ECONOMIC STATUS ASSESSMENT FOR IMPLEMENTING THE BALLAST WATER MANAGEMENT CONVENTION IN GHANA

1ST DRAFT REPORT

EXECUTIVE SUMMARY

The issue of marine Invasive Alien Species has emerged as a global topical issue because of the potential threat they pose to the marine ecosystem and sustainable development of natural resources in general. In economic terms, it is estimated that the IAS problem could cost countries billions of dollars in lost revenue if adequate control measures are not put in place to check their spread.

In Ghana, 85% of her international trade by volume is carried by sea which implies a great risk of exposure to IAS. The synthesis of this report is therefore to meet the GEF-UNDP-IMO Globallast projects requirement for the preparation of national economic assessment for ballast water management. This exercise seeks to identify cost –effective strategies for ballast water management with the aim of preventing the new introduction and spread of the marine IAS.

After conducting this economic assessment, it is obvious that ballast water management activities are economically feasible compared to the huge cost that Ghana may incur if she does not put in place the necessary mechanisms to halt the further spread of the marine IAS.

PREFACE ABOUT THE ECONOMIC ASSESEEMENT

This report aims at assessing the economic costs of ballast water management activities that Ghana needs to do in order to prevent the spread of marine invasive species; such economic valuations are essential to improve the decision making process from the grass-roots to the maritime industry level using ecosystem management principles to develop national strategies and action plans that will facilitate the management of risks associated with marine invasive alien species.

The specific aims of this report are:

1. Comparison between the devastating effects of marine IAS and the cost involved in the organization of national ballast water management activities to prevent it from happening in the first place.
2. To economically value our ecosystem's goods and services and potential impacts that may arise as a result of the introduction of marine IAS.
3. To clarify that the successful management of invasive species are economically beneficial in the long- term and it is therefore important to put in place preventive mechanisms than to wait for the worst case scenario to happen.
4. To serve as a guide as well as tool to aid the ballast water management activities that the country is currently engaged in.

It is obvious that some capacity already exists in maritime industry in Ghana, so there are certain activities that can be handled easily without incurring further cost to the country and therefore were not valued. Some of the items were however valued based on related training performances organized in the country within the framework of the GEF-UNDP-IMO GloBallast Partnerships Project.

The GloBallast Partnerships Project has already hired consultants in Ghana to carry out activities on the national ballast water rapid status assessment, national ballast water management strategy, legal implementation ballast water management and guideline on the economic assessment for ballast water management in Ghana. These are captured in section 4.1.2 and were not included in the overall estimations of as the GloBallast Partnerships project provided funding for these research activities.

As Ghana has conducted a port biological baseline survey at the Tema Port funded by the Ghana Ports and Harbours Authority (GPHA), the cost has been easily captured together with projections for the conduct of a similar activity at the port of Takoradi. It is also important to note that, training programmes captured under this section are essential to sensitize and educate a number of major stakeholders to become aware of the issue of marine IAS so that they can provide support when necessary.

It is the hope that International Maritime Organization (IMO) in the maritime industry would provide the needed financial assistance in order to help the country conduct most of these programmes contained in the report. Ghana fully supports the ratification of the ballast water convention and results of this report will go and long way to facilitate its ratification.

SOURCES OF INFORMATION

a. Ghana Maritime Organization
b. Ghana Ports and Harbour Authority
c. Marine Fisheries Research Division of the Fisheries Commission
d. Information Sources from the Ghana's Universities

ACKNOWLEDGEMENT

This economic status assessment of ballast water management in Ghana was conducted by Mr. Ben Owusu-Mensah, Maritime Transport Economist and Consultant, and funded by the GEF-UNDP-IMO GloBallast Partnerships Project with institutional collaboration by the Ghana Maritime Authority (GMA) and technical input from Dr. Elvis Nyarko, Marine Biologist and Head, Oceanography and Fisheries Department, University of Ghana, Legon. All the sources of data are duly acknowledged.

INTRODUCTION

Invasive Alien Species (IAS) are species whose introduction and/or spread outside their natural past or present distribution threaten biological diversity. IAS occurs in all taxonomic groups, including animals, plants, fungi and microorganisms, and can affect all types of ecosystems. While a small percentage of organisms transported to new environments become invasive, the negative impacts can be extensive and over time, these additions become substantial. If an introduced species finds its 'new' habitat to be conducive enough, it may survive, and reproduce, spread through its new environment, increase in population density and out compete native organisms, thus becoming invasive. These invasive species occupy similar niches in the marine environment to native species with potentially serious impacts on the native species such as competing with the native species for food and/or space, or by interbreeding and so altering the gene pool. In addition they may also potentially alter habitats and the balance of existing communities, resulting in changes to the structure and function of entire marine ecosystems. Consequently, aquatic communities are becoming increasingly homogenized as a result (Roman, 2010).

These invasive alien species arrive in the ballast or on the hulls of ships, through the movement of shellfish and bait, by the opening of new channels or canals, through intentional release, and other vectors. Rapid increases in trade and shipping mean we are now capable of moving more organisms around the world (in the ballast water of ships) in one month, than we used to in one century. It is estimated that 3000-4000 million tons of untreated ballast water are discharged from ships every year in ports, as cargoes are loaded and vessels de-ballast. Furthermore, approximately 10,000 marine species each day may be transported across the oceans in the ballast water of cargo ships and introduced into a non-native environment (EMSA, 2008). Such

introduced species may include aquatic bacteria, viruses, pathogens and other living organisms (Peters, 2010).

Eighty five percent (85%) of Ghana's international trade by volume is carried by sea which implies a great risk of exposure to marine Invasive Alien Species (IAS). The recent discovery and the commencement of drilling of oil in commercial quantities coupled with the expected increases in the imports and exports will undoubtedly lead to increased shipping traffic calling at the ports of Ghana. As national trade and traffic volumes expand, so will the harmful effects of these activities, especially, the possible transfer of IAS through ship's ballast waste.

