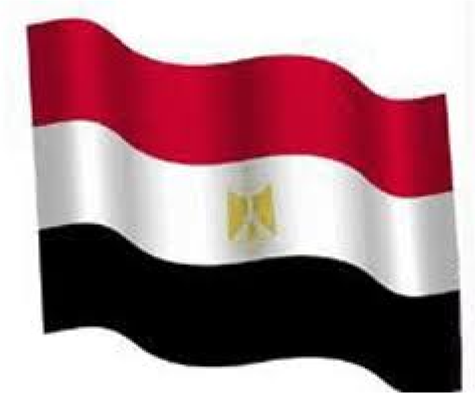

Ballast Water Economic Assessment for EGYPT, RED SEA

National Economic Assessment for Ballast Water Management in EGYPT, Red Sea

Red Sea PORTS Authority(RSPA) – 2011

Draft Report- Novmber,2011

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Contents

1 Introduction

1 .1 Shipping and Marine invasive alien species:

Vessels sail from port of source if not fully laden, either partly laden or without cargo. They take additional weight of ballast water to adjust stability and sail effectively and safely to destination. This ballast water contains a large number of organisms of different species drawn on board and when discharged at destination the survived species are released live in the waters. Thus, ballast water serves as a potential vector for the transfer of species from one part of the world to another. Since the destination is a new area outside of the range of the geographical source, the species are commonly referred as alien and if the environmental condition is favourable they may establish and spread, in the absence of natural controls such as predators or parasites, and drastically change the ecosystem with potential to cause harm to the local environment, economy and human health. Such species are generally called as "**Introduced Species**" or "**Invasive Alien Species**" (**IAS**).

Alien invasive species are still away from control and rating their economical, social and ecological effects. The consequences of marine species invasions include:

- Ecosystem changes, which original/endemic species composition and ecological processes may be altered by the invading species.
- Economic impacts on Fisheries, coastal industry and other commercial activities and resources may be disrupted by the invading species resulting in loss of revenue and removal costs.

In EGYPT, there is no data base information about the IAS and their spreading magnitude in Egyptian Red Sea waters. In spite of the effort developed by the government but Egypt still lacks of adequate information of the type, numbers, status and structure of IAS (If present) in EGYPT red sea.

Ballast water is of particular concern as a vector for the introduction of invasive alien species both because of the large quantities of ballast water being used and discharged into new environment around the world, but also because of the huge variety and number of species which it may transfer.

More than 90% of all worldwide trade goods are transported on ocean and moves an estimated 10 billion tonnes of ballast water globally each year, and is estimated to be responsible for the transfer 7,000 species globally every day which including the introduction of the most damaging and costly IAS of the comb jellyfish to the black Sea, and the introduction of the zebra mussel at the American Great Lakes.

Once the marine IAS is established, it is nearly impossible to control or wipe them out. So management of the marine IAS must concentrate on precautionary measures. The international community through the International Maritime Organization (IMO) has been addressing the issue of IAS and ballast water since 1980s. The International Convention for the Control and Management of Ships Ballast Water & Sediments (referred onward as the Ballast Water Management (BWM) Convention) adopted in February 2004 is a key tool to this end.

The BWM convention has not yet entered into force. Up to June 2012, 35 parties representing 27.95% of the world merchant tonnage had ratified the convention. To enter into force, 30 signatories are needed, representing 35% of the tonnage.

Economic analysis of IAS, their possible impacts and management options can support strategic decisions regarding IAS responses, and facilitate national planning. This report is primarily aimed to serve as a practical tool to support the development of a national ballast water management strategy. However, it also has a broader utility for considering the economic aspects of IAS impacts and management responses, and can be used for other decision support, including making a case for ratification of the Ballast Water Convention.

For the purposes of development of a national ballast water management strategy, a simple economic assessment based on readily available data, such as national statistics, is often sufficient.

This report is prepared to provide a straightforward and structured approach to undertaking such assessments. In some instances, however, much more detailed analysis may be desired, in which case it is recommended to engage an expert economist. While detailed methods for economic assessment and valuation is beyond the scope of this report.

1 .2 The Aim of the Economic assessment

In general, the objective of the economic assessment is to provide an understanding of the economic value of resources that may be under threat of a potential bio-invasion, as well as estimation of the costs related to pre-cautionary action toward the implementation of the BWM convention.

This report is prepared in order to assess the economical overhead of ballast water management activities to existing maritime operational system of Egypt. Also it is aimed to make a comparison between the impacts of the aquatic invasive species and the cost of the national ballast water management system.

This economic assessment study demonstrates and quantifies the economic values of an ecosystem and the potential impacts to these values by introduction of an invasive species.

This assessment study is primarily aimed to serve as a practical tool to support the actions on the national ballast water management strategy.

The results of this report are supporting the national decision on ratification the Ballast Water Convention.

1 .3 Source of information

This report is prepared by using the formal (actual and estimated) available statistical from concern bodies of Egypt.

There are two principle sources for the formal national information and statistical data on Egypt. They are statistical yearbooks and annual reports on fisheries statistics. At the national level, the population data produced by the government of Egypt.

Egypt Statistical Yearbooks have a vital importance, due to the fact that it is the main source of data needed to economic assessment, the central statistical Agency has concerned to publishing statistical Book annually. Recent statistical yearbooks (2008 and 2010) were used as basic sources on this assessment of the sectors.

The General Authority of Fisheries Wealth is the responsible for fisheries management and preparing annual reports on Fisheries statistics, such these reports which give the basic statistical information on the economic assessment of fisheries sector.

The preparatory activities under this assessment report were calculated by using the costs of similar training activities which were held in EGYPT within the scope of the Globallast Partnership Project.

The costs of legal, policy and institutional reforms are estimated by using the costs of the similar work packages of the national ballast water management project of Egypt.

In most cases there were some complications in defining the cost of different services/benefits because the tariffs changes due to many parameters. On this kind of situations, some calculations made including approximations like as mean values.

2 Methodology

In this report the below mentioned basic economical assessment methods were used.

2 .1Market price analysis:

Market prices can be used for any ecosystem good or service that can be bought or sold, and can be applied to e.g. loss of income, loss of employment, loss of marketable goods, costs etc. This is a comparatively inexpensive method, and requires less data intensive analysis to arrive at a value. In addition, this technique is flexible enough so that it can be used e.g. where an invasive alien species has replaced or diminish directly consumable species, when invasive alien species affect the production of marketable goods, or when invasive species themselves become marketable goods. This means that market price analysis often is recommended when a valuation study is to be conducted for an invasive alien species impact, whereas many other techniques, while valid and valuable in their own right, require much longer time periods for data collection, analysis and reporting. An added benefit is that many countries already collect the data necessary through the collection of national statistics, making this an easy technique to carry out "in-house."

