# Ballast Water Economic Assessment for Yemen

National Economic Assessment for Ballast Water Management in Yemen

**Maritime Affairs Authority(MAA) – 2010**

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*The preparation of this report for the above titled project by MAA Maritime Affairs Authority (Yemen) and has been undertaken within national consultant team of the brief using all reasonable skills and care.*

# 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 Yemen, there is no data base information about the IAS and their spreading magnitude in Yemeni waters. In spite of the effort developed by the government but Yemen still lacks of adequate information of the type, numbers, status and structure of IAS (If present) in Yemen.

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 September 2010, 26 parties representing 24.44% 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 Yemen. 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 Yemen. These bodies are; MPIC, MFW, MAA, etc.

There are two principle sources for the formal national information and statistical data on Yemen. They are statistical yearbooks and annual reports on fisheries statistics. At the national level, the population data produced by the central statistical office (CSO) of the government of Yemen. It has publication of the preliminary of the national Census of 2004 for Yemen.

Yemen Statistical Yearbooks have a vital importance, due to the fact that it is the main source of data needed to economic assessment, the CSO has concerned to publishing statistical Book annually. Recent statistical yearbooks (2008 and 2009) were used as basic sources on this assessment of the sectors.

The Ministry of Planning and international Cooperation (MPIC) is the responsible authority for preparing the National five Year Plans, the 3$^{th}$ five year plan recognises the continued importance of fisheries to Yemen and the problems which this sector is facing. Thus the annual growth rate target for this sector has been set at 2%. During the preparation process of this assessment report the statistical data on the 9$^{th}$ National Development Programme for 2007 - 2013 was used.

The Ministry of Fish wealth (MFW) is the responsible for fisheries management and preparing annual reports on Fisheries statistics, such these reports which were prepared under MWF 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 Yemen 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 Yemen.

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 .1 Market 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 .2 Travel 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 has 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

Mainstream economics postulates that human well-being (economic welfare) is functionally linked to the consumption of goods and services. The benefits that human beings receive from ecosystem processes are referred to as ecosystem services, and the economic value of an ecosystem is the measure of the welfare provided by the flow of its goods and services.

Ecosystems provide valuable services to human production and consumption. The Millennium Ecosystem Assessment 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.

Ecosystem valuation must encompass a wide range of goods and services provided by nature, not just the direct market values (Emerton and Bos, 2004). The value of the ecosystem should be given in terms of the total economic value (TEV), which includes direct use, indirect use and non-use values (Turner and others 2000).

There are a number of well-known techniques that may be used to calculate components of TEV: market prices, production function approaches, surrogate market approaches, cost-based approaches, and stated preference approaches (Emerton and Bos, 2004). In cases where it is possible to calculate the TEV, the complex approach for BW economic

assessment is used: *TEV= VEcosystem= VDirect-use+ VIndirect-use+ VNon-use.* Nevertheless, it is often not possible to calculate the full TEV.

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.

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.

However, establishing quantitative values for indirect and non-use values of ecosystems can require detailed studies by trained environmental economists and the use of large data sets and advanced statistical analyses. Quantification may be a costly and time-consuming exercise. Hence, in some instances, qualitative analyses to indentify the categories of values and the flow of benefits and costs to various stakeholder groups may in itself provide critical information for decision makers.

## 3 .2 Categories of economic value

*The Total Economic Value (TEV) of an area/ecosystem is a function its use values and non-use values (Table 1).*

***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.

***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. It is the value that national and international populations derive without necessarily visiting the site, but just from knowing the reefs and other national resources there continue to exist in good condition. This can also include a bequest value, e.g. the satisfaction one gets from knowing a resource will be passed on to future generations.

**Table 1: The range of potential total economic values**

| TEV | Types of values | Examples of extractive values/benefits | Examples of damage caused by marine IAS |
|---|---|---|---|
| **Use** | **Direct use** | Capture Fisheries, | Loss of tourism and recreational |

| | | | |
|---|---|---|---|
| **Value** | **values** | Aquaculture/Mariculture, Recreation/Tourism, Aquarium trade, Pharmaceutical, and Bio-prospecting Research/Education | benefits, risks to human health, loss of fish/shellfish stocks loss of Aquarium trade, Pharmaceutical outputs and goods, |
| | **Indirect use values** | Ecosystem services, climate stabilization, flood control, habitat, watershed protection, natural services, coastal protection, waste assimilation, disturbance regulation | Effects on marine ecosystem health, e.g. changing chemical composition of the water and carbon store, toxicity through the food chain, loss of genetic resources |
| | **Option values** | Future information, future direct and indirect uses | No insurance that marine coastal areas are free from harmful algal blooms |
| **Non-Use Value** | **Bequest values** | Preservation of resources for future generations, leaving use and non-use values for legacy | Loss of legacy benefits, e.g. no marine species/ habitats for the future, 'way of life' connected to traditional uses |
| | **Existence values** | Biodiversity, ritual or spiritual values, culture, heritage, community values, landscape | Risk of loss of existence benefits, e.g. threatened, endangered, and charismatic species |

## 3 .3 Economic evaluations and calculations for key sectors

There have been some notable changes in the proportional share of GDP output accounted for by Yemen's different economic sectors since 2000. Overall industry has been its share of GPD increase from just under 26% in 2000 to 40% in 2002.