However, as a nation, no serious steps have been taken to address the issue. Currently, both Ghana Ports and Harbours Authority and Ghana Maritime Authority have no records on ballast water management practices by ships calling on Ghana's ports. Ghana has not signed, ratified or acceded to the Ballast Water Convention. In order to fully implement a legal regime that properly manages the issue of ships' ballast water, it would be necessary for Ghana to take immediate steps to ratify this Convention. This would enable the translation of the convention into domestic legislation in order to ensure its application in the country. Ghana has ratified other environmental treaties which have some relevance to the issue of IAS but not specifically with ballast water as a vector.

In general, economic impacts of non-native species may include monetary costs for management, cost and damages incurred due to fouling of equipment and vessels, aesthetic and/or recreation impacts, public health implications and actual losses relative to impacts to fishery or aquaculture resources.

The economic cost of invasive alien species can be very large. The costs associated with the

*Carcinusmaenas*invasion in the US are estimated at $44 million, but it is unclear how this figure was derived (Pimentel et al. 2005). Non-native marine species may also result in aesthetic impacts that alter recreation and are costly to clean up. For example, *Carcinus fragile* often washes ashore and forms large clumps on beaches that are unsightly and result in noxious odors (Pederson et al. 2005). The most threatening event for the Caspian Sea in the early 80's was the introduction of the North American Comb Jelly *(Mnemiopsisleidyi)* into the black sea via ship ballast water. Its spread was rapid, out-competing indigenous species and consuming fish eggs and larvae as well as zooplanktons that are prey to commercial fishes, leading to a devastating impact on the fisheries such as anchovy, Mediterranean horse mackerel and sprat in the Azov and Caspian Sea. By 1992, the annual losses caused by drops in commercial catches of marketable fish were estimated to be at least US$240 million (GBMS, 2010). Recently, exotic fish have been reported to be costing the American economy billions of dollars. The invasion of the Asian carp in the Mississippi river and into the Great Lake is putting the region's $7 billion a year fishing industry at risk, leading to a shut down between Michigan and Illinois. Also, environmental losses and damages of about $120 billion a year have been attributed to the invasive nature of the Asian silver and the bighead carp (Washington Post, 2010). These fish species were depleting the food supply of the native fish sustaining those ecosystems.

The Zebra mussel, have become an invasive species in Great Britain, Italy, Sweden and Ireland by disrupting ecosystems and causing damage to harbours, waterways, ships and boats, and water treatment and power plants. In Britain, Anglian water estimated that it cost £500, 000 to remove the mussels from their treatment plants, whilst in the US an estimate of $267 million dollars is reported to have been spent in the management of Zebra mussels for electric generation and water treatment facilities for the period of 1989 to 2004. Invasive species are known to degrade coastal

infrastructure. Some species destroy the structural integrity of piers and other wood pilings leading to significant economic loss. For example, in San Francisco Bay, the introduction of the navy worm is reported to have excavated majority of wood pilings, causing warehouses and loaded freight cars to collapse into the bay.

In recent years there has been an increasing resolve to arrest and control IAS, due to its significant threats to global biodiversity (Wilcove et al, 1998). Also, because invasive species have a profound impact on vital sectors of the economy as well as wildlife and endangered species, efforts in their control and management demand global approach.

Management of IAS is expected to be anticipatory rather than reactive. The best and cost-effective solution is to prevent the arrival of new alien pest. The anticipatory approach to managing IAS is further given credence by GBMS, (2010). A sustainable and long-term management of IAS means preventing the introduction of non-native species, whilst providing for their control and minimizing economic, ecological and human health impacts invasive species cause. Consequently, a national policy framework towards the ratification of the ballast water convention must be flexible, whilst offering a blue print from which all government agencies along with their partners can work to meet the standards set forth in the ballast water management convention. Nevertheless, such processes call for some monetary cost in ensuring compliance monitoring and enforcement, planning and capacity building such as establishment of an independent panel of experts to advice on the risk and benefits and the development of a national database on alien species.

There is therefore the need for economic analysis of IAS, their possible impacts and management options so as to support strategic decisions regarding IAS responses and facilitate national planning. Hence, the aim of this report is to serve primarily as a practical tool to support the development of a national ballast water management

strategy, it also has estimations on the economic costs of activities related to aspects of IAS impacts and management responses that will be useful for decision support, towards the ratification of the ballast water convention.

This document is essentially a simple economic assessment based on readily available data, such as national statistics for the development of a national ballast water management strategy. While an attempt has been made at quantitatively assessing the risks associated with the introduction of invasive species via ballast water and to also identify cost-efficient strategies for ballast water management, it is conceded that much more detailed analysis may be desired, in which case it is recommended to engage an expert to employ detailed and advanced methods for economic assessment and valuation far beyond the scope of this report (Roman, 2010).

METHODOLOGY

There are a multitude of techniques available for costing ecosystem goods and services, many of which require advanced skills to be carried out in a scientifically sound and statistically rigorous manner. The most commonly used methods that will be adopted are discussed.

Market Price Method

The market price method uses the prices of goods and services that are bought and sold in commercial markets to determine the economic value of an ecosystem service (Carson and Bergstrom, 2003). This method values changes in either quantity or quality of a good or service and can be applied to loss of employment, loss of marketable goods, cost etc. This robust method uses the producers' and consumers' actual willingness to pay that is demonstrated through the price or a good purchased (Khan, 1998). For example, where an invasive alien species affect the production of marketable good or when invasive species themselves become marketable goods. This method uses standard accepted economic techniques; it is comparatively inexpensive and requires less data which are relatively easy to obtain for established markets. Several case studies have revealed the importance of market price method in the valuation study for an invasive alien species impact.

Like all valuation methods, the market price method has few limitations and may be used with other models such as the discounted cash flow method. By this method, it's likely that the true economic value of goods and services may not be fully reflected in market transactions due to market imperfections. Also, the method cannot be used to

measure the value of larger scale changes caused by invasive species to ecosystems.

Process Outline

a) Collect data on or specify the change in the quantity of the good or service.

b) Data collection on the prices of goods, should note prices distorted by taxes or subsidies and, identify similar goods that are unaffected by such distortions. This data must be a time series data e.g. inter-annual and seasonal variation of prices and socio-economic preferences.

c) Multiply the price by the change in quantity to determine the value of the change.

