Republic of Trinidad and Tobago

National Economic Assessment for Ballast Water Management

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1. INTRODUCTION

The twin island state of Trinidad and Tobago is located between 10^0 to 11^0 North latitude and 60^0 to 61^0 West longitudes and is the Caribbean's southernmost island state. Like most Caribbean small-island states, Trinidad and Tobago's coastal waters are an economically important natural resource and at the same time, a vulnerable one. Trinidad and Tobago's coastal waters contain some of the region's most productive biodiversity reserves and are also the location of rich and productive oil and gas reserves.

Trinidad and Tobago is a producer of oil and natural gas. The energy sector of Trinidad and Tobago is by far the most important contributor to the country's Gross Domestic Product (GDP), Government revenues and foreign exchange. In 2004, crude oil production averaged 122,902 barrels per day (bbl/d), while natural gas production averaged 2,938 million standard cubic feet per day (Ministry of Planning and Development Central Statistical Office, 2007). The petrochemical sector (including plants producing methanol, ammonia, urea, and natural gas liquids) has continued to grow in line with natural gas production, which continues to expand. Trinidad and Tobago is the fifth-largest exporter of Liquefied Natural Gas (LNG) in the world and the single largest supplier of LNG to the U.S., supplying between 70-75 % of all LNG imported into the U.S (Ministry of Planning and Development Central Statistical Office, 2007).

(1 .1) Shipping and Marine IAS

In order to accommodate Trinidad and Tobago's rapidly expanding energy sector, a strong maritime framework is important . This would allow support for continuing offshore exploration activity and the transportation of goods and services between the land and sea bases. In addition, the country has also developed into a major hub to facilitate trade between the smaller islands and countries in mainland South America which are major trans-shipment points between the Americas e.g. Guyana and Brazil. Trinidad and Tobago has 8 major ports, 2 of which are among the most highly developed in the Caribbean- the port of Point Lisas and the port of Port of Spain (Ministry of Trade, Industry and Investment, 2008).

Apart from the increased maritime shipping, Trinidad and Tobago has also seen a significant growth in the yachting industry over the last 30 years with numbers having increased 10-fold during the period 1980 to 2000. Being geographically outside of the hurricane belt, the islands offer a prime hurricane Caribbean shelter with excellent boating and repair facilities and the industry generates approximately US$ 40 million in revenue annually and employs over 2000 people locally (Tourist Development Company, Trinidad and Tobago). The global development in maritime shipping relates to such transport of oil and gas as well as recreational boating.

This development has resulted in the increasing and continuous movement of marine species from their native to non-native environments. While ballast water discharge from ships and tankers, has been identified as the primary pathway for the majority of invasions by non-indigenous species (Williams et al 1988; Carlton & Geller 1993; Ruiz *et. al.* 2000) recreational vessels are considered less likely to support extensive invasions (Carlton and Hodder 1995).

Marine biofouling occurs when living organisms (microorganisms, macroalgae and invertebrates) attach to any submerged or surface structure in the marine environment. This leads to subsequent biological deterioration costing the shipping industry millions of dollars every year worldwide (Hellio 2010). Similarly, where there is movement of ballast water carriers (e.g. ships, oil rigs, barges etc.) between geographic areas; they provide a pathway for the introduction of Invasive Alien Species (IAS). It is estimated that 3 to 5 billion tonnes of water are transferred across the globe each year (Tamelander *et. al.*, 2010). It is these IAS which are detrimental to the global economy, coastal ecosystems, biodiversity, fisheries (including mariculture), coastal infrastructure, human livelihoods and human health (GISP 2009). IAS has therefore become an increasing threat to marine and coastal environments and especially in terms of their negative impacts on biodiversity. The potential impact of such non-native species on marine ecosystems and coastal economies is a relatively new topic, particularly in the Caribbean.

IAS is an increasing threat to marine and coastal environments and their biodiversity because these organisms come from outside of their own region and present a complex set of both research and management challenges. Marine environments present exceptionally challenging conditions for the control of such bio-invasions (Meliane and Hewitt, 2005). In this respect, *Perna viridis*, the green mussel has already invaded the west coast of Trinidad and Tobago (Agard *et. al.* 1992), possibly having been introduced via ballast water. Unfortunately, the economic costs of this invasion were never calculated although coastal industries (at Point Lisas Industrial Estate and the Electric power company) suffered tremendous losses due to clogged pipes and waterways etc. This is, however, now being examined as part of an ongoing assessment of the regional project "Mitigating the Threats of Invasive Alien Species in the Insular Caribbean".

At a very simple level, one particular indigenous species may be threatened directly by the sudden proliferation of a predator or competitor species in a community. A number of such effects will cumulatively impact across biological scales resulting in more complex changes in terms of the availability of resources (e.g. nutrients, light, oxygen), the dynamics of competition for resources, and ecosystem structure and function (Kairo *et al.*, 2003). This in turn can have severe impacts on the biodiversity and ecosystem functions (which sustain associated resources) of our islands. Additionally, invasive species may out-compete local and commercially important

species resulting in direct economic concerns, for example where a fishery is threatened e.g. the Black Sea invasion of *Mnemiopsis leidyi*, a jellyfish (Ivanov *et. al.*, 2000) and the lionfish *(Pterois volitans*) invasion which has recently reached the Caribbean. Additionally, negative impacts on ecosystems such as coral reefs will in turn have direct and severe negative impacts on tourism and related economic sectors.

The Caribbean is considered a unique biogeographic region with endemic species and is among the top five world hotspots for marine and terrestrial biodiversity (Rivera-Monroy *et. al.* 2004). The region includes several island groups each with diverse tropical environments and a large number of endemic species many of which we are still not knowledgeable on (Miloslavich *et. al.* 2005).