There are a few caveats for using the information. If the market for goods and services is distorted by subsides or other market externalities, the results may not reflect the true economic and social costs of an invasive alien species impact. However, awareness of such factors can be sufficient to recognize that the market prices may under or over estimate the true costs, and make necessary corrections. Lastly, while this methodology determines the value of products derived from an ecosystem, it can miss the true (complete) value of the ecosystem due to only examining the market for goods, while excluding other non-marketable services.

2 .2Travel cost method

Travel costs valuation is particularly useful for ecosystem level valuation of recreational or leisure destinations, e.g. the value of a given water body for fishing activity. The method is frequently used, but it does depend on a large data set and complex statistical skills, and is gathering information from visitors to recreational sites is very labour intensive.

3 Assessing economic value of resources at risk from IAS impacts.

The possible impacts of IAS are manifold, and can affect human health, infrastructure, trade and ecosystems. In all cases this may have economic implications. The spread of IAS is associated with ballast water and also fisheries and aquaculture, that have led to human poisoning, closures of shellfish farms and bans on gathering wild shellfish.

Assessing and valuating impacts of species introduction is thus important both for managing IAS incursions as well as for supporting preventive action. However, assessing the economic impacts of an IAS requires a structured process for evaluating the specific attributes of the ecosystems, economies, and cultures affected.

This chapter provides an overview of the used approaches to economic assessment of ecosystem values, and outlines a simple framework for economic value assessment of sectors and resources at risk that can make an estimate of the possible costs to society and industry arising from ballast water mediated species introductions.

3.1 The value of ecosystems:

According to GEF-UNDP-IMO- IUCN (2010) ecosystems provide valuable services to human production and consumption. The Millennium Ecosystem Assessment (www.millenniumassessment.org) classifies these services into:

- Provisioning services such as food and water;
- Regulating services such as flood and disease control;
- Cultural services such as spiritual, recreational, and cultural benefits;
- Supporting services, such as nutrient cycling, that maintains the conditions for life on Earth.

Ascribing values in economic or monetary terms can be done with relative ease for some of these services such as the revenue generated by a fishery in the marketplace. For other services that are not traded in markets, however, it is much more difficult to ascribe value. For example, a coastal ecosystem acting as a fish nursery habitat is valuable because it provides a safe environment for fish to grow in before moving into other areas where they are caught. There is no direct market for the coastal ecosystem, but the price of fish can give a 'shadow value' for the habitat. This is an example of a so-called indirect use value.

Capturing the complete value of ecosystems is done through a conceptual framework called Total Economic Value (TEV). By adopting a TEV framework in the early stages of an economic analysis, direct and indirect services that are both ecologically and economically important can be identified. Importantly, TEV helps us to understand that ecosystems provide values beyond ecosystem goods and services traded in the marketplace. Further, some of these values may be critical to community livelihoods. Using the TEV framework to capture the full value of the ecosystem services avoids the pitfalls of industrial studies that may only capture marketable values.

3.2 Categories of economic value

The Total Economic Value (TEV) of an area/ecosystem is a function of its *use values* and *non-use values* (GEF-UNDP-IMO- IUCN, 2010):

- ***Direct use values***, derived from direct use or interaction with environmental resources and services, can involve commercial, subsistence, leisure or other activities, such as fisheries and tourism.
- ***Indirect use values***, which relate to the indirect support and protection provided to economic activity by the ecosystems natural functions, can include flood control and protection against storm surges, as well as spawning or nursery areas for commercially caught fish.
- ***Option value*** is the value individuals place on the option to be able to use the environment sometime in the future, expressed for example as the willingness to pay for biodiversity conservation.
- ***Non-use values***, on the other hand, are derived from people's happiness based on the knowledge of the *existence* of an ecosystem or species from which they derive no real use but that they want to know is preserved. This can also include a *bequest* value, e.g. the satisfaction one gets from knowing a resource will be passed on to future generations.

It is important to be aware of these different values when estimating the possible economic implications of IAS introductions. Identifying the full range of goods and services humans derive from their local environment enables a more comprehensive assessment of what stands to be impacted. While a relatively accurate measure of several direct use values that may be impaired or lost can be generated, exact quantification of other values is often difficult. However, considering the full range of values can help to assign, at the very least, a 'ballpark figure' to other services that may be affected. Using the services of an expert environmental economist can help further tease out these nuanced values if necessary.

3.3 A framework for assessing economic value of resources at risk:

3.3.1 Key sectors:

Many marine ecosystems and resources are not traded in markets and so do not have an obvious price. There is a risk from IAS, therefore, that the effects of BW activity on the natural habitats will be ignored. Though environmental impacts do not have a price that does not mean they do not have value. This is the difference between financial analysis, which is concerned only with goods and services traded in markets, and economic analysis which is concerned with society's well being or welfare. If we are concerned with people's welfare, we must fully consider environmental impacts.

The coastal waters of Egypt, Red Sea are also characterized by their high level of primary and secondary production, making them an important feeding and nursery grounds for marine species. More than 400 commercial species of fish and marine organisms have been recorded.

There are numerous sectors, stakeholders and processes that may be impacted by an IAS incursion in some way, a few stands to be directly affected and/or are more vulnerable. These sectors are thus of particular importance when considering the economic impacts of IAS. Frequently, these are also the sectors for which economic value can be most easily assessed.

The Red Sea has a number of unique marine habitats, including coral reefs, mangroves, and sea grass beds. They provide key resources for coastal populations providing food, shoreline protection and stabilization as well as economic benefits from tourism.

3.3.1.1 Fisheries:

According to PERSGA (2002) the fisheries of the Red Sea and Gulf of Aden are of considerable socio-economic importance to PERSGA member states, in terms of national food security and income generation for rural communities. Fisheries resources are exploited by artisanal subsistence fishermen, local commercial fisheries and foreign industrial fisheries targeting invertebrates, demersal finfish and pelagic finfish. Many species cross national boundaries and are essentially shared stocks.

The fisheries of the Red Sea of Egypt Red Sea and adjacent gulfs are based on a long-standing traditional (artisanal) fishery where coral reefs spread along the Red Sea Coast and Gulf of Aqaba, with relatively shallow fishing grounds (maximum 70 m depth) with flat sandy bottoms in the Suez Gulf, the only area suitable for trawling. The narrow, reef-rich continental shelf of much of the coastline is suitable only for artisanal fishing with hook and line or inshore set net.