Case Study

The zebra mussel *(Dreissenapolymorpha)* is native to the Caspian and Black Sea and the Sea of Azov. It is a freshwater species but is included here as it is a graphic example of the damage that can be caused by an invasive species. Carried to North America in ballast water, it is now one of the most infamous examples of biological invasion. The species is now established in the UK, Western Europe, Canada and the US. In the US the mussel has spread through all the major river basins east of the Rocky Mountains. Zebra mussels multiply rapidly—one female can produce several million eggs a year and they can cover any surface, even each other. The mussel competes with zooplankton for food and interferes with native molluscs, often suffocating or starving them.

The devastating impact of the zebra mussel is clearly demonstrated in the American Great Lakes where it was introduced unintentionally in the mid-1980s. It smothered natural ecosystems and altered the water conditions, severely affecting fisheries. It has also cleared the way for large-scale invasion by other alien species, leading to a situation known as ‘invasional meltdown’. The mussel causes a large amount of damage to infrastructure. Between 1989 and 2000, the financial damage incurred in the US is estimated at between

US$ 750 million and US$ 1 billion based on the market price of commercially important fishes. The economic, social and environmental effects were so dramatic that in 1990 the US introduced the first national legislation on ballast water.

Travel Cost Method

The travel cost method determines the value of an ecosystem based on the amount of money spent to reach the particular destination. The aim of this method is to calculate the willingness to pay for a constant price facility. It can estimate the benefits or cost associated with changes in entrance fees to recreational areas, removing an existing site or adding a new site or changes in environmental quality at a site (www.ecosystemvaluation.org, 2003). Importantly this method does not require large data set and complex statistical skills. On the other hand, it can be difficult to determine the value of one particular destination if a single trip encompasses many destinations.

Process Outline

a) A sample of visitors to the ecosystem/recreational area is surveyed and is further divided into zones of equal distance from recreational area.

b) Calculate the average distance and the average travel cost to the facility in each zone

c) Obtain visitation rates for each zone, using the information to estimate total number of visitor days per head of local population. (Visit Rate = The number of visitors to a given zone/the population of that zone.)

d) The Visit Rate is statistically regressed against Travel Cost to obtain a Visit Rate Curve.

e) The curve is then used to obtain estimates of Visit Rates given different levels of Total Cost.

ECONOMIC CALCULATIONS AND APPROXIMATIONS

4.1: PREPARATORY PHASE COSTS

4.1.1: Capacity Building, Coordination and Communication

In this section the cost for preparing national and international meetings are calculated with respect to the national legislation on travel allowances and similar activities done other developed nations.

a) Introductory Training on Ballast Water Management;

i. **Expected Participants**

Ghana Maritime Authority (GMA), Ghana Ports and Harbours Authority (GPHA), Shipowners & Agents Association (SOOAG),Ghana Shippers' Council, Ministry of Environment, Science and Technology (MEST), Ghana National Petroleum Corporation (GNPC), Environmental Protection Agency (EPA,) International Oil Companies (IOC), Ministry of Transport, Ministry of Tourism, Universities and research institutions.

ii. Participation: 65 people

iii. Duration: 5 days

Table 1: Cost Calculation for Training

Cost items	Calculation	Total Amounts (GH¢)	Total Amounts ($)
Accommodation	65 x 5 days x GH¢150.00	48,750.00	30,468.75
Training venue	GH¢2480.00x 5days	12,400.00	7,750.00
Daily allowance	65 x 5 days x GH¢248.00	80,600.00	50,375.00
Training documents	GH¢1985.00	1,985.00	1,240.63
Travel costs	65 xGH¢298.00	19,370.00	12,106.25
Trainers	15x 5days x GH¢1000.00	75,000.00	46,875.00
Lunch	65 x 5 days xGH¢30.00	9,750.00	6,093.75
Coffee Break	65 x 5 days x GH¢15.00	4,875.00	3,046.88
Dinner	65 xGH¢30 x 5 days	9,750.00	6,093.75
Social Activities	GH¢ 3970.00	3,970.00	2,481.25
TOTAL		**266,450.00**	**166,531.25**

b) Training on legal Implementation of the BWM Convention;

i. **Expected Participants**

Ghana Maritime Authority (GMA), Ghana Ports and Harbours Authority (GPHA), Shipowners& Agents Association (SOAAG) ,Ghana Shippers' Council, Ministry of Environment, Science and Technology (MEST), Ghana National Petroleum Corporation (GNPC), Environmental Protection Agency (EPA,) International Oil Companies (IOC), Ministry of Transport, Ministry of Tourism, Universities and research institutions.

i. Participation: 65 people

iii. Duration: 5 days

Table 2: Cost Calculation for Training

Cost items	Calculation	Total Amounts (GH¢)	Total Amounts ($)
Accommodation	65 x 5 days x GH¢150.00	48,750.00	30,468.75
Training venue	GH¢2480.00x 5days	12,400.00	7,750.00
Daily allowance	65 x 5 days x GH¢248.00	80,600.00	50,375.00
Training documents	GH¢1985.00	1,985.00	1,240.63
Travel costs	65 xGH¢298.00	19,370.00	12,106.25
Trainers	15x 5days x GH¢1000.00	75,000.00	46,875.00
Lunch	65 x 5 days xGH¢30.00	9,750.00	6,093.75
Coffee Break	65 x 5 days x GH¢15.00	4,875.00	3,046.88
Dinner	65 xGH¢30 x 5 days	9,750.00	6,093.75
Social Activities	GH¢ 3970.00	3,970.00	2,481.25
TOTAL		**266,450.00**	**166,531.25**

c). Specialized training to the shipping industry (ship and port-side issues);

i. **Expected Participants**

Ghana Maritime Authority (GMA), Ghana Ports and Harbours Authority (GPHA), Shipowners& Agents Association (SOAAG) ,Ghana Shippers' Council, Ministry of Environment, Science and Technology (MEST), Ghana National Petroleum Corporation (GNPC), Environmental Protection Agency (EPA,) International Oil Companies (IOC), Ministry of Transport, Ministry of Tourism, Universities and research institutions and others.