For fisheries reference is made to status assessment (figure21) whilst the catch has followed a variable patter over recent years the overall trend is negative both in terms of quantity and value.

The third five year plan (TFYP) recognises the continued importance of agriculture and fisheries to Yemen and the problems with which these sectors are faced. Thus the annual growth rate target for these sectors has been set at 8%. The growth target is even more impressive at 13% per annum.

This section provides limited an economic review and assessment of Yemen including a commentary the key sectors within the economy as well as outlines a framework for assessing the value of resources at risk from bio-invasion and thus the potential economic implications of IAS introduction.

### 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 Yemen 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 600 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.

- ***Fisheries:***

  Yemen's Seas are one of the most important sources that cater fish for the people's needs, as one of the main nutritious elements in their food, particularly those who are living in the coastal areas. Fisheries provide a renewable natural resource and a main source of revenues for the Gross National Product (GNP). Furthermore, fisheries constitute a habitat for about 350 species of fish and marine living resources in the Yemeni territorial waters, which qualifies the country to be one of the main exporters of fish in the region.

  Generally, fisheries makes up one of the key sectors that play a major role in the national economy, and contribute to the GDP with a rate of (1 – 2 %) besides the ratio of the generated added value which is estimated at YR36,486 million according to recent statistics.

  The fish sector is also an important source of revenues from fish exports, estimated at YR17 billion in 2004. In addition to supporting food security, fish is a significant source of income for a big number of coastal societies, where most of the poor live along the coasts of Yemen.

  Though the fish stock has the capacity to allow fishing a quantity of 350 to 400 tons annually without decreasing beyond its minimum rate, the volume of fishing activities and their contribution to the GDP is still limited and deficient, due to the low fish product as a result of the lack of using modern techniques for fishing, in addition to many obstacles that impede the best exploitation of the fish wealth (Ref: Annual Fishing Report by the Ministry of Fish Wealth).

  Fishing is the main occupation of about 60,000 to 70,000 artisan fishermen directly supporting about 400,000 members of their families. In addition an unknown, but relatively high, number of people are also engaged in downstream fishery processing and marketing. Artisanal fishermen control about 14,000 different types of fishing boats and produce an average annual catch of 172,000 metric tons, representing more than 80% of the total fish production. Some 65% of this total catch is from the Gulf of Aden and 35% from the Red Sea.

  This important sector has been assessed on the basis of statistical data obtained from official government agencies such as the Ministry of Fish Wealth (Ref: Annual Fishing Reports) and the central statistical office (CSO) (Ref: Yemen

Statistics Yearbook). The statistical assessment depended on calculating the average value of fish production quantity and its financial price during the last ten years (2000 – 2009), and evaluating the contribution of this sector to the GDP. This statistical method takes into consideration the annual variations in the quantity of fish production and the market price that makes it difficult to take an individual year as a standard reference for evaluation of the fish production rate and the possible potential loss in this sector due to invasion of the marine alien species, in comparison with the current prices

- ***Coastal aquaculture:***

This sector is still too weak in Yemen in terms of infrastructure with view to its effective presence and contribution to the GDP, despite the conditions which encourages investment in this sector. There is a plenty of highly nutritious fish and marine resources which are globally demanded, and can be easily cultured. Therefore, a big amount can be produced, such as shrimp, lobster, crabs, sea cucumber, seaweeds, commercial fish, and others. In the last few years, a big concern and interest in aquaculture was shown. Furthermore, a number of projects were proposed, and are currently under study and construction. For the purpose of annual evaluation of other fisheries, on which there is no available data.

Due to the lack of official or actual data about the number fish farms and workers in these farms and the quantity of annual product and its financial values, it was based on very limited data for assessing the economic value. These data show information about two farms one is located on the Red Sea and the other is in the Gulf of Aden, as actual indicators and samples which can be relied on for the evaluation of annual product of other farms about which there is no data available.

- ***Other living resources:***

A plenty of marine and coastal resources other than fish, however there are too scarce data which is almost unavailable or difficult to collect or estimate. These resources are such as (extraction of salt from coastal salt bongs, other coastal trades, exploitation of wetlands, and trade of aquarium fish and medical herbs.

At present more than two companies are licensed to collect coral reef fishes for the aquarium trade. There are limited catch records. Fish collecting for the aquarium trade may be impacted and decline in reef associated fishes by IAS invasion.

In this report, the economic importance and value of wetlands and salt pools in Aden based on data available from this sector that provided by Aden Wetlands Conservation Project and other latest studies and reports on wetlands, in detail. Concerning the trade of aquarium fishes, the report depends on outdated data (1997 – 2001) for calculating and estimating the annual average production about this type of commercial activity and its annual productivity.