There are 4 fisheries centres along the Suez Gulf, 6 along the Red Sea Coast and 3 along the Gulf of Aqaba. There are only two developed fishing ports (Suez and Hurghada). The fishing fleet in 2001 was composed of 78 trawlers and 83 purse seiners in the Suez Gulf, and 711 boats using longline and hooks along the whole fishing ground, in addition to about 128 trawlers working outside Egyptian territorial waters, around the Gulf of Aden.

The catch in the Gulf of Suez constitutes 44 percent of the total landing of the Red Sea fisheries, while the Red Sea contributes 34 percent and 21 percent comes from outside Egyptian territorial waters. The Gulf of Aqaba catch composed less than 1 percent of the regional landing.

Catches include about 35 fish species groups, dominated by mackerel (Scomber spp.) (22 percent), lizard fish (Saurida undosquamis) (11 percent), snapper and emperors (Lutjanus spp. and Lethrinidae) (8 percent), threadfin bream (Nemipterus spp.) (7 percent), sardine (Sardinella spp.) (6 percent), grouper (Epinephelus spp.) (5 percent) and gray mullet (Mugil spp.) (5 percent). For conservation purposes, the number of trawl licences issued for fishing inside the Gulf of Suez is limited and fishing is not allowed from 1 June to 30 September each year. Recently, catching sea cucumber has become economically important and reached 139 tonne in 2001 (http://www.fao.org).

The monthly catch of the Red Sea, according to the landing sites in 2010 (in tons), (Fish Statistics Book 2010), is shown in Table 1.

Table (1): Monthly catch of the Red Sea, according to the landing sites in 2010 (in tons)

Area	Month / Landing sites	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Suez Gulf	**Ataka**	2411	1761	979	882	54	0	0	0	1210	2004	1501	1641	12443
	Salkhana	37	21	30	23	18	0	0	0	65	115	62	43	414
	Ras Ghareb	92	21	55	24	19	0	247	0	13	179	188	28	866
	Tour	700	497	423	558	196	0	9	0	196	825	752	481	4637
Total		**3240**	**2300**	**1487**	**1487**	**287**	**0**	**256**	**0**	**1484**	**3123**	**2503**	**2193**	**18360**
Red sea	**Ataka**	197	123	159	57	56	0	0	0	0	188	102	288	1170
	Ghrgada	362	377	307	423	926	311	182	0	466	948	467	1477	6246
	Branies	877	1155	1103	785	898	11	29	0	766	3608	1525	1441	12198
	Safaga	89	97	46	77	58	68	0	0	199	96	126	58	914
	Quseir	293	96	184	262	920	180	162	0	0	470	212	108	2887
	Abu Ramad	33	36	33	38	123	11	27	0	27	143	42	36	549
	Shlatien	129	79	107	195	230	55	0	0	142	348	132	198	1615
Total		**1980**	**1963**	**1939**	**1837**	**3211**	**636**	**400**	**0**	**1600**	**5801**	**2606**	**3606**	**25579**
Gulf of Aqaba		4	1	1	2	12	0	0	0	8	3	1	3	35
Total		4	1	1	2	12	0	0	0	8	3	1	3	35
Grand total		**5224**	**4264**	**3427**	**3326**	**3510**	**636**	**656**	**0**	**3092**	**8927**	**5110**	**5802**	**43974**

Source: Fish Statistics Book 2010

3.3.1.2 Coral Reefs:

Egypt coastline possesses a significant proportion and considerable range of the coral reefs found in the Red Sea with about 3800 Km2 of reef area (Spalding et al. 2001) and 1,800 km long (PERSGA 2010). Among the about 300 hard coral species found in the Red Sea, 2/3 are found in the Egyptian reefs, including some endemic species (Kotb et al. 2008). These numbers are higher than those recorded for the Caribbean and equal to Indian Ocean. Egyptian reefs are fringing reefs alongside the coastline. The northern part of the Red Sea has the highest coral diversity and number of islands while the south has the highest terrestrial biodiversity for the whole country (Shaalan 2005).

PERSGA 2010 performs a permanent survey of reefs. Live coral cover of Egyptian reefs averages 48%. Major fishes are the butterflyfish (Chaetodontidae) with 7.2/500 m3, parrotfish (2.2/500 m3), snapper and grouper (0.8/500 m3) (see Table 1). Some population of the marine mammals dugong (Dugong dugon) are present in different area (Tiran Islands, Nabq and Abu Galum Marine Park in the North, El Quseir in the South) as well as marine turtles (hawksbill, green turtle, leatherback and logger-head) or sharks.

Key-species abundance during reef checks of 2002 and 2008 made by PERSGA is shown in table 2.

Table (2): Key-species abundance during reef checks of 2002 and 2008 (Persga 2010).

Abundance (fish number/100 m^2 reef)	2002	2008
Butterflyfish	6.8 ± 0.36	6.10 ± 0.07
Diadema (sea urchin)	< 5	< 1
Giant clam	2.2 ± 2	3 ± 1.4
Grouper	0.77 ± 1.0	0.74 ± 0.03
Lobster	0.02 ± 0.08	-
Parrotfish	2.0 ± 1.6	2.0 ± 0.4
Sea cucumber	< 1	Nearly 0
Snapper	5 ± 5	11 ± 10
Sweetlips	0.4 ± 0.1	0.8 ± 0.05
Triton	< 1	-

LOCAL THREATS TO THE EGYPTIAN CORAL REEFS:

Among the direct impacts, there are trampling, coral breaking by divers or snorkelers, damages from recreational boat anchoring and boat grounding. Riegl and Velimerov (1991) found that coral breakage was the most common damage, especially on highly frequented reefs. Also, all observed damage was most frequent within the first ten meters depth, suggesting that major threats on coral reefs are produced by inexperienced divers and snorkelers rather than by experienced divers who practice a more eco-friendly tourism (Jobbins 2006).

The number of hotels in the Gulf of Aqaba has increased from 5 in 1989 to 141 in 2006 while the number of hotel rooms increased from 565 to more than 48,000. Similarly around Hurghada the number of hotel rooms increased from a few hundreds in 1989 to 35,000 in 2004 (Kotb et al. 2008).

The number of tourism boats has increased sharply over the last 20 years leading to increased damage from anchoring and boat groundings. In Sharm El Sheik dive boat numbers rose from 23 in 1989 to 350 in 2006 and in Hurghada the number of boats increased was from less than 50 to more than 1200 boats.

