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Informing Wetland Management: An Economic Valuation of Tam Giang - Cau Hai Lagoon, Vietnam

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Natural wetlands are ecosystems. They provide numerous goods and services for the local population inside a wetland or its periphery, and for communities in the wider landscape. Commonly the intrinsic and economic values of goods and services provided by wetlands are insufficiently considered in planning and decisions on socio-economic or sectoral development, to guide the conservation and wise use of wetland resources. This paper estimates the total economic value (TEV) of ecosystem services provided by the Tam Giang-Cau Hai (TG-CH) wetland lagoon in Vietnam, at US$77.291 mill. The estimate is based on various methods, for specific ecosystem services. Two wetland management options, including: (i) "Business as Usual" and (ii) Establishment of wetland conservation area (WCA) are formulated, to conduct a quantified benefit analysis. The option of establishing a TG-CH WCA is able to bring the significantly higher TEV (around US$178 mill.) than the "Business as Usual" over a 20-year time horizon 2016-2035. Our findings add to the empirical evidence suggesting that wetland conservation is not only good ecologically, but also viable economic policy. The study's results reinforce the significant economic value of wetland, and seek to support decision-making on wetland management strategies selection.

Key words: *Wetland management, economic value, Vietnam, Tam Giang-Cau Hai.*

Introduction

Wetlands - natural and anthropogenic - cover an estimated 30% of Vietnam's total land area (around 10 mill. hectares - ha), and are extremely diverse in type, morphology, resources, biological value and functions (VEPA, 2005). The wetland systems have contributed greatly to the recent economic development of Vietnam, both directly and indirectly. They underpin numerous economic activities, notably within agriculture, fisheries and tourism. Wetlands

also contribute to the maintenance of critical ecological functions, including water purification, flood and erosion control, protection against storm surges, climate change mitigation through carbon storage, and maintenance of habitat for biodiversity. The diversity of Vietnam's wetlands, specifically its natural wetland types, supports a wealth of flora and fauna species of both global and national significance, notably numerous fish, bird and invertebrate species, including many endemic and globally threatened species.

Despite widespread understanding as to the multiple benefits of wetlands, and a general commitment to conserve wetlands in Vietnam, they are among the most abused and neglected ecosystems, and continue to be degraded as the result of a multitude of human development activities (Nguyen et al., 2016a; VEPA, 2005). The conversion of natural wetlands to agriculture, especially to rice paddies and, more recently, to aquaculture ponds, has emerged as a major, direct threat to the natural wetlands in Vietnam. Moreover, the pollution from agricultural production, industrial facilities, the over-exploitation from fishing, bird hunting and collection of mineral and organic materials, also seriously threatens natural wetlands. Over the past 20 years, 183,724 ha of mangrove forests have been lost to the country, while aquacultural areas have increased to 1.1 mill. ha (VEPA, 2005). In the Mekong delta, only 0.068 mill. ha of the original 4.0 mill. ha currently remains as primary wetland forest (Nguyen et al., 2016a). As reported by the Critical Ecosystem Partnership Fund (CEPF, 2012), Vietnam harbours over 40% of all globally threatened species in the entire Indo-Burmese biodiversity hotspot, including over 100 species found only in Vietnam. Meanwhile, threats to wetlands biodiversity are likely to keep growing (MONRE, 2016). This is mainly because the ecosystem services provided by wetland are not valued in economic terms, as a result of which the values of wetland are largely ignored in land-use decision-making, in planning and management. This situation is unlikely to change any time soon, given many competing demands on wetlands resources, and the continuing lack of recognition of wetlands values.

During the past three decades, research on the economic valuation of ecosystem services has grown fast, and gained broader attention. One important motivation for valuation studies has been to generate a better and more comprehensive informational base for policy formulation and decision-making. Such studies can inform societal decision mechanisms, to cope with the allocation of scarce resources among competing demands (McDonough, et al., 2017; Turner et al., 2003; Costanza, et al., 1997). A variety of studies have focused on the economic value of wetland around the world, although most have focused on some selected values of wetland (see, for example, Donato et al., 2011; Chong, 2005; Barbier & Cox, 2004; Sathirathai, 1997). A literature review also reveals that several studies have estimated the economic value of wetland, but only a few attempts have been made to evaluate changes in total economic value (TEV) under different management options (Wu et al., 2009; Gammage, 1997; Sathirathai, 1997; Bann, 1997). As for Vietnam, some works have related wetland valuation

recently. The timber value of Cangio mangrove was estimated at US$31.2 per ha per year, while net benefit from aquatic products was US$1.68 per ha/year (Nguyen et al., 2000). The wetlands' value associated with capture fisheries, aquaculture, timber, fuel wood and medicinal plants in Camau mangrove was worth US$362 at 2001 price level per ha per year (Do & Bennett, 2005). The economic value of clam exploitation in Xuanthuy national park was estimated to be between US$1,000-US$2,750 per ha/year; a great contribution to local community income (Moran & Vu, 2012). The tourism value of wetland areas in Vietnam was estimated at US$6-14 mill. in 2000 for Mun Islands (Pham & Tran, 2001); US$29.36 mill. in 2015 for Nhatrang Bay (Quach, 2019; Bui et al., 2017) and US$5.7 mill. for the Cangio mangrove (Dinh & Le, 2013). The recent study of MOE, Bird Life and Viet Nature (2016) estimated the net benefit of Thaithuy wetland at US$15 mill. per year, plus US$60.3 mill. of carbon storage function. As for TG-CH lagoon, Tran et al (2009) estimated the direct use values of TG-CH at US$296 per ha per year in 2005, while the estimated figure in 2002 was around US$2034.3-2301.21 per ha (Mai et al., 2003).

