Our study proposes the expectation that people are likely to be confident in their choices regardless of shorter or longer-term payment horizons therefore exhibiting greater choice certainty. We speculate that the higher levels of choice certainty to avoid mangrove removal and loss of ES are potentially due to assertions of environmental degradation where development on the mangroves occur. Studies have explored the influence of negative publicity on WTP (e.g. Donovan and Hesseln, 2004; Aanesen et al., 2023) and attitudes towards environmental goods and services (e.g. Homar and Cvelbar, 2024). However, these studies have not explored the certainty among respondents for forgoing economic development initiatives for environmental conservation. The inclusion of a choice certainty measure may improve model fit but in instances of negative publicity to economic development, WTP values may not vary significantly in cases of greater choice certainty.

2.2.3. Ex-post interviews

Ex-post interviews as used in our study refer to a "follow-up" interview done after completion of the DCE and at a different time. This can be done after a project's completion for evaluation purposes and to devise future strategies. However, DCEs can include ex-ante and ex-post techniques or "before" and "after" choice tasks that are presented in the same survey (Colombo et al., 2022). Ex-ante techniques are for instance Cheap Talk Scripts to mitigate hypothetical bias (e.g. Carlsson et al., 2005). Ex-post techniques have been used to implement debriefing choice certainty questions after choice tasks (Mamkhezri et al., 2020). Another approach involves asking respondents to state their maximum WTP for goods and services after choice tasks to check for choice inconsistencies (e.g. Colombo et al., 2016). Other ex-post approaches that do not use debriefing questions such as estimating annual discount rates (e.g. Howard et al., 2021) and combining revealed preference data if available with stated preference data (e.g. Brooks and Lusk, 2010) are alternatives.

We use a short choice task questionnaire and semi-structured interview questions in our follow-up interviews as qualitative research has generally been found to add value to DCEs (Vass et al., 2017). In the environmental SP literature ex-post interviews have been used with either focus group discussions or in-depth interviews to consolidate the SP methods. Focus groups and public deliberation for environmental decision making were used in CV studies (e.g. Brouwer et al., 1999; Clark et al., 2000) and DCE studies (e.g. Powe et al., 2005). More recently, follow-up in-depth interviews were used post-DCE (e.g. Rakotonarivo et al., 2017; Bjørnåvold et al., 2022; Gorton et al., 2023). Other mixed-method approaches include supplementing a previous DCE by interviewing geo-referenced households (e.g. Yao et al., 2019) and using a rating and ranking game to examine the ES included in the DCE (e.g. Oleson et al., 2015).

3. Methods

3.1. Mangrove research site

Trinidad and Tobago are the southern-most islands in the Caribbean with a population of approximately 1.3 million of which 60,000 live in Tobago (CSO, 2022). There are 11 mangrove sites (Fig. 1) in Tobago mainly in the island's southwest (SW). These mangrove sites have experienced hydrological alteration and pollution (Juman and Ramsewak, 2013), and there is still no explicit mangrove management plan for the island (IMA, 1995; Juman and Hassanali, 2013). The Bon Accord Lagoon (approximately 0.91 km^2) and Buccoo Bay (approximately 0.42 km^2) mangrove research site is located in SW Tobago and encompasses approximately 60 % of the island's mangroves, (Fig. 1) (Juman and Hassanali, 2013; Juman and Ramsewak, 2013). The Buccoo Reef and Bon Accord Lagoon are jointly classified as a wetland of international importance under the RAMSAR convention, an intergovernmental treaty for national action and cooperation with international partners on the wise use of key wetlands (RAMSAR, 2005). Back in 1995, the Institute of Marine Affairs (IMA) of T&T proposed a Buccoo Area Management Plan for the reef, seagrass and mangrove, and recommendations were made, but they were not implemented (IMA, 1995; Juman and Hassanali, 2013).

3.2. Survey design and implementation

The DCE has as its status quo (SQ), equivalent to an "opt out" option, the construction of a large-scale hotel development at Bon Accord five to ten years in the future which will result in some loss of mangroves and their associated ES, but an increase in tourism revenue for the island. The DCE preamble (Appendix A) is motivated by the cancelled hotel plans in 2019 (LoopTT, 2018; Doodnath, 2019), key informant and resident interviews. The DCE preamble in our study refers to the information provided to respondents before attempting the choice tasks. This was done to prepare respondents to answer the questionnaire and includes an explanation of the study scenario background, mangrove conservation programme and ES being valued. Respondents felt that the DCE preamble was credible because resort development and Tobago's interest as a tourist destination is still viable by developers and the government (Doodnath, 2019; VisitTobago, 2022).

Table 1 shows the attributes and associated attribute-levels based on the DCE preamble. The baseline information in the SQ with the future hotel scenario and the no hotel baseline for the attributes were informed by the literature, key informant and resident interviews and the pilot survey for feasibility and realism. Without the preamble scenario, fisheries sector catch is 2500 tonnes per annum (Mohammed and Lindop, 2015); coastal erosion at the research site is moderate (McCue, 2014); there are four flash floods per year on average in the research area confirmed from stakeholder interviews; the number of birds, fish and relevant species are approximately 150 (Juman, 2004; Juman and Hassanali, 2013; LoopTT, 2018); Tourism sector earnings from new hotel development (through taxes and revenue from the hotel) on the research site are none without a new hotel; and annual resident costs were discussed in the resident interviews/focus group. The last two attributes include cost elements but only one payment vehicle attribute (cost) to the respondent - the annual tax respondents pay. The tourism revenue from the hotel represents money coming into the island (not direct costs to the individual respondent like the annual tax). However, it means the respondent has to trade-off not only natural ES. But this tourism revenue represents the recreation, tourism opportunities and perhaps other development/jobs that may be forgone for less expansive hotel development.

DCEs require a structured survey development approach involving systematic steps (Mariel et al., 2021). Our experiment design underwent various stages, first the literature identified potential mangrove ES

Fig. 1. Location of Bon Accord and Buccoo mangrove, Tobago (IMA, 2016; OSM, 2023).

Table 1
Mangrove Discrete Choice Attributes and Levels.

Attribute	Alternative levels
Fisheries sectors catch per year	15 % ↑, 30 % ↑, 45 % ↑, *2000 tonnes*
Rate of coastal erosion	Low rate, Moderate, *High rate*
Flash flood frequency per year on average	5 floods, 3 floods, *7 floods*
Number of species (birds, fish, crab and other relevant species)	15 % ↑, 30 % ↑, 45 % ↑, *130 species*
Mangrove cover (removed for tourism development)	10 % removed, 20 % removed, 40 % removed, *60 % removed*
Tourism sector earnings from development on the mangroves (tax and other revenues coming from the hotel)	10 % ↓, 20 % ↓, 30 % ↓, *80,000,000 USD*
Respondent cost or WTP per year for 5-year or 25-year mangrove conservation programme	30 TTD, 60 TTD, 90 TTD, 120 TTD, 150 TTD, *0 TTD*

Note: Conversion 6.77 Trinidad and Tobago dollars (TTD): 1 USD; arrows indicate direction of percentage change; status quo level italicised.

Table 2
Example Choice Task.

Attribute	SQ	Option A	Option B
Fisheries caught per year	2000 tonnes per year	30 % ↑	45 %↑
Rate of coastal erosion	High	Low	Moderate
Frequency of flash flooding on average per year	7 floods per year	No change from SQ - 7 floods per year	3 floods per year
Number of species (birds, fish, crab and other relevant)	130 species	30 % ↑	15 % ↑
Mangrove removed for tourism/coastal development	60 % of mangrove removed	10 % of mangrove removed	40 % of mangrove removed
Tourism sector earnings from development on the mangrove per year (tax and revenue)	80 million USD per year	No change from SQ – 80 million USD per year	30 % ↓
Annual tax contribution by you per year for a 5 year programme	$0TT	$150TT per year (750TT total for 5 years)	$30TT per year (150TT total for 5 years)
Please select one [✓]			
For the above choice, how sure are you about the choice made (please select one [✓])?	Certain [] Reasonably certain []	Uncertain []	Somewhat uncertain []

attributes, which were discussed with subject matter experts, key informants and residents to contextualise the scenario and refine the attributes (see Howai, 2023) and levels. The pre-DCE qualitative research involved 36 in-depth interviews and two focus groups, which were cleaned, transcribed and analysed with NVivo version 12 to explore current and future mangrove ES uses on the island (Howai, 2023). For example, forestry and fisheries products, recreation, scientific research, coastal protection, aesthetics, biodiversity and habitat were among the recognised mangrove ES (Howai, 2023). Second, 48 choice tasks were created using an efficiency design (D-Optimal) that minimises the D-error to create reasonable choice tasks when classical (full factorial and fractional-factorial) designs are infeasible (Scarpa and Rose, 2008; Vermeulen et al., 2011) because they yield too many attribute-level combinations that undermine the practicality of the questionnaire (Mangham et al., 2009; Harkness and Areal, 2018). The D-Optimal design was generated using priors such as 0.1 that indicated small but positive WTPs for the attributes in the experiment (when moving towards what is expected to be a more desirable attribute level). The final D-error is 0.0178, and an example of a final choice task is in Table 2.

Third, with the 48 choice tasks a questionnaire was designed starting with a preamble describing the DCE scenario (see Appendix A). The attributes with associated levels (Supplementary Sheet S1) were refined and finalised after in-depth interviews and focus groups with stakeholders (e.g. fishers, boat tour operators, environmental NGOs and Tobago House of Assembly (THA) members). This was followed by 12 choice tasks per respondent (respondents see six choice cards, repeated

twice with one change i.e. the payment horizon – one block of six tasks with 5 years and the same block with 25 years as the payment horizon). We chose a within-sample design to observe how the same respondents' choices may change in a differing payment horizon. We opted for payment horizons rather than a time horizon attribute to compare WTP using the same six choice tasks which would not have been possible with using time horizon as an attribute itself. It should be noted that using a within-sample approach the correlation in the two groups of six choice tasks are ignored due to the correlation across the choices from the same respondent.

The 48 choice tasks from the D-Optimal design were broken into eight blocks of six tasks. For approximately half of the responses, the 25-year payment horizon questions were presented as the first six tasks to balance the order of which payment horizon appears first. It was stated in bold text on the questionnaire and verbally as well (in person) before starting the choice tasks whether the six tasks were the 5 year treatment or the 25 year treatment. After the 12 choice tasks there were de-briefing and socio-demographic questions (Supplementary Sheet S2). Budget reminders were given in the full DCE implementation to get respondents to think of the 5- and 25-year annual tax as an actual payment.

On completion of the dichotomous choice ex-post questions (see Appendix E for its description) the interviewee answered semi-structured interview questions to explore attitudes and motivations on choices classified into themes (based on the interview questions) of the SQ, cost attribute (resident tax), payment horizons, choice certainty, current and future mangrove uses (Supplementary Sheet S3). The interviews were transcribed, and no qualitative coding software was used. However, key points raised by multiple interviewees are in a narrative form with quotes from the ten interviewees for and against the respective themes from the interview questions (Appendix E).

