FARM AND BUSINESS

The Journal of the Caribbean Agro-Economic Society

Volume 15, Issue 1, December 2023

Available online at https://ideas.repec.org/s/ags/fabtho.html

Farm and Business

The Journal of the Caribbean Agro-Economic Society

ISSN 1019–035X

Available online at https://ideas.repec.org/s/ags/fabtho.html

Farm and Business

The Journal of the Caribbean Agro-Economic Society

Mangrove Ecosystem Services in Tobago: Challenges, Uses and Future Prospects

Niko Howai[a]*

[a]*Department of Agri-Food Economics and Marketing, School of Agriculture, Policy and Development, University of Reading, UK; Department of Economics, School of Social Sciences, Oxford Road, University of Manchester, UK*

ARTICLE INFO

Article history:
Received 15 May 2023
Received in revised form 31 October 2023
Accepted 24 November 2023

Keywords:
Ecosystem services
Mangroves
Qualitative analysis
Stakeholders
Tobago

ABSTRACT

Mangroves in Tobago face challenges from anthropogenic disturbances such as pollution, fragmentation and cover loss through conversion to alternative uses for economic development. However, mangroves also provide a wide range of use and non-use benefits or ecosystem services (ES) to the residents of Tobago. In this study 36 key informant interviews and two focus group discussions were undertaken to identify current uses, challenges, and future opportunities for the mangrove areas, particularly in South-West Tobago. The key informant interviews involved various stakeholder groups that have a vested interest in the use of the mangrove. The two focus-group discussions were done with residents and fishers. NVivo 12 was used in the qualitative analysis to code the data on ES uses, challenges and opportunities. Current ES uses (direct and indirect) identified include forestry products, crab and shellfish, recreation, scientific research, water purification and coastal protection. Non-use (bequest and existence) benefits identified include the aesthetics, biodiversity and habitat. Option and future-uses opportunities include more developed eco-tourism ventures, sustainable development, an exploration of the viability of tannin extraction and further employment opportunities from the provision of fisheries products to the growing tourism sector on the island.

1. Introduction

Mangroves comprises of intertidal trees and shrubs that are found on tropical and sub-tropical coastlines and are approximately found within the geographic bounds of 30° North and 30° South latitude. (Friess 2016; Spalding, Blasco, and Field 1997). As Table 1 shows, there are a wide range of mangrove ecosystem services (ES) or benefits that can be valued and considered in societal welfare and decision-making by authorities. These mangrove benefits include but are not limited to, first, goods for direct extraction such as forestry and fishery products (Uddin et al. 2013; Hutchison, Spalding, and Zu Ermgassen 2014). Second, as a buffer against natural disasters such as storm and tidal surge protection for coastal communities and the wider society (Alongi 2008; Das 2022; Das and Vincent 2009). Third, the global good of carbon sequestration and storage or "blue carbon" provided by the mangroves is comparatively higher than that of terrestrial forests (Elwin et al. 2019; Alongi 2020). Fourth, mangroves can mitigate the impacts of coastal flood damage, erosion and water flow regulation due to its root structure that helps with sedimentation (Barbier 2016; Spalding et al. 2014). Fifth, biodiversity of flora and fauna, is expected to be greater in the mangrove and may provide humans with benefits such as productivity (Uddin et al. 2013; Corte et al. 2021). In Trinidad, the Scarlet Ibis which is the national bird and an environmentally sensitive species roosts in the Caroni Swamp and provides an opportunity to attract people for eco-tourism tours and recreation (Ebersole 2018).

Table 1 - Mangrove ecosystem services (derived from Kathiresan, 2012)

Ecosystem Service Classification	Some Benefits
Provisioning	Fishery products (e.g., crab, fish, mollusc and prawn), Forestry products (e.g., charcoal, firewood, tannin and timber), fuel and fresh water.
Regulating	Carbon sequestration and storage, coastal erosion protection, natural disasters buffer (e.g., hurricanes, storms and tidal surges), screening solar Ultraviolet radiation, flood and water flow regulation, sediment trapping, water purification.
Supporting	Habitat for species (e.g., for endemic and migratory birds, mammals, amphibians, insects, fish nurseries),

* *Corresponding author. Niko Howai*
E-mail address: niko.howai@manchester.ac.uk

Ecosystem Service Classification	Some Benefits
	genetic diversity of organisms, trapping and recycling nutrients.
Cultural	Aesthetics, education, heritage value, inter-generational, tourism activities and recreation.

Mangroves also face many threats globally such as deforestation, conversion to aquaculture and agriculture, urban development, industrial activities, pollution, tourism and natural disasters (Friess et al. 2019; Spalding et al. 2021). Mangrove losses are most prevalent in two regions around the world, Southeast Asia at 6% and the Americas (North and Central) and Caribbean at 7% net loss rates (Polidoro et al. 2010; Spalding et al. 2021). First, pond aquaculture via shrimp and fishponds affects waterflows, lowers mangrove cover, reduces water quality, lowers carbon stocks and disturbs natural food chains and the negative effects have been recorded in countries across southeast Asia like Thailand (Alongi 2002; Elwin et al. 2019; Primavera 2006). Second, agricultural practices are known to incur large-scale mangrove removal, having negative impacts on mangrove regenerative capacity as observed in Myanmar (Rice cultivation) and Indonesia (Oil Palm) (Richards and Friess 2016; Beymer-Farris and Bassett 2012). Third, urban development also encroaches on mangrove habitats and India recorded approximately 40% mangrove losses to agriculture combined with urban development (Upadhyay, Ranjan, and Singh 2002; Polidoro et al. 2010). Fourth, pollution, such as industrial effluent, oil and pesticide runoff diminishes mangroves ES and health with cases reported in the Caribbean (e.g., Cuba, Jamaica, Puerto Rico and Trinidad and Tobago) and Latin America (e.g., Belize, Columbia and Nicaragua) (P. Bacon 1993; FAO 2007; Schleupner 2008). Fifth, Caribbean islands that depend heavily on tourism have undergone large scale conversion of mangrove sites (e.g., Barbados and Martinique) (Schleupner 2008; FAO 2007). Finally, natural disasters such as hurricanes have destroyed mangroves, for instance Hurricane Irma in 2017, led to approximately 90% of mature mangrove losses in the British Virgin Islands (Moore 2018; Imbert 2018).

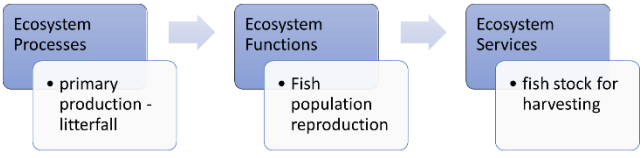
The many reported benefits and challenges facing mangrove sites, led to the overarching research question, using the island of Tobago as a case study, that endeavours to determine which mangrove ES, challenges and future uses are most recognised by the local residents and other stakeholder groups. The ES can be both use and non-use and are characterised using the total economic value (TEV) framework (Dixon and Pagiola 1998). To answer the research question, qualitative analysis using NVivo 12 investigating stakeholders' perceptions are done. Using a Grounded Theory (discussed further in the Methods) approach this allows to compare important stakeholder perceptions to the uses, challenges and prospects raised in the literature review. Specifically, 1) the topic frequency of Tobago's residents and stakeholder groups mentioning the challenges affecting mangroves are categorised; 2) the topic frequency of Tobago's stakeholders mentioning mangrove uses and prospects are classified using the TEV framework; and 3) consider the potential implications of findings on mangrove uses and research.

1.1. Understanding ecosystem services and the total economic value framework

The term ecosystem is a good starting point to understand ecosystem services (ES). The 'ecosystem' originated in 1935 by Tansley to develop the understanding of the entire system in which organisms interact to include the organic physical, habitat and inorganic factors. This was done to emphasize that organisms do not only interact amongst themselves but between the organic and inorganic factors (Tansley 1935). The term ES, first coined by Paul and Anne Ehrlich in 1981 integrated natural and social science in economic and sustainable development due to environmental pollution and limited resource availability (Braat and de Groot 2012). The definition of ES is continuously evolving in literature and depends on its context of use such as whether it is for an economic or ecological basis. For instance, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is continuously assessing the knowledge on biodiversity and ES and their linkages for the values that nature provides to humankind (Pascual et al. 2017; Díaz et al. 2015; IPBES 2019).