Trinidad and Tobago became a member of the International Maritime Organization (IMO) in 1965. IMO's main task has been to develop and maintain a comprehensive regulatory framework for global shipping and its concerns today includes: safety, environmental concerns, legal matters, technical co-operation, maritime security and the efficiency of shipping. For example, the International Convention for the Prevention of Marine Pollution from Ships (the MARPOL Convention 1978) covers prevention of pollution of the marine environment by ships from operational or accidental causes (e.g. oil, chemicals, harmful substances in packaged form, sewage and garbage addressed in 6 technical annexes). The Shipping Marine Pollution Draft Bill (2004) once enacted will enhance the effectiveness of Trinidad and Tobago's activities under the MARPOL Convention (1978) Convention.

In the context of this assessment, General Obligations (under Article 2) of the Shipping Marine Pollution Bill (2004) are detailed as: "*Parties undertake to give full and complete effect to the provisions of the Convention and the Annex in order to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. Parties are given the right to take, individually or jointly with other Parties, more stringent measures with respect to the prevention, reduction or elimination of the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments, consistent with international law. Parties should ensure that ballast water management practices do not cause greater harm than they prevent to their environment, human health, property or resources, or those of other States".*

The most recent conventions in this area are (i) on anti-fouling systems to prevent the use of harmful anti-fouling systems on ships (AFS 2001) and (ii) on ballast water management to prevent the invasion of alien species through exchange of ships' ballast water (BWM 2004) and (iii) on ship recycling to ensure that ships, when being recycled after reaching the end of their operational lives, do not pose any unnecessary risks to human health, safety and to the environment (Hong Kong International Convention for the Safe and Environmentally

Sound Recycling of Ships, (2009). The Legal Review on issues related to BWM for Trinidad and Tobago (Best, 2012) describes in further details, the legislation of relevance to this economic assessment.

Invasions by alien species will have a negative impact on a number of ecosystems and resources from which we derive benefits. For example, the sustainability of the rich fishery associated with Trinidad and Tobago's coastal waters will be directly threatened by IAS. So too, there will be negative impacts on coral reefs, wetlands and other natural resources and all associated ecotourism activities. Such negative impacts will be directly translated to people's livelihoods and may directly reduce their incomes and hence their quality of life. Out of a total of approx. 30 ports in Trinidad and Tobago, about 12 or so handle ballast waters exchanges (Maritime Services Division, Ministry of Transport). The scale of oil tanker traffic and the growing number of recreational vessels within Trinidad and Tobago's waters only serve to highlight the point that dealing with marine IAS should be a high priority issue, since there will be direct impacts on the livelihoods and directly on the GDP of our small island state.

(1 .2) The Aim of the Economic Assessment

The overall aim of this economic assessment is to: provide information on the economic value of the natural resources of Trinidad and Tobago that may be negatively impacted on, as a result of potential bio-invasions due to ships' ballast waters. These values are based to a large extent on estimations since there is only very limited appropriate data available. The costs (again with many estimations) associated with the implementation of a National Ballast Water Management (NBWM) system have also been identified. These costs cover a range of activities: e.g. initial/preparatory actions, the legal, policy and institutional elements and compliance related costs in respect of Ballast Water Management (BWM). This assessment is an evaluation based therefore, on a combination of calculated (actual) values and estimated values for the BWM system implementation.