All interviews and surveys were conducted in English as the official language of T&T, and the pre-DCE in-depth interviews and focus groups on the island were done January to February 2020, prior to the pilot DCE with 20 respondents in March 2020. The full DCE implementation took place from April to September 2020 and data collection was carried out by the first author. The DCE data collection took a hybrid approach with online and face-to-face surveys due to the impacts of COVID-19. Of the $n = 292$ total usable respondents, 13 % were from the online questionnaires. Respondents were adult residents with key decision-making responsibility in the household. The online questions were made on Qualtrics and designed to mirror exactly the face-to-face questionnaire. Convenience sampling was used for the face-to-face DCE, following a similar approach to the other DCEs conducted on the island (e.g. Beharry-Borg and Scarpa, 2010; Alemu et al., 2019). Surveys were done door-to-door at homes in Buccoo and Bon Accord/Canaan. Additionally, surveys were administered at food outlets, retail shops, shopping malls and business offices in southwest, Tobago. To corroborate the Hierarchical Bayesian Logit model results, ten ex-post interviews were undertaken from June to August 2021 with individuals that we had contact information for and were willing to be interviewed after their original DCE.

3.3. Analytical framework

Choice Models are based on the originally tested theory of choice behaviour that Thurstone (1927) proposed and Lancaster's (1966) consumer theory which suggests a product will have multiple components creating a bundle of characteristics that derive utility and is now underpinned by Random Utility Theory (RUT) (McFadden, 2001). The initial Random Utility Model (RUM) is as follows:

$$U_{kjt} = V_j(x_{kjt}) + e_{kjt} \tag{1}$$

Where, U_{kjt} is the utility that person j gets from x_{kjt}. The assumption is that individual j receives a linear utility from the k^{th} choice in the t^{th} choice task and e_{kjt} is Gumbel distributed.

Our model is estimated in WTP space, to reduce instability with estimates from preference space (Train and Weeks, 2005; Scarpa et al., 2008; Balcombe et al., 2010; Balcombe et al., 2022). Additionally, the model is interpreted directly from the estimates as WTPs in TTD. In a Bayesian perspective being even weakly informative on the priors in WTP space is more feasible and easier to undertake (Balcombe et al., 2022). The systematic utility we employ is:

$$U_j(p, x, q) = \exp(\alpha_j) V_j(p, x, q) + e \tag{2}$$

$$V_j(\mathrm{p}, \mathrm{x}, \mathrm{q}) = -p + \sum \beta_{kj} x_k + \theta_j q \tag{3}$$

Where (note that the quantities below will vary across options and choice tasks, but we avoid these subscripts for simplicity), p is price (tax), x_k is the level of the kth attribute, q is 1 if SQ and 0 otherwise and e is a Gumbel distribution. This parameterisation in WTP space whereby the parameters β_{kj} and θ_j are the WTP for the j^{th} person for the k^{th} attribute and SQ.

The setup utilised in 2) and 3) follows a convention. The standard hierarchical approach is to specify distributional forms for the individual WTPs that are a-priori normally distributed. We also follow this approach. However, we deviate from the standard practice for hierarchical models of assigning explicit prior distributions to the mean WTPs. Instead, the mean WTPs are implicitly derived as components of a total mean WTP to which we assign an explicit prior distribution. Using this approach, the mean WTPs still have posterior distributions that can be calculated, and the individual WTPs can be defined hierarchically based on these means. The motivation behind our approach is that we believe we have a reasonable idea as to plausible range of total WTPs. but are less secure about each of the values of the attributes that contribute to that total.

To implement this approach, we posit that there is a parameter ω which is the total mean WTP for all attributes. Then each of the mean WTPs for each attribute is some proportion of this total, see 4) and 5). An informative prior is assigned to ω but then the proportions are set non-informatively. The model in eqs. 2 and 3 are parameterised as such that the scale variable $\exp(\alpha_j)$ is log normally distributed and the willingness-to-pays $\beta_{k,j}$ and θ_j for the attributes and the SQ respectively are assumed to be normally distributed as follows:

$$\begin{aligned} \alpha_j &\sim N(\overline{\alpha}\sigma_\alpha) \\ \beta_{k,j} \sim N(\overline{\beta}_k \sigma_{\beta,k}) \ &and \ \theta_j \sim N(\overline{\theta}\sigma_\theta) \end{aligned} \tag{4}$$

The setup in 4) is as would be found in a standard hierarchical model. However, instead of assigning explicit priors to the mean WTPs, these are calculated by introducing the parameters $b_1, \ldots b_k$ that will be used to form a simplex along with a parameter ω that represents the total willingness-to-pay. More specifically these are defined as:

$$\begin{aligned} \overline{\beta}_k &= \frac{b_k}{\sum b_k + 1}\omega \\ \overline{\theta} &= \frac{-1}{\sum b_k + 1}\omega \end{aligned} \tag{5}$$

A default prior is defined for this simplex such that any simplex is equally likely from a prior point of view. For a given scale of the attribute levels, ω will represent the mean parameter estimated over a bounded region with an upper bound. Importantly, 5) implies that:

$$\omega = \sum_k \overline{\beta}_k - \overline{\theta} \tag{6}$$

For empirical implementation, the prior mean WTP for all parameter is 100 TTD with a maximum of 450 TTD (three times the highest tax offered in the experiment). The total WTP upper bound of 450 TTD is higher than the average annual residential water utility rate set by the Regulated Industries Commission of Trinidad and Tobago at approximately 360 TTD per annum in 2019 for 180 cubic metres of water (15

cubic metres per month) (Ramdass, 2023). The water utility rate is a good proxy for setting the total WTP upper bound as it was also mentioned in the ex-post interviews by three respondents as a good reference point for setting the tax to residents. Readers are reminded also that this is for the mean, there is additional heterogeneity in individual responses and therefore the total WTP for some individuals might considerably exceed this upper bound and diverge from the overall mean. This structure of 2) and 3) can also be easily modified to allow for the WTPs to depend on the characteristics of individuals, to allow for the "noise" (embodied in the parameter α_j) to be dependent on the certainty score provided by respondents about their choices, see 7).

The extended model: Uncertainty.

Here the certainty score $s = 1, 2, 3, 4$ where 1 indicates certain; 2, reasonably certain; 3 somewhat uncertain and 4 uncertain. Eqs. 2) and 3) remain ostensibly the same except for the modification of the scale parameter below:

$$\begin{aligned} U_j(p,x,q,s) &= \left(1-\rho\frac{s}{4}\right)exp\ (\alpha_j)V_j\ (p,x,q)+e \\ V_j(p,x,z) &= -p+\sum\beta_{kj}x_k+\theta_j q \\ \rho &\sim N(01)\ Tr[01] \end{aligned} \tag{7}$$

4. Results

We present the DCE results in this section. The method of estimation and checks on convergence are discussed in Appendix B. The respondents' attitudes to mangroves and economic development in Appendices, Table C.1. The descriptive statistics of sample composition in Appendices, Table C.2. Finally, the mean WTP plots are in Appendices, Fig. C.1. The model was run with different priors but is largely invariant to results other than the upper bound for the total WTP. The upper bound used was made based on findings in pre-DCE interviews with residents (explained in Section 2.1) and ex-post interviews (explained in Section 3.3).

4.1. Choice models: Payment horizons and individual characteristics

Table 3 presents key results in the WTP Space for the 5 and 25-year payment horizons, and the "merged" models.[5] WTP results are presented for the attributes' maximum percentage and level changes (Table 3), and 1 % and one level changes can be found in Appendix Table C.3. This format of reporting was used because the variables allows us to show the WTP results for the most improved levels offered. The variables are treated in continuous form including the ordinal erosion variable because when estimated in discrete form the WTP to mitigate moderate erosion was only slightly lower than for high erosion. To reiterate the Bayesian modelling approach used has a prior mean WTP for the total of all parameters set in a range of 100 TTD up to a maximum of 450 TTD but individual response heterogeneity indicates that some respondents may exceed this upper limit and diverge from the overall mean as observed by the lower and upper credible interval (CI) ranges.

The reported maximum percentage and level changes in Table 3 are found by subtracting the SQ level from the respective attribute's highest level value. For example, in the fisheries and species attributes percentage level changes moves from a baseline (SQ or 0 % change) to 45 % (most improved level offered) and the reporting shows the 45 % increase. While for the mangroves attribute 60 % removal (SQ) to 10 % mangrove removal (most improved level offered), giving a difference of 50 % across the attribute's parameter range. A final example, flash flood frequency moves from seven floods (SQ) to three floods (most improved level offered), and we have a difference of four floods.

The standard deviations are considerably smaller than the mean value estimates for the models, in a loose sense the Bayesian results correspond to the classical interpretation of means that are "significantly different from zero." The CI ranges across the four models do not include 0 TTD within the lower and upper bound, supporting the assertion of reliability in the resulting mean WTPs. The Watanabe-Akaike Information Criterion (WAIC) (Vehtari et al., 2017) results supports merging the 5-and 25-year models. A positive difference in WAICs suggests that the next model is favoured over the previous model and all comparisons yield a positive value.[6] In terms of the attribute specific results there are minimal differences between the mean WTP in annual tax across the models. The SQ aversion (the attribute specific constant) is the highest across all estimated models signifying a strong WTP to avoid the SQ.

The highest mean WTP for an attribute is to avoid a 50 % decrease in mangrove cover across all estimated models (101.77 to 110.10 TTD). The second highest is a shift from high erosion to low erosion (29.50 to 34.37 TTD), and the third is to avoid a decrease in tourism revenue (28.38 to 30.17 TTD). The disparity in mean WTPs between avoidance of mangrove loss and the other attributes is high. All attributes were consistently valued across the four models regardless of the payment horizon and choice certainty measure. There is a small decline in mean WTP from the 5 to 25-year payment horizons for the attributes flood frequency (2.24 TTD), number of species (1.22 TTD), mangrove cover (2.16 TTD) and tourism revenue (0.04 TTD). There is a small increase for fisheries catch (0.15 TTD) and the greatest increase for erosion control from the 5 to 25-years (4.87 TTD). Finally, in the extended model, the certainty score presents minimal change to the mean WTP distribution across the attributes. The WAIC results also show that allowing for individual characteristics provides a better model than without it.

We examine the ordering effect of the payment horizons as the tasks are identical except for the duration of payment. The results show that there are some differences between the mean WTPs of the first and last six choice tasks for the two payment horizons (see Table 4) but for most attributes the changes are unsubstantial. The greatest differences for the attributes are avoidance of a 50 % decrease in mangrove cover for the 25-year horizon from the first to last six tasks by 18.41 TTD. Followed by the coastal erosion for the 25-year horizon shown as the first six tasks as compared to when it is shown in the last six tasks at 6.49 TTD. The other attributes' changes are roughly between 0.15 and 4.50 TTD.