The review of recent papers on the economic valuation of wetlands, with a special Vietnamese focus, reveals that several studies have estimated the economic value of wetland. However, these have generally focused on some benefits derived from local wetlands. Only a few attempts (none in Vietnam) have been made to evaluate changes in economic value of wetland under different management options. As highlighted by Turner et al. (2003), it is just this type of study that is of great relevance to decision-makers faced with the complex trade-off between multiple uses of wetland. There is an urgent need for more research studies on wetland management strategies, to complement and extend the current environmental valuation knowledge stock. This study is conducted in such circumstances, to undertake an economic valuation of TG-CH wetland, to demonstrate the economic importance of the lagoon. The paper also aims at analysing the change in economic value of TG-CH wetland under different management scenarios. Information generated through this study is expected to advocate for mainstreaming wetlands values into development and land use planning. The present paper also contributes to the still short literature on the economic valuation of ecosystem services of wetland in developing countries, with Vietnam as a case study.

Research Methodology

Study Site

With an area of 21,620ha along the coast of Thua Thien Hue province in central Vietnam, TG-CH is considered the largest coastal lagoon system in Southeast Asia (Tran, 2007; MONRE, 2016). The lagoon system runs parallel to the East Sea for around 70km. It includes diverse habitat types, from river deltas to estuaries, with inlets surrounded by sand dune barriers, shallow open waters and seagrass beds. TG-CH lagoon is an extremely dynamic

system characterised by high levels of diversity, due to spatial and temporal variation in ecological conditions across the lagoon complex, particularly differences in salinity levels and between dry and rainy seasons. The lagoon is also an important nursery for both inland and marine fish species, as well as an important ground for birds, especially for migratory species. In total 921 species have been documented in TG-CH so far, including 287 phytoplankton species and 223 fish species, with six recorded in the Red Book of Vietnam (MONRE, 2016). Aquaculture, fisheries and agriculture in the lagoon are the main sources of livelihood, for approximately 300,000 people living in and around the lagoon (Tran et al., 2009).

Methods

To achieve the research objectives, we employ a mixed method design utilising both quantitative and qualitative methods. The economic value of wetland is assessed based on the TEV framework, while the economic analysis of wetland management options is investigated through wetland management options design and assessment.

Economic Value of Wetland

Total Economic Value. Goods and services resulting from TG-CH wetland are measured by applying the concept of TEV. TEV of ecosystem services is an economic term, which refers to all net benefits derived from the ecosystem. TEV can be subdivided into use and non-use values. Use values are benefits that arise from the actual use of the ecosystem, both directly and indirectly, such as fisheries, aquaculture, timber, fuel wood, tourism and provision of critical ecological functions. Non-use values include an existence value, which reflects the value of an ecosystem to humans, irrespective of whether it is used. TEV is a quantification of the full contribution ecosystems made to human wellbeing (Barbier et al., 1997).

Valuation Methods. The following methods have been used to value the economic goods and services from TG-CH. They are, by nature no different from the methods used to value any other type of environmental assets.

Market Price Method

The market price method estimates direct use values from TG-CH lagoon. When products are sold in the market, market prices are used to calculate the generated gross income. If the products are used only for subsistence, the gross income is calculated based on surrogate prices; i.e. the market prices of the closest substitute for such a product or opportunity cost of time and labour spent in collecting and processing the product from wetland.

Local direct use value = Net income generated for local use = {*PiQi - Ci*}

Where: *P* = prices of product *i*; *Q* = amounts of product *i* being collected; *C* = costs involved in the collection of product *i*.

Travel Cost Method

The travel cost method (TCM) is based on the expenditures incurred by households or individuals, to reach a site. The sum of travelling cost (including transportation cost, opportunity cost of time travelling and other expenditures such as accommodation, food etc.) and any induced cost, gives a proxy for market prices in a demand estimation. There is a general agreement in considering TCM as one of the most effective approaches in valuing recreation value. This study utilises the partial TCM method proposed by Merriman and Murata (2016), where annual value of nature-based recreation is estimated from the direct expenditure by visitors to the site, and the records of visitor numbers to the TG-CH wetland.

Recreational value = Total travel cost per visitor * visitor numbers to the site = *TCMi*Q*

Where: *TCMi* = Total individual travel cost per visitor; *Q* = number of visitors.

Contingent Valuation Method

The non-use of TG-CH wetland is measured using the contingent valuation method (CVM) through the administration of a survey questionnaire. The main aim of the CVM questionnaire survey is to ascertain people' willingness to pay (WTP) for biodiversity conservation in TG-CH lagoon. CVM is the most widely used method for estimating non-use values. A number of techniques for placing a value on non-marketed goods and services are available, such as the bidding game, the payment card, the discrete choice, and the close-ended approach. For this study, the close-ended approach explored the WTP for wetland biodiversity conservation. This approach is incentive compatible, when a survey is perceived by respondents as a potential source of influence on policy decision-making (Carson et al., 1999). The bids used in the WTP question are obtained through Focus Group Discussions (FGDs) with the local staff and people, and pretested for final use in the questionnaire.