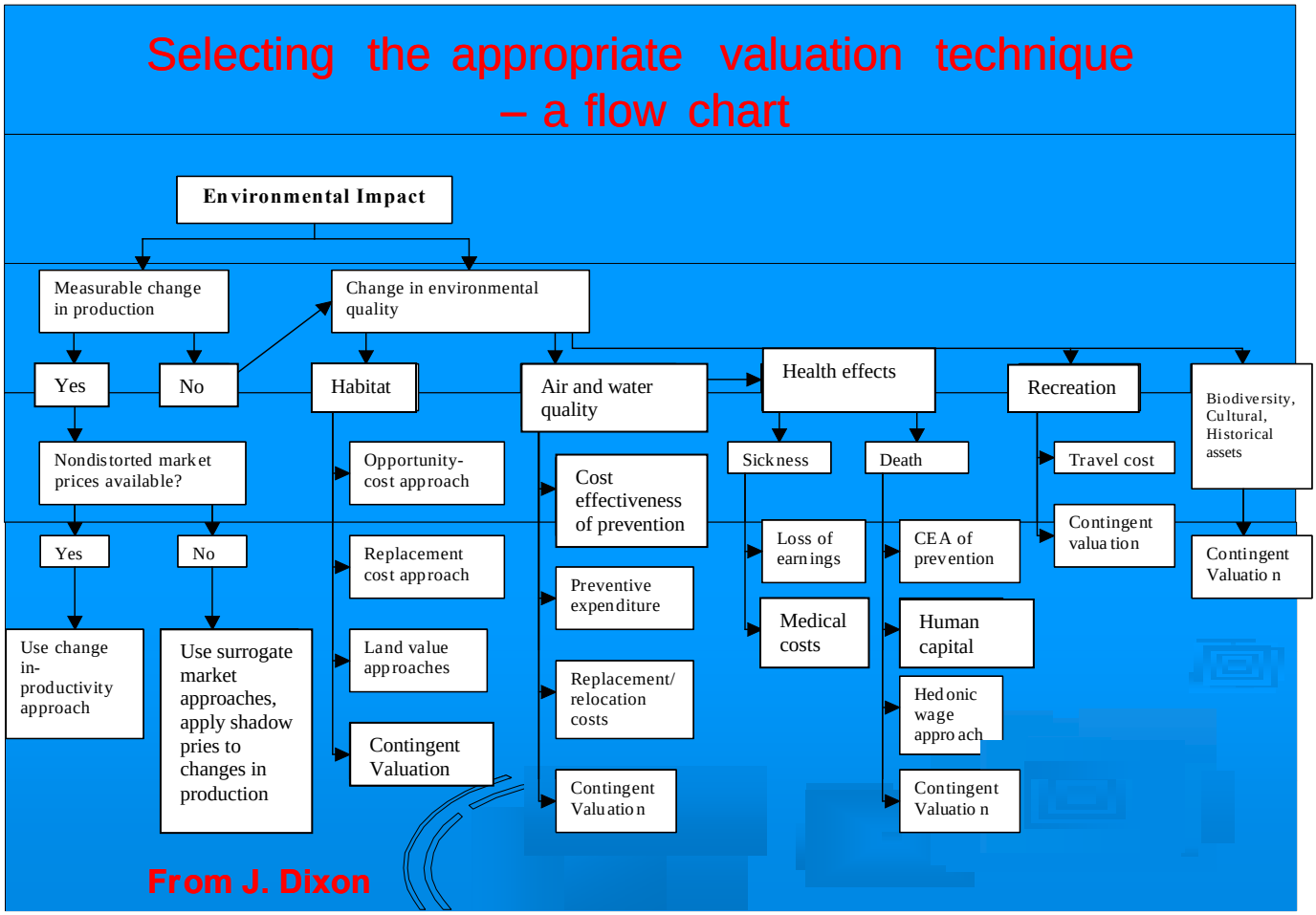
(1 .3) Sources of Information

Much of the formal national information and statistical data for Trinidad and Tobago was retrieved from: the Central Statistical Office (CSO), the Ministry of Planning and Development, the Environmental Management Authority (EMA) publications, the Institute of Marine Affairs (IMA) publications, the University of the West Indies (UWI) Publications and other relevant scientific information (both published and grey literature). The Maritime Services Division, Ministry of Transport provided information on the port and maritime related costs.

2. METHODOLOGY

There are a number of market and non-market-based techniques that can be used to value the environment. These techniques range from revealed preference procedures (market-based such as the productivity and market price methods and the surrogate market approaches such as the Travel Cost Method) to stated preference methods (non-market based such as contingent valuation and contingent choice). In the case where markets exist, a measure of the willingness to pay for an environmental good or service can be readily observed. Where there are no markets, or imperfect markets, values need to be determined by different techniques (questionnaires and surveys). The choice of valuation technique depends on data availability and many other factors depending on the environmental impact being considered (Fig. 1).

Fig. 1: Factors to consider when selecting an appropriate valuation technique



Source:

M.S. delos Angeles, World Bank Institute - available at: earthmind.net/rivers/docs/iwl-talk-methods-wbi.pdf

For this socio-economic assessment as it relates to BWM, the market price method was employed for valuing the resources potentially at risk from IAS. The main reason for this choice is that data for the other valuation types are not readily available. In fact, this is only now being researched/ studied in Trinidad and Tobago.

(2 .1) Market price analysis

This method estimates the economic values for environmental products or services that are bought and sold in a market. This is usually achieved by measuring the *use value of resources* traded in a market, and producing an estimate of the consumer surplus and producer surplus from price and quantity data. One of the disadvantages of employing this method stems from market imperfections and/or policy failures, which may create market distortions. These distortions can result in a failure to reflect the economic value of goods and services to society as a whole and produce a misleading conclusion of values.

3. ASSESSING THE ECONOMIC VALUE OF RESOURCES AT RISK

Globalization has had a significant positive impact on trade, transport and tourism, all of which can facilitate the introduction and eventual spread of alien species. According to the World Resources Institute, the annual value of the world's ecosystem services is roughly US$33 trillion (http://www.wri.org/publication/content/8381), which is approximately twice the value of its gross national product. These alien species can have substantial economic and environmental impacts on a country such as Trinidad and Tobago.

(3 .1) The value of Trinidad and Tobago's ecosystems

Trinidad and Tobago's coastal areas contain an array of rich biodiversity reserves including productive and critical habitats- coral reefs, sea grass beds, estuaries, mangrove forests and coastal swamps, beaches and bays. A number of these sites have been identified for global and regional priority, are considered among the "Global 200" list of top global priority ecoregions by World Wildlife Fund (WWF), and have been designated as Ramsar sites (World Bank/GEF 1999). The coastal areas account for approximately 90% of annual fish production at the same time they encompass scenic nature sites. Other coastal and marine resources include crustaceans (shrimps, lobsters, crabs), cephalopods (squid), cetaceans (marine mammals including whales, dolphins, and porpoises) and sea turtles. Trinidad and Tobago in fact supports the largest nesting assemblage of leatherback sea turtles in the insular Caribbean, and perhaps the second largest in the Western Hemisphere and the third or fourth largest in the world (Fournillier and Eckert 1998) and **(**Ministry of Planning and Development Central Statistical Office 2007). Even in the absence of potential bio-invasions, there is already widespread concern for the decline in numbers of some marine and coastal species e.g. the much reduced population of manatees (*Trichechus manatus manatus*) that are still present in the Nariva Swamp.

(3 .2) Key sectors and their economic value

For the purposes of this report and based on data availability (at present), focus shall be placed on the following key sectors: fisheries, coastal tourism and the coral reef ecosystem.

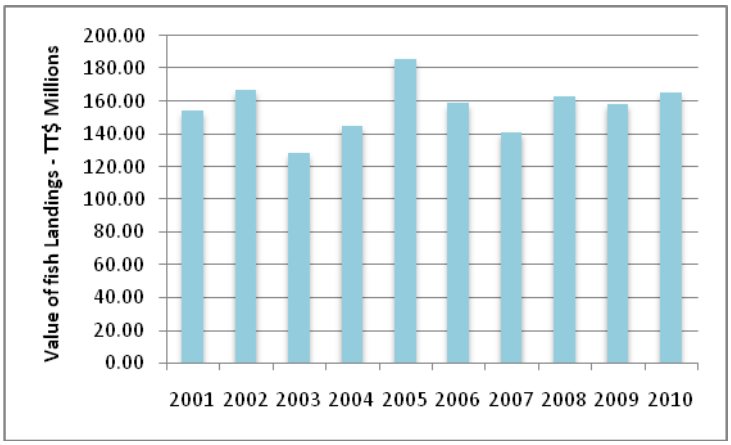
(3.2.1) Fisheries

Fishing occurs throughout the marine environment (near shore coastal waters and deep ocean) in Trinidad and Tobago and in estuaries. Today, the local fishing industry is largely artisanal, based on resources occurring in the coastal and territorial waters, and is characterized by multi-species, multi-gear and multi-fleet operations (Chan A Shing, 2002). Studies on the coastal and marine fisheries resources present in the waters under the jurisdiction of

Trinidad and Tobago have identified a total of 1,013 finfish species in 474 genera, 170 families and 36 orders (Ramjohn, 1999).