We also investigated the proportion of agreements over the six choice tasks across payment horizons and found that approximately 30 %, 27 % and 19 % of respondents had five, four and all six of the six choice tasks in agreement over the two time horizons respectively (see Fig. 2). This suggest that 76 % of respondents exhibited choice consistency in over half of the twelve choice tasks they answered.

Respondents are more likely to be 'certain' 45.92 % (1609 responses) and 'reasonably certain' 41.84 % (1466 responses) than 'somewhat uncertain' 8.08 % (283 responses) and 'uncertain' 4.17 % (146 responses) about their choices, perhaps reducing the entropy in responses and providing WTP values closer to the true WTP. Fig. 3 depicts the numbers of agreements on choice certainty responses where one represents 'certain' to four 'uncertain.' The majority were either 'certain' (588 responses) and 'reasonably certain' (480 responses) in all choice tasks across the two payment horizons.

In exploring the relationship in our design characteristics and choice certainty we do a random effects model (see Table 5) in python statsmodels with equations in Appendix D2. The dependent variable is the choice certainty categorised from one to four, the independent variables are the payment horizon (dummy variable, 1 if 25 year) and order is the sequence in which the choice tasks appear. It can be inferred there are very small but non-the less significant positive effects for payment

[5] The merged models treat the responses from respondents as emanating from the same preferences (WTPs) irrespective of the payment horizon.

[6] The WAIC is additive across all observations of the dependent variable. Therefore the sum of the WAIC from two models explaining a different subsection of data can be compared with the WAIC from one model explaining all the data.

Table 3
Five, Twenty-Five, Merged and Extended Choice Model Results.

	5 years			25 years			5 and 25 years - merged			5 and 25 years – choice certainty		
WTP in annual tax	Mean	Lower 10 % CI	Upper 90 % CI	Mean	Lower 10 % CI	Upper 90 % CI	Mean	Lower 10 % CI	Upper 90 % CI	Mean	Lower 10 % CI	Upper 90 % CI
45 % inc in Fish	$21.572 (2.781)	18.126	25.309	$21.720 (2.743)	18.398	25.291	$19.043 (2.268)	16.236	21.999	$19.036 (2.233)	16.290	21.980
high to low erosion	$29.495 (3.971)	24.489	34.780	$34.371 (4.690)	28.351	40.504	$33.330 (3.993)	28.218	38.581	$32.786 (3.894)	27.932	37.914
Avoid 4 floods	$29.123 (3.918)	24.143	34.179	$26.880 (3.596)	22.354	31.593	$28.622 (3.954)	23.670	33.905	$29.029 (3.821)	24.290	33.976
45 % inc in species	$26.365 (3.640)	21.817	31.247	$25.146 (3.357)	21.060	29.529	$24.064 (3.217)	20.085	28.261	$24.117 (3.137)	20.127	28.284
Avoid 50 % dec in Mangrove	$110.101 (6.408)	101.879	118.249	$107.941 (6.234)	99.909	115.988	$101.923 (7.585)	92.160	111.259	$101.770 (7.562)	91.841	111.149
Avoid 30 % dec in tourism	$28.415 (3.666)	23.727	33.196	$28.382 (3.568)	23.892	33.083	$30.060 (3.638)	25.424	34.809	$30.177 (3.531)	25.711	34.714
Avoid the SQ	$203.625 (24.755)			$204.154 (25.218)			$212.074 (34.889)			$212.213 (32.187)		
WAIC	2544.826			2485.775			4654.606			4639.313		
Diff_WAIC				59.051			375.995			15.293		
Se_WAIC	48.602			49.258			21.071*			6.161*		

Standard deviation in parenthesis; Credible intervals (CI) at the 90 % level; inc is increase; dec is decrease; Mean, CI and standard deviation values expressed in TTD; The Watanabe-Akaike Information Criterion (WAIC); difference in WAIC (diff_WAIC); Standard error WAIC (Se_WAIC).
* denotes the standard error difference WAIC.

Table 4
Ordering effects in the choice tasks across payment horizons.

Mean WTP in annual tax	5 years – First six tasks	5 years – Last six tasks	25 years – First six tasks	25 years – Last six tasks
45 % inc in fish Catch	25.989 (3.521)	26.155 (3.740)	23.547 (3.146)	27.992 (4.195)
High to low erosion	31.064 (4.817)	34.659 (5.083)	40.028 (5.626)	33.543 (5.024)
Avoid 4 floods	31.888 (4.653)	31.414 (4.511)	30.378 (4.299)	29.812 (4.344)
45 % inc in species	28.445 (4.228)	31.975 (4.724)	29.588 (4.297)	29.035 (4.072)
Avoid 50 % dec in mangroves	97.292 (8.063)	100.974 (7.931)	106.344 (7.238)	87.932 (7.736)
Avoid 30 % dec in tourism revenue	30.444 (4.393)	31.306 (4.303)	30.132 (4.234)	31.810 (4.441)
Avoid the status quo	202.772 (26.509)	191.150 (28.829)	187.407 (29.772)	207.692 (27.181)

Note: All values in TTD; standard deviations in parenthesis; inc is increase; dec is decrease.

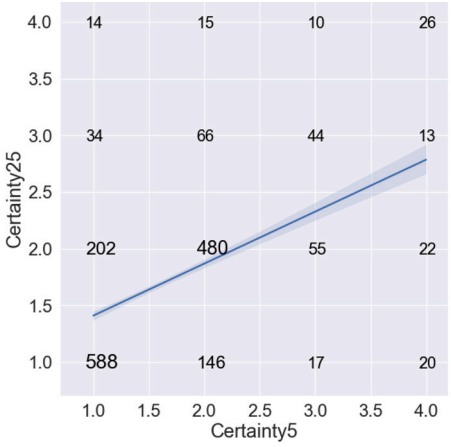

Fig. 3. Agreements on choice certainty over payment horizons.

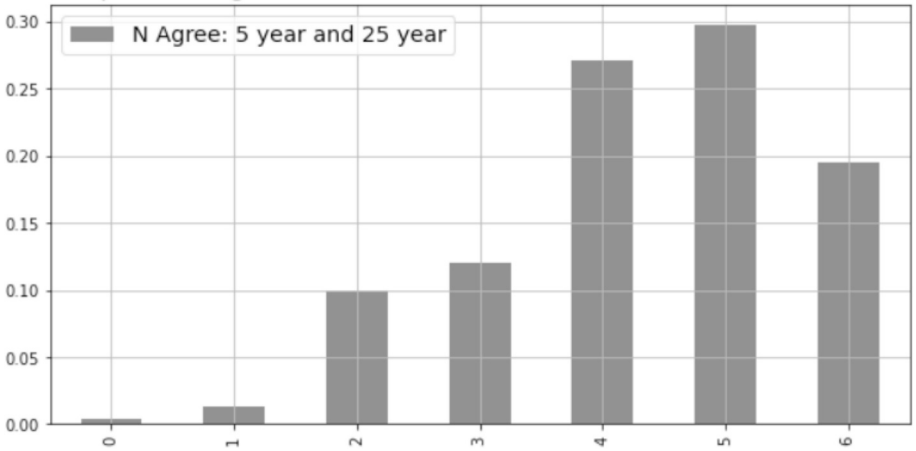

Fig. 2. Proportion of agreements over the six common tasks, across time horizons.

Table 5
Mixed Linear Model Regression Results – Certainty.

	Coefficient	*p*-value	2.5 % CI	97.5 % CI
Payment horizon (25 years)	0.038 *	0.058	−0.001	1.721
	(0.020)			
Choice task order sequence	0.012 **	0.037	0.001	0.024
	(0.006)			
Group variable	0.274			
	(0.045)			
Log-likelihood	−3465.3251			
Observations	3504			

Note: standard errors reported in parenthesis; Statistical significance at the 1 %, 5 % and 10 % level denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, respectively; Confidence intervals (CI) at 2.5 % lower and 97.5 % upper bounds; No. of groups 292; Group size 12.

horizon and order sequence on choice certainty.

4.2. Ex-post interview findings

Further insight is provided by the ex-post in-depth interviews to investigate respondents' thinking and motivation for their preferences in the DCE. The topics were SQ aversion, cost (respondent tax payment), time horizons, choice certainty and mangrove uses (see Table E.2 in Appendices for interviewee quotes). To summarise the ex-post interview findings we begin with the high SQ aversion. It was observed that there is a desire to avoid ES losses and the perception of the trade-off between mangrove conservation and tourism revenue gains supports the avoidance of mangrove losses. Second, interviewees considered the intergenerational and island wide benefits of their tax payments, though preferring the tax to be within household budget and be reasonable and affordable. Third, though DCE results were similar across payment horizons, ex-post interviews were mixed on the concept of payment horizon duration. Four individuals prefer the 5-year payment horizon to observe if the tax they pay for mangrove conservation is useful as circumstances may change and the total cost is high when added over 25 years. While six prefer the 25-year horizon to ensure longer lasting benefits. Additionally, the outcome of the mangrove conservation and management programme is desirable regardless of the length of payment horizon and that payments once per year are reasonable.

Fourth, certainty levels are high (six certain and four reasonably certain), suggesting that individuals are confident in choices made based on their own knowledge and information in the DCE preamble, and tend to favour the alternatives to the SQ. However, it is also highlighted that one cannot perfectly discern preferences with complete certainty from the choice task options as there are unknowns such as what may occur in real life over the payment horizon that can influence choices. Fifth, all interviewees felt that mangroves at the research site and across the island such as in Petit Trou, Lambeau and Kilgwyn should be protected and used for eco-tourism, educational tours and scientific research. Finally, there is a general belief that economic development provides betterment to society once certain criteria are met, such as minimal impact on the mangroves island wide, and getting more stakeholders and impartial specialists (e.g. scientists and engineers) involved in the decision-making and development. However, interviewees noted this is challenging to achieve in the Bon Accord/Buccoo area due to the coastal squeeze, and mangrove removal may be hard to counter once hotel and other infrastructural developments commence.

5. Discussion and policy implications

Our paper was motivated by a relatively simple but important policy and development-oriented question: would Tobago's residents prefer more economic development at the expense of their mangroves, or less development but more mangrove preservation. And more specifically, how much, if anything, would the islanders be willing to pay to increase the ES provided by mangroves. But in posing this question, we also tackled some important methodological questions with respect to DCEs: do payment horizons matter, and if not why; why respondents exhibit a high degree of choice certainty; and to what extent are ex-post surveys a useful tool.

First, our findings provide clear evidence that residents of Tobago highly value mangroves, along with some of the ecosystem services mangroves provide, over economic development irrespective of the payment horizon used. Similar to Ardeshiri et al. (2019), they used time horizons as an attribute and found each survey segment had some WTP for a 50 year payment horizon, suggesting respondents held some bequest values (for future generations). Marre et al. (2015), found respondents value non-use values even up to 100 years and may view the non-use benefits as timeless. While Lew (2018), used three distinct payment treatments 'one-off,' '5-years' and '25-years' and found respondents discount future payments at high levels and there were no statistically significant differences across models.