Beaches are prime attractants for resort developers, but as there are few natural beaches, some coastal resorts have created artificial beaches on rocky shores. This concerns not only reef habitats, but also the sand transported down current causing sedimentation and increasing water turbidity.

Among indirect impact there is sewage run-off, sedimentation following urban construction, dredging, coastal alteration, over-fishing (including sharks as well as invertebrates like sea cucumbers) and destructive fishing (blast fishing), pollution, discharge of chemicals (chlorine, copper…) from desalination plants. For example, coastal modification around Hurghada for touristic land reclamation has been the prime cause of reef degradation through the discharge of increasing quantities of fine sediment (El-Gamily et al. 2001). Holden (2000) estimated that 73% of the coral along the Egyptian coast has been damaged as a result of construction.

Most important is the Crown of thorn starfish (*Acanthaster planci*) predator considered as an alien species.

Crown of thorn starfish - Predator Outbreaks

Crown of thorn starfish (*Acanthaster planci*) classified under phylum Echinodermata. And they feed on coral reefs. In normal circumstances, they don't exceed small numbers of 10m², but in some cases they increase greatly in number and accumulate over each other until 50 starfish /m² that caused great problems because they feed on coral reefs, causing their death.

Acanthaster planci was rarely observed prior to the 1990s. In 1994 there was a moderate outbreak (200 individuals) at Ras Mohammed in south Sinai. It was estimated that the 20 - 30 cm sized starfish caused a loss of 20-30 % of total live coral cover. From 1995 to 1998 the populations of starfish appeared to increase in density, with records of up to five starfish per 10 m2 (Salem 1999). In 1998 a further outbreak of approximately 250 to 300 small (7 -15 cm) individuals occurred at Ras Mohammed, but the greatest outbreak (10,000 individuals) occurred around Gordon reef, near Tiran island. EEAA efforts have diminished the impact of the starfish by organising the collection of over 60,000 *A. planci* between 1998 and 1999.

In 2001, great efforts were exerted from protected areas staff. NGOs and volunteers from Sharm El-Sheikh, Dahab and Hurghada, collected 150,000 starfish. In 2002 and onwards, their numbers have decreased dramatically, and the coral reefs also recovered, exhibited by an increase in growth rate (10cm/year) (EEAA, 2007 & 2008).

Crown of throns causing coral bleaching

Collecting Crown of throns by hand

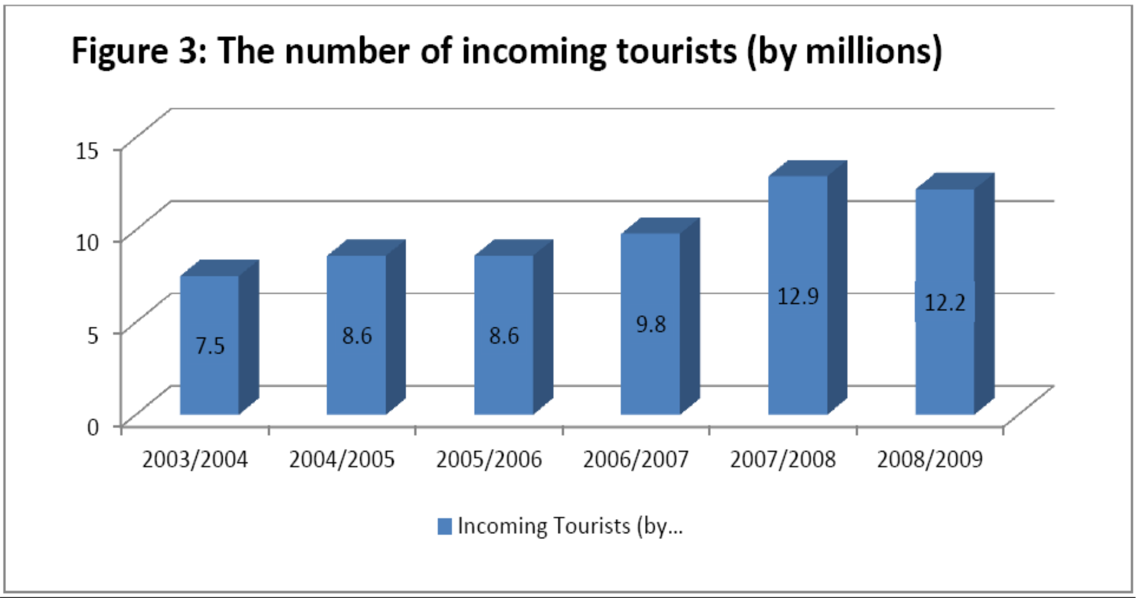
3.3.1.3 Coastal tourism in the Red Sea of Egypt:

Tourism in Egypt is considered as one of the main sources of the national income as well as one of the major pillars of comprehensive development. It is associated with about 70 feeder and complementary services and industries. It is one important factor of economic growth as it represents about 40% of the Egyptian non-commodity exports in 2007/2008. The tourism sector represents the main source of foreign currency. Also, it is one of the main labour-intensive activities as the total employment provided by this sector is estimated at about 4.5 millions jobs which is equivalent to about 13% of the total labour force. Moreover, the contribution of the tourism sector in GDP in 2008/2009 reached about 3.6%. (EGYPT yearbook 2009)

The past years witnessed an expansion of hotels and tourist villages which amounted up to 1486 hotels in 2009 with an accommodation capacity that reached about 213 thousand rooms. Also, the number of hotels under construction reached about 624 hotels with an accommodation capacity that exceeded 190 thousand rooms.

The Red Sea governorate represents about 33% of the total capacity, followed by south governorate (North Sinaï) at about 32%, the Greater Cairo governorates at about 13%, the governorates of Luxor and Aswan at about 4%, and the Floating hotels at about 8% of the total hotel capacity.