There are many definitions of ES, however it can be characterised threefold. Firstly, as the '...conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life (Daily 1997).' Secondly, it refers to the benefits humans derive from ecosystem functions directly and indirectly (Costanza et al. 1997). Finally, it is the factors of ecosystems used to derive human well-being (Boyd and Banzhaf 2007; Fisher, Turner, and Morling 2009). Through these definitions at the core of ES is sustaining human well-being. This objective is achieved through the ecosystem processes and functions that lead to services (Braat and de Groot 2012).

Ecosystem processes refer to the biological, chemical and physical changes that occur such as nutrient cycling and primary production. While ecosystem functions refer to the capacity of the ecosystem to provide value for human needs and wants. It acts as the intermediary between ecosystem processes and services (see figure 1). Ecosystem functions can be the water purification from nutrient cycling and a reproducing fish population from primary production (de Groot et al. 2010; Braat and de Groot 2012; Crossman et al. 2013). The outcome would be for example the provisioning services of clean water for drinking and swimming and harvested fish stock for nutrition (Braat and de Groot 2012). There are different classifications



of ES that were mainstreamed by the Millennium Ecosystem Assessment (MA, 2003, 2005). They include the provisioning, regulating, habitat or supporting and cultural services (de Groot et al. 2010; Fisher, Turner, and Morling 2009; Rodríguez, Pascual, and Niemeyer 2006).

Fig. 1 - Ecosystem linkages: processes, functions and services

TEV comprises of use and non-use values (NUV), in economic terms, direct use values refer to the interaction with resources through physical and visual contact e.g., recreation at a lake or timber extraction (Pearce and

Moran 1994; Tietenberg 2004; Marre et al. 2015). Indirect use values (IUV) are the passive benefits e.g., watershed protection by forests and nutrient cycling (Pearce and Moran 1994; Marre et al. 2015). There is a third, use value known as option value (OV) and it is the protection of resources to have the possibility of using it in the future (Pearce and Moran 1994; Pearce and Özdemiroglu 2002). The non-use benefits are either bequest or for future generations e.g., the legacy of a national park. Finally, the existence use is the satisfaction to persons for the mere presence of an environmental resource such as a mangrove, river or beach they may never use (Arrow et al. 1993; Pearce and Moran 1994). All of these values make up the TEV and figure 2 shows the relationships between economic values and examples of mangrove ES. To date this is the first qualitative research analysis of mangrove ecosystems in Trinidad and Tobago.

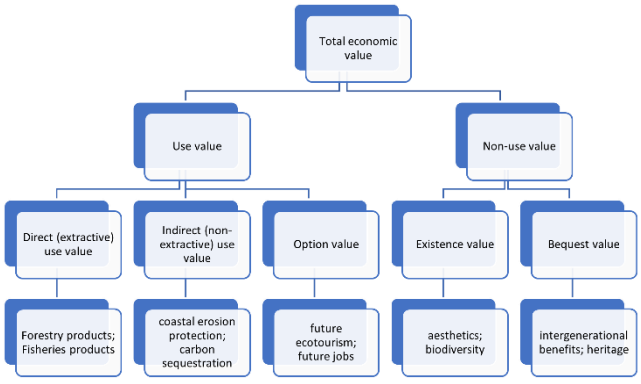


Fig. 2 - Total Economic Value and mangrove ES (modified from Dixon and Pagiola, 1998)

2. Background – Mangroves in Trinidad and Tobago

There are 48 mangrove sites in Trinidad and Tobago. These are categorised into 35 in Trinidad, 11 in Tobago and two on offshore islands (P. Bacon 1993; R. Juman and Ramsewak 2013b). These sites can be found on all coasts of Trinidad and the North (Leeward) and South (Windward) coasts of Tobago (P. Bacon 1993; R. Juman and Ramsewak 2013b). The total mangrove coverage is estimated at approximately 70 km^2 in Trinidad and 1.9 km^2 in Tobago (IMA 2020). However, only three sites are protected, and the non-protected sites encounter similar challenges to the protected sites. These challenges include but are not limited to fragmentation and mangrove cover loss, conversion to alternative land uses, pollution, unplanned housing and coastal erosion (R. Juman and Ramsewak 2013b). The mangrove comprises a mixture of basin, estuarine and fringed mangrove systems and all eight of the mangrove species found in the Caribbean have been recorded in Trinidad and four species found in Tobago (P. Bacon 1993; R. Juman and Hassanali 2013).

A major challenge impacting mangroves in Trinidad and Tobago, is mangrove fragmentation (Bryan-Brown et al. 2020). Fragmentation refers to the physical break-up of contiguous forests into sub-parts due to other uses for example conversion to agriculture, infrastructure building and urban development which may threaten the environment (Tran and Fischer, 2017; Gilani et al., 2021). Trinidad and Tobago was considered one of ten hotspots around the world for mangrove fragmentation for alternative uses (Bryan-Brown et al. 2020). Trinidad and Tobago scored in the top ten in the world in two of four fragmentation metrics used in this study by Bryan-Brown et al. (2020) for measuring mangrove fragmentation globally. This was fourth in mean perimeter area fractal dimension (PAFRAC) and eight in mean patch size (hectares). In Trinidad and Tobago, actual mangrove cover loss while present was relatively lower when compared to the other countries such as Indonesia, Malaysia and Myanmar (Bryan-Brown et al. 2020).

The major challenges potentially influencing mangrove fragmentation and loss have been economic development, general human activity and natural processes (Al-Tahir and Baban 2005). Historically, conversion to rice cultivation occurred at the two largest sites (Nariva and Caroni Swamps) in Trinidad (R. Juman and Ramsewak 2013b; R. Juman and Hassanali 2013). Other issues affecting mangroves in Trinidad were further anthropogenic disturbances to the Nariva Swamp mangrove. These changes included forest fires, hydrological alteration, pollution, reclamation for housing and farming and saltwater intrusion (R. Juman and Ramsewak 2013b). At Caroni Swamp post 1950s, mangroves were reclaimed for sewage treatment ponds, a solid waste landfill and unplanned housing in the area (R. Juman and Hassanali 2013). Pollution from sewage, wastewater from industry and farming cultivation run-off affected the Caroni swamp, which resulted in 1.7 km^2 of mangrove die-off in 2001 (R. Juman and Ramsewak 2013a).

Table 2 shows the impacts facing mangrove sites in SW, Tobago. Historically the two largest sites (Bon Accord/Buccoo and Kilgwyn) were threatened by resort development and airport expansion (Bacon, 1993). In the present context, coastal squeeze in the South-West (SW) Tobago from housing and potential resorts, airport expansion and infrastructural development are challenges facing the mangrove areas. Like Bon Accord/Buccoo, Kilgwyn site is located on the South-west (windward) coast of Tobago. The bay is surrounded by seagrass beds and a fringing coral reef. The mangrove site is split in two, and they are called Kilgwyn swamp and Friendship swamp. Most of the mangroves were cleared for the development of the international airport in Tobago. Solid waste disposal and pollution have further impacted the area (R. Juman and Hassanali 2013; R. Juman and Ramsewak 2013b). Friendship mangroves located east of Kilgwyn are exposed to wind damage, reclamation and hydrological alteration.