Second, the results suggests the potential trade-offs for increased mangrove ES conservation, especially the non-use values such as bequest and existence values (Dixon and Pagiola, 1998) of mangrove cover itself and indirect use values such as coastal erosion protection are preferred by the residents over new hotel development that potentially brings with it increased revenue and tax earnings for the island. This preference is also observed in the locals' attitudes towards supporting mangrove conservation.

Third, respondents had high self-reported choice certainty and insensitivity to payment horizons with similar WTP results irrespective of which horizon was used. Though in ex-post interviews some respondents acknowledged the importance of time and cost constraints. The insensitivity to the payment horizons are perhaps due to the perceived disbenefits associated with widespread mangrove removal and loss of ES associated with a potential hotel. While the high level of certainty (87.76 % of responses choosing certain and reasonably certain) perhaps suggests that hypothetical bias and choice reversals are less likely, with respondents strongly supporting their choices and therefore mangrove and ES conservation and management. This compares with the literature, Ready et al. (2010) found calibration of certainty levels can mitigate hypothetical bias. Additionally, an average certainty score of 7.8 (10 being certain) in Pelletier et al. (2022) suggesting respondents have a high level of confidence in their choices is comparable to our findings. In terms of the WTP estimates (Table 3) our results show using the WAIC that the choice model with certainty is preferred over other models, however the WTP estimates do not change significantly, from the merged 5 and 25-year model. In general this finding is consistent with the SP literature where differences in WTP estimates are minor across models (e.g. Lundhede et al., 2009; Dekker et al., 2016).

Fourth, we found high levels of status quo avoidance. Based on development that does not incorporate mangrove and mangrove ES conservation. The ex-post interviews provided insight, suggesting that respondents were rational, weighing up the trade-off between the benefits of conserving ES relative to the ES loss from wide-scale development-induced mangrove removal. Respondents indicated that costs, time and certainty were considered which was consistent with them understanding the DCE. The ex-post interviews allowed respondents to integrate their valuation preferences into a socio-cultural narrative and have proven useful for more pluralistic valuation (Jacobs et al., 2018). More broadly, we found ex-post interviews to be a useful tool to explore both the robustness of findings as well as exploring respondents' thinking in a qualitative manner. Similarly, Gorton et al. (2023), did ten post-DCE interviews and found respondents face challenges such as confusion and lack of trust while comparing the criteria of DCE attributes. This differs from our ex-post interviews, where interviewees stated they engaged with the survey in a way that showed they understood the criteria in the DCE. Importantly, when given estimates of their WTP during the ex-post interview residents did not indicate that such estimates were unrealistic. One common feature with the literature is

that qualitative follow-up interviews complimented the DCE results (e.g. Bjørnåvold et al., 2022; Gorton et al., 2023).

The policy implication is that the government should focus on long-term mangrove specific management policies and plans. Our findings suggests that mangrove cover should be a priority in considering the trade-off between development plans like hotels on the research site and not developing the coastline. Large-scale developments on mangroves are found to be less preferred by residents than smaller less invasive initiatives such as eco-tourism projects and parks. The attitudes and ex-post interviews suggest that residents have a similar willingness to conserve other mangrove areas in the SW and wider Tobago. Therefore, there is potential benefit transfer of estimates from this case study to other mangrove sites in T&T and wider Caribbean that might have population characteristics and attributes similar to our study (Luenberger, 1992; Rolfe et al., 2015).

Finally, respondents are willing to reduce coastal erosion over the long-term because of a slightly higher WTP to keep erosion levels low over 25 years as compared to five years. Given the challenges small island developing states face with sea-level rise and risks to coastal populations (McMichael et al., 2020) this is perhaps an important attribute to consider for policy. The central government, THA and environmental authorities can use mangrove ES valuation by residents, thus allowing a platform to mitigate socio-environmental conflict with knowledge on residents' mangrove ES values to inform policy with consideration of residents' preferences.

6. Conclusion

In planning mangrove land-use it might be useful to consider the following. First, the mangrove ES were valued and found to be preferred to large scale hotel development on mangrove sites. Second, mangroves provide benefits that people value even if they do not directly use ES. There are indirect benefits associated with mangroves such as coastal erosion protection and flash flood water regulation. Third, the intrinsic values mangroves provide such as heritage and cultural are considerable even if locals do not use the resources. The findings show locals prefer more mangroves in both payment horizons and overall were more certain than uncertain about their choices. This suggests there is public support for policies that consider the long-term protection of mangroves and its ES. Finally, the ex-post interviews proved a reliable tool to explore the thinking of respondents beyond the DCE but has the potential for expansion in future research with larger follow-up sample sizes to explore DCE results and the socio-cultural narrative of respondents for integrated valuation.

CRediT authorship contribution statement

Niko Howai: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Investigation, Conceptualization. **Kelvin Balcombe:** Writing – review & editing, Visualization, Methodology, Formal analysis, Conceptualization. **Elizabeth J.Z. Robinson:** Writing – review & editing, Visualization, Methodology, Conceptualization.

Ethical approval

Our study received ethical approval by the research ethics committee of the School of Agriculture, Policy and Development, University of Reading (No: 001049P/001149/001621).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

There is the possibility that without greater conservation and environmental management mangroves will be lost either through neglect or to facilitate development projects in the future. This will affect the services they provide such as a home for adult and juvenile fishes and other marine life, a home for birds and other wildlife, protection from coastal erosion, flood control and storm surges. Mangrove forests also help filter wastewater and excessive nutrients from running off into nearby beaches and the reefs. Without them the natural beauty of the land will be affected and the viability of the areas for tourism activities like bird watching.

However, future projects on mangrove forested sites are not without its merits. There can be increased revenue earning from building new hotels and infrastructure expansions that can provide jobs and job security well into the future. The execution of a sustainable environmental management plan in how these large investments interact with the environment can control the negative outcomes and find a balance between the factors that affect the environment and the benefits that people living close to the mangroves and the island of Tobago can gain.

A management and conservation programme can involve various activities such as the provision of mangrove saplings, the training of the community members in re-planting of trees where losses have occurred after development, an education programme about the benefits of keeping mangrove resources for persons living in the area and for future generations, monitoring and patrols to improve safety and security for locals and visitors around the mangrove area and protection of the mangroves itself where required. The project can be co-managed by a non-profit organisation such as a local NGO and involve the communities in the management process. In this scenario the questions are asked to consider how much you will be willing to contribute once per year for a fixed duration for this initiative to succeed.

Imagine a potential future occurrence 5 to 10 years from now where a large-scale hotel development will be built at Bon Accord/Buccoo mangrove site. Under this scenario the risk of mangrove loss is high with extensive mangrove cover removal and a subsequent loss of some of the associated natural benefits that come with having the mangroves at Bon Accord/Buccoo if no contributions are made to a conservation and management programme.

It is expected that restrictions will be placed on the hotel to limit and regulate the acreage that can be cleared for development and size of the hotel

(room count) which can affect the revenue stream. In order to achieve improved provisions of the benefits of the mangroves this requires financial support. The contribution by you (key decision-maker in the household) to the programme is via an annual tax payment collected by an audited collection committee comprising of THA authorised personnel. All tax money received will be given to a local joint-select committee for mangrove conservation and management that comprises of fishers, village council members, the THA and an NGO that ensures the benefits of the monetary contributions are allocated appropriately and received. This conservation and management programme of the mangrove will be organised and co-managed with the various parties previously mentioned. The benefits of the programme can include:

1) Monitoring and enforcement of guidelines on the mangrove cover that can be removed to build a hotel or other development.
2) A greater quantity of fisheries catch per year at both subsistence (own use) and commercial (sale on markets) for the island.
3) Maintaining protection from strong winds, waves and storm surges to reduce coastal erosion and damage to property.
4) Limit and reduce flood risks on average of flash and major or significant flooding in the surrounding areas by ensuring the mangrove cover can consolidate the drainage of the area.
5) Encourage the increase in the abundance of the variety of species that inhabit the mangroves such as birds, fishes, mammals, reptiles, amphibians, crustaceans and other important species that are an essential attraction point for tourism.
6) Develop a balance between the natural beauty of the land and the building of tourism infrastructure to earn more revenue for the island.
7) To conserve the existing natural habitat for present and future generations to have more fish, birds and natural scenery.
8) Replenishment of the mangroves with saplings where losses have already occurred due to development.
9) Patrol and security of the mangrove area to ensure locals, visitors and tourists' safety.
10) To have additional clean-up activities taking place to remove plastic and other debris washed up or dumped in the mangrove area.

Appendix B

Estimation used Stan[7] with a Python interface and employed Hamiltonian MCMC (via the No-U-Turn Sampler) algorithm. Hamiltonian MCMC is widely recognised as one of the most efficient ways to simulate the distributions of model parameters. MCMC estimation requires the algorithm to run a number of iterations or burn-ins before collecting samples of the parameters. Both the burn-in (warm-up) and the subsequent collection phase must be sufficiently long to ensure that the distribution of the parameters is adequately simulated. The adequacy of this simulation is referred to as "convergence." All models in Table 3 had a burn-in of 8000 iterations on six independent chains at 10,000 total iterations. 2000 post warm-up draws were taken from the six independent chains for a total of 12,000 draws used. Convergence was observed visually via trace plots and the Rhat diagnostic (Vehtari et al., 2019; Balcombe et al., 2021). The trace plots appeared good, stable and random converging to a common distribution. The ex-post questionnaire CV based approach used individual WTPs for the j^{th} person

Appendix C

Table C.1
Attitudes to Mangrove.

	Very likely	Likely	Neutral	Unlikely	Very unlikely	Total
Support mangrove conservation	176	91	20	1	4	292
	(60.3)	(31.2)	(6.8)	(0.3)	(1.4)	(100)
	Very concerned	Slightly concerned	Neither	Slightly unconcerned	Very unconcerned	
Mangrove loss concern	223	59	7	1	2	292
	(76.4)	(20.2)	(2.4)	(0.3)	(0.7)	(100)
	DPEP	SPEP	Neither	SPED	DPED	
Mangrove preservation or economic development	103	91	67	18	13	292
	(35.3)	(31.2)	(22.9)	(6.2)	(4.5)	(100)

Note: DPEP – Definitely prefer environmental preservation; SPEP- Somewhat prefer environmental preservation; SPED- Somewhat prefer economic development; DPED- Definitely prefer economic development; Percentages in parenthesis ().

Table C.1 summarises the DCE respondents' attitudes towards mangrove conservation, loss and environmental preservation compared with development. Perhaps not surprisingly, almost all respondents were positive about supporting mangrove conservation and highly concerned about the loss of mangrove, with approximately two-thirds preferring preservation over economic development.

Table C.2
Descriptive Statistics.