Benefit Transfer Method

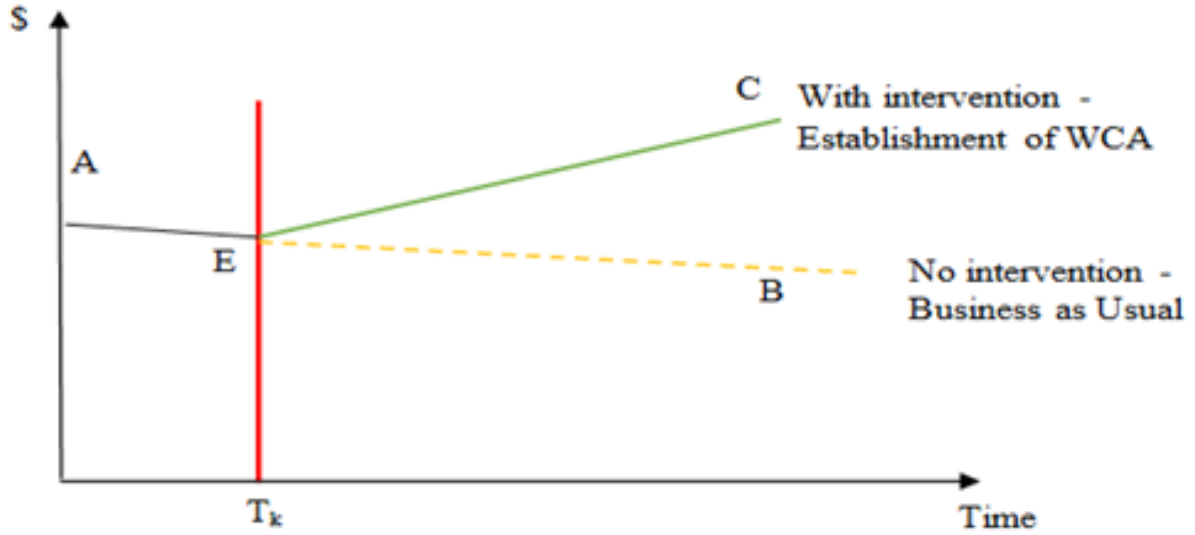
Benefit transfer is a valuing methodology. It estimates ecosystem economic values by transferring available information from one site, to a place where the valuation study cannot be performed, under the assumption that characteristics in both sites are similar. For this

study, the benefit transfer is applied to estimate the value arrived from agricultural activities, and the value of carbon storage and water purification by the TG-CH wetland.

Economic Analysis of Wetlands Management Options

Economic analysis of management strategies is based on the comparison of TEV of different management options (Figure 1). In this study, we consider two management options for TG-CH namely: (i) Maintenance of status quo or BAU (without intervention scenario) and (ii) Establishment of WCA (with intervention scenario). Previous studies indicated decreasing economic returns to scale and quality of wetland (Quach, 2019; Ghermandi et al., 2008; Griffen & Drake, 2008; Woodward & Wui, 2001; Hakoyama & Iwasa, 2000). Therefore, without intervention, the value of the goods and services provided by TG-CH wetland in future years is represented by the line A-B. The line A-B slopes slightly downward, under the assumption that current management practice will reduce the value of the wetland ecosystem services. An intervention with positive impacts on wetland ecosystem services is assumed to occur at time Tk. From time Tk the value of wetland ecosystem will increase according to the curve E-C, as result of the conservation efforts. A sensitivity analysis with different social discount rates is applied to analyse the change in benefit, created by different management options. All results are presented in terms of the value generated over the next twenty years, as a net present value (NPV) figure. NPV is based on a stream of present net benefits in which future values are altered from the current values, along the lines of feasible or expected growth or declines in value. A social discount rate of 10%, which has been widely used in developing countries (Dinh & Le, 2013; Tran et al., 2009; Do & Bennett, 2005), served as a base for calculation.

Figure 1. Wetland management option analysis



Source: Adapted from Balmford et al. (2008) and Merriman & Murata (2016)

Data Collection

Data was collected from different sources, including peer review, reports, FGDs and household and tourist surveys. The secondary data included information on wetland status, and a socioeconomic profile of local communities and resource users. Fishing and agriculture activities were obtained from the provincial Department of Agriculture and Rural Development (DARD), while tourist data was collected from the Department of Sport, Culture and Tourism (DOSCT). FGD was conducted with the participation of government representatives, local communities, fishers, aquaculture farmers and tourists. Based on information collected through direct interviews and FGDs, supported by information from available literature sources, key ecosystem services of the TG-CH lagoon were identified for estimating the TEV. These key ecosystem services included aquaculture, fish catching, sea-grass harvest, other agricultural activities, tourism, carbon storage, water purification and biodiversity conservation. A summary of key ecosystem services, methods and data is shown in Table 1.

Table 1: TG-CH wetland ecosystem services, valuation methods and data

	Ecosystem services	**Valuation method**	**Data source**
1	Aquaculture	Market-based pricing	FDG, secondary data from DARD, MONRE, household survey
2	Seagrass	Market-based pricing, benefit transfer	FDG, secondary data from DARD, Tran et al (2009)
3	Capture fishery	Market-based pricing	FDG, secondary data from DARD, MONRE, household survey
4	Agriculture activities	Market-based pricing, benefit transfer	FDG, secondary data from DARD, household survey, Tran et al (2009)
5	Tourism	TCM	FDG, secondary data from provincial DOSCT, tourist survey
6	Carbon storage	Benefit transfer	Donato et al. (2011) and Merriman & Murata (2016)
7	Water purification	Benefit transfer	Miguel et al. (1998),
8	Biodiversity	CVM	FDG, secondary data from DARD, household and tourist survey

For collecting the necessary data and information, between January and April 2017, a face-to-face household survey was conducted with 230 households in nine communes of six districts in and around TG-CH lagoon. These communes were selected based on the consultations and FGDs with district staff, and represented well the livelihoods and biodiversity of TG-CH. A

questionnaire with the specific questions to tourists was elaborated and delivered to 40 domestic and foreign tourists.