ii. Participation: 215 people

iii. Duration: 5 days

Table 3: Cost Calculation for Training

Cost items	Calculation	Total Amounts (GH¢)	Total Amounts ($)
Accommodation	215 x 5 days x GH¢ 150.00	161,250.00	100,781.25
	(participants may cover their own expenses)		
Training venue	5 days x GH¢ 3970.00	19,850.00	12,406.25
Daily allowance	215 x 5 days x GH¢ 248.00	266,600.00	166,625.00
	(participants may cover their own expenses)		0.00
Training documents	GH¢ 5955.00	5,955.00	3,721.88
Travel costs	215 x GH¢ 298.00	64,070.00	40,043.75
	(participants may cover their own expenses)		0.00
Trainers	5 x 5days x GH¢ 1000.00	25,000.00	15,625.00
Lunch	215 x 5 days x GH¢ 30.00	32,250.00	20,156.25
Coffee break	215 x 5 days x GH¢ 15.00	16,125.00	10,078.13
Dinner	215 x 5 days x GH¢ 30.00	32,250.00	20,156.25
Social Activities	GH¢ 4960.00	4,960.00	3,100.00
TOTAL		**628,310.00**	**392,693.75**

d) Training of Port State Control officers (compliance monitoring and enforcement);

i. Expected Participants: Based on Ghana Maritime Authority (GMA) nomination

ii. Participation: 40 people

iii. Duration: 5 days

Table 4: Cost Calculation for Training

Cost items	Calculation	Total Amounts (GH¢)	Total Amounts ($)
Accommodation	40 x 5 days x GH¢ 150	30,000.00	18,750.00
Training venue	GH¢ 2480.00	2,480.00	1,550.00
Daily allowance	40 x 5 days x GH¢ 248.00	49,600.00	31,000.00
Training documents	GH¢ 1985.00	1,985.00	1,240.63
Travel costs	40 x GH¢ 298.00	11,920.00	7,450.00
Trainers	15 x 5days GH¢ 1000	75,000.00	46,875.00
Lunch	40 x GH¢ 30.00 x 5 days	6,000.00	3,750.00
Coffee Break	40 x GH¢ 15.00 x 5 days	3,000.00	1,875.00
Dinner	40 x GH¢ 30 x 5 days	6,000.00	3,750.00
Social Activities	GH¢ 3970	3,970.00	2,481.25
TOTAL		**189,955.00**	**118,721.88**

e) National Sensitization and Training Workshop on Port Biological Baseline Surveys

i. Expected participants:

GMA, Trainers (experts on PBBS), nomination from GMA

ii. Participation: 40 people

iii. Duration: 3 days

Table 5: Cost Calculation for Training

Cost items	Calculation	Total Amounts (GH¢)	Total Amounts ($)
Accommodation	40 x 3 days x GH¢ 150.00	18,000.00	12,000.00
Training venue	GH¢ 2480.00	2,480.00	1,653.33
Daily allowance	40 x 3 days x GH¢ 248.00	29,760.00	19,840.00
Training document	GH¢ 1985.00	1,985.00	1,323.33
Travel costs	40 x GH¢ 298.00	11,920.00	7,946.67
Trainers	15 x 3days GH¢ 1000.00	45,000.00	30,000.00
Lunch	40 x GH¢ 30.00 x 3 days	3,600.00	2,400.00
Coffee Break	40 x GH¢ 15.00 x 3 days	1,800.00	1,200.00
Dinner	40 x GH¢ 30.00 x 3 days	3,600.00	2,400.00
Social Activities	GH¢ 3970.00	3,970.00	2,646.67
Diving equipment	GH¢ 5460.00	5,460.00	3,640.00
Laboratory equipment	GH¢ 15985.00	15,985.00	10,656.67
TOTAL		**143,560.00**	**95,706.67**

4.1.1.1 National Task Force (NTF) Meeting

i. Expected Participants: Strictly for NTF members appointed by Ghana Maritime Authority (GMA)

ii. Participation: 14 people

iii. Duration: 3 day

This would be a 3-days meeting which will be organized once per year.

Table 6: Cost Calculation for NTF Meeting

Cost items	Calculation	Total Amounts (GH¢)	Total Amounts ($)
Accommodation	14 x 3 days x GH¢ 150	6,300.00	3,937.50
Meeting venue	GH¢ 2480.00	2,480.00	1,550.00
Daily allowance	14 x 3 days x GH¢ 248.00	10,416.00	6,510.00
Meeting documents	GH¢ 1985.00	1,985.00	1,240.63
Travel costs	14 x GH¢ 298.00	4,172.00	2,607.50
Lunch	14 x GH¢ 30.00 x 3 days	1,260.00	787.50
Coffee Break	14 x GH¢ 15.00 x 3 days	630.00	393.75
Dinner	14 x GH¢ 30.00 x 3 days	1,260.00	787.50
TOTAL		**28,503.00**	**17,814.38**

4.1.1.2 Hosting of Regional Task Force (RTF) Meetings

Regional task force meetings are organized under the activities of the regional organizations. The cost of these meetings is covered under the budget of these organizations. Also there are funding sources to tap into, such as the IMO Integrated Technical Cooperation Programme. On the table below the cost of these meetings are calculated.

i. Expected Participants: Strictly for RTF members

ii. Participation: 32 people

iii. Duration: 5 days

Table 7: Cost calculation for RTF meetings

Cost items	Calculation	Total Amounts (GH¢)	Total Amounts ($)
Accommodation	32 x 5 days x GH¢ 150.00	24,000.00	15,000.00
Meeting venue	GH¢ 2480.00 x 5 days	12,400.00	7,750.00
Daily allowance	32 x 5 days x GH¢ 298.00	47,680.00	29,800.00
Meeting documents	GH¢ 1985.00	1,985.00	1,240.63
Travel costs	32 x GH¢ 298.00	9,536.00	5,960.00
Lunch	32 x GH¢ 30 x 5 days	4,800.00	3,000.00
Coffee Break	32 x GH¢ 15 x 5 days	2,400.00	1,500.00
Dinner	32 x GH¢ 30 x 5 days	4,800.00	3,000.00
Social Activities	GH¢ 6945.00	6,945.00	4,340.63
Interpretation	GH¢ 10000.00	10,000.00	6,250.00
TOTAL		**124,546.00**	**77,841.25**