	Sample (%)		Sample (%)
No of respondents	100		100
Gender		Education	
Female	55.1	Tertiary	42.5
Male	44.5	Secondary	38.4
Prefer not to say	0.3	Primary	13.7

(*continued on next page*)

[7] Stan is an open-source software available from https://mc-stan.org/. Details can be found in the documentation from https://mc-stan.org/users/documentation/ which also includes the reference manual with a description of Hamiltonian MCMC (currently chapter 15).

Table C.2 (*continued*)

	Sample (%)		Sample (%)
		No formal	2.7
		Other	1.0
		Prefer not to say	1.7
Age group		Income range (Monthly TT)	
18–25	16.8	<5000	32.2
26–35	22.3	5001–10,000	29.1
36–45	21.9	10,001–15,000	10.3
46–55	17.8	15,001–20,000	6.8
56–65	11.3	>20,000	3.1
>65	8.2	Prefer not to say	18.5
Location		Employment Type	
Bon Accord and environs	41.4	Public	26.4
Buccoo and environs	25.7	Private	20.2
Scarborough and environs	11.6	Self-employed	13.7
Plymouth	6.8	Unemployed	2.7
Other	14.4	Student	3.4
		Retired	9.2
		Other	20.2
Environmental NGO membership		Prefer not to say	4.1
Yes	7.9		
No	92.1		

Note: 292 respondents.

Table C.3
Choice models 1 % and one level change results.

	5 Year	25 year	Merged	Merged with choice certainty
	Mean	Mean	Mean	Mean
1 % inc in fish	0.479	0.483	0.423	0.423
	(0.062)	(0.061)	(0.050)	(0.050)
One level erosion	14.748	17.186	16.665	16.393
	(1.985)	(2.345)	(1.996)	(1.947)
Avoid one flood	7.281	6.720	7.156	7.257
	(0.979)	(0.899)	(0.989)	(0.955)
1 % inc in species	0.586	0.559	0.535	0.536
	(0.081)	(0.075)	(0.071)	(0.070)
Avoid 1 % dec in mangrove	2.202	2.159	2.038	2.035
	(0.128)	(0.125)	(0.152)	(0.151)
Avoid 1 % dec in tourism	0.947	0.946	1.002	1.006
	(0.122)	(0.119)	(0.121)	(0.118)

Note: Standard deviation in parenthesis; All values expressed in TTD.

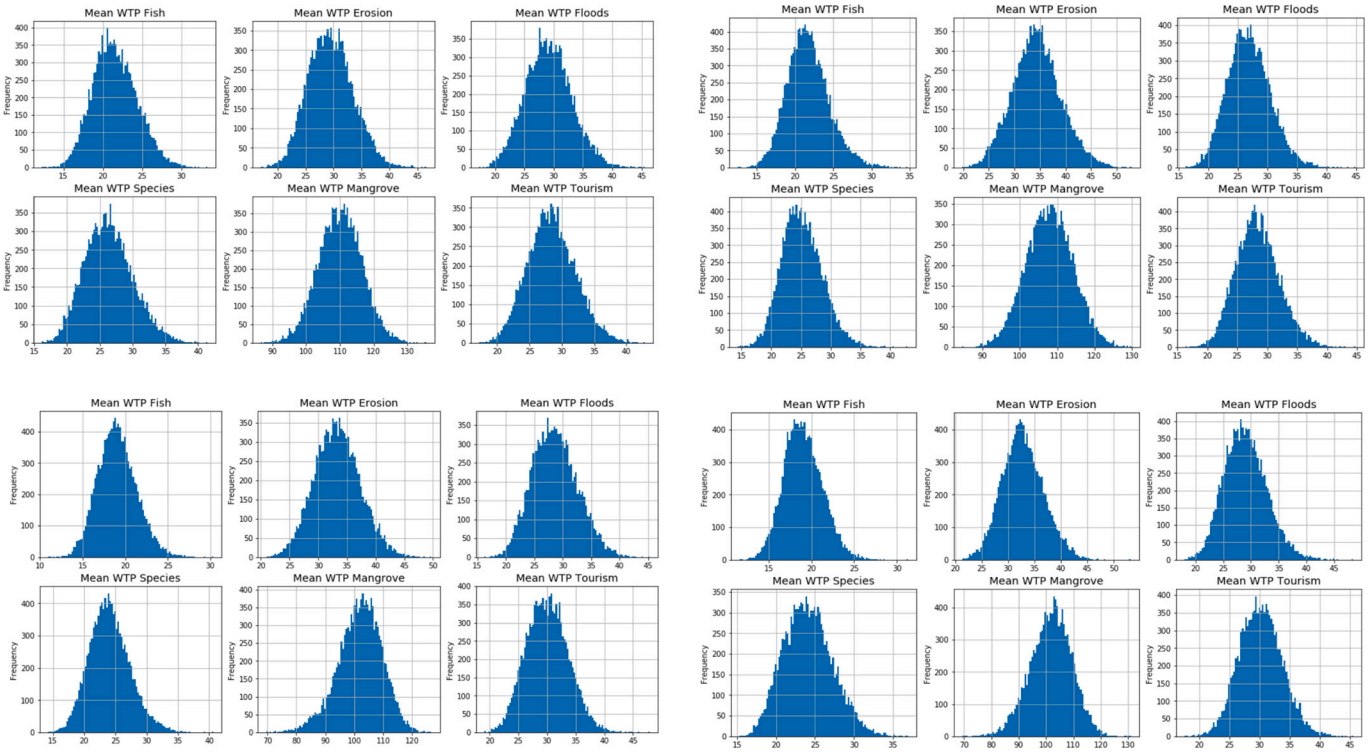

Fig. C.1. Mean WTP Plots For Five, Twenty-Five, Merged and Extended Model with Certainty.
Top left: 5 year model; Top right 25 year model; Bottom left: merged; Bottom right: merged model -certainty.
The mean WTP plots for all models in Fig. C.1 have a 'bell-shaped' appearance and a cluster around the mean values. The vertical axis represents the frequency of the WTP distribution and the estimated WTPs appear random (normal) and positive. The horizontal axis represents the monetary values with the means of the attributes at the midpoint of the curve and is the mean across the population as given in the results, Table 3.

Appendix D1

The extended model with certainty and socio-demographic characteristics which is a M x 1 vector specific to each individual where it is normalised so that:

$$\begin{aligned} \sum_j z_j &= 0 \\ \omega_j &= 2\omega \frac{e^{\gamma' z_j}}{1+e^{\gamma' z_i}} \\ U_j(p,x,z,s,q) &= \left(1-\rho\frac{s}{4}\right) exp\ (\alpha_j) V_j\ (p,x,z,q) + e \end{aligned} \tag{D1.1}$$

Except now,

$$\begin{aligned} \overline{\beta}_{kj} &= \frac{b_k}{\sum b_k + 1}\ 2\omega \frac{e^{\gamma' z_j}}{1+e^{\gamma' z_j}} \\ \overline{\theta}_j &= \frac{-1}{\sum b_k + 1}\ 2\omega \frac{e^{\gamma' z_j}}{1+e^{\gamma' z_j}} \end{aligned} \tag{D1.2}$$

With the additional priors

$$\gamma_m \sim N(0,1)\ for\ m = 1, \ldots, M \tag{D1.3}$$

The signs of γ indicate the way in which the demographics positively or negatively influence the overall willingness-to-pay for the difference between the best possible option and the status quo. The socio-demographic factors have been scaled so that at the mean for demographic the total WTP is estimated as with the previous model but there is a logistic function that allows the total WTP to at most double or drive it towards zero.

There are small effects on total WTP for the mangrove conservation and management programme for instance if the respondent is female, if the respondent is more educated, and if the respondent is a member of an environmental NGO. It is noticeable that the resulting WTPs are very similar to the models without the socio-demographic factors included. For instance, an explanation for the small effect on the WTP by environmental NGO membership may be due to an awareness by Tobago's residents about the mangrove ES regardless of whether the respondent is a member of an environmental NGO or not. The results in Table D.1 are what the predicted effects are but in classical terms they are insignificant.

Table D.1
Socio-Demographic Influence on Total Willingness to Pay.

	Gender- Female	Age	Income	Environ Organisation	Tertiary Education
Count	12,000	12,000	12,000	12,000	12,000
Mean	0.116	0.014	−0.019	−0.056	0.003
Standard deviation	0.108	0.349	0.111	0.192	0.120
Minimum	−0.333	−1.212	−0.391	−0.728	−0.511
25 %	0.043	−0.221	−0.094	−0.186	−0.079
50 %	0.116	0.012	−0.019	−0.058	0.003
75 %	0.188	0.253	0.056	0.070	0.083
Maximum	0.487	1.495	0.394	0.830	0.458

Appendix D2

The equational form of the mixed linear regression model is as follow:

$$\eta_{j,t} = \mu_j + \beta h_{j,t} + \beta_t + e_{j,t} \quad \text{Where } \mu_j \sim N\left(\mu\sigma_\mu^2\right) \text{ and } e_{j,t} \sim N\left(\mu\sigma_\mu^2\right) \tag{D2.1}$$

$\eta_{j,t}$ is the certainty expressed by the j_{th} person in the t_{th} task.
$h_{j,t}$ is the horizon of the t_{th} performed by the j_{th} person.
t is the order of the t_{th} task.
$e_{j,t}$ is an unobserved independent and identically distributed error.

Appendix E

For the ex-post interviews, the individual WTPs derived for each respondent identifiable by their unique identification number (ID) in their respective completed questionnaires for the merged 5- and 25-year model are used. The WTP values for the two alternatives in each task and to avoid the status quo were used to design a CV based dichotomous choice ex-post questionnaire. From the 48 choice cards, one of the 12 choice tasks in the DCE questionnaire that an interviewee previously answered where they would have chosen one of the alternatives, was used with the interviewee's original choice and payment blocked out to determine the maximum that the interviewee would pay using a price ladder, to choose their unpreferred option over the SQ and then their preferred option over the unpreferred option (Supplementary Sheet S3).

On completion of the price ladder, when the interviewee would go no higher in their WTP the maximum WTPs for the unpreferred option over the SQ and the preferred option over the unpreferred option are added together to give the summated WTP (SWTP see Table E.1.

Table E.1). The agreed WTP was then found by asking interviewees if the SWTP is what they would actually pay, to which they could give a yes or no response. If interviewees did not agree with their SWTP, this was followed by a question working the SWTP downwards until the interviewee agreed on a maximum they would pay. In Table E.1 choices are also consistent with the SQ aversion. All ten ex-post interviews exhibited transitivity of preferences over the SQ. Six respondents have a SWTP less than 1000 TTD, with four greater than, however only one interviewee (ID 20) was willing-to-pay the SWTP.

Table E.1
Ex-post DCE Dichotomous Choice Results.