- ***Coastal tourism:***

  Coastal tourism has recently witnessed a remarkable development, particularly inbound tourism and the coastal tourist establishments where the number of visitors to the recreational areas during holidays. However, it still needs a big concern in order to contribute effectively in supporting the national economy. In spite of that Yemen has a beautiful seashores and a broad areas which are greatly suitable and attractive, it still lacks recreational resorts, marinas, cabanas, parks, swimming platforms, beach cabins and cottages, .

  Tourist hotels and restaurants is one of the most important sectors, which contribute in the growth of Yemen's GDP, rather than the oil sector.

  For the assessment of this important sector, the report depends on statistical data obtained from the Annual Statistics Book and reports by the Ministry of Tourism which provide official information about the number of visitors from abroad as well as the number of Hotels, their bed capacity, average daily expenditure per visitor, and number of tourist nights (average length of stay), in addition to the contribution of this sector to the annual GDP. However, there is a lack of data about seashore and Eco-tourism, as well as the number of beneficiaries from sector and its annual receipts for the national economy and local population. These values and variables were estimated, assuming that the coastal tourism form 50% out of total tourism in Yemen. Most of the visitors from abroad have tourist programs including coastal places, cities, or islands (e.g Aden, Al-Mukalla, Al-Khokha, marine protected areas, and islands like Socotra, and etc.). This assumption is almost true since most of the inbound tourism activities take the form of visits to coastal cities and seashores for the purpose of recreation and welfare during holidays and special occasions. Contribution of restaurants and hotels has been evaluated based on the average value for the last ten years (2000 - 2009), and average number of visitors during the last three years, in addition to the average number of Yachts visiting the Yemeni ports in the last eight years (2002 – 2009).

### 3.3.2. 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).

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.

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 Yemen:***

  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.

  Coral reefs provide a wide array of goods and services to the society. In order to estimate losses in economic value or welfare associated with anthropogenic coral reef deterioration, the impact of IAS on the reefs' flow of goods and services can be converted into economically meaningful measurements.

  In Yemen, the corals are not used much for recreation & tourism at present. Yachts may stop off in the vicinity, with some associated diving and snorkelling. Unfortunately, the current underlying threat of terrorist attacks on foreigners in region puts off many potential visitors.

  The greatest value of the coral reefs will be their non-use value. Indeed, the non-use value is likely to be elevated significantly due to the coral areas of Yemen fairly limited human uses. Non-use value relates to the fact that people both nationally and internationally are generally willing to pay for the continued protection and existence of important habitats such as coral reefs, particularly those in good condition with low levels of use and pressures. Unfortunately few studies have been undertaken to determine non-use values for coral reefs, but it is likely that such values could be considerable.

## 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.

A basic framework for identifying the economic value of key sectors and potential costs as a result of IAS introduction are summarized in **Annex 1.**

# 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 Yemen within the Globallast Partnership project activities.

**a) Introductory training on ballast water management:**

Participation : 25 people

Duration : 5 days

**Table 2: Coast 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 |
| **Total** | | **$12,875** |

**b) Training on legal implementation of the BWM Convention:**

Participation : 20 people

Duration : 5 days

**Table 3: coast 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** |

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

Participation : 40 people
Duration : 5 days

**Table 4: Cost calculation for training**

| Cost items | Calculation | Total Amounts |
|---|---|---|
| **Accommodation** | 40x5 days x$20 (participants may cover their own expenses) | $4000 |
| **Training venue** | In kind contribution | In kind contribution |
| **Daily allowance** | 40x5 days x$20 (participants may cover their own expenses) | $4000 |
| **Training documents** | $2000 | $2000 |
| **Travel costs** | 40x$120 (participants may cover their own expenses) | $4800 |
| **Trainers** | In kind contribution | In kind contribution |
| **Lunches** | 40 x $10 x 5 days | $2000 |
| **Coffee Breaks** | 40x $5x5 days | $1000 |
| **Social Activities** | $2000 | $2000 |
| **Total** | $3000 (if participants may cover their own expenses) 19800 $ | |

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

Participation : 20 people
Duration : 5 days

**Table 5: 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 6: 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 1 per year.

**Table 7: 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 8: 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

Yemen 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 9: 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

Yemen 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 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 Environmental Economics** | 45 days | $1500/ month=$2250 |
| **Total** | | **$3750** |

#### 4.1.2.3 Developing a national BWM Strategy

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

**Table 11: 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 | $1,500 / month=$1,500 |
| **Total** | | **$6000** |

#### 4.1.2.4 Legislative review and implementation

As part of its planned activities within the national Ballast Water Management Project, Yemen 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 12: 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** |

### 4.1.3. Port Biological Baseline Surveys (research and monitoring)

The cost of the PBBS Study is calculated with an estimation of choosing 5 high areas on Yemen coasts for repeating the study 2 times.