Results and Discussion

Valuation of Ecosystem Services for TG-CH
Direct Use Values

Aquaculture. The total area of aquaculture and fishery in TG-CH wetland in 2015 was 16,060 ha, in which 6,799 ha of aquaculture ponds and 9,261 ha of fishery harvest (MONRE, 2016 and Nguyen et al., 2016). The average area per household was 1,849m^2 for households with pond-farming of fish. The gross benefit per household per year from fish aquaculture was US$3,246.9[1] with market price of fish at US$6.22 per kg. The average benefit from aquaculture in TG-CH wetland in 2016 was US$17,560 per ha. Production costs of aquaculture included direct cost, depreciation cost of ponds, and other costs. Direct costs accounted for about 85% of total cost. Among items of direct costs, costs for buying feeds and seeds usually made up the largest part (77.32%), followed by labour cost (24.19%). The average cost of aquaculture in TG-CH wetland in 2016 was estimated at US$7,003.4 per ha. The average net profit from fish aquaculture was US$10,557 per ha per year. With the total area for aquaculture in the lagoon of 6,799 ha, the total net value is US$71.777 mill.

Seagrass. Seagrass and fresh water hydrophytes are harvested to provide feeds for livestock, poultry and fish in TG-CH. Seagrass in the lagoon is also harvested to provide fertiliser and organic matter for crops such as tobacco, red pepper and tomatoes. Every year 150,000 tons of sea grasses are harvested in TG-CH. The benefit transfer method is applied to estimate direct use benefit from seagrass products. According to Tran et al. (2009) in 2005 the seagrass products collected from the TG-CH lagoon provided a net benefit of US$128,222. With the annual inflation rate of 5%, the net benefit from the sea-grass products harvested from the TG-CH lagoon is estimated at US$0.214 mill.

Capture Fishery. There are different types of equipment (gear) for capture fishery in TG-CH lagoon such as fish traps, and the pushing net, drag net, drift net, fish-pot, gill net, cast netting, etc. Shrimp and fish are major products from capture fisheries in the lagoon. The capture fisheries production in the lagoon also provides other products such as crab and oyster. There are 1,635 fishing boats and vessels catching in the TG-CH wetland. On average one household in TG-CH has 1.4 boats. The annual income of a household from capture fishery in 2016 was estimated at US$4,742.7. The catching cost included regular costs (gas cost, labour cost, etc.) and equipment depreciation. A household catching fish expended

[1] The exchange rate is US$1=VND 22,344

US$391.1 for depreciation cost, US$600.1 for gas and petrol, US$899.1 for labour cost, and US$108.7 for other costs. The annual cost of a household was US$1,999.2. The household's annual net benefit from the fish catch was US$2,743.5 or US$1,959.3 per boat. With the total number of 1,635 fishing boats and vessels catching in the TG-CH wetland, the total benefit from capture fishery is estimated at US$3,204 mill.

Agricultural Activities. In TG-CH, the benefit from agriculture comes from two main activities: (i) rice cultivation and (ii) farming of aquatic poultry. According to Tran et al. (2009), gross benefit per ha of rice crop in 2005 was US$461 and the net benefit per ha was US$182.2. With the total area under rice cultivation in TG-CH of 2,176.79 ha, a total benefit of rice cultivation is estimated at VND36US$1.635 mill, with net benefit value of US$0.647 mill. The total benefit for aquatic poultry in the lagoon is estimated to be worth US$71,607.6 per year and the net benefit of aquatic poultry is US$0.05 mill. The agriculture value of TG-CH has a potential net annual return to the local economy of US$0.697 mill.

Tourism. TG-CH is unique in both natural and cultural values. The lagoon stretches along the East coast and tourists can also enjoy bathing on the beaches. There are some cultural heritage areas along the coast such as Champa tower, a Buddhist pagoda, and Catholic churches and family temples. Tourism is a new and welcome source of income for the household in TG-CH communes. A visit to TG-CH lagoon was established in 2010. Tourism costs may cover transportation cost, opportunity cost of time, and other expenditure such as on-site accommodation, food, transportation and souvenirs. Total economic value from tourism to TG-CH wetland in 2016 was estimated at US$0.383 mill.

Indirect Use Value

Carbon Storage. Wetlands can absorb a significant amount of carbon into the plant biomass through net primary production, and sequester some of this carbon in the soil for long periods. The value of carbon storage was estimated as based on carbon stocks and a price for carbon. The areas of different habitat types of TG-CH were identified from the land use map and MONRE (2016), Nguyen et al. (2016), and the absorption capacity of different wetland habitats was based on the works of Donato et al. (2011), and Merriman & Murata (2016). The price of Plan Vivo certification ($31.69 MgC, in 2016) was used for the calculation. The estimated value for total carbon storage in TG-CH wetland was US$10.83 mill. and the annual value was US$0.542 mill.

Table 2: Value of carbon storage in TG-CH wetland

	Habitat type in TG-CH wetland	**Area (ha)**	**Carbon storage (MgC/ha)**	**Total carbon storage in TG-CH wetland (MgC)**	**Estimated carbon storage value using Plan vivo price (US$ mill.)**
1	Mangrove forest	5.81(1)	1,023*	5,943.63	0.188
2	Intertidal mudflat	3,816.2(2)	88**	335,825.6	10.642
	Total value			341,769.23	10.830
	Annual value				**0.542**

(1) From Nguyen et. al. (2016); (2) From MONRE (2016)
(*) From Donato et al. (2011); (**) From Merriman and Murata (2016)

Water Purification. TG-CH wetlands act as sinks for wastewater from local communities and industrial plants in the area, and hence purifies water to some degree. The larger the size of the lagoon, the higher "self-purify" pollution capacity. Due to the lack of data on absorptive capacity of the TG-CH wetland, pollution sources and load entering the lagoon, the study employed the benefit transfer method to value the water purification function of TG-CH. Based on the work of Miguel et al. (1998), the value of water purification of TG-CH mangrove in the lagoon was estimated at US$1,193/ha/year or US$0.107 mill. per year.