To alleviate some of the negative impacts on the mangroves, a degree of protection has been afforded to three of the total 48 sites in the country, two in Trinidad and one in Tobago (R. Juman and Hassanali 2013). Caroni, Nariva and Bon Accord Lagoon are Ramsar sites or Wetlands of International Importance. First Nariva was made a Ramsar site in 1993, followed by Caroni and Bon Accord Lagoon/Buccoo Reef in 2005 (Juman and Hassanali, 2013). In particular for SW Tobago, the Bon Accord Lagoon and Buccoo Reef were designated restricted areas in 1973 under the 1970 Marine Area (Preservation and Enhancement) Act. To date Bon Accord Lagoon/Buccoo Reef is the only designated Marine Protected Area (MPA) in the country (R. Juman and Hassanali 2013). In 1994, the Institute of Marine Affairs (IMA) developed a management plan for the area, which was adopted by the Tobago House of Assembly (THA). However, it did not address pollution originating from outside of the restricted area boundary. Furthermore, the management plan was not implemented by the authorities full-scale and the Bon Accord/Buccoo site has experienced degradation (R. Juman and Hassanali 2013). Drivers to make the Bon Accord Lagoon/Buccoo Reef MPA a Ramsar site are the biological diversity, the

unique contiguous nature of the coral reef, seagrass and mangroves and the existence of threatened and endangered species (RAMSAR 2005). Despite this, the MPA still faces degradation and management measures have not been fully achieved (R. Juman and Hassanali 2013).

Table 2 - South West Tobago mangrove sites and impacts (Derived from R. Juman and Ramsewak, 2013b)

Mangrove Site	Protection Status	Various impacts	Delineation of sites
Buccoo Bay	Protected	Reclamation for development, hydrological alteration and pollution.	Buccoo Bay and Bon Accord Lagoon comprise the same Marine Protected Area (MPA) and RAMSAR site.
Bon Accord Lagoon	Protected	Reclamation for development and pollution.	
Kilgwyn Swamp	Non-Protected	Reclamation for airport, waste disposal and pollution.	Kilgwyn and Friendship swamps are connected to each other in the same bay-Kilgwyn Bay.
Friendship Swamp	Non-Protected	Reclamation, wind damage and hydrological alteration.	
Petit Trou	Non-Protected	Reclamation for a resort and pollution.	

2.1. Buccoo Marine Park management: plans and implementation

The focus of the IMA's 1994 management plan was on the entire Buccoo Reef Marine Park due to the contiguous nature of the coral reef, seagrass beds and mangroves. However, there is an observable emphasis on the Buccoo Reef as established by the goal of the plan for the management of the human use of the Buccoo Reef and its adjacent coastal areas in a sustainable manner to meet future needs (IMA 1995). There is a present contextualisation of use conflicts that can potentially disrupt the ecological and environmental integrity of not only the Reef but the Bon Accord Lagoon, adjacent mangrove at Buccoo Bay and beaches. These threats historically came from the discharge of partially treated or untreated sewage plant effluent and wastes from farms and fish-processing facilities directly into the Bon Accord Lagoon and Buccoo Bay (IMA 1995). More pertinent and specifically for this study the mangrove area ownership has been controversial, it was privately owned in the past which had implications for its inclusion under the protection of the overall Marine Park and management activities (IMA 1995). At present, crab catching is the only regular use activity in the mangrove wetland and landward development has led to mangrove tree clearing and the placement of drainage channels through the mangrove into the Bon Accord Lagoon. The trade-off in land use which has a mangrove fragmentation linkage is historically prevalent. Use conflict remains present because of the consideration to protect the wetland habitat and its natural drainage as compared to land development activities near to the mangrove (IMA 1995).

Various recommendations were made in the IMA's management plan. First, in terms of the Marine Areas (Preservation and Enhancement) Act, 1970 amended 1996, issues were raised such as a lack of specification in the Act on which "Minister" has authority over implementing the legislation and who has authority to enter the restricted area (IMA 1995). Second, greater authority to enforcement agencies by the Minister to stop, search, seize fish and equipment and make arrests of persons in breach of the regulations and that the authorised personnel to conduct such official functions should be members of the Ministry of National Security such as the Police Service, Fisheries Officers of the THA and any other Board, Committee or duly appointed body by the Minister (IMA 1995). Third, new regulations were recommended prohibiting littering and pollution of any type in the Marine Park. Fourth, limiting the quantity and size of boats to the reef at a given point in time, prohibiting taking, harming, injuring or killing marine life, prohibiting damage to coral, mining, and removal or destroying natural features (IMA 1995). These recommendations made were not officially adopted into the Marine Areas legislation to date.

Further recommendations were made for development and pollution control. First, development that hinders proper management of the Marine Park should not be allowed. Coastal development near to the Marine Park should incorporate the preservation of coastal vegetation inclusive of the mangrove areas, beaches and maintenance of the water quality (IMA 1995). This was recommended to be done as a joint effort between the THA and the Town and Country Planning Division of Trinidad and Tobago with due consideration of the ecological and hydrological linkages between terrestrial and marine environments in planning and permitting developments (IMA 1995).

However, this did not stop proposed hotel plans between 2017 to 2019. In the motivation for this study the proposed international beach resort which would have boosted the economy and would have been constructed in an area encompassed by the mangrove called 'No Man's Land' towards Buccoo Bay. It was suggested that the Environmental Management Authority and Town and Country Planning approval were not achieved for the planned resort (LoopTT 2017). Eventually a series of negative publicity led to the cancellation of the resort in 2019. Presently, more developments have been planned in the coastal areas of Tobago, with further airport expansion near to Kilgwyn Swamp and two new hotel developments not close to any mangrove site (VisitTobago 2022). In 2022, the THA endeavoured to control the use of the Buccoo Marine Park under the provision of the Act, especially for hosting party events and unauthorised access (THA, 2022).

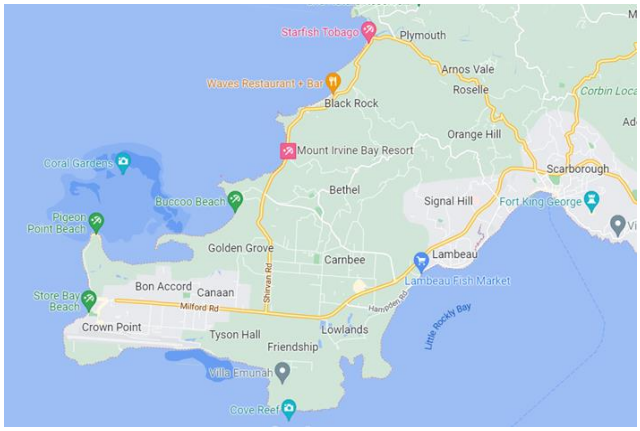
2.2. Synergies in use

Due to the variety of uses mangroves provide to communities and other stakeholders decisions have to be made on their conservation and management to achieve win-win scenarios for economic development and mangrove protection. Synergies occur where one ES change influences other ES in the same environmental system (Turkelboom et al. 2015). For instance, in an MPA, the synergistic relationship occurs between algal grazing and recreation opportunities (Turkelboom et al. 2015). The MPA enhances the fish population which subsequently increases algal grazing by the fish that protects the coral and in turn increases recreation opportunities. An important concept from the Millennium Ecosystem Assessment (MA) is that the well-being of people and environmental conditions are connected, and environmental management done comprehensively could potentially deliver benefits for the population and create win-win scenarios

(Howe et al. 2014). To create synergies and win-win scenarios various factors have to be considered together such as ES management, stakeholder benefits across various groups and ensuring no one ES dominates the other services (Howe et al. 2014). In practice win-win scenarios do not always occur and it is important to have well-planned management of ES (Bennett, Peterson, and Gordon 2009; Howe et al. 2014).

3. Methods

The communities of Bon Accord, Crown Point and Canaan along with Buccoo, Carnbee and Golden Grove which are approximately 12 and 10 km SW of the capital city of Scarborough are where the in-depth interviews took place with the residents and stakeholder groups (see figure 3). The community members share similar socio-demographic characteristics and live within two to three km from the mangrove site at Bon Accord/Buccoo. The focus groups took place in Plymouth for the residents and Buccoo for the fishers. Table 3 shows all the stakeholder groups that were interviewed and the timeline in which interviews were carried out. In terms of acquiring key informant stakeholders, Brown et al. (2001), suggested that some of the stakeholders for this area in Tobago included the THA, local communities, fishers and local businesses and entrepreneurs. The local businesses include dive shops and reef tour operators (Brown et al. 2001). Other important



stakeholder groups for this study include the environmental non-governmental organisations (NGOs) and hotels/guest houses on the island. The various stakeholder groups are best represented in different ways such as either through focus groups or key informant in-depth interviews (Brown et al. 2001). The fishers and residents represent the local communities in the vicinity of the research site and focus group discussions were arranged with these members of the communities. All participation was non-incentivised and therefore voluntary as persons gave their time without compensation.