The following figure (Fig. 2) shows data on the value of fish landings in Trinidad and Tobago for the period 2001-2010.

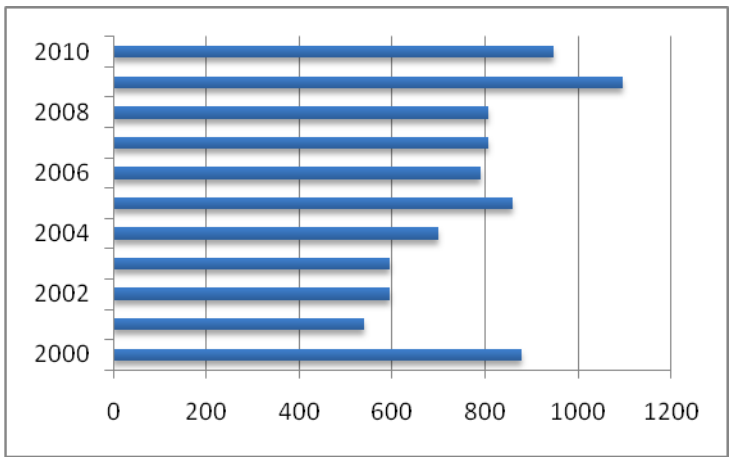
Fig. 2: Value of Fish Landings in Trinidad and Tobago: 2001-2010
(*Source: Fisheries Division, Trinidad and Tobago*)



In 2005 the value of fish landings were the highest for the period shown. In that year the marine fisheries sector contributed TT$63 million to the Gross Domestic Product (GDP). This represented 10% of the total GDP for agriculture, forestry and fishing and 0.09% of the national GDP (http://www.sidctt.com/Content.aspx?id=8).

The figure below (Fig. 3) shows the number of registered fishers in Trinidad and Tobago for the 2000-2010 period.

Fig. 3: Number of Registered Fishers in Trinidad and Tobago: 2000-2010
(*Source: Fisheries Division, Trinidad and Tobago*)



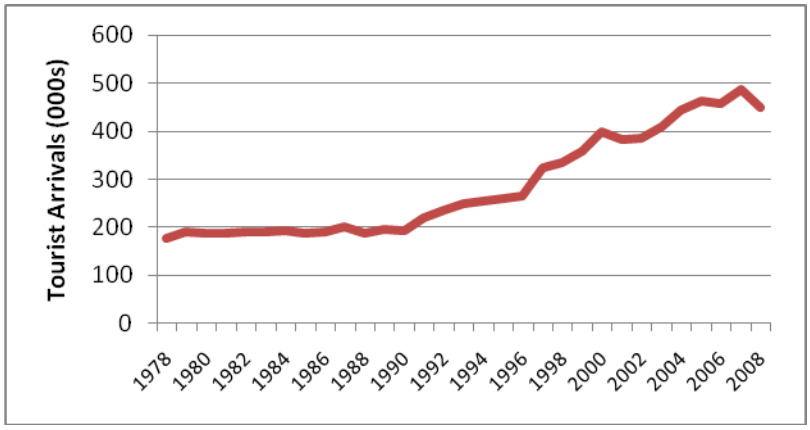
Approximately 63,000 persons are employed in the fishing sector with an eestimated 51,000 being fisher folk (Chan A Shing, 2002). With regard to employment, fisheries contributed 23.6% to employment (2003) in the agriculture, forestry and fishing sector and 1.18% to national employment. Although the contribution of fishing to the national GDP is relatively low, the livelihoods of several coastal communities tend to be dependent on fisheries.

(3.2.2) Coastal Tourism

In comparison to many other Caribbean countries, Trinidad and Tobago's tourism industry is currently at its growth stages; as the industry accounted for just over 1% of the 22.1 million international arrivals to the Caribbean in 2009. Separately the islands have different tourism development potentials, as each island has its own distinctive selling potential and targets different niche and source markets. In this respect, Tobago's tourist selling proposition is based on its beaches and reefs and is contributes more to the coastal tourism sub-sector of the total tourism sector. It was estimated that on an annual basis approximately 33% of visitors to Trinidad and Tobago use the coastal resources (Tourism Development Company, 2010). Several beaches in Trinidad and Tobago (Pigeon Point, Maracas, Mayaro etc.) are very popular for recreation and tourism – both local and foreign. The figure below (Fig. 4) shows tourist arrivals over a 30-year period in Trinidad and Tobago.

Fig. 4: Tourist arrivals to Trinidad & Tobago for the period 1978 – 2008.

(*source:Tourism Development Company, Trinidad and Tobago*)



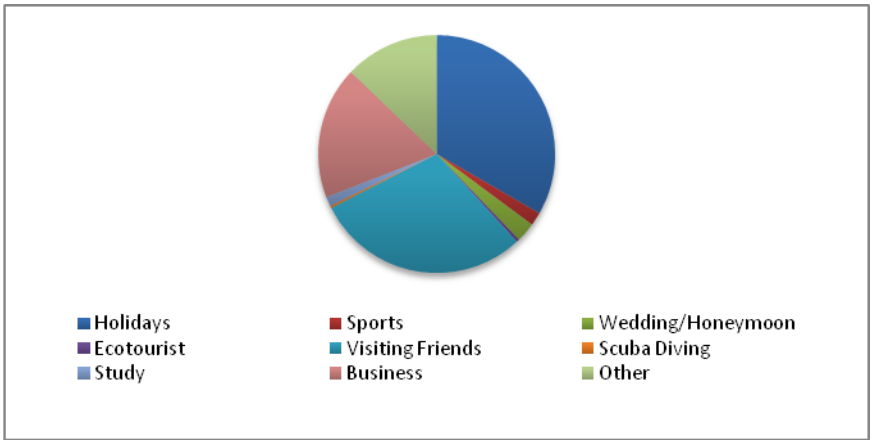
Tourists visiting Trinidad and Tobago spend approximately US$ 187.50 on average on tourist-related activities per day.