Non-Use Value

The value of biodiversity conservation represented by the non-use of TG-CH lagoon was measured, using the CVM survey. The study targets two groups of respondents to assess the value of biodiversity: (i) local people and (ii) tourists both domestic and international.

WTP of Local People

TG-CH lagoon covers the wide areas of five districts of Quang Dien, Phong Dien, Phu Vang, Huong Tra and Phu Loc and part of Hue city. The mean WTP per household in each district was calculated directly from the survey. Phu Loc district has the highest mean WTP of US$4.92. Hue city has the lowest value of US$0.45. The mean WTP per household in TG-CH is US$3.02 per year. Aggregation of WTP, obtained by multiplying the mean WTP by the total annual number of households in each district, is shown in Table 4. It is estimated that households in TG-CH would be willing to pay for biodiversity conservation, annually, a total of US$364,931.

Table 3: Total WTP for biodiversity conservation

No.	District	No. of Households	WTP/household (US$)	Aggregate WTP (US$)
1	Hue	70,825	0.45	31,697.5
2	Phong Dien	18,588	3.02	56,278.6
3	Quang Dien	1,715	2.88	4,946.5
4	Huong Tra	23,229	3.02	70,332.8
5	Phu Vang	36,428	1.81	65,756.3
6	Phu Loc	27,625	4.92	135,919,8
	Total	**178,410**	**3.02**	**364,941.1**

WTP of Visitors

The WTP of visitors for biodiversity conservation in TG-CH was estimated by a tourist survey. A question "What is the maximum amount you would pay for visiting TG-CH wetland each time?" was asked of domestic and international visitors. Both agreed to pay for conservation of biodiversity and ecosystem services in TG-CH wetland. On average, each Vietnamese visitor is willing to pay US$0.67 per visitor, while the figure for international group is as high as US$3.50 per visitor. Table 4 displays the result of estimated WTP of visitors to TG-CH wetland every year.

Table 4: WTP of visitors to TG-CH lagoon

	Mean of WTP (US$)	Visitor number to TG-CH lagoon in 2016	Estimated tourism value (US$)
Domestic	0.67	975	653.25
International	3.50	525	1,837.5
Total		**1,500**	**2,490.75**

Total WTP for Biodiversity Conservation

The summary of WTP estimations by different stakeholders is presented in Table 5. It is estimated that the total WTP of the population living in and around TG-CH lagoon and visitors could reach US$0.367 mill.

Table 5: Summary of estimated WTP

Parameter	Local people	Visitor		Total
		Domestic	International	
Mean WTP (US$)	3.02	0.67	3.5	
Aggregate WTP (US$)	364,941.1	653.25	1,837.5	367,422.17

Total Economic Value of TG-CH Wetland

Economic value of TG-CH lagoon is a summing of direct use value, indirect use value and non-use value. The TEV of TG-CH lagoon in 2016 is estimated at US$77.291 mill., of which the direct use value - from fish catching, sea-grass harvest, agricultural activities, tourism - accounts for US$76.275 mill. (98.69%); the indirect use value - from carbon storage and water purification - US$0.649 mill. (0.84%) and the remaining of 0.47% came from non-use value or biodiversity value. The use values attributed to the direct utilisation of TG-CH wetland are significant. The role of aquaculture is very important. It exclusively made up to US$71.777 mill. (92.87 %) of TEV of the TG-CH lagoon. The estimated TEV and its components for TG-CH is higher than those obtained in Tran et al. (2009) and Mai et al. (2003). The key message here is that the value of wetland and natural assets much depends on valuation methods, tools and data availability. Clearly, this is an important issue that needs more attention in conducting economic valuation studies.

Table 6: Total economic value of TG-CH lagoon

Economic values		**Total value per year (US$ mill.)**	**%**
1. Direct use value		**76.275**	**98.69**
1.1	Aquaculture	71.777	92.87
1.2	Seagrass	0.214	0.28
1.3	Capture fishery	3.204	4.15
1.4	Agriculture activities	0.697	0.90
1.5	Tourism	0.383	0.50
2. Indirect use value		**0.649**	**0.84**
2.1	Carbon storage	0.542	0.70
2.2	Water purification	0.107	0.14
3. Non-use value		**0.367**	**0.47**
3.1	Biodiversity	0.367	0.47
TEV		**77.291**	**100**

Economic Analysis of Different Wetlands Management Options

This section is concerned with what will happen to TEV over time, under alternative management options. We make some key assumptions for different management options based on a literature review, the results of FGDs, and surveys. For the TEV estimation, we assume two cases of slow and rapid degradation/improvement of the wetland. In the first case, the TEV is assumed to change as the slow rate as the minimum trend. In the second case, we assume that wetland use intensifies, so the TEV changes at a maximum trend.

Wetlands Management Options

Two options for TG-CH management and key assumptions are described below.

Maintenance of Status Quo - "Business as Usual"

This option involves taking no major actions to conserve TG-CH. It represents a situation where existing local utilisation of wetland resources continues to expand in volume and area, and wetland areas continue to be given over to small-scale cultivation, in line with population growth. In practice, this option applies throughout much of the Vietnam wetlands including TG-CH, under current forms of management and levels of use.