4.1.2 Legislative, Policy and Institutional Reform Cost

4.1.2.1 National BW Status Assessment

Table 8: Cost Calculation for Consultancy

Relevant Personnel	Time for Study	Fee for the Expert (GH¢)	Fee for the Expert ($)
Expert on Shipping Industry	1 Month	8,186.35	5,116.47
Expert on Marine and Coastal environment	3 Month	24,559.05	15,349.41
Expert on Invasive Species (Marine Biologist/Microbiologist)	2 Month	16,372.70	10,232.94
TOTAL		**49,118.11**	**30,698.82**

4.1.2.2 Economic Assessment

Table 9: Cost Calculation for Consultancy

Relevant Personnel	Time for Study	Fee for the Expert (GH¢)	Fee for the Expert ($)
Expert on Shipping Industry	1 Month	8,186.35	5,116.47
Expert on Economics	3 Month	24,559.05	15,349.41
TOTAL		**32,745.40**	**20,465.88**

4.1.2.3 Developing a National BWM Strategy

Table 10: Cost Calculation for Consultancy

Relevant Personnel	Time for Study	Fee for the Expert (GH¢)	Fee for the Expert (GH¢)	Fee for the Expert ($)
Expert on Legislations	3 months	8186.35/Month	16,372.70	10,232.94
Expert on Administrative Infrastructure	3 months	8186.35/Month	16,372.70	10,232.94
Expert on Invasive Species (Marine Biologist / Microbiologist)	2 months	8186.35/Month	24,559.05	15,349.41
TOTAL			**57,304.46**	**35,815.29**

4.1.2.4 Legislative Review and Implementation

Table 11: Cost Calculation for Consultancy

Relevant Personnel	Time for Study	Fee for the Expert (GH¢)	Fee for the Expert (GH¢)	Fee for the Expert ($)
Expert on Legislations	3 months	8186.35/Month	24,559.05	15,349.41
Expert on Administrative Infrastructure	3 months	8186.35/Month	24,559.05	15,349.41
Expert on Invasive Species (Marine Biologist / Microbiologist)	3 months	8186.35/Month	24,559.05	15,349.41
Expert on Shipping Industry	3 months	8186.35/Month	24,559.05	15,349.41
TOTAL			**98,236.21**	**61,397.63**

4.1.3 Port Biological Baseline Surveys (PBBS) (Research and Monitoring)

The cost of the PBBS Study is calculated with an estimation of choosing 5 high risk areas on Ghana's coast. This research and monitoring will be carried out twice.

Table 12: Cost Calculation for PBBS Service

a. Tema

Item	Number of times/ Quantity	Cost (GH cedi)	Total cost (GH cedi)	Total cost ($)
Boat Hiring	30	1,000.00	30,000.00	18,750.00
Laptop Computer	1	1,800.00	1,800.00	1,125.00
Field/Laboratory allowance for four (4) Scientists	30 working days	80.00	2,400.00	1,500.00
Field/Laboratory allowance for (2) Technicians	30 working days	40.00	1,200.00	750.00
Global Positioning System (hand held)	2	1,200.00	2,400.00	1,500.00
Hiring of Divers	7 days	80.00	560.00	350.00
Printer	1	1,500.00	1,500.00	937.50
Hiring of vehicle/driver	30	300.00	9,000.00	5,625.00
Fueling	30	100.00	3,000.00	1,875.00
GIS analysis	1	1,000.00	1,000.00	625.00
Awareness creation workshop			3,000.00	1,875.00
Soft substrata/ Fisheries			4,980.00	3,112.50
Hard substrata analysis			14,368.00	8,980.00
Nutrient and water quality analysis			7,320.00	4,575.00
Plankton Analysis			4,530.00	2,831.25
Reporting data processing			3,300.00	2,062.50
SUB-TOTAL			90,358.00	56,473.75
30% Administrative/ Contingency			27,107.40	16,942.13
GRAND TOTAL			**117,465.40**	**73,415.88**

b. Takoradi

Item	Number of times/ Quantity	Cost (GH cedi)	Total cost (GH cedi)	Total cost ($)
Accomodation for 4 Scientists, 2 Technicians and a Driver	30	150.00	31,500.00	19,687.50
Boat Hiring	30	1,000.00	30,000.00	18,750.00
Laptop Computer	1	1,800.00	1,800.00	1,125.00
Field/Laboratory allowance for four (4) Scientists	30 working days	80.00	2,400.00	1,500.00
Field/Laboratory allowance for (2) Technicians	30 working days	40.00	1,200.00	750.00
Global Positioning System (hand held)	2	1,200.00	2,400.00	1,500.00
Hiring of Divers	7 days	200.00	1,400.00	875.00
Printer	1	1,500.00	1,500.00	937.50
Hiring of vehicle/driver	30	300.00	9,000.00	5,625.00
Fueling	30	300.00	3,000.00	1,875.00
GIS analysis	1	1,000.00	1,000.00	625.00
Awareness creation workshop			3,000.00	1,875.00
Soft substrata/ Fisheries			4,980.00	3,112.50
Hard substrata analysis			14,368.00	8,980.00
Nutrient and water quality analysis			7,320.00	4,575.00
Plankton Analysis			4,530.00	2,831.25
Reporting data processing			3,300.00	2,062.50
SUB-TOTAL			**122,698.00**	**76,686.25**
30% Administrative/ Contingency			36,809.40	23,005.88
GRAND TOTAL			**159,507.40**	**99,692.13**

4.1.4 Risk Assessments

Table 13 highlights the cost of preparing the risk assessment studies under the national ballast water management project.

Table 13: Cost Calculation for Consultancy

Relevant Personnel	Time for study	Fee for the expert (GH¢)	Fee for the expert (GH¢)	Fee for the expert ($)
Expert on Risk Assessment	3 months	16,373/Month	49,118.00	30,699.00
Expert on Data Bases	3 months	16,373/Month	49,118.00	30,699.00
Expert on Invasive Species (Marine Biologist / Microbiologist)	3 months	16,373/Month	49,118.00	30,699.00
Expert on Shipping Industry	3 months	16,373/Month	49,118.00	30,699.00
Software		9,923.00	9,923.00	6,202.00
Hardware		5,954.00	5,954.00	3,721.00
TOTAL			**212,349.00**	**132,718.00**

4.2 COMPLIANCE-RELATED COSTS

4.2.1 Flag State Obligations

4.2.1.1 Establishing Procedure for Issuing BWM Certificate

It is aimed at giving authorization to GMA for the issuing of the ballast water management certificate to ships. The cost for this process is going to be reimbursed from ships by GMA.