(3.2.3) Coral Reefs and associated Ecosystem values

The island of Tobago has approximately 70% of its' surrounding waters comprised of fringing and platform reefs and is where the world famous Buccoo Reef, is located. The amenity value of the Tobago coral reefs contributes significantly to the island's income. This was confirmed by the World Resources Institute (WRI, 2008) in an economic valuation report which estimated the value of coral reefs to Tobago's economy (at 2006) as between US$100 and US$130 million. In addition to this, the coral reef fisheries were believed to have an annual value of between US$0.8 and US$1.3 million (WRI, 2008).

Studies have shown that there has been significant loss of coral due to bleaching, pollution and sedimentation, human damage and storm/wave activity (IMA, 2010 and Ali 2009). Further, the annual value of shoreline protection services provided by coral reefs is estimated to be between US$ 18 and 33 million for Tobago in 2007 (World Resource Institute, 2008). With regard to tourists and the purpose of their visit, the available data shows that on average 0.4% of the tourists visit the islands for ecotourism and 0.3% for scuba diving, respectively (Fig. 5).

Figure 5: Tourist Arrivals According to Purpose of Visit – 2005
(*source:Tourism Development Company, Trinidad and Tobago*)



(3 .3) Economic Evaluations and Calculations for the 3 Key sectors

The table below (Table 1) shows the average annual cost of economic values for Fisheries, Coral reefs and Coastal tourism.

Table 1: Average Annual Cost of Economic Marketable Values for Key Sectors in Trinidad and Tobago

Direct use values - Key Sectors	Total	Number employed or dependent	Total value of Sector (M-million)
Fisheries (marine)	13,942[a] (catch)	63,000 [a1]	26.48 M $US [a]
Coral Reef (fisheries and reef tourism)	9,432[b] (no. resource users)	32,400 [c]	0.83 - 1.37 M $US [b]
Coastal tourism Hotel and restaurant Activities (e.g. beach visits, sightseeing, yachting)	138,166 [d] (no. resource users)	15,939 [d]	0.54 M $US [d]

source: [a] Fisheries Division Figures for 2010, [a1] Chan A Shing, Fisheries Division (2002)
[b] calculated based on 40% of average visiting population and [c] approx. 60% on population of Tobago employed (after WRI 2006 and 2008),
[d] WRI (2006 and 2008)

The estimated costs above suggest a combined annual value of approximately 27.85 M $US to 28.39 M $US for these key sectors. This value must however be considered in the context that the various related economic activities are not included e.g. the livelihoods of taxi-drivers, tour guides etc.

The potential problem of IAS and these sectors can be appreciated in context, when one considers the seafood consumption of approx. 14 kg per capita per yr (Sea Food Development Company of Trinidad and Tobago, *pers. comm.*). In this respect, the potential costs of the negative impacts of fish by Harmful Algal Bloom (HAB) biotoxins have been documented for Chesapeake Bay, US. In this case, physical and chemical changes in the local marine ecosystems rendered the fish populations increasingly susceptible to the opportunistic pathogen e.g. as produced by the dinoflagellate *Pfiesteria pscicida*. This pathogen stimulates the production of suffocating mucus in fish gills and also weakens the epidermis of finfish, creating lesions- which in turn are exploited by bacteria and fungi. The commercial Atlantic menhaden fish species suffered mass mortalities as a result of this invasion in Chesapeake Bay in 1996. The cost to the fishing industry was an estimated USD $20 million loss in revenue, primarily through a major decline in consumer confidence in seafood.

A documented fish-kill due to blooms of the algae *Cochlodinium polykrikoides* in Balayan Bay, Manila in 2002 quoted an estimated loss of 10 tons of assorted reef fishes and the economic dislocation of approximately 6,500 municipal fishermen dependent on the Bay.

In the Caribbean, the lionfish (*Pterois volitans*) has already had significant negative impact on coral reef biodiversity including fisheries. Lionfish pose a threat to the integrity of the reef food web and are capable of impacting commercial fisheries, tourism and overall coral reef health (Morris 2012). Based on these data, it is reasonable to suggest that the potential impacts of IAS on these sectors in Trinidad and Tobago can be significantly detrimental both on the environment as well as the economy.

4. ASSESSING AND VALUATING THE COST OF ENACTING THE CONVENTION

In this section, all the assessments, associated costs and calculations are presented in order to define the economical extent of Ballast Water Management activities. The tables (i to xvii) below cover details of each of the activities. The costs are calculated using cost estimates (in general for 20 participants) of similar such activities in the region. Additionally some of the costs as reported for Turkey and Jordan (Socio-economic Assessments for BWM) have been used as a guide for the calculations. Both local (TT dollars) and US dollars **(rate of $6.50 TT dollars= 1 USD)** are included in the tables with total cost in US dollars.