Respondent	Max WTP for unpreferred option over SQ (1)	Max WTP for preferred over unpreferred option (2)	Summated WTP (1) + (2) = (3)	Agreed WTP	Card used	Task used	Preferred option
1 (ID 51)	70	160	230	160	14	8	A
2 (ID 208)	1000	378	1378	300	47	11	B
3 (ID 270)	1000	2000	3000	2000	3	3	A
4 (ID 5)	150	190	340	200	28	10	A
5 (ID 20)	1000	500	1500	1500	16	4	A
6 (ID 42)	90	110	200	110	3	9	B
7 (ID 279)	400	500	900	500	3	3	A
8 (ID 288)	2400	2400	4800	NR	3	9	B
9 (ID 28)	500	75	575	0	31	1	B
10 (ID 290)	330	220	550	NR	28	4	B

Note: NR – No Response; WTPs in TTD.

Table E.2
Ex-post interviewee quotes.

Thematic Topic	Interviewee Number	Quote
Status Quo aversion	Two	"…the price of development is high, you do not want to get rid of so many things (nature)…biodiversity suffers at the expense of development, but I suspect the tourism revenue earnings should be coming from people exploring to see different animals."
cost (respondent tax payment)	One	"it cannot be too high a cost…once it is reasonable"
	Five	"I see it (the payments) more as an investment for me, the future (generations), the children and everyone."
	Eight	"…there is a limit I cannot take my entire salary and spend it on environmental support…"
Time horizons preference	Two	"I would prefer five years…because it would help me make further decisions…my earnings for the whole time period from 5-years to 25-years can vary"
	Five	"…as it (25 years) seems more realistic for the environmental programme to get the benefits"
	Six	"I would be more comfortable to pay over a shorter time period, because it does not run too far ahead, which is easier in terms of the cost"
	Ten	"I would rather pay into a longer project such as a 25-year programme at a realistic price."
Choice certainty	Three	"if I was not sure I would put disagree and since I was not able to disagree with anything fully in this survey, I was more confident in making my choices."
	Five	"…you can never be too sure, but not to the extent of being uncertain or somewhat uncertain (in choice)."
Mangrove uses	Three	"natural human inclination once the commerce (tourism revenue from the hotel) starts to get better (mangrove removal will be hard to control)"
	Seven	"…you can do development around the mangrove. Around anywhere in nature as a matter of fact, developers can incorporate construction…without destroying the mangroves."

Appendix F. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2025.108693.

Data availability

Additional data related to this publication are available Mangrove ecosystem services discrete choice experiment in Tobago (Original data) (Mendeley Data)

References

Aanesen, M., Czajkowski, M., Lindhjem, H., Navrud, S., 2023. Trade-offs in the transition to a blue economy - mapping social acceptance of aquaculture expansion in Norway. Sci. Total Environ. 859. https://doi.org/10.1016/j.scitotenv.2022.160199.

Abdurrahim, A.Y., Dharmawan, A.H., Adiwibowo, S., Yogaswara, H., van Noordwijk, M., 2023. Relational and Instrumental Values of Tropical Peat Landscapes: Morality and Political Ecology in Indonesia. In: Current Opinion in Environmental Sustainability. Elsevier B.V. https://doi.org/10.1016/j.cosust.2023.101318.

Alemu, I.J.B., Schuhmann, P., Agard, J., 2019. Mixed preferences for lionfish encounters on reefs in Tobago: results from a choice experiment. Ecol. Econ. 164. https://doi.org/10.1016/j.ecolecon.2019.106368.

Allen, J.C., Hall, C., Bergstrom, J., Pemberton, C., 2003. Measuring values for wetlands protection in a developing country from domestic and international citizen groups. In: American Agricultural Economics Association Annual Meeting. Montreal.

Ardeshiri, A., Swait, J., Heagney, E.C., Kovac, M., 2019. Willingness-to-pay for coastline protection in New South Wales: beach preservation management and decision making. Ocean Coast. Manag. 178 (May), 104805. https://doi.org/10.1016/j.ocecoaman.2019.05.007.

Balcombe, K., Fraser, I., 2011. A general treatment of "dont know" responses from choice experiments. Eur. Rev. Agric. Econ. 38 (2), 171–191. https://doi.org/10.1093/erae/jbr010.

Balcombe, K., Fraser, I., Di Falco, S., 2010. Traffic lights and food choice: a choice experiment examining the relationship between nutritional food labels and price. Food Policy 35 (3), 211–220. https://doi.org/10.1016/j.foodpol.2009.12.005.

Balcombe, K., Bradley, D., Fraser, I., 2021. Do consumers really care? An economic analysis of consumer attitudes towards food produced using prohibited production methods. J. Agric. Econ. 72 (2), 452–469. https://doi.org/10.1111/1477-9552.12410.

Balcombe, K., Bradley, D., Fraser, I., 2022. Consumer preferences for chlorine-washed chicken, attitudes to Brexit and implications for future trade agreements. Food Policy 111. https://doi.org/10.1016/j.foodpol.2022.102327.

Barbier, E.B., 2017. Marine ecosystem services. Curr. Biol. 27 (11), R507–R510. https://doi.org/10.1016/j.cub.2017.03.020.

Beharry-Borg, N., Scarpa, R., 2010. Valuing quality changes in Caribbean coastal waters for heterogeneous beach visitors. Ecol. Econ. 69 (5), 1124–1139. https://doi.org/10.1016/j.ecolecon.2009.12.007.

Bjørnåvold, A., David, M., Bohan, D.A., Gibert, C., Rousselle, J.M., Van Passel, S., 2022. Why does France not meet its pesticide reduction targets? Farmers' socio-economic trade-offs when adopting agro-ecological practices. Ecol. Econ. 198. https://doi.org/10.1016/j.ecolecon.2022.107440.

Bliem, M., Getzner, M., Rodiga-Laßnig, P., 2012. Temporal stability of individual preferences for river restoration in Austria using a choice experiment. J. Environ. Manag. 103, 65–73. https://doi.org/10.1016/j.jenvman.2012.02.029.

Brander, L.M., Wagtendonk, A.J., Hussain, S.S., McVittie, A., Verburg, P.H., de Groot, R. S., van der Ploeg, S., 2012. Ecosystem service values for mangroves in Southeast Asia: a meta-analysis and value transfer application. Ecosyst. Serv. 1 (1), 62–69. https://doi.org/10.1016/j.ecoser.2012.06.003.

Breeze, T.D., Bailey, A.P., Potts, S.G., Balcombe, K.G., 2015. A stated preference valuation of the non-market benefits of pollination services in the UK. Ecol. Econ. 76–85. https://doi.org/10.1016/j.ecolecon.2014.12.022. Elsevier.

Brooks, K., Lusk, J.L., 2010. Stated and revealed preferences for organic and cloned milk: combining choice experiment and scanner data. Am. J. Agric. Econ. 92 (4), 1229–1241. https://doi.org/10.1093/ajae/aaq054.

Brouwer, R., Powe, N., Turner, R.K., Bateman, I.J., Langford, I.H., Kerry Turner, R., Bateman, I.J., 1999. Public attitudes to contingent valuation and public consultation public attitudes to contingent valuation and public consultation. Environ. Values 8 (3), 325–347.

Brouwer, R., Logar, I., Sheremet, O., 2017. Choice consistency and preference stability in test-retests of discrete choice experiment and open-ended willingness to pay elicitation formats. Environ. Resour. Econ. 68 (3), 729–751. https://doi.org/10.1007/s10640-016-0045-z.

Bryan-Brown, D.N., Connolly, R.M., Richards, D.R., Adame, F., Friess, D.A., Brown, C.J., 2020. Global trends in mangrove forest fragmentation. Sci. Rep. 10 (1), 1–8. https://doi.org/10.1038/s41598-020-63880-1.

Burkhard, B., Kroll, F., Müller, F., Windhorst, W., 2009. Landscapes' capacities to provide ecosystem services - a concept for land-cover based assessments. Landscape Online 15 (1), 1–22. https://doi.org/10.3097/LO.200915.

Burkhard, B., Kroll, F., Nedkov, S., Müller, F., 2012. Mapping ecosystem service supply, demand and budgets. Ecol. Indic. 21, 17–29. https://doi.org/10.1016/j.ecolind.2011.06.019.

Carlsson, F., Frykblom, P., Lagerkvist, J.C., 2005. Using cheap talk as a test of validity in choice experiments. Econ. Lett. 89 (2), 147–152. https://doi.org/10.1016/j.econlet.2005.03.010.

Chan, K.M., Gould, R.K., Pascual, U., 2018. Editorial overview: Relational values: What are they, and what's the fuss about?. In: Current Opinion in Environmental Sustainability. Elsevier B.V, pp. A1–A7. https://doi.org/10.1016/j.cosust.2018.11.003.

Clark, J., Burgess, J., Harrison, C.M., 2000. ""I struggled with this money business"": respondents' perspectives on contingent valuation'. Ecol. Econ. 33. Available at: www.elsevier.com/locate/ecolecon.

Colombo, S., Glenk, K., Rocamora-Montiel, B., 2016. Analysis of choice inconsistencies in on-line choice experiments: impact on welfare measures. Eur. Rev. Agric. Econ. 43 (2), 271–302. https://doi.org/10.1093/erae/jbv016.

Colombo, S., Budziński, W., Czajkowski, M., Glenk, K., 2022. The relative performance of ex-ante and ex-post measures to mitigate hypothetical and strategic bias in a stated preference study. J. Agric. Econ. 73 (3), 845–873. https://doi.org/10.1111/1477-9552.12484.

Costanza, R., 2020. Valuing natural capital and ecosystem services toward the goals of efficiency, fairness, and sustainability. Ecosyst. Serv. 43. https://doi.org/10.1016/j.ecoser.2020.101096.