**Table 13: Cost calculation for service**

| Cost items | Calculation | Total Amounts |
|---|---|---|
| **Accommodation** | 6 x2 days x 5 areas x$100 | $6,000 |
| **Travel expenses** | 5000$ | $5,000 |
| **Taxonomist** | 2 days x 5 areas x $2000 | $20,000 |
| **Divers** | 2 days x 2 divers x 5 areas x$1,500 | $30,000 |
| **Diving Equipment** | $5,000 | $5,000 |
| **Laboratory Equipment** | $5,000 | $5,000 |
| **Total** | | **$ 71,000x 2 = $142,000** |

### 4.1.4. Risk Assessments

Yemen 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 14: 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 200 Personnel are working in the Maritime Affairs Authority of Yemen in order to enhance maritime safety and marine environment protection.

The Maritime Affairs Authority of Yemen 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 MAA.

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

**Table 15: Cost calculation for service**

| Cost items | Calculation | Total Amounts |
|---|---|---|
| **Establishing certification requirements** | MAA will give the certificates with a service charge $1,500 x 25 Yemeni flagged ships. | $37,500 |
| **Communication of requirements and procedures to the shipping industry and IMO** | MAA will communicate with IMO. | |
| **Maintenance of records of issued Certificates** | $300 x 25 Yemeni flagged ships. | $7500 |
| **Total** | | **$45,000** |

#### 4.2.1.2 Approval of ships` BWM plans

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

**Table 16: cost calculation for service**

| Cost items | Calculation | Total Amounts |
|---|---|---|
| **Training of staff** | MAA will train their staff | No cost |
| **Establishing protocols for vetting and approving BWM Plans** | Will be responsibility of MAA | No cost |

#### 4.2.1.3 Type approval of BWM systems

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

**Table 17: cost calculation for service**

| Cost items | Calculation | Total Amounts |
|---|---|---|
| **Review of the technical reports and test results** | MAA will give the certificates with a service charge $15,000 | $375,000 |

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

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

**Table 18: Cost calculation for service**

| Cost Items | calculation | Total Amounts |
|---|---|---|
| **Initial, Renewal, Intermediate and Annual surveys** | MAA will give the certificates with a service charge<br>Initial: 1500 $<br>Renewal:1500$<br>Intermediate: 1000$<br>Annual:500$ | $112,500 |

| | | |
|---|---|---|
| | Total=$4,500 x 25 Yemeni Flagged Ships | |

#### 4.2.1.5 Approval of exemption applications

MAA is the responsible authority for approving the exemption applications.

**Table 19: Cost calculation for service**

| Cost items | Calculation | Total Amounts |
|---|---|---|
| **exemption application** | MAA is responsible | No cost |

#### 4.2.1.6 Training of crew members

**Table 20: 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 21: Cost calculation for Inspection of ships**

| Cost Items | Calculation | Total Amounts |
|---|---|---|
| **Port State cost (inspection of ships)** | About 4000 Calls Yemeni ports annually 5 – 10% of them surveyed<br><br>1 surveyor gets 1000 $ per month and surveys 30 ships per month = $33 per ship<br><br>2 surveyors per survey x $33 per ship x 400 ships per year = $ 26,400 per year | $26,400 per year |

#### 4.2.2.3 Sampling

1) Sampling for compliance with D-1 standard

**Table 22: Cost calculation for equipment**

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

2) Sampling to ensure D-2 compliance.

**Table 23: Cost calculation for service**

| Cost items | Calculation | Total Amounts |
|---|---|---|
| **Equipment** | US$3,000x3 port corporations | $9,000 |
| **Taxonomist** | US$3,000 per month x12 | $36,000 |
| **Laboratory cost** | $2,000 per month x12 | $24,000 |
| **Total** | | **$69,000** |

#### 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 24: 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 25: Cost calculation for training**

| Cost items | Calculation | Total amount |
|---|---|---|
| Training of personnel | US$400x500Yemeni seafarers | US$200,000 |

#### 4.2.3.2 BWM Plans

**Table 26: Cost calculation for service**

| Cost items | calculation | Total Amounts |
|---|---|---|
| **Service fee of the MAA** | $2,500 per ship x 25 Yemeni flagged ships | $62,500 |

#### 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 27: Cost calculation consultancy**

| Relevant Personnel | Time | Fee for the expert |
|---|---|---|
| **Expert on Ballast Water Implementations** | 3 months | $3,000 per month x 3 months =$9,000<br>$9,000 per 10 major ports= $90,000 Total |

A basic framework for identifying and compilation of costs related to BWM are summarized **in Annex 2**.

# 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 (MAA, 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 shown below.