Table 14: Cost Calculation for Service

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Establishing certification requirements	GMA will give the certificates with a service charge GH¢ 4961.42 x 300Ghanaian flagged ships	1,488,426.00	930,266.30
Communication of requirements and procedures to the shipping industry and IMO	Ghana Shippers Council will communicate and coordinate with sector.	No cost	No cost
Maintenance of records of issued Certificates	GMA will give the service including the service charge for establishing certificates	No cost	No cost

4.2.1.2 Approval of Ships` BWM Plans

GMA will give approvals for ballast water management plans of the ships. The cost for this process is going to be reimbursed from ships to GMA

Tables 15: Cost Calculation for Service

Cost Items	Calculation	Total Amount
Training of Staff	GMA will train their Staff	No Cost
Establishing protocols for vetting and approving BWM plans	GMA's responsibility	No Cost

4.2.1.3 Type Approval of BWM Systems

GMA will give type approvals for treatment facilities. The cost for this process is going to be reimbursed from companies to GMA.

Table 16: Cost Calculation for Service

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Review of the technical reports and test results	GMA will give the certificates with a service charge GH¢30,330.00 per ship x 300 Ghanaian flagged vessels	9,099,000.00	5,686,875.00

4.2.1.4 Surveys (Initial, Renewal, Intermediate, Annual, Additional)

GMA will give type approvals to the treatment facilities. The cost for this process is going to be reimbursed from companies to GMA

Table 17: Cost Calculation for Service

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Initial, Renewal, Intermediate, Annual surveys	GMA will give the certificates with a service charge Initial: GH¢4,961.42 Renewal: GH¢4,961.42 Intermediate: GH¢3,969.14 Annual: GH¢443 Total = GH¢14,335.07x 300 Ghanaian Flagged Ships	4,300,521.00	2,687,825.63

4.2.1.5 Approval of Exemption Application

GMA is the responsible authority for approving the exemption applications

Table 18: Cost Calculation for Service

Cost Items	Calculation	Total Amount
Exemption application	GMA is Responsible	No Cost

4.2.1.6 Training of Crew Members

Table 19: Cost Calculation for Training

Cost Items	Calculation	Total Amount
Training Cost	The Seaman takes relevant certificates for education or the company of the ship give the fees for education	The cost of this activity is included to the industry obligations

4.2.2 Port State Obligations

4.2.2.1 Compliance Monitoring and Enforcement (CME)

No additional cost is defined under the CME activities. All the cost of compliance and enforcement activities will be included to the Inspection of ships.

4.2.2.2 Inspection of Ships

Table 20: Cost Calculation for Training

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Port State Cost (Inspection of Ships)	3,000 calls Ghanaian ports annually 92% of them surveyed =2,760 ships 1 surveyor gets GH¢ 3,175.00per months and surveys 30 ships per month = GH¢ 105.83 per ship. 2 surveyors per survey x GH¢ 105.83 per ship x 2,760ships per year=GH¢ 584,181.60per year.	584,181.60per year	365,113.50

4.2.2.3 Sampling

1) Sampling for compliance with D-1 standard

Table 21: Cost Calculation for Training

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Salinometer	GH¢ 297.69X 70 Harbour Masters	20,838.30	13,023.94

2) Sampling to ensure D-2 compliance

Table 22: Cost calculation for training

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Equipment	GH¢ 5953.71x 7 District Directorate	41,676.00	26,047.00
Expert on Invasive Species (Marine scientist/ Microbiologist)	GH¢ 16370.00 per month x 12	196,440.00	122,775.00
Laboratory cost	GH¢ 5550.00per month x 12	66,600.00	44,625.00
TOTAL		**304,716.00**	**193,447.00**

4.2.2.4 Sediment Reception Facilities

Waste handling costs calculation with respect to current tariff's in Ghana

Table 23: Cost Calculation for Training

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Waste handling	GH¢ 556.06/m^3 x 1000 tonnes per year	556,060.00	347,537.50

4.2.2.7 Designation of Areas for Ballast Water Exchange

Table 24: Cost Calculation for Consultancy

Relevant Personnel	Time for study	Fee for the expert (GH¢)	Fee for the expert ($)
Expert on Risk Assessment	3 months	GH¢ 16373.00 per month = GH¢ 49119.00	30,699.38
Expert on Hydrodynamics of Sea water	3 months	GH¢ 16373.00 per month = GH¢ 49119.00	30,699.38
Expert on Invasive Species (Marine scientist/ Microbiologist)	3 months	GH¢ 16373.00 per month = GH¢ 49119.00	30,699.38
Expert on Shipping Industry	3 months	GH¢ 16373.00 per month = GH¢ 49119.00	30,699.38
TOTAL		**196,476.00**	**122,797.52**

4.2.3 Industry Obligations

4.2.3.1 Training of Crew Members (IMO Model Courses, etc.)

Table 25: Cost Calculation for Training

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Training of the personnel	GH¢ 496.00 per staff x 23,095 Ghana seafarers	11,455,120.00	7,159,450.00

4.2.3.2 BWM Plans

Table 26: Cost Calculation for Service

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Service fee of GMA	GH¢ 4960 per ship x 300 Ghana flagged ships	1,488,000.00	930,000.00

4.2.3.4 BWM Options

BW Treatment

Table 27: Cost Calculation BW Treatment

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Treatment equipment	GH¢ 843442.00 per ship (mean value) x 300 Ghana flagged ships	253,032,600.00	158,145,375.00
Operational cost	GH¢0.02 per tons of ballast water (mean value) x 80,000,000 tons ballast discharged to Ghana ports annually	1,600,000.00	1,000,000.00
TOTAL		**254,632,600.00**	**159,145,375.00**

Table 28: Cost Calculation BW Exchange

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
	GH¢ 0.09 per tons of ballast water (mean value) x 80,000,000 tons ballast discharged to Ghana ports annually	7,200,000.00	4,500,000.00

4.3. OTHER ISSUES NOT COVERED BY THE CONVENTION

4.3.1 Port Biological Monitoring Programmes

The main problem of the port biological monitoring programmes is how to raise the needed funds and sustain it. There is the therefore the need for the port authorities to support local scientists to be able to conduct the monitoring programme frequently. The Ghana Ports and Harbours Authority must therefore be congratulated for funding the conduct of the first port biological baseline survey in Ghana.