(i) Introductory Training/Workshop on Ballast Water Management:

20 participants, over 5 days

Cost calculation for training

Cost items	Calculation	Amounts
Accommodation/breakfast	20 x 5 days x 780	$ 78,000 TT
Training venue	5000 x 5	$ 25, 000 TT
Training documents	will be online	will be online
Trainers	In kind contribution	In kind contribution
Lunches	20 x 5 x 158	$ 15,800 TT
Coffee Breaks	20 x 45 x 5	$ 4500 TT
Dinners	20 x 5 x 200	$ 20,000 TT
Social Activities	$ 30,000	$ 30,000 TT
Total		$173,300 TT **USD 26,700**

(ii) Training on Legal Implementation of the BWM Convention

20 participants, 5 days

Cost calculation for Training/Workshop

Cost items	Calculation	Total Amounts
Accommodation/breakfast	20 x 5 days x 780	$ 78,000 TT
Training venue	5000 x 5	$ 25, 000 TT
Training documents	will be online	will be online
Trainers	In kind contribution	In kind contribution
Lunches	20 x 5x 158	$ 15,800 TT
Coffee Breaks	20 x 45 x 5	$ 4500 TT
Social Activities	$ 30,000	$ 30,000 TT
Total		$153,300 TT

		USD 23,600

(iii) **Specialized Training for the shipping industry (ship-and port-side issues);**

20 participants, 5-days.

Cost calculation for Training/Workshops

Cost items	Calculation	Total Amounts
Accommodation	20 x 5 days x 780	$ 78,000 TT
Training venue	5000 x 5	$ 25, 000 TT
Training documents	will be online	will be online
Trainers	1200 x 5	$ 6, 000 TT
Lunches	20 x 5x158	$ 15,800 TT
Coffee Breaks	20 x 5x45	$ 4500 TT
Social Activities	$ 30,000	$ 30,000 TT
Total		$159,300 TT **USD 24,510**

(iv) **Training of Port State Control officers (Compliance Monitoring and Enforcement);**

20 participants, 5-days

Cost calculation for Training/Workshop

Cost items	Calculation	Total Amounts
Accommodation	20 x 5 days x 780	$ 78,000 TT
Training venue	5000 x 5	$ 25, 000 TT
Training documents	will be online	will be online
Trainers	$1200 x 5 days	$ 6, 000 TT
Lunches	20 x 5x158	$ 15,800 TT
Coffee Breaks	20 x 5x45	$ 4500 TT
Dinners	20 x 5 x 200	$ 20,000 TT
Social Activities	$ 30,000	$ 30,000 TT
Total		$179,300 TT **USD 27,600**

(v) Training on Port Biological Baseline Surveys;

20 participants (including Port personnel), over 5 days

Cost calculation for Training/Workshop

Cost items	Calculation	Total Amounts
Accommodation	20 x 5 days x 780	$ 78,000 TT
Training material	3000	$ 3, 000 TT
Training venue	5000	$ 5 000 TT
Transport	20 x5x 200	$ 20, 000 TT
Trainers	1200 x 5	$ 6, 000 TT
Lunches	20 x 5x158	$ 15,800 TT
Coffee Breaks	20 x 45 x5	$4500 TT
Social Activities	$ 15,000	$ 15,000 TT
Diving Equipment and Boat rental	$ 8,650	$ 8,650 TT
Laboratory Equipment	2$ 80,000	$ 80,000 TT
Total		$ 241,950 TT **USD 38,712**

(vi) National Task Force Meetings

This will be a 1 day meeting organised once per month.
12 participants, 1 day per month
The cost below outlines the yearly cost

Cost calculation for NTF Meeting

Cost items	Calculation	Total Amounts
Accommodation	In kind	In kind
Refreshments	12 x 40 x12	$ 7200.00 TT
Stipends	1 x 2700 x12(Chairman) 1 x 1400 x 12(Deputy Chairman) 10 x 1000 x 12(Member)	$169,200 TT
Total		$ 176, 400 TT **USD 27, 140**

(vii) Regional Task Force meetings

20 participants, 2dys

Cost calculation for training

Cost items	Calculation	Total Amounts
Accommodation	20 x 2 days x 780	$ 31, 200 TT
Training venue	In kind	In kind
Daily allowance	20 x 2 x 100	$ 4,000 TT
Training documents	will be online	Will be online
Airport taxi costs	20 x 2x200	$ 8, 000 TT
Trainers	In kind contribution	In kind contribution
Lunches	20 x2x158	$ 6, 320 TT
Coffee Breaks	20 x2x 45	$ 1, 800 TT
Dinners	20 x 2 x 200	$ 8,000 TT
Social Activities	$ 30,000	$ 30, 000 TT
Total		$89, 320 TT **USD 13,740***

*Possibility of regional Funding

(viii) National Ballast Water Management Status Assessment

Cost calculation for consultancy (status-completed)

Relevant Personnel	Time for Study	Fee for the expert
Expert on Marine and Coastal Environment	3 months	$ 32,500 TT
Total		$ 32,500 TT **USD 5,000**

(ix) National Ballast Water Management Socio-Economic assessment

Cost calculation for consultancy (status-completed)

Relevant Personnel	Time for Study	Fee for the expert
Socio-economic and Ecosystems Expert	3 months	$ 32,500 TT
Total		$ 32,500 TT **USD 5,000**

(x) National Ballast Water Management Legislative Review and Implementation

Cost calculation for consultancy (status-completed)

Relevant Personnel	**Time for Study**	**Fee for the expert**
Expert on Legislation	3 month	$32,500 TT
Total		$ 32,500 TT **USD 5,000**

(xi) National Ballast Water Management Strategy

Cost calculation for consultancy (status- completed)

Relevant Personnel	**Time for Study**	**Fee for the expert**
Expert to prepare Report	3 months	$32,500 TT
Total		$ 32,500 TT **USD 5,000**

(xii) Port Biological Baseline Surveys (research and monitoring)

Cost calculations for consultancy. 6 participants, 2 days. (Status: proposed)

Cost Items	Calculation	Total Amounts
Accommodation	2 days x 780 x 6	$ 9,360 TT
Travel expenses	18,000	$ 18,000 TT
Lunches and dinners	2 x 6 x 200	$ 2,400 TT
As per IMO GloBallast surveys using the Hewitt and Martin protocols (Campbell *et. al.*, 2007). This covers cost of sampling, equipment, taxonomic experts, Divers and equipment and Laboratory facilities. This also includes Data analyses, database development and Report preparation.	$ 825,500 TT per survey per port	16,510,000 TT (20 ports)
Total		$ 16,539,760 TT **USD 2, 544, 578**