Fish is the most important natural resource harvested in TG-CH. Local fishers described declines in the availability of this resource. The FGDs with local staff and community members reveal that population, pollution and overexploitation are the anticipated causes of reductions in the fish catch volume recently. These could decrease the net benefit from fishing by at least 3% per year to a maximum 10% per year. Aquaculture production and other activities would also be reduced by 2-5% due to the polluted water supply. For tourist development, TG-CH has recently attracted more visitors due to its unique characteristics and better access to the lagoon. The number of visitors would increase by an estimated rate of 2-3% per year. With the BAU scenario, the usual activities would not reduce the mangrove area. Therefore, the net benefit from carbon storage is supposed not to change. As for non-use value, with the loss of habitats, the biodiversity value of the wetland would be reduced at a rate of 2-5% per year.

Establishment of WCA in TG-CH

This option would involve setting in place measures to conserve the wetland, to utilise them sustainably, and to share their benefits equitably by establishing a WCA. This would involve some restrictions on wetland resource utilisation activities - those which are, or become, unsustainable. Sustainable, consumptive and non-consumptive, resource utilisation activities would be continued, and possibly further developed. It would also probably involve efforts to engage adjacent communities much more in wetland management, and to set in place a range of alternative rural development activities aiming to strengthen local livelihoods, including options to decrease local reliance on wetland products.

The benefits of WCA are broadly studied in the literature. Establishment of WCA has been shown to be an appropriate management tool for biodiversity conservation, sustainable fisheries and ecotourism. By implementing conservation activities, the pollution and overexploitation of fish in the wetland would be well controlled. This would contribute to

increasing aquaculture yields and fish catch volumes, as well as to reduce production costs. With better pollution controls and more friendly environmental management, seagrass collection, tourist development activities would be more developed. The mangrove forest coverage will increase and provide better functioning and regulating services. The net benefit of all services providing by mangrove forest is assumed to increase by 3-5% per year. The main assumptions for TG-CH management options analysis are shown in Table 7.

Table 7: Summaries of assumptions for TG-CH management options analysis

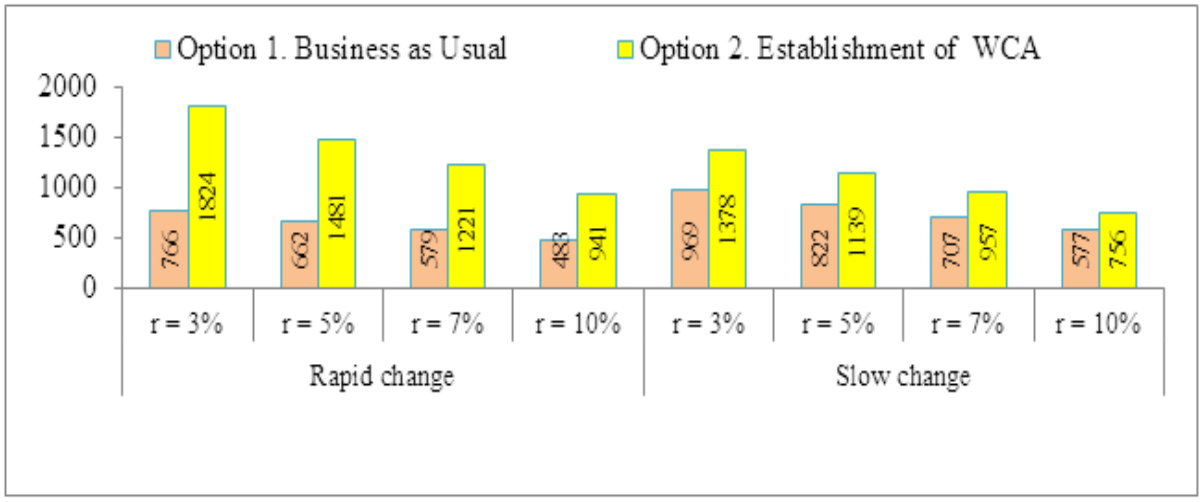
Option	**Impact**	**TEV**		**Sources of reference**
		Rapid change (%)	**Slow change (%)**	
Option 1. Status quo - "Business as Usual"	Direct use value - Aquaculture - Natural harvest/Seagrass and agriculture activities - Fishing - Tourism	 -5 -5 -10 +3	 -2 -2 -3 +2	Quach (2019), Ghermandi et al. (2008), Griffen & Drake (2008), Woodward and Wui (2001), Hakoyama & Iwasa (2000), FGDs
	Indirect use value	0	0	
	Non-use value	-5	-2	Bui et al. (2017), FDGs
Option 2. Establishment of WCA	Direct use value - Aquaculture - Natural harvest/Seagrass and agriculture activities - Fishing - Tourism	 +5 +5 +5 +10	 +2 +2 +3 +3	Quach (2019), Bui et al. (2017), IMOLA (2011), Halpern et al. (2009), Halpern (2003),
	Indirect use value	+5	+3	
	Non-use value	+10	+3	Bui et al. (2017), household survey, FDGs

Wetland Management Options Analysis

The first option attempts to estimate the NPV of TG-CH wetland, under a continuation of present conditions. Based on the findings of the static TEV estimation, the NPV of TG-CH wetland, in economic terms, could be calculated at US$483 mill. in case of rapid reduction and US$577 mill. in case of slow change (time horizon 20 years, discount rate of 10%). The

value also varies across different discounting rates. It was observed that, the higher discount rate, the lower the NPV. The option of WCA establishment would significantly improve the wetland environment, and the TEV of the wetland will rapidly increase. The TEV of the wetland for 20 years would range between US$756 mill. and US$1,824 mill. when the discounting rate changes from 3% per year to 10% per year.