To sustain the interest of the port authorities, the port biological monitoring programme should also incorporate environmental monitoring assessments that the port may also frequently need. For cost effectiveness, monitoring should be conducted two times a year, that is, dry and wet seasons. Estimation of costs for such surveys is as indicated in the table below.

Table 29: Cost Calculation for Service

Cost Items	Calculation	Total Amount (GH¢)	Total Amount ($)
Accommodation	6 x 2 days x GH¢ 163.73 x 2 seasons	3,929.52	2,455.95
Travel expenses	GH¢ 4911.81 x 2 seasons	9,823.62	6,139.76
Expert on Invasive Species (Marine scientist/ Microbiologist)	2 days x GH¢ 16373.00 x 2 seasons	65,492.00	40,932.50
Divers	2 days x 2 divers x GH¢ 4962.00 x 2 seasons	39,696.00	24,810.00
Diving Equipment	GH¢ 5953.71 x 2 seasons	11,907.42	7,442.14
Laboratory Equipment	GH¢ 6946.00 x 2 seasons	13,892.00	8,682.50
TOTAL		**144,740.56**	**90,462.85**

4.3.2 Port BWM Plan Development

Table 30: Cost Calculation Consultancy

Cost Items	Calculation	Total Amount (GH¢)	Total Amount (GH¢)	Total Amount ($)
Expert on Ballast Water Implementations	GH¢ 16373.00 per month x 3 months	49119.00 per port x 2 major ports	98,238.00	61,398.75

RESULTS

Direct use values Key Sectors	**Total yield/catch/#users etc (where applicable)**	**#employed or dependent**	**Total value of sector**	**Total value of sector as % of GDP**	**Vulnerability to IAS (high, medium, low)**	**% loss (worst case scenario)**	**$ loss (worst case scenario)**
Fisheries	400,000 metrictonne/year fish catch					60% loss in fish stocks	More than 1 billion USD loss
	12.16% of Africa production (2008)	124,000 registered fisherman	1.6 billion TL	5%	High		
Aquaculture	80,000 tonne/year fish production						
	32% of world production	5,000 workers in fish farms	512 million TL	0.5%	High	80% can be lost if the ecosystem is changed	$409 million
	Bed capacity: 100,000 Hotels 10 million tourists per year 2.5% of world capacity						
Coastal Tourism			$18 billion	6%	High	30% can be lost if the ecosystem is changed	$5.4billion

Additional Costs to Society or Industry	#employed or dependent	Total value of sector	Total value of sector as % of GDP	Vulnerability to IAS (high, medium, low)	Type of costs possibly incurred	$ cost (worst case scenario)
Shipping	5000 Registered seaman in Ghana	224,776,283 tonnes of cargo handled on 2008 300 Ghana flagged ships	NA	Low	None	None
Coastal infrastructure	2 major ports		NA	Low	None	None

Public Health	IAS Species (with potential human health impact)	Possible impact pathway (e.g. food, water, recreation etc)	Possible impacts (food poisoning, physical harm etc)	# affected (worst case scenario)	Treatment costs per person)	$ cost (worst case scenario)
Vulnerable groups	Poisonous algaes	Food, water	Poisoning,	More than 10% of the population	$200	$ 1.4billion
	Pathogens like cholera	Water, recreation	Epidemic diseases	7 million people		

Issue	Obligation to whom flag/port/industry	Cost to whom flag/port/industry	Type of cost (cash/time , in kind etc)	Estimated cost ($)	Estimated cost (GH¢)	Possible source of funding or funding mechanism (if application Status
PREPARATORY PHASE						
Capacity building, education and communication						
National Task Force Meetings	GMA	GMA	Cash and in kind	17,814.38	28,503.00 /year	IMO/GloBallast
Training (CME, PBBS, etc)	GMA	GMA	Cash and in kind	94,5447.10	1,512,715.36	IMO/GloBallast
Regional Task Force meetings	GMA	GMA	Cash and in kind	77,841.25	124,546.00	IMO/GloBallast
LEGISLATIVE, POLICY AND INSTITUTIONAL REFORM						
National BW Status Assessment	GMA	GMA	Cash	30,698.82	49,118.11	GloBallast (Concluded)
Economic Assessment	GMA	GMA	Cash	20,465.88	32,745.40	GloBallast (Concluded)
National BWM Strategy	GMA	GMA	Cash	35,815.29	57,304.46	GloBallast (Concluded)

Legal review and drafting	GMA	GMA	Cash	61,397.63	98,236.21	GloBallast (Concluded)
Port Biological Baseline Studies (research and monitoring)	GMA	GMA	Cash and in kind	173,108.01	276,972.80	
Risk Assessments	GMA	GMA	Cash and in kind	132,718.00	212,349.00	IMO/GloBallast
COMPLIANCE RELATED COSTS						
Flag State Obligations						
Establishing procedures for issuing BWM, certificate	GMA	Industry	Cash	930,266.30	1,488,426.00	
Approval of ships' BWM Plans	GMA	Industry	In kind	None	None	
Type Approval of BWM Systems	GMA	Industry	Cash	5,686,875.00	9,099.000.00	
Approval of exemptions	GMA	Industry	None	None	None	
Surveys	GMA	Industry	Cash	2,687,825.63	4,300,521.00	
PORT STATE OBLIGATIONS						
Compliance Monitoring and Enforcement	Port	No additional cost				

Inspection of ships	Port	Port	Time, in kind	365,113.50/year	584,181.60/ year	
Introduction of BW reporting form	Industry	No additional cost				
Sampling	Port state	Port state	Cash	193,447.00 /year	307,716.00 / year	
Sediment reception facilities	Industry	Industry	Cash	347,537.50	556,060.00	
Communication of requirements to IMO and other member states	Port state	Port state	Time, in kind	None		
Communication of BWM requirements to ships	Port state	Port state	Time, in kind	None		
INDUSTRY OBLIGATIONS						
Training of crew members	Industry	Industry	Cash/time	7,159,450.00	11,455,120.00	
BWM Plans	Industry	Industry	Cash/time	930,000.00	1,488,000.00	
BWM Record Books	Industry	Industry	Cash/time	No additional costs		