(xiii) Risk Assessments

Cost calculation for consultancy. (status-proposed)

Relevant Personnel	Time for Study	Fee for the expert
Expert on Risk Assessment	3 months@ $20,000	$60,000 TT
Expert on Data Bases	3 months@ $20,000	$60,000 TT
Expert on Invasive Species	3 months @ $20,000	$60,000 TT
Expert on Shipping Industry	3 months@ $20,000	$60,000 TT
Accommodation/Travel costs for 4 experts		$ 200,000 TT
Software/Data Base Development		$100,000 TT
Total		$540,000 TT **US $84,000**

(xiv) Approval of ships' BWM Plans

Cost calculation for service. (status: proposed)

Cost items	Calculation	Total Amounts
Training of Staff (Approved Recognized Organizations {ROs} will train their staff)	NA	No cost
Establishing protocols for vetting and approving BWM Plans (Maritime Administration {MA} will authorize ROs)	NA	No cost

(xii) Approval of exemption applications

Cost calculation for service. (status: proposed)

Cost Items	Calculation	Total Amounts
Exemption application (MA Responsible)	NA	No cost

(xiii) Training of crew members

Cost calculation for training. (status: proposed)

Cost Items	Calculation	Total Amounts
Training cost (Training at Seafarer's or company's expense)	NA	No cost

(xiv) Sampling for compliance with D-1 Standard

The D1 standard is for ballast water exchange, and specifies the volume of water to be replaced.

Cost calculation for equipment. (status: proposed)

Cost Items	Calculation	Total Amounts
Flow meters (Flow meters @$10,000 TT X 20 Port/ Port Facilities)	10,000 x 20	$ 200,000 TT **US$30,800**

(xv) Sampling to ensure D-2 compliance

The D2 standard covers approved ballast water treatment systems, and specifies levels of viable organisms left in water after treatment

Cost calculation for service. (status: proposed)

Cost Items	**Calculation**	**Total Amounts**
Equipment		$100,000 TT
Taxonomist	10500 x 12	$126,000 TT
Laboratory cost	10500 x 12	$126,000 TT
Total		$352,000 TT **US 56,320**

(xvi) Designation of areas for Ballast Water Exchange

Cost Calculation for Consultancy. (status-proposed)

Relevant Personnel	Time for Study	Fee for the expert
Expert on Risk Assessment	3 months @20,000 TT	$60,000 TT
Expert on Hydrodynamics of Sea water	3 months@20,000 TT	$60,000 TT
Expert on Invasive Species	3 months@20,000 TT	$60,000 TT
Expert on Shipping Industry	3 months@20,000 TT	$60,000 TT
Total		$240,000 TT **US 36,925**

(xvii) Port BWM Plan Development

Cost calculation consultancy (status-proposed)

Cost Items	Calculation	Total Amount
Expert on Ballast Water Implementations (1 month @20,000 TTD per 3 major ports) Ballast Water Management Awareness and Education programme	20, 000 X 3	$60,000 TT **USD 9,230**

5. RESULTS

The valuation of costs associated with enacting the Ballast Water Management Convention was calculated for specific activities above (4). The table below (Table 2) shows the total costs for all preparatory and monitoring activities.

Table 2: Costs associated with enacting the BWM Convention (Preparatory and Monitoring)

BWM Item	**Cost**
Introductory Training/Workshop on Ballast Water Management:	**$ 26,700.00**
Training on Legal Implementation of the BWM Convention:	**$ 23,600.00**
Specialized Training for the shipping industry (ship-and port-side issues):	**$ 24,510.00**
Training of Port State Control officers (Compliance Monitoring and Enforcement):	**$ 27,600.00**
Training on Port Biological Baseline Surveys:	**$ 38,712.00**
National Task Force Meetings:	**$27,140.00**
Regional task force meetings- Regional Funding Possibility*	**$ 13,740.00***
NBWM Ecological assessment:	**$5,000.00**
NBWM Socio- economic assessment:	**$5,000.00**
NBWM Legislative review and implementation:	**$5,000.00**
NBWM National Strategy Report	**$5,000.00**
Port Biological Baseline Surveys (research and monitoring):	**$2,544,578.00**
Risk Assessments:	**$84,000.00**
Approval of ships' BWM Plans:	***(No cost)***
Approval of exemption applications:	***(No cost)***
Training of crew members :	***(No cost)***
Sampling for compliance with D-1 Standards :	**$30,800.00**
Sampling to ensure D-2 compliance:	**$ 56,320.00**
Designation of areas for Ballast Water Exchange:	**$ 36,925.00**
Port BWM Plan Development:	**$ 9,230.00**

TOTAL:	**USD 2,963,855.00**

Additional activities to be included for enactment of the BWM include certification, controls and monitoring. These are listed (Appendix 1) although no such costs are presently available. .

Apart from the above calculations, there are additional costs to society such as (i) Industrial impacts and (ii) public health impacts. At this point in time, the potential problems faced in Trinidad and Tobago can only be appreciated by reviewing examples outside of our Caribbean territory. In this respect, similar potential costs have described for the Great Lakes area in Nature Conservancy by the Anderson Economic Group (2012) http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/michigan/newsroom/aquatic-invasive-species-cost-businesses-hundreds-of-millions-annually-1.xml). This report suggests that Aquatic Invasive Species (AIS) cost businesses in the Great Lakes area- "*hundreds of millions annually in direct costs and even more from indirect costs*". "*These costs are related to removal, maintenance and management of those species. State and federal governments are forced to spend additional millions as they attempt to control the impacts and prevent the spread of AIS. Industries most affected include sport and commercial fishing, water treatment, power generation and tourism.*". *"For example, the cost of controlling zebra mussels at one water treatment facility is approximately $353,000 US annually".* When multiplied (to include total numbers of plants) - this figure of course increases. *"The region spends over $100 US million annually on managing a pest infestation which they may have been able to prevent". "The AEG report highlights in particular the impact on power plants, which is estimated at spending $130 US million annually to remove AIS from 106 plants that utilize water from the Great Lakes. For example, zebra mussels have become such a problem for power generation that in 1989, the Detroit Edison plant in Monroe – the largest fossil-fuel plant in the world – had to shut down operations for three days to clean their intake pipes".*

Invasive species cause significant disruptions to species and especially so within the food chain. It is of critical importance to be able to quantify damages as a combination of environmental impacts and direct impacts on the economy. In effect, IAS is not just an environmental problem but an economic one. Although the final figures are not known, financial costs were extremely high for a number of industrial plants in the Point Lisas Industrial Estate with the invasion by the green mussel (*Perna viridis)* in 1990 in Trinidad and Tobago.