Figure 2. Net benefit of TG-CH lagoon under different management options (US$ mill.)



The results of economic analyses clearly demonstrate that the TEV of the option with TG-CH WCA establishment is the highest (between US$756 mill. to US$1,824 mill. over a 20-year time horizon 2016-2035). The difference of TEV between WCA establishment and BAU options varies between US$178 mill. and US$1,057 mill., with the discount rate ranging from 3% to 10% per year under assumptions of slow and rapid degradation/improvement of the wetland resources. The findings appear to be similar with those of Wu et al., (2009), Halpern et al. (2009), Halpern (2003), and Sathirathai (1997) and Bann (1997). Establishment of WCA is found to have positive impacts on the TEV of wetland in the long run. However, it should be noted that the TEV difference, obtained between the different wetland management options, strongly depends on a range of assumptions made.

Conclusion

As the largest coastal lagoon system in Southeast Asia, TG-CH lagoon wetland provides varieties of ecosystem services. The principal ecosystem services in TG-CH were found to be fishing, aquaculture, tourism, sea grasses, carbon storage, water purification and biodiversity. Various valuation methods were used to estimate the values of individual ecosystem services. While market price method was used for valuing the ecosystems services of aquaculture, fish catching and other agricultural activities, the benefit transfer was used for estimating the value of carbon storage and water purification. In addition, TCM was used for estimating the

tourism services. CVM was employed for valuing biodiversity conservation. The TEV of TG-CH in 2016 was estimated at US$77.291 mill., of which the direct use value accounted for 98.69%; the indirect use value - 0.84% and the remaining of 0.47% came from non-use value or biodiversity value. With a wide range of goods and services provided by TG-CH wetland, significant social and economic benefits have been obtained.

Two different wetland management options with various assumptions on discount rate and the growth rate of wetland resources were formulated, to conduct a quantified benefit analysis so as to show the economic value of different options. An analysis of the status quo situation showed that the values obtained from the TG-CH wetland are likely to be compromised in future, due to lack of sustainable management. Higher values would be generated under a management option of establishing WCA over a 20-year time horizon 2016-2035. This indicates that attempting to establish WCA is the right approach to deal with biodiversity conservation and sustainable use of wetland in Vietnam. Our findings added to the empirical evidence suggesting that wetland conservation is not only good ecologically, but also a viable economic policy. However, it should be noted that the qualitative analysis of these management options and strategies is highly subjective and may differ according to the assumptions made.

The case study of the TG-CH wetland provided a gross assessment of ecosystem services in a scientific way, and assessed how these would change were the wetland altered under different management options. This provided information to decision-makers about the importance of the wetland ecosystems in TG-CH, in terms of their contribution to the development and wellbeing of the local people. Though the research scope is limited to TG-CH wetland, policy makers, researchers and local communities may find applicability for other locations, as this study gave an illustrative reference for assessing wetland management strategies in Vietnam. It is also expected that academics and a wider civil society audience who are involved in biodiversity conservation and sustainable use of wetland, will also benefit from the study.

REFERENCES

Balmford, A., Rodrigues, A.S.L., Walpole, M., Brink, P., Kettunen, M., Braat, L., & R. De Groot (2008). *The economics of biodiversity and ecosystems: Scoping the science.* Cambridge, UK: European Commission.

Barbier, E. B., Acreman M., & Knowler, D. (1997). *Economic valuation of wetlands: A Guide for policy makers and planners.* Gland, Switzerland.: Ramsar Convention Bureau.

Barbier, E.B., & Cox, M. (2004). An economic analysis of shrimp farm expansion and mangrove conversion in Thailand, *Land Economics*, 80(3):389-407

Bann, C. (1997). *An economic analysis of alternative mangrove management strategies in Koh Kong Province, Cambodia.* EEPSEA Research Report.

Bui, X.B., Sandorf, E. D. & Aanesen, M., (2017). Informing management strategies for a reserve: Results from a discrete choice experiment survey. *Ocean and Coastal Management,* 145, 35-43.

Carson, R.T., Flores, N.E., & Mitchell, R.C. (1999). *The theory and measurement of passive use value*, in by Bateman, I.J. & Willis, K.G., eds., Valuing Environmental preferences: Theory and practice of the contingent valuation method in the USA, EC, and developing countries. New York: Oxford University Press, 97-130.

CEPF (2012). Ecosystem profile Indo-Burma biodiversity hotspot: 2011 update.

Chong, J. (2005*). Valuing the role of wetlands in livelihoods: Constraints and opportunities for*
community fisheries and wetland management in Stoeng Treng Ramsar site, Cambodia. IUCN Water, Nature and Economics Technical Paper No. 3, IUCN - The World Conservation Union, Ecosystems and Livelihoods Group Asia, Colombo.

Costanza, R., Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, J., Raskin, R., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature,* 387, 253-260.

Dinh, D.T., & Le, H.T. (2013). *Valuing environmental and natural resources: From the theory to application in Vietnam,* Transportation publishing house, Hanoi, Vietnam.

Do, N.T., & Bennett, J. (2005). *Economic valuation of wetlands in Vietnam's Mekong Delta: a case study of direct use values in Camau province*. Occasional Paper No. 8. Environment Management and Development Program, Asia Pacific School of Economics and Government, The Australian National University.