CSO, 2022. Population Statistics. Available at: https://cso.gov.tt/subjects/population-and-vital-statistics/population/ (Accessed: 1 September 2022).
Das, S., 2022. Valuing the role of mangrove in storm damage reduction in coastal areas of Odisha. In: Haque, A.K.E., Mukhopadhyay, P., Nepal, M., Shammin, M.Rumi. (Eds.), Climate Change and Community Resilience. Springer Nature Singapore. https://doi.org/10.1007/978-981-16-0680-9.
Dean, G., Rivera-Ferre, M.G., Rosas-Casals, M., Lopez-i-Gelats, F., 2021. Nature's contribution to people as a framework for examining socioecological systems: the case of pastoral systems. In: Ecosystem Services. Elsevier B.V. https://doi.org/10.1016/j.ecoser.2021.101265.
Dekker, T., Hess, S., Brouwer, R., Hofkes, M., 2016. Decision uncertainty in multi-attribute stated preference studies. Resour. Energy Econ. 43, 57–73. https://doi.org/10.1016/j.reseneeco.2015.11.002.
Dixon, J., Pagiola, S., 1998. Economic analysis and environmental assessment. In: Environmental Assessment Sourcebook. Environmental Department The World Bank. Available at: https://www.researchgate.net/publication/240621224.
Donovan, G., Hesseln, H., 2004. Consumer Willingness to Pay for a Naturally Decay-Resistant Wood Product. Available at: https://academic.oup.com/wjaf/article/19/3/160/4717684.
Doodnath, A., 2019. Sandals pulls out of Tobago. Available at: https://tt.loopnews.com/content/sandals-pulls-out-tobago (Accessed: 27 August 2019).
FAO, 2007. North and Central America. In: The World's Mangroves 1980–2005 FAO Forestry Paper 153. Food and Agriculture Organization of the United Nations, Rome, pp. 29–36.
Ferecatu, A., Önçüler, A., 2016. Heterogeneous risk and time preferences. J. Risk Uncertain. 53 (1). https://doi.org/10.1007/s11166-016-9243-x.
Fraser, I., Balcombe, K., Williams, L., McSorley, E., 2021. Preference stability in discrete choice experiments. Some evidence using eye-tracking. Journal of Behavioral and Experimental Economics 94. https://doi.org/10.1016/j.socec.2021.101753.
Friess, D.A., 2016. Mangrove forests. Curr. Biol. 26 (16), R746–R748. https://doi.org/10.1016/j.cub.2016.04.004.
Friess, D.A., Rogers, K., Lovelock, C.E., Krauss, K.W., Hamilton, S.E., Lee, S.Y., Lucas, R., Primavera, J., Rajkaran, A., Shi, S., 2019. The state of the world's mangrove forests: past, present and future. Annu. Rev. Environ. Resour. 44, 89–115. https://doi.org/10.1146/annurev-environ-101718-033302.
Gao, Q., Qin, L., Meng, H., Shen, J., Wang, X., Cui, S., Li, Z., 2024. Optimizing recreation in Yellow River Mouth Park based on reference-dependent analysis. In: Sheng, Q., Dobbie, G., Jiang, J., Zhang, X., Zhang, W., Manolopoulos, Y., Wu, J., Mansoor, W., Ma, C. (Eds.), Advanced Data Mining and Applications. Springer, Sydney.
Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A., Rubin, D.B., Carlin, J., Stern, H., Rubin, D., Dunson, D., 2013. Bayesian Data Analysis. CRC Press.
Gelo, D., Turpie, J., 2021. Bayesian analysis of demand for urban green space: a contingent valuation of developing a new urban park. Land Use Policy 109. https://doi.org/10.1016/j.landusepol.2021.105623.
Goeken, N., Kurz, P., Steiner, W.J., 2021. Hierarchical Bayes conjoint choice models – model framework, Bayesian inference, model selection, and interpretation of estimation results. Marketing, Zeitschrift fur Forschung und Praxis 43 (3), 49–64. https://doi.org/10.15358/0344-1369-2021-3-49.
Gorton, M., Yeh, C.H., Chatzopoulou, E., White, J., Tocco, B., Hubbard, C., Hallam, F., 2023. Consumers' willingness to pay for an animal welfare food label. Ecol. Econ. 209. https://doi.org/10.1016/j.ecolecon.2023.107852.
Greene, W.H., Hensher, D.A., 2003. A latent class model for discrete choice analysis: contrasts with mixed logit. Transp. Res. B Methodol. 37 (8), 681–698. https://doi.org/10.1016/S0191-2615(02)00046-2.
Guerriero, C., Pacelli, A., 2019. Discounting benefits and costs. In: Cost-Benefit Analysis of Environmental Health Interventions. Elsevier, pp. 129–143. https://doi.org/10.1016/B978-0-12-812885-5.00007-X.
Guo, Q., Shen, J., 2022. A comparison between mixed logit model and latent class logit model for multi-profile best-worst scaling: evidence from mobile payment choice dataset. Appl. Econ. Lett. 29 (14), 1300–1305. https://doi.org/10.1080/13504851.2021.1927955.
Harkness, C., Areal, F., 2018. Consumer willingness to pay for low acrylamide content. Br. Food J. 120 (8), 1888–1900. https://doi.org/10.1108/BFJ-01-2018-0043.
Hassanali, K., 2017. Challenges in mainstreaming climate change into productive coastal sectors in a Small Island state – the case of Trinidad and Tobago. Ocean Coast. Manag. 142, 136–142. https://doi.org/10.1016/j.ocecoaman.2017.04.001.
Himes, A., et al., 2023. Why nature matters: a systematic review of intrinsic, instrumental, and relational values. BioScience [Preprint]. https://doi.org/10.1093/biosci/biad109.
Himes-Cornell, A., Grose, S.O., Pendleton, L., 2018. Mangrove ecosystem service values and methodological approaches to valuation: where do we stand? Front. Mar. Sci. 5 (OCT), 1–15. https://doi.org/10.3389/fmars.2018.00376.
Homar, A.R., Cvelbar, L.K., 2024. Combatting climate change through message framing? A real behavior experiment on voluntary carbon offsetting. J. Travel Res. 63 (4), 883–903. https://doi.org/10.1177/00472875231179400.
Howai, N., 2023. Ecosystem Services in Tobago: challenges, uses and future prospects. Farm and Business 15 (1). https://doi.org/10.22004/ag.econ.339780.
Howard, G., Whitehead, J.C., Hochard, J., 2021. Estimating discount rates using referendum-style choice experiments: an analysis of multiple methodologies. J. Environ. Econ. Manag. 105, 102399. https://doi.org/10.1016/j.jeem.2020.102399.
IMA, 1995. Management Plan for the Buccoo Reef Marine Park Volume II-the Management Plan. Carenage, Trinidad and Tobago.
IMA, 2016. State of the Marine Environment Trinidad & Tobago - 2016. Chaguaramas, Trinidad.
IPBES, 2013. Decision IPBES-2/4: Conceptual framework for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Available at: https://www.ipbes.net/resource-file/2763 (Accessed: 19 February 2024).
IPBES, 2019. In: Brondízio, E.S., Settele, J., Díaz, S., Ngo, H.T. (Eds.), The Global Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat. Available at, Bonn, Germany. https://doi.org/10.5281/zenodo.3831673 (Accessed: 1 October 2023).
Jacobs, S., et al., 2018. The means determine the end – pursuing integrated valuation in practice. Ecosyst. Serv. 29, 515–528. https://doi.org/10.1016/j.ecoser.2017.07.011.
Juman, R.A., 2004. Characterisation and Ecology of the bon Accord Lagoon, Tobago. The University of the West Indies, St Augustine Campus, West Indies.
Juman, R., Hassanali, K., 2013. Mangrove conservation in Trinidad and Tobago, West Indies. Mangrove Ecosyst. 5, 35–63.
Juman, R., Ramsewak, D., 2013. Status of mangrove forests in Trinidad and Tobago, West Indies. Caribb. J. Sci. 47 (2–3), 291–304. https://doi.org/10.18475/cjos.v47i3.a18.
Kathiresan, K., 2012. Importance of mangrove ecosystem. Int. J. Mar. Sci. https://doi.org/10.5376/ijms.2012.02.0010 [Preprint].
Ku, Y.C., Wu, J., 2018. Measuring respondent uncertainty in discrete choice experiments via utility suppression. J. Choice Model. 27, 1–18. https://doi.org/10.1016/j.jocm.2017.08.002.
Lancaster, K.J., 1966. A new approach to consumer theory, source. J. Polit. Econ. 74 (2), 132–157.
Lew, D.K., 2018. Discounting future payments in stated preference choice experiments. Resour. Energy Econ. 54, 150–164. https://doi.org/10.1016/j.reseneeco.2018.09.003.
LoopTT, 2018. Scientist: Removal of Tobago mangroves could cause flooding. Loop News. Available at: https://tt.loopnews.com/content/scientist-removal-tobago-mangroves-could-cause-flooding (Accessed: 2 November 2018).
Luenberger, D.G., 1992. Benefit functions and duality. J. Math. 21, 461–481.
Lugo, A.E., 2002. Conserving Latin American and Caribbean Mangroves: Issues and Challenges. Bosques Número Especial.
Lundhede, T.H., Olsen, S.B., Jacobsen, J.B., Thorsen, B.J., 2009. Handling respondent uncertainty in choice experiments: evaluating recoding approaches against explicit modelling of uncertainty. J. Choice Model. 2 (2), 118–147. Available at: www.jocm.org.uk.
Mamkhezri, J., Thacher, J.A., Chermak, J.M., Berrens, R.P., 2020. Does the solemn oath lower WTP responses in a discrete choice experiment application to solar energy? J. Environ. Econ. Policy 9 (4), 447–473. https://doi.org/10.1080/21606544.2020.1738276.
Mangham, L.J., Hanson, K., McPake, B., 2009. How to do (or not to do)...Designing a discrete choice experiment for application in a low-income country. Health Policy Plan. 151–158. https://doi.org/10.1093/heapol/czn047.
Mariel, P., Hoyos, D., Meyerhoff, J., Czajkowski, M., Dekker, T., Glenk, K., Jette Jacobsen, B., Liebe, U., Søren Olsen, B., Sagebiel, J., Thiene, M., 2021. Environmental Valuation with Discrete Choice Experiments Guidance on Design. Implementation and Data Analysis, Switzerland. Available at: http://www.springer.com/series/8876.
Marre, J.B., Brander, L., Thebaud, O., Boncoeur, J., Pascoe, S., Coglan, L., Pascal, N., 2015. Non-market use and non-use values for preserving ecosystem services over time: a choice experiment application to coral reef ecosystems in New Caledonia. Ocean Coast. Manag. 105, 1–14. https://doi.org/10.1016/j.ocecoaman.2014.12.010.
Mashayekhi, Z., Danehkar, A., Sharzehi, G.A., Majed, V., 2016. Coastal communities WTA compensation for conservation of mangrove forests: a choice experiment approach. Knowl. Manag. Aquat. Ecosyst. 2016-Janua (417). https://doi.org/10.1051/kmae/2016007.
Mattmann, M., Logar, I., Brouwer, R., 2019. Choice certainty, consistency, and monotonicity in discrete choice experiments. J. Environ. Econ. Policy 8 (2), 109–127. https://doi.org/10.1080/21606544.2018.1515118.
McCue, J., 2014. Guidelines for the incorporation of an ecosystem based approach (EbA) into an integrated coastal zone management policy.
McFadden, D., 2001. Economic choices. Am. Econ. Rev. 91 (3), 351–378. Available at: http://elsa.berkeley.edu/.
McMichael, C., Dasgupta, S., Ayeb-Karlsson, S., Kelman, I., 2020. A review of estimating population exposure to sea-level rise and the relevance for migration. In: Environmental Research Letters. IOP Publishing Ltd. https://doi.org/10.1088/1748-9326/abb398
Meyer, A., 2013a. Estimating discount factors for public and private goods and testing competing discounting hypotheses. J. Risk Uncertain. 46 (2), 133–173. https://doi.org/10.1007/s11166-013-9163-y.
Meyer, A., 2013b. Intertemporal valuation of river restoration. Environ. Resour. Econ. 54 (1), 41–61. https://doi.org/10.1007/s10640-012-9580-4.
Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being : Synthesis. Island Press, Washington DC.
Mohammadi, T., Zhang, W., Sou, J., Langlois, S., Munro, S., Anis, A.H., 2020. A hierarchical Bayes approach to modeling heterogeneity in discrete choice experiments: an application to public preferences for prenatal screening. Patient 13 (2), 211–223. https://doi.org/10.1007/s40271-019-00402-w.
Mohammed, E., Lindop, A., 2015. Trinidad and Tobago: Reconstructed Fisheries Catches, 1950–2010. Vancouver.
Nazneen, S., Farid, A., Ksaibati, K., 2023. Impact of drivers' attributes on children injury severities in traffic crashes. J. Traf. Transport. Eng. (Eng. Edition) 10 (4), 647–658. https://doi.org/10.1016/j.jtte.2022.08.004.
Oleson, K.L.L., Barnes, M., Brander, L.M., Oliver, T.A., Van Beek, I., Zafindrasilivonona, B., Van Beukering, P., 2015. Cultural bequest values for