The additional costs to society or industry may therefore include impacts on: (i)Shipping (International & Domestic), (ii) Coastal Infrastructure and (iii) Public health within vulnerable marine groups (includes resource users, workers, seafood consumers etc.). The vulnerability of each category to marine IAS range from medium (i

and ii) to high (iii). For example, ballast water-borne pathogens may directly affect communities from swimming or seafood contamination.

The following table (Table 3) shows a comparison of the costs of only some environmental/ economic resources (calculated above at 3.3), with costs of BWM enactment.

Table 3: Itemized costs of Environmental/Economic resources (estimate) and BWM associated costs (estimate)

Item	**Costs (approximate)**	**Item**	**Costs (approximate)**
Environmental/Economic Resources (from Table 1) **Environmental Services* (as at 3.3.3)** ***determined for coral reefs***	$ 3.21 million US *(per year)* $ 130 million US *(per year)*	Enactment activities as identified at Table 2	**USD** 1, 352,106.00
Additional costs (as above- to society/industry etc.)	Approx. 1 Million US *(per year)*	Additional costs approximate (e.g. associated with inflation or revised plans, and additional costs- see Appendix)	**USD** 500,000.00
Total	➢ 134 Million USD *per year*		**USD** 1, 852,106.00

6. CONCLUSIONS

The World Wildlife Fund (WWF, 2009) suggests that since the Ballast Water Convention was adopted in 2004 the world's seas and waterways have continued to be invaded by unwanted species. The report suggests that *"Global economic losses from the damage caused by harmful invasive aquatic species were estimated to have exceeded USD7 billion per year in 2004/05, making the total bill between the 2004 adoption of the Convention and end of 2009 at least USD50 billion in present-day value*". This figure approximates to "*the 2008 gross domestic product of the country of Bulgaria*". This sum reflects only "d*amage and repair costs to fisheries, aquaculture, water supply systems, industrial infrastructure and harbors*" and does *not* include "*all of the indirect economic losses caused by changes to marine biodiversity and habitats, including impacts to and even near-extinctions of endemic species*".

When there are relatively minor changes in species and/or habitats this tends to cause additional stress to marine ecosystems. These impacts are often very difficult to evaluate and/or calculate. Even in areas where studies have been done on IAS, the complete impacts both from an environmental and an economic sense will perhaps never be truly understood. For example, ecosystem changes may lower the local environment's resilience to other stress factors, such as pollution, climate change and overfishing. All of these have related and associated costs which will therefore need to be factored in the overall calculation.

This socio-economic assessment for BWM is timely given that Trinidad and Tobago has acceded to the BWM Convention. This report is based on potential and projected impacts since the data on natural resource evaluation and marine resources evaluations are lacking. However, the projections are realistic since they are based on real data and appropriate examples are applied. Trinidad & Tobago has a large maritime industry and is also a trans-shipment hub in the Caribbean. The possibility of invasion by an introduced/alien species is real and it is critical that we understand the severity of negative impacts that a worse-case scenario can have.

The main findings of this report (although based on estimations) suggest that it makes financially good sense to enact the BWM Strategy given that the costs to do so are inexpensive (1, 852,106.00 USD) compared with the much greater anticipated losses to a valuable ecosystem (134 Million USD *per year*), if it is not implemented. Further, the implementation of the BWM Strategy will result in a much reduced losses to both the overall economy and ecosystems of Trinidad and Tobago and hence sustain the very resources on which we depend.

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Appendix 1

Additional Activities (proposed, no available costs) to be included for enactment of the BWM.

i. Establishing procedures for issuing BWM Certificate

Cost Calculation for Service. (status-proposed)

Cost Items	Calculation	Total Amounts
Establishing certification requirements		$5, 000 TT
Communication of requirements and procedures to the shipping industry and IMO (Advertisements)		$5,000 TT
Maintenance of records of issued Certificates (Facilitate computerization and acquisition of filing cabinets)		$10,000 TT

ii. Type approval of BWM systems

Cost calculation for service. (status-proposed)

Cost Items	Calculation	Total Amounts
Review of the technical reports and test results	NA	No Cost

iii. Surveys (Initial, Renewal, Intermediate, Annual, Additional)

Cost calculation for service. (status-proposed)

Cost Items	Calculation	Total Amounts
Initial, Renewal, Intermediate, Annual surveys	NA	No Cost

iv. Compliance monitoring and enforcement (CME)

Cost calculation for service. (status-proposed)

Cost items	Calculation	Total Amounts
Port State Cost (Inspection of Ships)	NA	No cost

v. Training of crew members (IMO model courses, etc)

Cost calculation for training. (status-proposed)

Cost Items	Calculation	Total Amounts
Training of the personnel	NA	No Cost

vi. BWM Plans

Cost Calculation for service. (status-proposed)

Cost Items	Calculation	Total Amounts
Service fee of the External Surveyors and Inspectors	NA	No Cost

vii. BW Treatment

Cost Calculation BW treatment. (status-proposed)

Cost Items	Calculation	Total Amounts
Treatment equipment (Sampling)		$10,000
Operational cost		

viii.BW Exchange

Cost calculation BW exchange. (status-proposed)

Cost Items	Calculation	Total Amounts
Operational Costs	NA	No cost