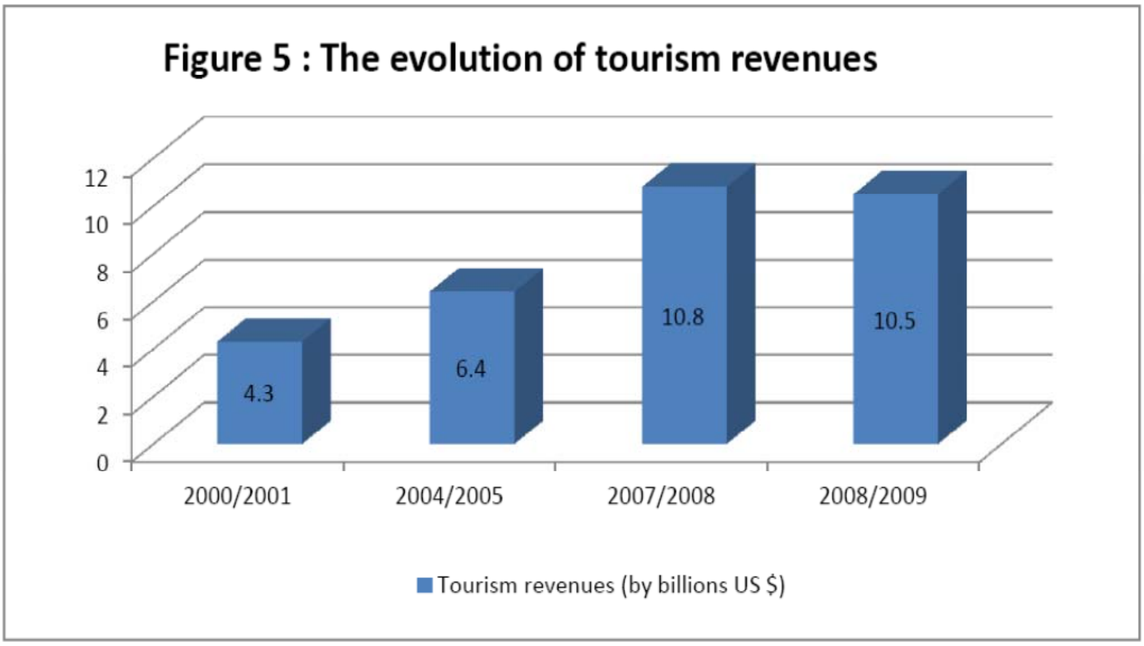
The number of incoming tourists to Egypt during the year 2008/2009 reached about 12,3 million tourists (compared to 7,5 million tourists during the year 2003/2004) spending about 123,4 million tourist nights, slight decrease due to the global crisis (Figure 1).



Source: ministry of tourism 2009

Figure (1): Number of incoming tourists by millions

The tourism revenues increased up to about 69% during the period from 2004/2005 to 2007/2008 since the revenues rose from 6.4 billion US dollar up to 10.8 billion US dollar. These revenues were affected by the financial crisis as they decreased to 10.5 billion in 2008/2009 (Figure 2).



Source: ministry of tourism 2009

Figure (2). The evolution of tourism revenue (2000 – 2009)

In 1999, 90% of Egypt's tourism investment was concentrated in coastal resorts or southern Sinai, with a large concentration on dive tourism and beach holidays around the Red Sea Gulf of Aqaba (Shackley 1999). As a result, tourism revenue in Egypt increased by 53% from 1988 to 1992 (Alavi and Yasin 2000). This is one of the world's fastest-growing resort areas, resulting in environmental concern for the coral reefs and the desert hinterland (Shackley 1999).

So the development of tourism sector has provoked a great progress of investment rate. It rose about 38.7% between 2006/2007 and 2007/2008. The private sector contributed to about 84% of these investments.

European countries are the main source of incoming tourism for Egypt since they constitute about 74.2% of the total number of tourists followed by the Middle East countries at 13.6%.

ECONOMIC LINKS WITH EGYPTIAN CORAL REEFS:

As we wrote before, Hurghada became the first tourist resort on the Egyptian Red Sea. Its coast extends to about 62 km along the Red Sea, and it is mainly supported by tourism from water-based sports and activities (Frihy et al. 1996). Hurghada and Safaga (50 km to the south) became an attractive destination. Both cities attract scuba divers because of abundance of coral reefs, white sandy beaches, exotic fish, clear water and year-round warm climate and boast some of the best diving sites in the world (Ibrahim and Ibrahim 2003; Gray 2000).

However, the success and sustainability of tourism in the Red Sea is threatened by the industry which supports it. Today Hurghada has been completely transformed into one of Egypt's premiere destinations and is home to over 35,000 residents, sprawls over approximately 60 km, and houses over 170 hotels and resorts, and approximately 60 dive centers (Serour, 2004). Over one hundred major recreational projects have been constructed in Hurghada. Uncontrolled tourism development threatens the marine and coastal environments and has become a source of national concern.

Tourism generates important economic activity globally and is a major source of foreign exchange income in many countries (Simpson et al. 2008). As we mentioned earlier, tourism in Egypt generates an estimated US$ 10.8 billion annually (equivalent to approximately 6% of national GDP if we consider the direct and indirect activities related to tourism), as well as it provides employment for 12% of the national work force (AFP, 2007). Much of the revenue from tourism in Egypt is derived from the Red Sea region (IUCN-USAID, 2007).

The coral reefs are considered a natural capital. The total economic value (TEV) of this natural capital can be derived from the value of all goods and services provided by marine ecosystems. The TEV can be broken up to obtain the value of different components of the ecosystems use (i.e. tourism, fishery and shoreline protection). The main advantage of calculating the TEV is to highlight the importance of the conservation of the reef ecosystem.

According to global estimates (World Bank, 2002), counting only the economic value of coral reef fisheries, tourism, and shoreline protection, the costs of destroying 1 km of coral reefs ranges between US$137,000 and 1,200,000 over a 25-year period and the properly managed coral reefs can yield an average of 15 tons of fish and other seafood per square kilometre each year. This means that the total economic value of Egypt's Red Sea reefs is estimated at US$ 205.5 million to 1800 million, and can yield about 1400 tonnes of seafood.

Assessment of the cost of degradation has been estimated through two steps:

(I) The quantification of the physical losses of natural capital (coral reefs habitats) as well as goods and services generated from the reefs ecosystem owing to unregulated tourism activities;

(II) The monetary valuation of the physical losses.

The cost of coral reefs and fisheries degradation in the Egyptian Red Sea area caused by unregulated tourism activities was estimated between US$ 2626 to 2673 million per year. These include:

1- The loss of natural capital: available estimates (Jameson and al, 1999) indicate that the replacement value of one square meter of coral reefs is US$ 3000. Based on an estimate of 4 million square meters (Institute of National planning, 2003) of coral reef damaged as a result of tourism projects within the studied area, the **total value of the loss of the natural capital is about 12 billion US dollars.**

2- The loss of income from marine recreational activities: as far the reef close to Hurghada becomes more congested, the more experienced divers are seeking alternative sites that led to considerable decrease in diver's payments. According to available estimations of World Bank (World Bank, 2002), the losses of income from marine recreational activities in Hurghada Area alone ranged between US$ 110 to 157 million. Moreover, Cesar (2003) gave **a value of US$ 9.6 billion/year globally for coral reefs contribution to tourism**, i.e. Egyptian reefs represent only 1% of the total reef tourism incomes.