Fig. 3 - Community locations in SW Tobago

Table 3 - In-depth interviews and focus groups timeline

Type	Group	Number (individuals)	Timeline
In-depth interviews	Expert opinion	3	June 2019
In-depth interviews	Fishers	1	January to February 2020
	Boat tour operators	5	
	NGOs	3	
	THA	5	
	Guest house owners	2	
	Residents	17	
Focus Groups	Fishers	3	January 2020
	Residents	5	

Note: THA members from Fisheries and Forestry Divisions; NGOs are environmentally focused.

In table 3, first, three expert opinion in-depth interviews in June 2019. This was followed by a series of in-depth key informant interviews with the stakeholders in January to February 2020 done in person and totalled 33 in-depth interviews (17 with general public residents and 16 with stakeholder groups) and two focus groups (three person and five-person group discussion) both done to contextualise the perceptions of mangrove by locals. The expert opinion semi-structured surveys were done on three individuals, the original target was ten persons but though three participated the insight was useful as they all conducted research on mangrove sites in Trinidad and Tobago. The experts ranged from 10 years to over 40 years' experience in their fields with two from the field of Marine Biology and one from Agricultural Economics. The expert opinion surveys lasted between 45 and 90 minutes and were done over video call on Skype.

An appropriate number of persons for focus group discussions is between 10 and 12 (large focus group) and five and eight (smaller focus group) (Krueger and Casey 2015). Though the three person focus group was a mini-focus group it was still useful in gleaming insight into mangrove ES in Tobago. Circumstances sometimes require smaller focus groups and where it is problematic to get participants, convening two-five persons can be useful when individuals have high expertise (O. Nyumba et al., 2018). Due to the busy work schedules of the fishers, it proved challenging to gather fishers in one location on shore but because of their specialist job this number was still useful. The moderation of the focus groups used semi-structured questions to guide but in an open-ended manner to encourage discourse. The residents focus group had five participants which falls at the lower end of the smaller focus group but is within the usual range of participant numbers. Finally, focus group duration can range between 30 to 120 minutes and depends on the topic's complexity and the participation numbers (Powell and Single 1996; Masadeh 2012). The fishers and residents focus groups were 70 and 50 minutes respectively.

The one-on-one in-depth interviews were done to ascertain the perceptions of those stakeholders that could not be easily coordinated together and captured in a focus group. The residents, THA Forestry and Fisheries Division personnel, boat tour operators, environmental NGOs and guest house owners were interviewed in this manner. The optimal sample size of interviewees is between 5 – 50 individuals and depends on factors such as heterogeneity of stakeholders, available budget for expenditure and time period available for data collection (Dworkin, 2012). The in-depth interviews were also done with semi-structured questions because of its advantage of initiation with key questions while allowing for flexibility to digress for idea development (Gill et al. 2008). While, the optimal time period for in-depth interviews ranges between 20 and 60 minutes (Gill et al. 2008). In this study the 33 in-depth interview surveys lasted between 20 to 60 minutes each.

Ethical clearance was acquired for each of the key informant surveys (experts, focus groups and in-depth interviews). Each participant's

responses were made anonymous through alphanumeric coding of the interviewee and the respective interview transcript. All respondents were given a participant information sheet with a declaration of the data management and data use plans in this study, along with their rights to withdraw from the study within an allocated timeframe before the end of the research. The qualitative data was originally used to inform the author's PhD thesis research using a non-market valuation stated preference method called choice modelling for the selection of attributes and levels that are traded-off by the choices individuals are asked to make in the survey to calculate marginal willingness-to-pay values for the factors that comprises bundles of environmental goods at different prices (Mariel et al. 2021; Atkinson, Bateman, and Mourato 2012).

The qualitative data in this paper was subsequently analysed with NVivo version 12 to identify the mangrove uses in Tobago. NVivo, created by QSR International is a popular computer-assisted qualitative data analysis software (CAQDAS), that assists researchers engaged in qualitative analysis, to collect, record, analyse, visualise and report data using features and tools to help structure the data collected (Dhakal 2022; Allsop et al. 2022). NVivo uses a variety of file types, such as audio, video, images and text (Dhakal 2022). Transcription of audio and video files can be done in NVivo directly or separately and then import the transcribed file (Allsop et al. 2022). In this research transcription of audio files were done in word processing software then imported to NVivo for manual thematic coding and analysis as part of the routine coding procedure.

A Grounded Theory (GT) approach was used to analyse the texts from the 36 individual in-depth interviews and two focus groups. GT is a research methodology that rigorously classifies and analyses data after collection through a systematic set of methods (Qureshi and Ünlü 2020; Mohajan and Mohajan 2022). GT was introduced (see Glaser and Strauss, 1967) to make qualitative research more methodological, and structured and has since evolved to contain differing paradigms such as positivist, postpositivist and constructivist (Qureshi and Ünlü 2020). However regardless of the paradigms GT involves coding the transcripts of the interviews and focus group discussions. A code in this sense of qualitative research is a word or group of words that provide salient and summative capture for a discrete portion of language-based data (Mohajan and Mohajan 2022).

First, open coding was undertaken to group data into smaller parts for analysis (Vollstedt and Rezat 2019). Second, axial coding was done to categorise the data organising the data from the prior open coding. Finally, selective coding was the final iteration which integrates the different categories that were constructed into a core concept or theory relevant to the way in which ES are used and its understanding, which in this study is the TEV framework, and associated challenges. The manual coding of responses were done as they related to various ES from the individual in-depth interviews and focus group discussions. NVivo is used to create nodes (labelling and category creation) of various themes (Dhakal 2022) under the areas of challenges, uses and future opportunities. Then querying the transcripts to search for those keywords and adding it to the respective node.

For example, using the GT approach in NVivo 12, open coding involved reviewing transcripts for mangrove benefits from the opinions of the residents and stakeholders. Then axial coding was done to categorise the mangrove benefits into ES. Finally, selective coding placed the mangrove ES into the overarching TEV framework of use and non-use values in present and future contexts. Limitations, include it can be time consuming to code text line-by-line, bias by personal preconceptions, and requires large amounts of data (Mohajan and Mohajan 2022). The coding categories drew from the literature on ES or benefits of mangrove to humankind and the challenges facing mangrove uses (e.g., Himes-Cornell, Grose, and Pendleton 2018; Polidoro et al. 2010; Brander, Florax, and Vermaat 2006; Das and Vincent 2009; Das 2017; P. R. Bacon 1987; R. A. Juman 2004; Spalding et al. 2021; Friess et al. 2020; Barbier 2017; Lugo 2002; Kathiresan 2012).

4. Findings and Discussions

Topic frequency is measured by the ratio of the topic being raised to the total number of interviews. Table 4 shows a list of challenges raised by participants, and its mention frequency. Pollution was mentioned in over half of the surveys at 57%. Issues such as dumping of waste and sewage treatment and drainage are examples of pollution challenges being faced. Mangrove fragmentation and cover loss was raised in just over 40% of the respondents, which can lead to other problems such as flooding and loss of wildlife. Food resources coming from the wildlife such as fisheries and other animals such as crabs are very important to the livelihoods of some individuals in the villages. This potential issue of loss of livelihoods was mentioned in 47% of the responses. Various crab species that are found in the mangrove are observed as a vital resource in the island of Tobago and culturally is important for local cuisine, without which would be a major loss for the island. Crime, pest and diseases and climate change were also mentioned as challenges on the lower end of the responses between 10 and 20% but having been mentioned due to the potential issues that arise from them. Figure 4, is a bar chart of the challenges facing mangrove ES.