Donato, D.C., Kauffman, J.B., Murdiyarso, D., Kurnianto, S., Stidham, M., & Kanninen, M. (2011). Mangroves among the most carbon-rich forests in the tropics. *Nature Geoscience,* 4, 293-297

Gammage, S. (1997). *Estimating the returns to mangrove conversion: sustainable management or short term gain?* International Institute for Environment and Development, Environmental Economics Programme, Discussion Paper, 97-02, London, UK

Ghermandi, A., van den Bergh, J.C.J.M., Brander, L.M., de Groot, H.L.F., & Nunes, P.A.L.D. (2008). *The Economic value of wetland conservation and creation: A Meta-analysis.* The Fondazione Eni Enrico Mattei report, Milano, Italy.

Griffen, B. D., & Drake, J. M. (2008). *Effects of habitat quality and size on extinction in experimental populations.* Proceedings of the Royal Society of London: Biological Sciences, 275(1648), 2251- 2256.

Hakoyama, H., & Iwasa, Y. (2000). Extinction risk of a density-dependent population estimated from a time series of population size. *Journal of Theoretical Biology,* 204(3), 337-359.

Halpern, B.S. (2003). The impact of marine reserves: do reserves work and does reserve size matter? *Ecological Applications*, 13(1), 117-137.

Halpern, B.S., Lester, S.E., & Kellner, J.B. (2009). Spillover from marine reserves and the replenishment of fished stocks. *Environmental Conservation*, 36(4),268-276.

IMOLA (2011). Proceedings of IMOLA sixth technical workshop, Thua Thien Hue, Vietnam.

Mai T.N. et al. (2003). *Economic valuation of demonstration wetland sites in Vietnam.* Vietnam component wetland report. Hanoi, Vietnam.

McDonough, K., Hutchinson, S., Moore, T., & Hutchinson, J. S. (2017). Analysis of publication trends 33 in ecosystem services research. *Ecosystem Services,* 25, 82-88.

Merriman, J.C., & Murata, N. (2016). *Guide for rapid economic valuation of wetland ecosystem services*. BirdLife International Tokyo, Japan.

Miguel, A. C., Seijo, J.C., Jorge, E., & Pérez, E. (1998). *Economic values of ecological services from a mangrove ecosystem.* International Newsletter of Coastal Management, Narragansett, Rhode Island, US.

Ministry of Environment of Japan, Bird Life and Viet Nature (2016). *Benefits of ecosystem services provided by Thaithuy wetland in Vietnam.* BirdLife International Tokyo, Japan.

MONRE [Ministry of Natural Resources and Environment] (2016), *Tam Giang-Cau Hai biodiversity assessment report.* MONRE. Hanoi, Vietnam

Moran, D., & Vu, T.P. (2012) *Ecosystem service valuation and payment mechanisms applied to Xuan Thuy national park.* Removing barriers hindering protected area management effectiveness in Vietnam project reprot. Hanoi,Vietnam.

Nguyen, H.T et al. (2000). *Valuation of the mangrove ecosystem in Can Gio mangrove biosphere reserve, Vietnam.* UNESSCO/MAB Project report. Hanoi, Vietnam.

Nguyen, H.H., Dargusch, P., & Moss, P. (2016a). A review of the drivers of 200 years of wetland degradation in the Mekong Delta of Vietnam. *Regional Environmental Change*, 16, 2303-2315

Nguyen, V.Q., Nguyen, T.T., Chu, T.C., Nguyen, D.T., Dam, D.T., Thanh, T., Vu, D.V., Dang, H.N., Ve, N., & Dinh, V.N. (2016b). *Degradation level and rehabilitation solutions of some coastal lagoons in central provinces.* Publishing house for science and technology, Hanoi, Vietnam.

Pham, K.N., & Tran, V.H.S. (2001). Recreational value of the coral surrounding Mun Islands of Vietnam: a Travel cost and contingent valuation study. EEPSEA Research Report.

Quach, T.K.N. (2019). Assessing the value of coral reefs in the face of climate change: the evidence from Nhatrang Bay, Vietnam. *Ecosystem Services*, 35, 99-108

Sathirathai, S. (1998). *Economic valuation of mangroves and the roles of local communities in the conservation of natural resources: Case study of Surat Thani, South of Thailand*. EEPSEA Research Report.

Tran, D.T. (2007). Tam Giang-Cau Hai lagoon: Resource potential and orientation for management. *Journal of Science and Marine Technology*, 2007, 53-62

Tran D.T., Cu, N.H. & Lan, T.D. (1997). *Estimation of wetland potentials and the proposal to establish a wetland protected area of the Tam Giang coastal lagoon.* Project report managed by Thua Thien Hue DOSTE, Thua Thien Hue, Vietam.

Tran, H.T., Mai, V.X., Do, N., & Navrud, S. (2009). Valuing direct use values of wetlands: a case study of Tam Giang-Cau Hai lagoon wetland in Vietnam. *Ocean and Coastal Management*, 52, 102-112.

Turner R. K., Paavola J., Cooper P., Farber S., Jessamy V., & Georgiou S. (2003). Valuing nature:
lessons learned and future research directions. *Ecological Economics,* 46, 493-510

Woodward, R.T., & Wui, Y.S. (2001). The economic value of wetland services: a meta-analysis. *Ecological Economics,* 37, 257-270.

Wu, J., Wang, X., Niu, K., & Li, S. (2009). *Cost-effectiveness of policy options for sustainable wetland conservation.* EEPSEA Research Report.

VEPA [Vietnam Environment Protection Agency]. (2005). *Overview of wetlands status in Vietnam following 15 years of Ramsar convention implementation.* Hanoi, Vietnam.