3- The cost of shoreline protection: the cost to build an artificial barrier **replacing a damaged reefs along the coast is estimated at 12.5 million US$ per km.** Based on the fact that the length of the coast in the studied area that has been affected by tourism developments and has been subject to dredging and land filling is **estimated at 105 km. (north of Hurghada-Safaga) the cost of the coast protection would amount to 1313 million US dollars.**

4- The cost of loss of fisheries resources: Based on the above mentioned estimates (one square kilometer yields 15 tones of sea food products and 4 million square meter of reefs were damaged), **the losses of fish production was estimated at 60 tons with a value of US$ 0.556 million at 2007 market prices.**

Under normal conditions reefs are self-repairing, natural breakwaters. However, if reefs become severely degraded, their ability to recover is markedly reduced and may have to be replaced using expensive engineering projects. **It has been estimated that it costs**

about 12.5 million USD$ per kilometre to build an artificial barrier replacing a damaged reefs.

The coral reefs, like agricultural lands are considered a natural capital. The total economic value (TEV) of this natural capital can be derived from the value of all goods and services provided by marine ecosystems. The TEV can be broken up to obtain the value of different components of the ecosystems use (i.e. tourism, fishery and shoreline protection).

According to global estimates, counting only the economic value of coral reef fisheries, tourism, and shoreline protection, the costs of destroying 1km of coral reefs ranges between US$137,000-1,200,000 over a 25-year period and the properly managed coral reefs can yield an average of 15 tones of fish and other seafood per square kilometre each year. This means that the total economic value of Egypt's Red Sea reefs is estimated at US$ 205.5 million to 1800 million, and can yield about 1400 tonnes of seafood.

Additional costs to society and industry:

Besides the potential loss in the revenues and income arising from the effects of alien species invasion to the industrial facilities, there are other sectors and commercial activities, which might be affected, limited, or exposed for a long time to damage. Such damage arises from repair, maintenance or cleaning works of coastal facilities (e.g. ports, power stations, and marine terminals, Oil platforms).

The transport sector is one of the important economical resources and a means of commercial transactions with the outside. Export and import activities by sea form a high percentage of the total commercial activities in dealings with the outside. Moreover, oil and gas exportation through the main marine terminals, which contribute with a great share to the state's annual budget considering the Suez Canal as one from the most important navigation lane for the international Sea born trade and for Egypt income as well.

In this assessment report, the average income and product of the maritime, oil, and gas sectors have been calculated for the last ten years, according to the official statistics published by official agencies.

- **Shipping and coastal infrastructure:**

The maritime transport activities relies on the marine environment and resources- (Marine living resources and habitat biology, the ecosystems and coastal beaches, the diverse species of living things)- are put to different and sometimes competing uses by people. They form the ecological processes on which life depends; they provide inputs to the production of goods and services, and the act as sinks for waste and pollution. They have uses which are not obvious or which we do not fully understand. For a more information (see the shipping chapter and additional resources section in the National BW Status Assessment Report))

- **Non-use and use values of the key ecosystem in EGYPT:**

Many marine ecosystems are not traded in markets and so do not have an obvious price. There is a risk from IAS, therefore, that the effects of BW activity on the natural habitats will be ignored. Though environmental impacts do not have a price that does not mean they do not have value. This is the difference between financial analysis, which is concerned only with goods and services traded in markets, and economic analysis which is concerned with society's well being or welfare. If we are concerned with people's welfare, we must fully consider environmental impacts.

3.4 A basic framework for Economic Value Assessment:

The BW economic assessment is a cost-benefit or loss-value analysis that evaluates a given ballast water management and bio-invasion response from an environmental resources perspective. It includes the calculation of the variables.

4 Assessing and valuating costs of enacting the convention

On this chapter, all the calculations and assessments are introduced in detail in order to define the economical extend of the ballast water management activities. This chapter is divided sub-sections which cover each of the activities.

4 .1 Preparatory phase costs:

4.1.1. Capacity Building, Coordination and Communication:

This section is showing the calculated costs for preparing national and international meetings. The costs are calculated with respect to the national legislation on travel allowances and similar activities done in Egypt Red Sea within the Globallast Partnership project activities.

a) Introductory training on ballast water management:

Participation : 25 people

Duration : 3 days

Table (3): Coast calculation for training

Cost items	Calculation	Total Amounts
Accommodation	25x3 days x$30	$2250
Training venue	In kind contribution	In kind contribution
Daily allowance	25x3 days x$30	$2250
Training documents	$1500	$1500
Travel costs	25x$100	$2500
Trainers	In kind contribution	In kind contribution
Lunches	25 x $15 x 3 days	$1125
Coffee Breaks	25 x$8 x3 days	$600
Social Activities	$2000	$2000
Total		**$12,225**

b) Training on legal implementation of the BWM Convention:

Participation : 20 people

Duration : 4 days

Table (4): coast calculation for training

Cost items	Calculation	Total Amounts
Accommodation	**20x4 days x$30**	**$2400**
Training venue	In kind contribution	In kind contribution
Daily allowance	20x4 days x$30	$2400
Training documents	1500$	$1500
Travel costs	20x$120	$2400
Trainers	In kind contribution	In kind contribution
Lunches	20 x $ 15 x 4 days	$1200
Coffee Breaks	20 x$8 x4 days	$640
Social Activities	$2000	$2000
Total		**$10540**

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

Participation : 30 people
Duration : 5 days

Table (5): Cost calculation for training

Cost items	Calculation	Total Amounts
Accommodation	30x5 days x$30 (participants may cover their own expenses)	$4500
Training venue	In kind contribution	In kind contribution
Daily allowance	30x5 days x$30 (participants may cover their own expenses)	$4500
Training documents	$2000	$2000
Travel costs	30x$120 (participants may cover their own expenses)	$3600
Trainers	In kind contribution	In kind contribution
Lunches	30 x $15 x 5 days	$2250
Coffee Breaks	30x $8x5 days	$1200
Social Activities	$2000	$2000
Total	$3000 (if participants may cover their own expenses) 20050 $	