**Table 28: the comparison between the operating costs and economical lost**

| Possible Economical Effect of AIS to Yemen | Total operating cost of BWM to Yemen |
|---|---|
| $ 655,200,000 USD(worst case) | $ 1,313,450 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 29: Results of the costs of economic marketable values from IAS impacted**

| Possible Ecological loss | Cost $ U.S.D | % |
|---|---|---|
| **Fisheries** | $ 92,900,000 | 14.18 |
| **Mariculture/Coastal Aquaculture** | N/A | None |
| **Other living resources** | $ 600,000 | 0.09 |
| **Coastal Tourism** | $ 87,000,000 | 13.28 |
| **Additional Industries** (shipping, infrastructures) | N/A | None |
| **Human/Public Health** | $ 450,000,000 | 68.69 |
| **In-direct use ecological values** | $ 24,700,000 | 3.76 |
| **Total** | **$ 655,200,000** | **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 30: Results of operational cost of BWM system**

| OPERATIONAL COSTS | Cost $ U.S.D | % |
|---|---|---|
| **Capacity building** | $112,550 | 8.56 |
| **Legislative, Policy and Institutional Reforms** | $27,000 | 2.06 |
| **PBB Studies and Risk assessment** | $ 168,000 | 12.79 |
| **Flag State Obligations** | $532,500 | 40.54 |
| **Port State Obligations** | $210,900 | 16.06 |
| **Industry obligations** | $262,500 | 19.99 |
| **Total** | **$ 1,313,450** | **100** |

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

## Annex 1 : Framework for identifying of costs related to IAS impacts on key sectors

| Direct Use Values Key Sectors | Total Yield /Catch/Users | Employed / Dependent | Total Value of Sector | TVE as% of GDP | Vulnerability to IAS | % loss (worst case scenario) | $ loss (worst case scenario) |
|---|---|---|---|---|---|---|---|
| **Fisheries:** **Total Fish Production** | 172,022 (ton/yr) average production for past 10 years | 66,588 Registered Fisherman& 400,000 Dependents | 37.1 billion Y.R average for 10 years | %1.1 | High | 50 % loss in fish stocks in fishery regions | Approx. 92.8 $Million USD |
| **Total Fishing Exports** | 88,178 (Ton/yr) As average exports for past 10 years 1st place in Yemen's exports non-oils | | 248,853 $ U.S average for last 5 years | %1.15 %40 of Non-oil exports | High | 50% loss in fish exports | Approx. 124,427 $US |
| **[1]Coastal Aquaculture** | <700 (ton/yr) of Shrimp production and another Crustaceans | More than 300 workers in shrimp farms | --- | n.a | High | 80% can be loss if the ecosystem is changed at/near farms | None |
| **Other living resources:** | | | | | | | |
| **[2]Aquarium fish trade** | 16,360 (metric tons/yr) of average aquarium fish exports | None | ---- | n.a | High | None | None |

[1] No available actual formally data about maricultures in Yemen, because lack of this sector. So this values is comparatively estimating based on some actual data for shrimp farms in Yemen.
[2] This is Estimating data resulting from average actual old data of five past years(1997-2001)

| Direct Use Values Key Sectors | Total Yield /Catch/Users | Employed / Dependent | Total Value of Sector | TVE as% of GDP | Vulnerability to IAS | % loss (worst case scenario) | $ loss (worst case scenario) |
|---|---|---|---|---|---|---|---|
| **Aden's Wetlands& Salt ponds** (Salters) | 2200 Ha. Area of wetlands,<br>About 3.45% from total Aden area | 882 workers and dependents | 40 Million R.Y annually | %0.002 | Medium | 30% loss in incomes of wetlands | Approx. 58.537 $USD |
| **Coastal Tourism:** | | 80,00 employed person in Yemen | 54,298 Million R.Y per yr. at market prices as average value for last 10 years | % 1.59 | | | |
| [3]Hotel & Restaurants: | 400 Hotel<br>16500 Beds | 22,488 employed persons in main coastal cities | | | Low | None | None |
| [4]Beach activity& visits | Approx. 500,000 tourists/yr | | 435 $Million USD | < %3.1 | Medium | %20 can be lost if the ecosystem is changed | 87 $Million USD |
| [5] Pleasure Yachts and Cruise ships | 115 yachts/yr<br>23 cruise ships/yr<br>As average for last 8 years | | | | | | |

[3] This is Estimating data resulting from mean actual data of 2008 for three major coastal governorates (Aden- Hodiedah- Hadhramout).
[4] This is Estimating data resulting from average actual data of three past years(2007-2009), with %50 default percent of coastal tourism.
[5] Annual average of Total Pleasure Yachts and Cruise ships visited the Yemeni ports during (2002-2009) years. Source: statistics of ports