Table 4 - Challenges facing mangrove ES

Challenges	Example (quotes from the participants)	Topic Frequency (%)
Fragmentation and loss	1. The coastal squeeze as a result of residential development 2. Development on the mangrove one you'll be adding more impermeable concrete layers to the area	43
Loss of food resources	1. There will be less food from cutting down the land, fish spawn and go to lay eggs. 2. When you put development close to the mangrove, come on it is a whole food source here being affected.	30
Loss of livelihoods	1. I think it is very important because if they are not catching crab, it comes like they are unemployed because it is what they do as a living. 2. It would destroy other persons livelihoods or cut down on other person's resources like the crab catchers.	47
Crime	1. Many of the criminals use the mangrove as their storage when they rob people and tourists.	20

	2. There are also illegal fish traps set.	
Pest and diseases	1. The prevalence of mosquitoes from the waterlogged soils and the presence of water constantly. So, with the turn of the mosquito borne diseases. 2. The communities associated with the wetlands face mosquitoes so there are diseases such as dengue, subsequent to dengue we had zika and chikungunya, we had people in Tobago affected by those.	17
Pollution	1. Kilgwyn/Friendship mangrove for years was a dumping ground. 2. When I say waste not just solid waste but also the sewerage and runoff from houses.	57
Climate change	1. Because now with climate change and sea level rise the mangrove towards the edge of the coast they might be removed.	10

Note: Dengue, zika and chikungunya are mosquito transmitted viral infections.

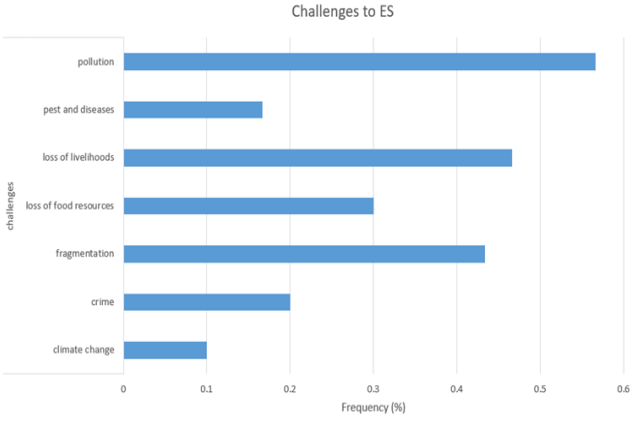


Fig. 4 – Challenges facing mangrove ecosystem services.

Table 5 presents the ES classified into their direct and indirect use of the mangroves. Two of the use value ES variables are mentioned in above 50% of participant responses, these are crab and shellfish at 53% and coastal protection from erosion, strong winds and waves and natural disasters. Coastal protection provided by the mangrove has the highest response rate at 70%. Water flow regulation concerned with the influence on flood control and direct food products from fisheries and other vertebrates are both mentioned at 40% of participant responses. Food included animals such as Iguanas, and fishes e.g., Snappers, Barracudas and Groupers. Water purification from filtering runoff was mentioned in 30% of participant responses, while education and research, recreation, forestry products such as timber and fish pots, farming stakes and fishing rods and carbon sequestration were mentioned between 13% to 23% in the total participant responses. Table 6 shows the ES classified as non-use for existence value which are biodiversity for non-consumption at 57% of participant responses such as the many species that live in the mangrove e.g., frogs, snakes turtles, birds, sponges and tunicates. Also, aesthetics or the natural presence of the land at 27% of participant responses. Habitat can be considered an indirect use as it has a fisheries linkage with spillover effects and juvenile offshore fish using it as a nursery and for its existence use as an area that functions as a home for all forms of wildlife.

Table 5 – Present mangrove use ES

Use	Ecosystem service	Example (quotes from participants)	Topic frequency (%)
Direct	Forestry products	1. We used to use the red mangrove to build fish pots. Also, long ago we used to use it to build kitchen and for furniture. 2. Also, the mangrove wood was used in construction of small houses and tents	23
Direct	Food (fish and vertebrates)	1. So, I grew up knowing that you can use the mangrove for food, fishing and hunting. 2. It provides food security with the fish stock.	40
Direct	Crab and shellfish	1. The crabs are very important traditionally. Both Trinidadians and Tobagonians want the crab. 2. I know the divers that catch the conch, they take out the meat and sell the meat to the food places and the shells to persons like me to sell as souvenirs.	53
Direct	Research and education	1. Even for educational tours throughout the mangrove. 2. You can also see benefits for scientific tourism.	20
Direct	Recreation and tourism activity	1. The boardwalk you can walk through and see many things without getting your feet dirty in the mangrove. 2. In terms of our culture, even in the goat race it is the mangrove wood that made the 'goat races' survive. People go back into the same areas to get wood from the mangrove for the goat race.	23
Indirect	Coastal protection	1. The mangrove is important to everybody, because it saves the land, homes and people. 2. That mangrove during a storm or rough seas saves many fishermen boats. If fishermen move the boats in time and though the wind blows strongly and the sea gets rough the	70

Use	Ecosystem service	Example (quotes from participants)	Topic frequency (%)
		lagoon remains relatively calm.	
Indirect	Water flow regulation	1. There will be flooding regulation, the mangrove basically acts as huge sponges to absorb any of the excessive water that comes from the land from heavy rainfall. 2. I think the mangrove is linked to potential flooding.	40
Indirect	Water purification	1. All the runoff from all the various communities around filters into the Bon Accord Lagoon, the mangroves act as a natural purification system. 2. Helps with the purification of waste and water.	30
Indirect	Carbon sequestration	1. The mangrove I believe assists in controlling the climate and also in cleaning the atmosphere.	13

Note: Goat racing is a cultural event held annually in Tobago as part of Easter festivities.

Table 6 - Present mangrove use and non-use ES

Use and non-use	Ecosystem Service	Example (quotes from the participants)	Topic frequency (%)
Existence	Aesthetics	1. I don't think there should be any buildings, I prefer the natural habitat remains and preserve the wetlands. 2. Mangrove can be very scenic.	27
Existence	Biodiversity (non-consumption)	1. I think it has many species, that live in the mangroves that we may not know about 2. Whereas you have the major beach for turtles being that of turtle beach at Pigeon Point the turtle of interest there is the Leatherback as well as the Hawksbill.	57
Indirect and existence	Habitat for animals	1. Shelter animals and not cutting for houses to be built on the site. 2. The mangrove also acts as nursery grounds to provide the juveniles to go back into the fish stock where we have the fishermen now participating in fishing.	40

Pemberton and Mader-Charles (2005), study in Trinidad and Tobago provided results where individuals do value eco-tourism at the Nariva swamp, as a means of conserving wetlands, and are willing-to-pay for protection of such sites, the creation of recreation opportunities, education and employment. Table 7 shows that eco-tourism is considered the most prevalent of all the ES mentioned with a 77% participant response frequency. This indicates that eco-tourism as a future prospect is regarded by all stakeholder groups as a viable option for both current and future generations. The other bequest and option value ES range between 7% to 27%. The future prospect of improved security in the mangrove to deal with the challenge of crime is an important possibility that should be explored. Also, with eco-tourism and tourism ventures, farmers and fishers may access additional jobs to provide food for facilities like resorts and parks. Sustainability is an important driver in having development that meets the needs of the present but still ensuring future generations have access to resources and eco-tourism projects are an appropriate avenue for this as recognised by the participant response frequency of 27% wanting sustainable development. Finally, though mentioned in 7% of the participant responses, forestry products making more substantial use of tannin to dye leathers in the Hide Industry is an opportunity available for future use that can minimise waste and capitalise on the natural benefits of mangroves. Figure 5 combines the use and non-use mangrove ES into one bar chart with the topic frequencies from Tables 5 to 7.