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

Participation : 20 people
Duration : 5 days

Table (6): Cost calculation for training

Cost items	Calculation	Total Amounts
Accommodation	20x5 days x$20	$2000
Training venue	In kind contribution	In kind contribution
Daily allowance	20x5 days x$20	$2000
Training documents	$1000	$1000
Travel costs	20x$120	$2400
Trainers	In kind contribution	In kind contribution
Lunches	20 x $10 x 5 days	$1000
Coffee Breaks	20 x$5 x5 days	$500
Social Activities	$2000	$2000
Total		**$10900**

e) Training on Port Biological Baseline Surveys

Participation : 25 people
Duration : 5 days

Table (7): Cost calculation for training

Cost items	Calculation	Total Amounts
Accommodation	25x5 days x$20	$2500
Training venue	In kind contribution	In kind contribution
Daily allowance	25x5 days x$20	$2500
Training documents	$1000	$1000
Travel costs	25x$120	$3000
Trainers	In kind contribution	In kind contribution
Lunches	25 x$10 x 5 days	$1250
Coffee Breaks	25 x$5 x5 days	$625
Social Activities	$2000	$2000
Diving Equipment	$3000	$3000
Laboratory Equipment	$3000	$3000
Total		**$18875**

4.1.1.1 National task force meetings:

Participation : 20 people
Duration : 1 day

This would be a 1 day meeting which will be organized 5 per year funds by Red Sea Ports Authority.

Table (8): Cost calculation for meeting

Cost items	Calculation	Total Amounts
Accommodation	20x1 day x$20	$400
Training venue	In kind contribution	In kind contribution
Daily allowance	20x1 day x$20	$400
Training documents	$1000	$1000
Travel costs	20x$120	$2400
Trainers	In kind contribution	In kind contribution
Lunches	20 x $10 x1day	$200
Coffee Breaks	20 x$5 x1 day	$100
Total		**$4500**

4.1.1.2 Regional task force meetings:

Regional task force meetings are organized under the activities of the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA). The cost of these meetings is covered under the budget of this organization. Also there are funding sources to tap into, such as the IMO Integrated Technical Cooperation Program. In the below table the cost of these meetings are calculated.

Participation : 15 people
Duration : 2 days

Table (9) Cost calculation for meeting

Cost items	Calculation	Total Amounts
Accommodation	15x2 days x$100	$3000
Training venue	$3000	$3000
Daily allowance	15x2 days x$150	4500
Training documents	$1000	$1000
Travel costs	15x$1000	$15000
Lunches	15 x$30 x2 days	$900
Coffee Break	15 x 10$ x2 days	$300
Social Activities	$2000	$2000
Interpretation	$5000	$5000
Total		**$34700**

4.1.2 Legislative, policy and institutional reform costs:

4.1.2.1 National BW status assessment:

Egypt prepared the status assessment report with the funds of Globallast Partnership Project. Although the cost is calculated for this activity in the below table in case that national sources were used.

Table (10): Cost calculation for consultancy

Relevant Personnel	Time for study	Fee for the expert
Expert on Shipping Industry	1 month	$1500 / month=$1500
Expert on Marine and Coastal Environment	45 days	$1500 / month=$2250
Expert on Invasive Species	1 months	$1500 / month= $1500
Total		**$5250**

4.1.2.2 Economic assessment:

Egypt prepared the economic assessment report with the funds of Globallast Partnership Project. Although the cost is calculated for this activity in the below table in case that national sources were used.

Table (11): Cost calculation for consultancy

Relevant Personnel	Time for study	Fee for the expert
Expert on Shipping Industry	1 month	$1500 / month= $1500
Expert on Environmental Economics	45 days	$1500/ month=$2250
Total		**$3750**

4.1.2.3 Developing a national BWM Strategy:

Egypt prepared the status assessment report with some funds of Globallast Partnership project. Although the cost is calculated for this activity in the below table case that national sources were used.

Table (12): Cost calculation for consultancy

Relevant Personnel	Time for study	Fee for the expert
Expert on Legislations	45 days	$1,500 / month=$2,250
Expert on administrative infrastructure	45 days	$1,500 / month=$2,250
Expert on Invasive Species	1 month	$3,000 / month=$3,000
Total		**$7500**

4.1.2.4 Legislative review and implementation:

As part of its planned activities within the national Ballast Water Management Project, Egypt is started in reviewing the existing national legislation and as well as to amendment of legislation or drafting of a new act, as necessary. The estimated cost of this activity is calculated in the below table:

Table (13): Cost calculation for consultancy

Relevant Personnel	Time for study	Fee for the expert
Expert on Legislations	2 month	$1,500/ month= $3,000
Expert on administrative infrastructure	2 months	$1,500 / month=$3,000
Expert on Invasive Species	2 months	$1,500 / month=$3,000
Expert on Shipping Industry	2 months	$1,500 / month= $3,000
Total		**$12,000**

4.1.2.5 Port Biological Baseline Surveys (research and monitoring):

The cost of the PBBS Study is calculated with an estimation of choosing 10 high areas on Egypt Red Sea coasts for repeating the study 4 times.

Table (14): Cost calculation for service

Cost items	Cn	Total Amounts
Accommodation	6 x2 days x 10 areas x$100	$12,000
Travel expenses	10000$	$10,000
Taxonomist	2 days x10 areas x $2000	$40,000
Divers	2 days x 2 divers x 10 areas x$1,500	$60,000
Diving Equipment	$5,000	$5,000
Laboratory Equipment	$15,000	$15,000
Total		**$ 139,000x 4 = $546,000**

4.1.2.6 Risk Assessments:

Egypt is planned to implement a risk assessment study within the national ballast water management project. The estimated cost of implementing this activity is calculated as shown in the following table:

Table (15): Cost calculation for consultancy

Relevant Personnel	Time for study	Fee for the expert
Expert on Risk Assessment	3 month	$1,500 / month=$4,500
Expert on Data Bases	3 months	$1,500 / month= $4,500
Expert on Invasive Species	3 months	$1,500 / month= $4,500
Expert on Shipping Industry	3 months	$1,500 / month=$4,500
Software		$5,000
Hardware		$3,000
Total		**$26,000**

4 .2 Compliance related costs:

4.2.1. Flag state obligations:

4.2.1.1 Establishing procedures for issuing BWM Certificate:

There are 2000 Personnel are working in The Egypt Safety Navigation Authority of Egypt the in order to enhance maritime safety and marine environment protection.

The Egypt Safety Navigation Authority of Egypt will be the responsible authority on issuing the ballast water management certificate to the ships. The cost for this process is going to be reimbursed from ships by the ESNA.