| Additional Costs to Society or Industry | | Employed / Dependent | Total Value of Sector | T.V of sector as% of GDP | Vulnerability to IAS | Type of costs possible incurred | $ cost (worst case scenario) |
|---|---|---|---|---|---|---|---|
| **Shipping**<br>Marine Transport | 70 Yemeni flagged ships *(include; fish vessels, tug boats)* | 160.000 employed& dependents (2004)<br>2000 Registered seaman in Yemen | 636,348 Million R.Y at market prices(2009)<br>7,783,328 (ton/yr) of average cargo handled for last 8 years | % 10.48 | Low | None | None |
| **Coastal Infrastructure:** | | | | | | | |
| **Ports& Harbours** | 10 key ports | More than 3,500 employed at ports *(without other beneficiaries)* | 1,399,459,780 Y.R average value of Imports by customs sea ports for last 4 years<br>1,255,261,134 Y.R average value of Exports by customs sea ports for last 4 years | % 23.33 of overall Imports profile<br>% 21.88 of overall exports profile | Low | None | None |
| **Terminals** | 3 major Oil/Gas Terminals | More than 2000 employed at Terminals | 1,019,543 (million R.Y) as average value for last 10 years | % 28.1 | Low | None | None |
| **Power plants** | 3.0 major coastal electric power stations | %49 of beneficiaries from total people | 758 M.W<br>Average of electric power generation capacity of coastal Stations | NA | Low | None | None |

| Public Health | IAS Species (with potential human health impact | Possible impacts pathways (e.g. food, water, recreation etc.) | Possible impacts (food poisoning, physical harm etc.) | # affected (worst case scenario) | Treatment costs per person | $ costs (worst case scenario) |
|---|---|---|---|---|---|---|
| **Vulnerable groups** | Poisonous algaes, | Food, water | Poisoning | More than 20% of the population | 100 $USD | 450 $ million USD |
| | Pathogens like cholera | Water, recreation | Epidemic Diseases | 4.5 million people | | |

| Indirect Use Values | Ecosystem that may be impacted | Total Area of Ecosystem | Vulnerability to IAS | % loss (worst case scenario) | [6] Total Global Value | Implications for society and industry | Estimated $ loss (worst case scenario) |
|---|---|---|---|---|---|---|---|
| - Nutrient rich, storage and cycling control.<br>- Water supply, quality control, and purifying systems.<br>- Food control, high primary production, and disturbance regulation.<br>- Shoreline protection, erosion control, soil formation and silt traps.<br>- Filter water pollutions, breaking down& absorbing pollutants, and waste assimilation.<br>- Breeding& resting areas for waterfowls& shore birds. | **Coastal Wetlands**<br>*Include; (marshes, bogs, lagoons, salt pools, sabkha, tidal flats, etc.)* | 1238.7 Ha. of Wetlands, from its<br>427.9 Ha. of waterflats at Aden, | **Medium**<br>***Sensitively indicators:*** *(102 sp. Sea/shore Birds, 21sp. Halophytes, some of crustaceans Mollusks, etc.)* | 35 % loss in incomes and services if ecosystem changed and injured by IAS invasion | 19,580 $U.S (per Ha.) | --- | Approx. 8.5 million $U.S may be lost |
| - Shoreline protection, silt aggregating and traps.<br>- Act as a buffer against extreme drought, storm surges and flood.<br>- Maintenance of ecosystems and reducing impacts on marine ecosystems.<br>- Nurseries& spawing areas for commercially fish& crustaceans.<br>- Biological control, support, refuges, and genetic resources | **Mangrove swamps and forests** | 2000-3000 Ha. In Yemen *(PERSGA,04& Sheppard et, 92)* | **Medium** | 20 % loss in incomes if ecosystem injured by IAS invasion | 9,990 $U.S (per Ha.) | | Approx. 4.0 million $U.S may be lost |
| | **Sea grasses /Algae beds** | 1000 ha *(as minimal estimation)* | **High**<br>***Sensitively indicators:*** *(9 sp. Sea grasses, 485 sp. Algae, 283 sp. Macro algae, etc.)* | 60 % loss in services if ecosystem changed and injured by IAS invasion | 19,004 $U.S (per Ha.) | | Approx. 11.4 million $U.S may be lost |

[6] Source: .....

| Indirect Use Values | Ecosystem that may be impacted | Total Area of Ecosystem | Vulnerability to IAS | % loss (worst case scenario) | [6] Total Global Value | Implications for society and industry | Estimated $ loss (worst case scenario) |
|---|---|---|---|---|---|---|---|
| - High biodiversity and productivity<br>- Contribution of climate stability, and global life-support (removing of $CO_2$ and Carbon store).<br>- Physical protection to; (coastlines, species, and ecosystems) from extreme storms & high waves.<br>- Sites of most commercial fisheries.<br>- Refuges and nurseries for many fish and other marine organisms.<br>- Resources for aquarium trade, curio and jewelry.<br>- Raw materials for pharmaceutical and other industries.<br>- Parks and grounds for dives, tourism, and recreation.<br>- Act as important breeding nursery and feeding grounds for range of commercial fish.<br>- Act as supporting other habitats and species. | **Coral reefs** | 1600 $m^2$ at Balhaf,<br>7500 $m^2$ at Bir Ali,<br>20,000 $m^2$ at Socotra<br>Kamaran and Ras Isa | **High**<br>***Sensitively indicators:*** *(300 sp. Corals, 600 sp. Assemblage Fish, etc.)* | 45 % loss in services if ecosystem changed and injured by IAS invasion | 6,075 $U.S (per Ha.) | | Approx. 0.8 million $U.S may be lost |
| | | | | | | | |

| Non– use Values | Ecosystem that may be impact | Total Area of Ecosystem | Vulnerability to IAS | % loss (worst case scenario) | Implications for society | estimated $ loss (if applicable) |
|---|---|---|---|---|---|---|
| **Cultural legacy** | | | | | | |
| **Religious/spiritual value** | | | | | | |
| **ect.** | | | | | | |
| | | | | | | |
| | | | | | | |