Table 7 - Future prospects for mangrove ES

Use and non-use	Future prospects	Example (quotes from the participants)	Topic frequency (%)
Bequest and option	Eco-tourism	1. We can have a park where people walk in and see the wildlife too. 2. Open something that brings eco-tourists rather than destroy the place with a large hotel. 3. So, you can build more boardwalks in the mangrove so the tourists can see. We don't really have much for tourists to see when they come but if we have a nice boardwalk through the mangrove, they can walk and see the birds.	77
Bequest and option	Sustainable development	1. We are not against development, but it must be done sustainably. 2. You just need a group of people to maintain the place to a certain	27

		standard and everything will be ok. So, it can have both development and maintain the natural benefits.	
Bequest and option	Jobs for fishers and farmers	1. The other fishermen can come together and pool the catch and a resort will pay more for the fish than the ordinary people.	10
Bequest and option	Security	1. Motion cameras might be useful, where they only come on when a person comes into the area in line of the camera. 2. But what the mangrove really needs is policing.	13
Bequest and option	Forestry product expansion	1. Not much mangrove is needed to get the tannin, some harvesting of the mangrove is used for tannin. 2. I still will want to see as part of the traditional way in terms of the tannin but it should be managed in such a way that it is sustainable.	7

Note: Tannins are a naturally occurring substance in plants.

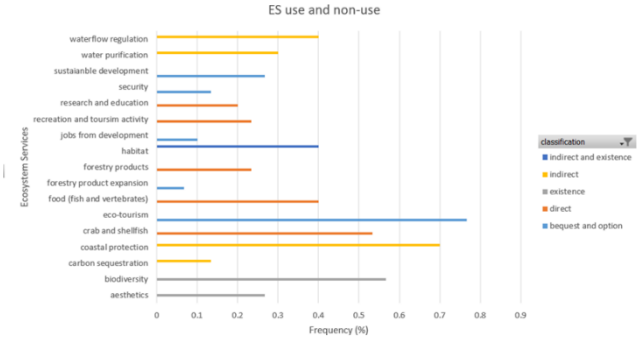


Fig. 5 – Mangrove Ecosystem Services use and non-use benefits.

5. Conclusions

There are many use and non-use benefits recognised by residents and other stakeholder groups and many threats facing mangroves. First, this study showed that residents and other stakeholders are aware of the challenges, use and non-use values of ES in present context and opportunities for the future. Second, that the residents and other stakeholder groups perceptions of the challenges and uses are similar to what is available in pre-existing literature on mangroves globally and specifically for the island. Third, this study provided a background to raise further areas of exploration using quantitative approaches in valuing mangrove ES, such as with stated preference methods like contingent valuation and discrete choice experiments. In addition, economic valuation combined with other approaches like the qualitative approach used in this paper are suitable avenues for obtaining pluralistic knowledge on ES as put forward by IPBES. Mangrove conservation is highlighted in the desire to have eco-tourism ventures to achieve more sustainable development over more classical "beach and hotel" ventures in mangrove areas. Finally, in answering the research question the most recognised challenges are pollution, loss of livelihoods and mangrove fragmentation and cover loss. While the factors recognised as important to the residents and other stakeholders as use and non-use benefits include eco-tourism ventures, coastal protection afforded by the mangroves, waterflow regulation, habitats and crab and shellfish.

REFERENCES

Allsop, David B., Joe M. Chelladurai, Elisabeth R. Kimball, Loren D. Marks, and Justin J. Hendricks. 2022. 'Qualitative Methods with Nvivo Software: A Practical Guide for Analyzing Qualitative Data'. Psych 4 (2): 142–59. https://doi.org/10.3390/psych4020013.

Alongi, Daniel M. 2002. 'Present State and Future of the World's Mangrove Forests'. Environmental Conservation 29 (3): 331–49. https://doi.org/10.1017/S0376892902000231.

———. 2008. 'Mangrove Forests: Resilience, Protection from Tsunamis, and Responses to Global Climate Change'. Estuarine, Coastal and Shelf Science. https://doi.org/10.1016/j.ecss.2007.08.024.

———. 2020. 'Global Significance of Mangrove Blue Carbon in Climate Change Mitigation'. Sci 2 (3): 57. https://doi.org/10.3390/sci2030057.

Al-Tahir, R., and S. Baban. 2005. 'An Evaluation of Recent Changes in Mangrove Forest Habitats in West Trinidad'. Tropical Biodiversity 8 (3): 187–98.

Arrow, Kenneth, Robert Solow, Paul R Portney, Edward E Leamer, Roy Radner, and Howard Schuman. 1993. 'Report of the NOAA Panel on Contingent Valuation'.

Atkinson, Giles, Ian Bateman, and Susana Mourato. 2012. 'Recent Advances in the Valuation of Ecosystem Services and Biodiversity'. Oxford Review of Economic Policy 28 (1): 22–47. https://doi.org/10.1093/oxrep/grs007.

Bacon, Peter. 1993. 'Mangroves in the Lesser Antilles, Jamaica and Trinidad and Tobago'. In Conservation and Sustainable Utilization of Mangrove Forests in Latin America and African Regions, edited by L.D. Lacreda. International Tropical Timber Organization/ International Society of Mangrove Ecosystems.

Bacon, Peter R. 1987. 'Use of Wetlands for Tourism in the Insular Caribbean'. Annals of Tourism Research 14 (1): 104–17. https://doi.org/10.1016/0160-7383(87)90050-8.

Barbier, Edward B. 2016. 'The Protective Service of Mangrove Ecosystems: A Review of Valuation Methods'. Marine Pollution Bulletin 109 (2): 676–81. https://doi.org/10.1016/j.marpolbul.2016.01.033.

———. 2017. 'Valuation of Mangrove Restoration'. Oxford Research Encyclopedia of Environmental Science 1: 1–22. https://doi.org/10.1088/1367-2630/11/12/125023.

Bennett, Elena M., Garry D. Peterson, and Line J. Gordon. 2009. 'Understanding Relationships among Multiple Ecosystem Services'. Ecology Letters 12 (12): 1394–1404. https://doi.org/10.1111/j.1461-0248.2009.01387.x.

Beymer-Farris, Betsy A., and Thomas J. Bassett. 2012. 'The REDD Menace: Resurgent Protectionism in Tanzania's Mangrove Forests'. Global Environmental Change 22 (2): 332–41. https://doi.org/10.1016/j.gloenvcha.2011.11.006.

Boyd, James, and Spencer Banzhaf. 2007. 'What Are Ecosystem Services? The Need for Standardized Environmental Accounting

Units'. Ecological Economics 63 (2–3): 616–26. https://doi.org/10.1016/j.ecolecon.2007.01.002.

Braat, Leon C., and Rudolf de Groot. 2012. 'The Ecosystem Services Agenda:Bridging the Worlds of Natural Science and Economics, Conservation and Development, and Public and Private Policy'. Ecosystem Services 1 (1): 4–15. https://doi.org/10.1016/j.ecoser.2012.07.011.

Brander, Luke M., Raymond J.G.M. Florax, and Jan E. Vermaat. 2006. 'The Empirics of Wetland Valuation: A Comprehensive Summary and a Meta-Analysis of the Literature'. Environmental and Resource Economics. https://doi.org/10.1007/s10640-005-3104-4.

Brown, Katrina, W. Neil Adger, Emma Tompkins, Peter Bacon, David Shim, and Kathy Young. 2001. 'Trade-off Analysis for Marine Protected Area Management'. Ecological Economics 37 (3): 417–34. https://doi.org/10.1016/S0921-8009(00)00293-7.

Bryan-Brown, Dale N., Rod M. Connolly, Daniel R. Richards, Fernanda Adame, Daniel A. Friess, and Christopher J. Brown. 2020. 'Global Trends in Mangrove Forest Fragmentation'. Scientific Reports 10 (1): 1–8. https://doi.org/10.1038/s41598-020-63880-1.

Corte, Guilherme N., Helio H. Checon, Yasmina Shah Esmaeili, Jonathan S. Lefcheck, and A. Cecília Z. Amaral. 2021. 'Mangrove Fragments as Key Coastal Reservoirs of Taxonomic and Functional Biodiversity'. Biodiversity and Conservation 30 (5): 1573–93. https://doi.org/10.1007/s10531-021-02158-y.

Costanza, Robert, Ralph D'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, et al. 1997. 'The Value of the World's Ecosystem Services and Natural Capital'. Nature TA - TT - 387 (6630): 253–60. https://www-nature-com.ezproxy.royalroads.ca/articles/387253a0.pdf.