BWM OPTIONS						
BW Exchange (D-1)	Industry	Industry	Cash/time	4,500,00000	7,200,000.00	
BW Exchange (D-2)	Industry	Industry	Cash/time	159,145,375.00	254,632,600.00	
Port Biological monitoring programmes	Port, State	Port, State	Cash/time	90,462.85	144,740.56	
Port BWM Plan development	Port	Port	Cash/time	61,398.75	98,238.00	

CONCLUSIONS

The results show that the operational cost of ballast water management system is definitely cheaper than the cost of possible harms of the invasive alien species. Also it has to be mentioned that only the economical lost from invasive alien species was calculated. The economical assessment methodology could not assess the economical impart to culture, human sociology and psychology. Also the cost of the possible cleaning activities for AIS is not in the scope of this report.

Table 31: Results

Possible Economical Effect of AIS to GHANA	8.16 Billion (worst case) ($)	GH¢ 13056000000 (worst case)
Operating Cost of BWM to port state	1,662,271.90	1,038,919.94
Operating Cost of BWM to industry	275,018,698.56	171,886,686.60
Total Cost of BWM	**276,680,970.46**	**172,925,606.54**

If we also include the lost on ``cultural value`` of the living place to the amount of possible effect of AIS then the difference between operating cost to the possible economical effects of AIS will increase. We can easily define that ballast water management activities are feasible with respect to the comparison between costs and lost.

Table 32: Results

OPERATIONAL COSTS	COSTS (GH¢)	COSTS ($)	%
Capacity building	1,523,228.00	952,017.50	0.52
Port Biological Baseline Surveys (PBBS) (research and monitoring)	276,972.80	173,108.01	0.09
Flag State Obligations	14,887,947.00	9,304,966.88	5.07
Port State Obligations	1,662,271.90	1,038,919.94	0.57
Industry Obligations	275,018,698.56	171,886,686.60	93.74
Total	**293,369,118.26**	**183,355,698.92**	**100.00**

The operational cost for ballast water management effects 5.07% for the flag state and 93.74% for the industry.

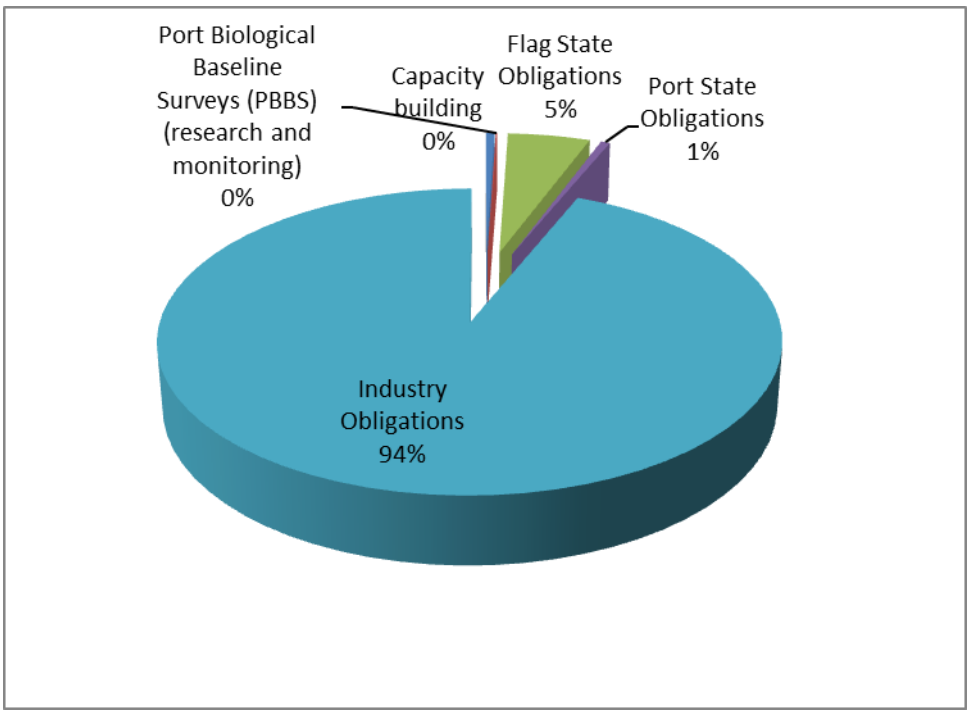

Figure 1. Percentages of operational costs

Also when we look at the cost items for industry we can see that 92.59% of the cost for industry is ballast water treatment. This is an obligation under the BWM Convention. All the ships have to treat their ballast water with respect to standards concerned in the convention.

Table 33: Results

INDUSTRY OBLIGATIONS	COST (GH¢)	COST ($)	%
Training of crew members	11,455,120.00	7,159,450.00	4.17
BW Plans	1,488,000.00	930,000.00	0.54
BW Exchange	7,200,000.00	4,500,000.00	2.62
BW Treatment	254,632,600.00	159,145,375.00	92.59
Port Biological Monitoring Programme	144,740.56	90,462.85	0.05
Port BW Plan Development	98,238.00	61,398.75	0.04
TOTAL	**275,018,698.56**	**171,886,686.60**	**100.00**

It is calculated that the 86.80% of all operational cost is ballast water treatment

Table 34: Results

INDUSTRY OBLIGATIONS	COST (GH¢)	COST ($)	%
BW Treatment	254,632,600.00	159,145,375.00	86.80
Other activities	38,736,518.26	24,210,323.92	13.20
All operational cost	**293,369,118.26**	**183,355,698.92**	**100.00**

In conclusion this economic assessment study shows that the ballast water management activities are feasible to implement. The total cost for the activities beside treatment is GH¢38736518.26($24,210,323.92). This amount could be achieved in Ghana with IMO and other entities outside Ghana in order to counteract such a huge treat of Alien species.