**The Sensitive and Vulnerable Areas** *(include Marine Protected Areas)* **in Yemen**

| Sensitive Areas of Concern | Characterizations/ Descriptions | Total Area of Ecosystem | Vulnerability/ Sensitivity | Importance/ Values/ Services/ Benefits | Threats/ Impacts |
|---|---|---|---|---|---|
| **Aden's Wetlands**<br>Aden,<br>*(Gulf of Aden)* | - Internationally important wetlands.<br>- Defined by RAMSAR as Important Bird Areas.<br>- Vital habitat for over 10,000 migratory waterfowls, including 3 globally threatened and 12 regionally important species.<br>- Defined by EPA as MPA's. | 22 $km^2$ | Very High | - They represent a rich natural heritage.<br>- Considered a great numbers of marine flora and fauna.<br>- Provided suitable habitats for huge numbers of migration water birds.<br>- Used as feeding, roosting area to migratory birds | Disturbance, Pollution, dredging, filling of coastal wetlands |
| **Al-Luhayah - opposite offshore islands**<br>Hodiedah, *(Red Sea)* | - The largest and well-developed mangrove forests, extensive mudflats, seagrass meadows and some coastal vegetation.<br>- Very important area for migratory waterfowl, providing ideal habitats for three globally threatened animal specie including; *(Green turtles-Dugon dugon- white-eyed gulls)*. | 300 $km^2$ | Moderate | | |
| **Balhaf - Bir Ali – Burum**<br>In Shabwa-Hadhramaut,<br>*(Gulf of Aden)* | - Regionally important for biodiversity and coral reefs.<br>- Designated by *PERSGA* as one of 6 MPAs for the Arabian Region.<br>- Defined by *UNESCO* as one of 11 Middle Eastern sites that deserves designation as *"World Heritage"*.<br>- Proposed by EPA as PA's | 40 km of coastline total length | Very High | - Overall immense value (rich marine ecology, archaeology, heritage, geology and biological diversity).<br>- Scenic coastline, extensive coral reefs and rich fishing area, bird, turtle nesting, Crater lake with mangroves. | - BW discharge from Gas supertanker<br>- LNG Terminal Activities<br>- Potential IAS threats<br>- Tourism development |

| Sensitive Areas of Concern | Characterizations/ Descriptions | Total Area of Ecosystem | Vulnerability/ Sensitivity | Importance/ Values/ Services/ Benefits | Threats/ Impacts |
|---|---|---|---|---|---|
| **Hannish islands group**<br>Taiz- Hodeidah,<br>*(center south of Red Sea)* | - Regionally important isolated Biogeographical islands.<br>- Designated as High value habitat | | Minimal | - A large colony of bridled terns, numbering 42,000 breeding pairs.<br>- Holocene Volcanoes, and volcanogenic, biogenic sediment. | |
| **Kamaran island - Ras Issa Peninsula**<br>In Al-Hodeidah,<br>*(Red Sea)* | - Regional-national significant breeding seabird species<br>- Designated as protected with high conservation value habitats<br>- Proposed by EPA as MPA's | 20 $km^2$ | High | - Island/ Headland complex contains Mangroves, and coral reefs with diverse associated fauna.<br>- Serve as landing, resting habitats for migratory birds. | - Chronic pollution from oil terminal<br>- Reef fisheries for aquarium trade |
| **Khor Umairah**<br>In Lahj,<br>*(Gulf of Aden)* | - Mixed seagrass and coral reef habitat<br>- Semi-enclosed lagoon | | High | - Supports marine turtle feeding grounds | Loss of Seagrass beds |
| **Mayyun Island- Bab el-Mandab**<br>In Taiz,<br>*(South of Red Sea)* | - High aspect island and adjacent coast, including Bab el Mandeb strait, and contains extensive Seagrass beds and mangrove stands.<br>- Strategically important Strait of Bab el Mandeb.<br>- Suggested by SAP as a MPAs. | 20 km<br>a wide of Mayyun | Moderate | - Very important waterway washing nutrients for organisms of the Red Sea.<br>- Diverse corals and reef at Bab el Mandeb and north | Navigation risks |
| **Sharma-Jethmun**<br>Hadhramaut,<br>*(Arabian Sea)* | - Regionally–international important habitat as Living & nesting Beaches for five globally threatened turtle species.<br>- It is the most site for green turtles nesting among all Arab | 3$km^2$ total area<br><br>50 km in length of beach | Very High | - A unique and very productive marine ecosystem due to seasonal upwelling that benefits various tropic levels.<br>- Sandy beach with mountain | Turtle and eggs collection |