Note: *Authorization may be given to an international classification society that is recognized and authorized by ESNA for the issuing the ballast water management certificate to the ships.*

4.2.1.2 Approval of ships` BWM plans:

ESNA will be the responsible authority on approval ships` BWM Plans. The cost of this process is going to be reimbursed from ships by the ESNA.

4.2.1.3 Type approval of BWM systems:

As part of its national responsibilities, ESNA will give the type of approval to the treatment facilities. The cost for this process is going to be reimbursed from companies to the ESNA.

Table (16): cost calculation for service

Cost items	Calculation	Total Amounts
Review of the technical reports and test results	ESNA will give the certificates with a service charge $15,000	1,875,000

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

ESNA will be the responsible authority on giving type approvals to the ships.

Table (17): Cost calculation for service

Cost Items	calculation	Total Amounts
Initial, Renewal, Intermediate and Annual surveys	ESNA will give the certificates with a service charge Initial: 1500 $ Renewal:1500$ Intermediate: 1000$ Annual:500$	4500x125 562,500

4.2.1.5 Approval of exemption applications:

ESNA is the responsible authority for approving the exemption applications.

Table (18): Cost calculation for service

Cost items	Calculation	Total Amounts
exemption application	ESNA is responsible	No cost

4.2.1.6 Training of crew members:

Table (19): Cost calculation for training

Cost items	Calculation	Total Amounts
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 Inspection of ships

Cost Items	Calculation	Total Amounts
Port State cost (inspection of ships)	About 10000 Calls Egypt Red Sea ports annually 10 – 15% of them surveyed 1 surveyor gets 1500 $ per month and surveys 50 ships per month = $30 per ship 2 surveyors per survey x $30 per ship x 1500 ships per year = $ 75,000 per year	$75,000 per year

4.2.2.3 Sampling:

1) Sampling for compliance with D-1 standard

Table (21): Cost calculation for equipment

Cost items	Calculation	Total Amounts
Salinometer	$ I50 x 10	$1,500

2) Sampling to ensure D-2 compliance.

Table (22): Cost calculation for service

Cost items	Calculation	Total Amounts
Equipment	US$3,000x5 port corporations	$15,000
Taxonomist	US$3,000 per monthx2 x12	$72,000
Laboratory cost	$2,000 per month x12	$24,000
Total		**$111,000**

4.2.2.4 Communication of requirements to IMO and other member states:

Nearly Zero

4.2.2.5 Communication of BWM requirements to ships:

Nearly Zero

4.2.2.6 Designation of areas for Ballast Water Exchange:

Table (23): Cost calculation for consultancy

Relevant Personnel	Time for study	Fee for the expert
Expert on Risk Assessment	2 month	$3,000 / month=$6,000
Expert on Hydrodynamics of Sea Water	2 months	$3,000 / month= $6,000
Expert on Invasive Species	2 months	$3,000 / month= $6,000
Expert on Shipping Industry	2 months	$3,000 / month= $6,000
Total		**$24,000**

4.2.3. Industry obligations:

4.2.3.1 Training of crew members (IMO model courses, etc):

Table (24): Cost calculation for training

Cost items	Calculation	Total amount
Training of personnel	US$400x2000Egyption seafarers	US$800,000

4.2.3.2 BWM Plans:

Table (25): Cost calculation for service

Cost items	calculation	Total Amounts
Service fee of the ESNA	$2,500 per ship x 1 25 Egypt flagged ships	$312,500

4.2.3.3 BWM Record Books:

No additional cost

4 .3 Other issues not covered by the Convention:

4.3.1. Port biological monitoring programmes

This programme depends upon the result and recommendations of the team that carried out the port biological baseline survey.

4.3.2. Port BWM Plan development:

Table (26): Cost calculation consultancy

Relevant Personnel	Time	Fee for the expert
Expert on Ballast ater Implementations	3 months	$3,000 per month x 3 months =$9,000 $9,000 per 10 major ports= $90,000 Total

5 RESULTS AND CONCLUSIONS

This chapter outlines a straightforward economic assessment results and data geared towards supporting and enabling national BWM planning and using economic valuations data to improve decision-making processes ranging from community or industry engagement and ecosystem management to the development of national strategies and action plans to manage the risk associated with invasive alien species.

This chapter also focuses on interpreting the economic assessment results, and deals primarily with compiling and synthesizing findings and drawing broad conclusions.

Regardless of the economic analysis methods, the results can be applied to relevant strategies, policies and actions through the identification and comparison of critical benefits and costs or the comparison between ecology and society loss and the operational costs related to BWM.

The economic data on possible marine IAS impacts (Chapter 3) and costs associated with ratification of the BWM Convention (Chapter 4) are different in many ways. The former by and large assesses costs and losses analysis of the value of resources or sectors as they may be affected or incurred to society as a whole, or to specific industries that are rarely directly related to the maritime sector (Shipping and coastal infrastructures). The latter seeks to identify operational costs of BWM system are distributed between stakeholders within the maritime sector (Maritime Sector, Ports, Shipping industry). However, the results in this report can be synthesized and compared in several ways that supports a decision making process, or as in the details in the tables showed below.

Table (27): the comparison between the operating costs and economical lost

Possible Economical Effect of AIS to EGYPT	Total operating cost of BWM to EGYPT
$ 2,606,000,000 USD(worst case)	$ 4,562,790 USD

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, without including non-marketed ecological services and non-marketable environmental values. The economical assessment methodology could not assess the economical impact to culture, human sociology and psychology. Beside, the cost of the possible cleaning activities for AIS is not at the scope of this report.

Table (28): Results of the costs of economic marketable values from IAS impacted

Possible Ecological loss	Cost $ U.S.D	%
Fisheries	$ 150,000,000	5.75
Mari culture/Coastal Aquaculture	N/A	None
Other living resources	$ 6,000,000	0.23
Coastal Tourism	$ 1,500,000,000	57.56
Additional Industries (shipping, infrastructures)	N/A	None
Human/Public Health	$ 900,000,000	34.54
In-direct use ecological values	$ 50,000,000	1.92
Total	**$ 2,606,000,000**	**100**

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 (29): Results of operational cost of BWM system

OPERATIONAL COSTS	Cost $ U.S.D	%
Capacity building	$72,590	1.6
Legislative, Policy and Institutional Reforms	$68,600	1.5
PBB Studies and Risk assessment	$ 572,000	12.6
Flag State Obligations	$2,401,000	53
Port State Obligations	$211,500	4.7
Industry obligations	$1,202,,000	26.6
Total	**$ 4,562,790**	**100**

As a conclusion this economical assessment study shows that the ballast water management activities are feasible to implement

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