Crossman, Neville D., Benjamin Burkhard, Stoyan Nedkov, Louise Willemen, Katalin Petz, Ignacio Palomo, Evangelia G. Drakou, et al. 2013. 'A Blueprint for Mapping and Modelling Ecosystem Services'. Ecosystem Services 4: 4–14. https://doi.org/10.1016/j.ecoser.2013.02.001.

Daily, Gretchen C. 1997. 'Nature's Services: Societal Dependence on Natural Ecosystems'. Nature 388 (6642): 529. https://doi.org/10.1023/a:1023307309124.

Das, Saudamini. 2017. 'Ecological Restoration and Livelihood: Contribution of Planted Mangroves as Nursery and Habitat for Artisanal and Commercial Fishery'. World Development 94: 492–502. https://doi.org/10.1016/j.worlddev.2017.02.010.

———. 2022. 'Valuing the Role of Mangrove in Storm Damage Reduction in Coastal Areas of Odisha'. In Climate Change and Community Resilience, edited by A.K.E. Haque, Pranab Mukhopadhyay, Mani Nepal, and M. Rumi. Shammin. Springer Nature Singapore. https://doi.org/10.1007/978-981-16-0680-9.

Das, Saudamini, and Jeffrey R Vincent. 2009. 'Mangroves Protected Villages and Reduced Death Toll during Indian Super Cyclone'. The Proceedings of the National Academy of Sciences 106 (18): 7357–60. www.pnas.org/cgi/content/full/.

Dhakal, Kerry. 2022. 'NVivo'. Journal of the Medical Library Association. Medical Library Association. https://doi.org/10.5195/jmla.2022.1271.

Díaz, Sandra, Sebsebe Demissew, Julia Carabias, Carlos Joly, Mark Lonsdale, Neville Ash, Anne Larigauderie, et al. 2015. 'The IPBES Conceptual Framework - Connecting Nature and People'. Current Opinion in Environmental Sustainability 14 (June): 1–16. https://doi.org/10.1016/j.cosust.2014.11.002.

Dixon, John, and Stefano Pagiola. 1998. 'Economic Analysis and Environmental Assessment'. In Environmental Assessment Sourcebook. Environmental Department The World Bank. https://www.researchgate.net/publication/240621224.

Ebersole, Rene. 2018. 'Trinidad's Dazzling National Bird Is Served Up as Bush Meat'. National Geographic. 2018. https://www.nationalgeographic.co.uk/animals/2018/08/trinidads-dazzling-national-bird-is-served-up-as-bush-meat.

Elwin, Angie, Jacob J. Bukoski, Vipak Jintana, Elizabeth J.Z. Robinson, and Joanna M. Clark. 2019. 'Preservation and Recovery of Mangrove Ecosystem Carbon Stocks in Abandoned Shrimp Ponds'. Scientific Reports 9 (1): 1–10. https://doi.org/10.1038/s41598-019-54893-6.

FAO. 2007. 'North and Central America'. In The World's Mangroves 1980-2005 FAO Forestry Paper 153, 29–36. Rome: Food and Agriculture Organization of the United Nations.

Fisher, Brendan, R. Kerry Turner, and Paul Morling. 2009. 'Defining and Classifying Ecosystem Services for Decision Making'. Ecological Economics 68 (3): 643–53. https://doi.org/10.1016/j.ecolecon.2008.09.014.

Friess, Daniel A. 2016. 'Mangrove Forests'. Current Biology 26 (16): R746–48. https://doi.org/10.1016/j.cub.2016.04.004.

Friess, Daniel A., Kerrylee Rogers, Catherine E. Lovelock, Ken W. Krauss, Stuart E. Hamilton, Shing Yip Lee, Richard, Lucas, Jurgenne Primavera, Anusha Rajkaran, and Suhua Shi. 2019. 'The State of the World's Mangrove Forests: Past, Present and Future'. Annual Review of Environment and Resources 44: 89–115. https://doi.org/https://doi.org/10.1146/annurev-environ-101718-033302.

Friess, Daniel A., Erik S. Yando, Jahson B. I Alemu, Lynn-Wei Wong, Sasha D. Soto, and Natasha Bhatia. 2020. 'Ecosystem Services and Disservices of Mangrove Forests and Salt Marshes'. In Oceanography and Marine Biology: An Annual Review, 58:107–42.

Gill, P., K. Stewart, E. Treasure, and B. Chadwick. 2008. 'Methods of Data Collection in Qualitative Research: Interviews and Focus Groups'. British Dental Journal 204 (6): 291–95. https://doi.org/10.1038/bdj.2008.192.

Glaser, Barney G., and Anslem L. Strauss. 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research. Adline Transaction.

Groot, R. S. de, R. Alkemade, L. Braat, L. Hein, and L. Willemen. 2010. 'Challenges in Integrating the Concept of Ecosystem Services and Values in Landscape Planning, Management and Decision Making'. Ecological Complexity 7 (3): 260–72. https://doi.org/10.1016/j.ecocom.2009.10.006.

Himes-Cornell, Amber, Susan O. Grose, and Linwood Pendleton. 2018. 'Mangrove Ecosystem Service Values and Methodological Approaches to Valuation: Where Do We Stand?' Frontiers in Marine Science 5 (OCT): 1–15. https://doi.org/10.3389/fmars.2018.00376.

Howe, Caroline, Helen Suich, Bhaskar Vira, and Georgina M. Mace. 2014. 'Creating Win-Wins from Trade-Offs? Ecosystem Services for Human Well-Being: A Meta-Analysis of Ecosystem Service Trade-Offs and Synergies in the Real World'. Global Environmental Change 28 (1): 263–75. https://doi.org/10.1016/j.gloenvcha.2014.07.005.

Hutchison, James, Mark D Spalding, and Philine Zu Ermgassen. 2014. 'The Role of Mangrove in Fisheries Enhancement'. Cambridge. www.nature.org.

IMA. 1995. 'Management Plan For The Buccoo Reef Marine Park Volume II-The Management Plan'. Carenage, Trinidad and Tobago.

———. 2020. 'Trinidad and Tobago's Mangrove Forest Distribution'. Mangrove Forests of Trinidad and Tobago Book. 2020. https://www.arcgis.com/apps/dashboards/b3a74c4b6df742d9bfdf76f95028a0ce.

Imbert, Daniel. 2018. 'Hurricane Disturbance and Forest Dynamics in East Caribbean Mangroves'. Ecosphere 9 (7). https://doi.org/10.1002/ecs2.2231.

IPBES. 2019. The Global Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Edited by Eduardo Sonnewend Brondízio, Josef Settele, Sandra Díaz, and Hien Thu Ngo. Bonn, Germany: IPBES secretariat. https://doi.org/10.5281/zenodo.3831673.

Juman, Rahanna A. 2004. 'Characterisation and Ecology of the Bon Accord Lagoon, Tobago, West Indies'. The University of the West Indies, St Augustine Campus.

Juman, Rahanna, and Kahlil Hassanali. 2013. 'Mangrove Conservation in Trinidad and Tobago, West Indies'. Mangrove Ecosystems, no. 5: 35–63.

Juman, Rahanna, and Deanesh Ramsewak. 2013a. 'Land Cover Changes in the Caroni Swamp Ramsar Site, Trinidad (1942 and 2007): Implications for Management'. Journal of Coastal Conservation 17 (1): 133–41. https://doi.org/10.1007/s11852-012-0225-0.

———. 2013b. 'Status of Mangrove Forests in Trinidad and Tobago, West Indies'. Caribbean Journal of Science 47 (2–3): 291–304. https://doi.org/10.18475/cjos.v47i3.a18.

Kathiresan, K. 2012. 'Importance of Mangrove Ecosystem'. International Journal of Marine Science. https://doi.org/10.5376/ijms.2012.02.0010.

Krueger, Richard A, and Mary Anne Casey. 2015. 'Focus Group Interviewing'. In Handbook of Practical Program Evaluation, edited by K Newcomer, H Hatry, and J Wholey, 4th edition, 506–34. John Wiley & Sons. http://ebookcentral.proquest.com/lib/umanitoba/detail.action?docID=2144898.