| Sensitive Areas of Concern | Characterizations/ Descriptions | Total Area of Ecosystem | Vulnerability/ Sensitivity | Importance/ Values/ Services/ Benefits | Threats/ Impacts |
|---|---|---|---|---|---|
| | regions.<br>- Defined by EPA as MPA's. | | | series and archeological sites<br>- | |
| **Socotra islands**<br><br>In Hadhramaut, (Indian ocean) | - Internationally important island for unique Biodiversity.<br>- Defined by *IOWH* as a *"World Heritage"*<br>- Defined by *UNESCO* as a PAs for *" Man & Biosphere"*.<br>- Defined by EPA as special protected area in Yemen. | 16498 $km^2$ as marine resource use reserve<br>1514 $km^2$ as marine national parks<br>154 $km^2$ as marine nature sanctuary (Hima) | Very High | - Island group with outstanding terrestrial plant and animal endemism<br>- Diverse and largely pristine marine environments and Biota<br>- | - Recreation/ Tourism development<br>- Fishing |
| | | | | | |
| | | | | | |

## Annex 2 : Framework for identifying and compilation of costs related to BWM

| Issue | Obligation to whom flag/port/ industry (specify) | Cost to whom flag/port/ industry (specify) | Type of cost (cash/time in kind, etc) | Estimated cost ( $ ) | Possible source of funding or funding mechanism (if applicable) |
|---|---|---|---|---|---|
| **PREPARATORY PHASE** | | | | | |
| **Capacity building, education and communication** | | | | | |
| National Task Force Meeting | MAA | MAA | Cash and in kind | **4500 $/year** | |
| Training (CME, PBBS, etc) | MAA | MAA | Cash and in kind | **73350 $** | |
| Regional Task Force Meeting | MAA | MAA | Cash and in kind | **34700 $** | |
| **Legal, Policy and Institutional reform** | | | | | |
| National BW Status Assessment | MAA | MAA | Cash | **5250 $** | |
| Economic Assessment | MAA | MAA | Cash | **3750 $** | |
| National BWM Strategy | MAA | MAA | Cash | **6000$** | |
| Legal review and drafting | MAA | MAA | Cash | **12 000 $** | |
| **Port Biological Baseline Studies** (research and monitoring) | MAA / MSBRA | MAA / MSBRA | Cash and in kind | **71 000 $** | |
| **Risk Assessment** | MAA / EPA | MAA / EPA | Cash and in kind | **26 000$** | |
| | | | | | |

| Issue | Obligation to whom flag/port/ industry (specify) | Cost to whom flag/port/ industry (specify) | Type of cost (cash/time in kind, etc) | Estimated cost ( $ ) | Possible source of funding or funding mechanism (if applicable) |
|---|---|---|---|---|---|
| **COMPLIANCE RELATED COSTS** | | | | | |
| **Flag State Obligations** | | | | | |
| Establishing procedure for issuing BMW | MAA | Industry | In kind | | |
| Approval of ships' BMW Plans | MAA | Industry | Cash | | |
| Type Approval of BMW Systems | MAA | Industry | Cash | | |
| Surveys | MAA | Industry | Cash | | |
| Approval of exemptions | MAA | Industry | Cash | | |
| **Port State Obligations** | | | | | |
| Compliance Monitoring &Enforcement | Ports | No additional cost | | | |
| Inspection of ships | Ports | Ports | Time, in kind | | |
| Introduction of BW reporting form | Industry | No additional cost | | | |
| Sampling | Port State | Port State | Cash | | |
| Sediment reception facilities | Industry | Industry | Cash | | |
| Communication of BWM requirements to IMO and other | Port State | Port State | Time, in kind | | |

| Issue | Obligation to whom flag/port/ industry (specify) | Cost to whom flag/port/ industry (specify) | Type of cost (cash/time in kind, etc) | Estimated cost ( $ ) | Possible source of funding or funding mechanism (if applicable) |
|---|---|---|---|---|---|
| member states | | | | | |
| Communication of BWM requirements to ships | Port State | Port State | Time, in kind | | |
| **Industry obligations** | | | | | |
| Training of crew members | Industry | Industry | Cash/time | | |
| BWM Plans | Industry | Industry | Cash/time | | |
| BWM Record Book | Industry | Industry | Cash/time | | |
| BWM options | Industry | Industry | Cash/time | | |
| BW Exchange (D-1) | Industry | Industry | Cash/time | | |
| BW Treatment (D-2) | Industry | Industry | Cash/time | | |
| **OTHERS** | | | | | |
| **Port biological monitoring programs** | Port State | Port State | Cash/time | | |
| **Port BWM Plan development** | Ports | Ports | Cash/time | | |