ecosystem service flows among indigenous fishers: a discrete choice experiment validated with mixed methods. Ecol. Econ. 114, 104–116. https://doi.org/10.1016/j.ecolecon.2015.02.028.
OSM, 2023. Open Street Map Bon Accord Lagoon Buccoo Bay, Copyright OpenStreetMap and contributors, under an open license. Available at: https://www.openstreetmap.org/#map=15/11.1694/-60.8249&layers=C (Accessed: 10 March 2023).
Oxford Business Group, 2015. Trinidad and Tobago Is Looking to Attract a Larger Share of Visitors to the Region. Oxford. Available at: https://oxfordbusinessgroup.com/reports/trinidad-tobago/2015-report/economy/trinidad-and-tobago-is-looking-to-attract-a-larger-share-of-visitors-to-the-region.
Özkaynak, B., Muradian, R., Ungar, P., Morales, D., 2023. What can methods for assessing worldviews and broad values tell us about socio-environmental conflicts? Curr. Opin. Environ. Sustain. 64, 101316. https://doi.org/10.1016/j.cosust.2023.101316.
Pascual, U., et al., 2017. Valuing nature's contributions to people: The IPBES approach. In: Current Opinion in Environmental Sustainability. Elsevier B.V, pp. 7–16. https://doi.org/10.1016/j.cosust.2016.12.006.
Pelletier, M.C., Tocock, M., MacDonald, D.H., Rose, J.M., Sullivan, C.A., 2022. Does information matter in the value of a wetland? J. Environ. Plan. Manag. 65 (7), 1323–1348. https://doi.org/10.1080/09640568.2021.1995339.
Pemberton, C.A., Mader-Charles, K., 2005. Ecotourism as a means of conserving wetlands. J. Agric. Appl. Econ. 37 (2), 463–474. https://doi.org/10.1017/s1074070800006933.
Penn, J.M., Hu, W., 2021. The extent of hypothetical Bias in willingness to accept. Am. J. Agric. Econ. 103 (1), 126–141. https://doi.org/10.1111/ajae.12121.
Peters, S.M., Guppy, R., Ramsewak, D., Potts, A., 2023. Socioeconomic dimensions of the Buccoo reef Marine Park, an assessment of stakeholder perceptions towards enhanced management through MSP. ICES J. Mar. Sci. 80 (5), 1399–1409. https://doi.org/10.1093/icesjms/fsad066.
Polidoro, B.A., et al., 2010. The loss of species: mangrove extinction risk and geographic areas of global concern. PLoS One 5 (4). https://doi.org/10.1371/journal.pone.0010095.
Polo, D., 2018. Budget 2019: Sandals project among major tourism plans for Tobago. Available at: https://tt.loopnews.com/content/budget-2019-sandals-project-among-major-tourism-plans-tobago (Accessed: 2 August 2019).
Powe, N.A., Garrod, G.D., McMahon, P.L., 2005. Mixing methods within stated preference environmental valuation: choice experiments and post-questionnaire qualitative analysis. Ecol. Econ. 52 (4), 513–526. https://doi.org/10.1016/j.ecolecon.2004.06.022.
Price, J., Dupont, D., Adamowicz, W., 2017. As time Goes by: examination of temporal stability across stated preference question formats. Environ. Resour. Econ. 68 (3), 643–662. https://doi.org/10.1007/s10640-016-0039-x.
Rakotonarivo, O.S., Jacobsen, J.B., Larsen, H.O., Jones, J.P.G., Nielsen, M.R., Ramamonjisoa, B.S., Mandimbiniaina, R.H., Hockley, N., 2017. Qualitative and quantitative evidence on the true local welfare costs of Forest conservation in Madagascar: are discrete choice experiments a valid ex ante tool? World Dev. 94, 478–491. https://doi.org/10.1016/j.worlddev.2017.02.009.
Ramdass, A., 2023. T&T's electricity and water rates lowest in the world, Trinidad Express. Available at: https://trinidadexpress.com/news/local/gonzales-t-t-s-electricity-and-water-rates-lowest-in-the-world/article_73413942-cabb-11ed-8a57-eb8cb21102e8.html.
RAMSAR, 2005. Buccoo Reef Bon Accord Lagoon Complex Ramsar Sites Information Service. Available at: https://rsis.ramsar.org/ris/1496 (Accessed: 16 March 2023).
Ready, R.C., Champ, P.A., Lawton, J.L., 2010. Using respondent uncertainty to mitigate hypothetical Bias in a stated choice experiment. Land Econ. 86 (2), 363–381. Available at: https://about.jstor.org/terms.
Regier, D.A., Sicsic, J., Watson, V., 2019. Choice certainty and deliberative thinking in discrete choice experiments. A theoretical and empirical investigation. J. Econ. Behav. Organ. 164, 235–255. https://doi.org/10.1016/j.jebo.2019.05.031.
Rigby, D., Burton, M., Pluske, J., 2016. Preference stability and choice consistency in discrete choice experiments. Environ. Resour. Econ. 65 (2), 441–461. https://doi.org/10.1007/s10640-015-9913-1.
Rolfe, John, Windle, J., Bennett, J., 2015. Benefit transfer: Insights from choice experiments. In: Johnston, R., Rolfe, J., Rosenberger, R., Brouwer, R. (Eds.), Benefit Transfer of Environmental and Resource Values. The Economics of Non-Market Goods and Resources. Springer, Dordrecht, pp. 191–208. https://doi.org/10.1007/978-94-017-9930-0_10.
Scarpa, R., Rose, J.M., 2008. Design efficiency for non-market valuation with choice modelling: how to measure it, what to report and why. Aust. J. Agric. Resour. Econ. 253–282. https://doi.org/10.1111/j.1467-8489.2007.00436.x.
Scarpa, R., Thiene, M., Train, K., 2008. Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. Am. J. Agric. Econ. 90 (4), 994–1010. https://doi.org/10.1111/j.1467-8276.2008.01155.x.
Spalding, M.D., McIvor, A., Tonneijck, F.H., Tol, S., van Eijk, P., 2014. Mangroves for Coastal Defence Guidelines for Coastal Managers & Policy Makers. Available at: www.nature.org.
Staples, A.J., Reeling, C.J., Widmar, N.J.O., Lusk, J.L., 2020. Consumer willingness to pay for sustainability attributes in beer: a choice experiment using eco-labels. Agribusiness 36 (4), 591–612. https://doi.org/10.1002/agr.21655.
Thurstone, L.L., 1927. A law of comparative judgment. Psychol. Rev. 34, 273–286.
Train, K., Weeks, M., 2005. Discrete choice models in preference space and willingness-to-pay space. In: Scarpa, R., Alberini, A. (Eds.), Applications of Simulated Methods in Environmental and Resource Economics. The Economics of Non-Market Goods and Resources. Springer, Dordrecht. https://doi.org/10.1007/1-4020-3684-1_1.
Tuholske, C., Tane, Z., López-Carr, D., Roberts, D., Cassels, S., 2017. Thirty years of land use/cover change in the Caribbean: assessing the relationship between urbanization and mangrove loss in Roatán, Honduras. Appl. Geogr. 88, 84–93. https://doi.org/10.1016/j.apgeog.2017.08.018.
Valiela, I., Bowen, J.L., York, J.K., 2001. Mangrove forests: one of the world's threatened major tropical environments. BioScience 51 (10), 807–815. https://doi.org/10.1641/0006-3568(2001)051[0807:MFOOTW]2.0.CO;2.
Vass, C., Rigby, D., Payne, K., 2017. The Role of Qualitative Research Methods in Discrete Choice Experiments: A Systematic Review and Survey of Authors. In: Medical Decision Making. SAGE Publications Inc., pp. 298–313. https://doi.org/10.1177/0272989X16683934
Vehtari, A., Gelman, A., Gabry, J., 2017. Practical Bayesian model evaluation using leave-one-out cross-validation and WAIC. Stat. Comput. 27 (5), 1413–1432. https://doi.org/10.1007/s11222-016-9696-4.
Vehtari, A., Gelman, A., Simpson, D., Carpenter, B., Bürkner, P.-C., 2019. Rank-normalization, folding, and localization: an improved R-hat for assessing convergence of MCMC. https://doi.org/10.1214/20-BA1221.
Vermeulen, B., Goos, P., Scarpa, R., Vandebroek, M., 2011. Bayesian conjoint choice designs for measuring willingness to pay. Environ. Resour. Econ. 48 (1), 129–149. https://doi.org/10.1007/s10640-010-9401-6.
Viscusi, W.K., Huber, J., Bell, J., 2008. Estimating discount rates for environmental quality from utility-based choice experiments. J. Risk Uncertain. 37 (2–3), 199–220. https://doi.org/10.1007/s11166-008-9045-x.
VisitTobago, 2022. Tobago announces ground-breaking hotel developments at WTM. Available at: https://www.visittobago.gov.tt/tobago-announces-ground-breaking-hotel-developments-wtm (Accessed: 12 March 2023).
West, G.H., Snell, H., Kovacs, K.F., Nayga, R.M., 2020. Estimation of the preferences for the intertemporal services from groundwater.
Williams, G., 2022. Temporal stability of WTP estimates in labeled and unlabeled choice experiment for emissions reduction options, Queensland, Australia. Environ. Econ. Policy Stud. https://doi.org/10.1007/s10018-021-00336-4 [Preprint].
Yao, R.T., Scarpa, R., Harrison, D.R., Burns, R.J., 2019. Does the economic benefit of biodiversity enhancement exceed the cost of conservation in planted forests? Ecosyst. Serv. 38. https://doi.org/10.1016/j.ecoser.2019.100954.
Zheng, D., Ao, C., Mao, B., Xu, L., 2022. Can respondent uncertainty be ignored when exploring heterogeneity in public preferences for air pollution treatment policies? Comparative results from choice experiment analysis. Sci. Total Environ. 808. https://doi.org/10.1016/j.scitotenv.2021.152169.