LoopTT. 2017. 'Conservation Group: Tobagonians "hoodwinked" over Sandals Plans'. 2017. https://tt.loopnews.com/content/conservation-group-tobago-hoodwinked-over-sandals-plans.

Lugo, Ariel E. 2002. 'Conserving Latin American and Caribbean Mangroves: Issues and Challenges'. Bosques Número Especial.

Mariel, Petr, David Hoyos, Jürgen Meyerhoff, Mikolaj Czajkowski, Thijs Dekker, Klaus Glenk, · Jette, et al. 2021. 'Environmental Valuation with Discrete Choice Experiments Guidance on Design, Implementation and Data Analysis'. Switzerland. http://www.springer.com/series/8876.

Marine Areas Preservation and Enhancement Act. 1970. Trinidad and Tobago. https://leap.unep.org/countries/tt/national-legislation/marine-areas-preservation-and-enhancement-act-cap-3702.

Marre, Jean Baptiste, Luke Brander, Olivier Thebaud, Jean Boncoeur, Sean Pascoe, Louisa Coglan, and Nicolas Pascal. 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 and Coastal Management 105: 1–14. https://doi.org/10.1016/j.ocecoaman.2014.12.010.

Masadeh, Mousa A. 2012. 'Focus Group: Reviews and Practices'. International Journal of Applied Science and Technology 2 (10). www.ijastnet.com.

Millennium Ecosystem Assessment. 2003. 'Ecosystems and Human Well-Being: A Framework for Assessment'. Washington DC.

———. 2005. Ecosystems and Human Well-Being : Synthesis. Washington DC: Island Press.

Mohajan, Devajit, and Haradhan Kumar Mohajan. 2022. 'Exploration of Coding in Qualitative Data Analysis: Grounded Theory Perspective'. Munich. https://mpra.ub.uni-muenchen.de/115551/.

Moore, G E. 2018. 'Mangrove Rapid Assessments Post-Hurricane Irma: Preliminary Results and Recommendations for the British Virgin Islands'. Durham.

Pascual, Unai, Patricia Balvanera, Sandra Díaz, György Pataki, Eva Roth, Marie Stenseke, Robert T. Watson, et al. 2017. 'Valuing Nature's Contributions to People: The IPBES Approach'. Current Opinion in Environmental Sustainability. Elsevier B.V. https://doi.org/10.1016/j.cosust.2016.12.006.

Pearce, David W., and Dominic. Moran. 1994. The Economic Value of Biodiversity. Earthscan.

Pearce, David. W, and Ece Özdemiroglu. 2002. 'Economic Valuation with Stated Preference Techniques : Summary Guide'. London: Dept. for Transport, Local Government and the Regions.

Pemberton, Carlisle A., and Kathleen Mader-Charles. 2005. 'Ecotourism as a Means of Conserving Wetlands'. Journal of Agricultural and Applied Economics 37 (2): 463–74. https://doi.org/10.1017/s1074070800006933.

Polidoro, Beth A., Kent E. Carpenter, Lorna Collins, Norman C. Duke, Aaron M. Ellison, Joanna C. Ellison, Elizabeth J. Farnsworth, 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.

Powell, Richard A, and Helen M Single. 1996. 'Focus Group'. International Journal for Quality in Health Care 8 (5): 499–504. https://academic.oup.com/intqhc/article-abstract/8/5/499/1843013.

Primavera, J. H. 2006. 'Overcoming the Impacts of Aquaculture on the Coastal Zone'. Ocean and Coastal Management 49 (9–10): 531–45. https://doi.org/10.1016/j.ocecoaman.2006.06.018.

Qureshi, Henna A., and Züleyha Ünlü. 2020. 'Beyond the Paradigm Conflicts: A Four-Step Coding Instrument for Grounded Theory'. International Journal of Qualitative Methods 19. https://doi.org/10.1177/1609406920928188.

RAMSAR. 2005. 'Buccoo Reef Bon Accord Lagoon Complex Ramsar Sites Information Service'. 2005. https://rsis.ramsar.org/ris/1496.

Richards, Daniel R., and Daniel A. Friess. 2016. 'Rates and Drivers of Mangrove Deforestation in Southeast Asia, 2000-2012'. Proceedings of the National Academy of Sciences of the United States of America 113 (2): 344–49. https://doi.org/10.1073/pnas.1510272113.

Rodríguez, Luis C., Unai Pascual, and Hermann M. Niemeyer. 2006. 'Local Identification and Valuation of Ecosystem Goods and Services from Opuntia Scrublands of Ayacucho, Peru'. Ecological Economics 57 (1): 30–44. https://doi.org/10.1016/j.ecolecon.2005.03.022.

Schleupner, Christine. 2008. 'Evaluation of Coastal Squeeze and Its Consequences for the Caribbean Island Martinique'. Ocean and Coastal Management 51 (5): 383–90. https://doi.org/10.1016/j.ocecoaman.2008.01.008.

Spalding, Mark D, F. Blasco, and C. Field. 1997. 'World Mangrove Atlas', 178.

Spalding, Mark D, Marice Leal, Gabby N Ahmadia, Lalao Aigrette, Dominic A Andradi-Brown, Yasmin Arquiza, Henriques Balidy, et al. 2021. 'The State of the World's Mangroves 2021'. www.mangrovealliance.organdwww.globalmangrovewatch.orgCONTACT:contact@mangrovealliance.orgmembership@mangrovealliance.org.

Spalding, Mark D, A. McIvor, FH. Tonneijck, S. Tol, and P. van Eijk. 2014. 'Mangroves for Coastal Defence Guidelines for Coastal Managers & Policy Makers'. www.nature.org.

Tansley, A.G. 1935. 'The Use and Abuse of Vegetational Concepts and Terms'. Ecological Society of America 16 (3): 284–307. https://doi.org/10.1038/bdj.2008.10.

THA. 2022. 'Prohibited Use of the Buccoo Reef Marine Protected Area'. 2022. https://www.tha.gov.tt/news/prohibited-use-of-the-buccoo-reef-marine-protected-area/.

Tietenberg, Thomas H. 2004. Environmental Economics and Policy. 4th ed. Pearson Addison Wesley. https://www.amazon.com/Environmental-Economics-Addison-Wesley-Tietenberg-2003-11-14/dp/B01K944WQO/ref=sr_1_9?crid=21W7YA4ZH21.

Tran, Loi X., and Andrew Fischer. 2017. 'Spatiotemporal Changes and Fragmentation of Mangroves and Its Effects on Fish Diversity in Ca Mau Province (Vietnam)'. Journal of Coastal Conservation 21 (3): 355–68. https://doi.org/10.1007/s11852-017-0513-9.

Turkelboom, Francis, Marijke Thoonen, Sander Jacobs, Marina Garcia-Llorente, Berta Martin-Lopez, and Pam Berry. 2015. 'Ecosystem Service Trade-Offs and Synergies (Draft)'. In , edited by M Potschin and K Jax. EC FP7 Grant Agreement no. 308428. www.openness-project.eu/library/reference-book.

Uddin, Md Shams, E. de Ruyter van Steveninck, Mishka Stuip, and Mohammad Aminur Rahman Shah. 2013. 'Economic Valuation of Provisioning and Cultural Services of a Protected Mangrove Ecosystem: A Case Study on Sundarbans Reserve Forest, Bangladesh'. Ecosystem Services 5: 88–93. https://doi.org/10.1016/j.ecoser.2013.07.002.

Upadhyay, V.P., R. Ranjan, and J.S. Singh. 2002. 'Human-Mangrove Conflicts: The Way Out'. Current Science 83 (11): 1328–36.

VisitTobago. 2022. 'Tobago Announces Ground-Breaking Hotel Developments at WTM'. 9 November 2022. https://www.visittobago.gov.tt/tobago-announces-ground-breaking-hotel-developments-wtm.

Vollstedt, Maike, and Sebastian Rezat. 2019. 'An Introduction to Grounded Theory with a Special Focus on Axial Coding and the Coding Paradigm'. In Compendium for Early Career Researchers in Mathematics Education, 81–100. http://www.springer.com/series/15585.


CAAES
The Caribbean Agro-Economic Society