SUMMARY OF COST-BENEFIT CASE STUDIES RELATED TO WASTEWATER MANAGEMENT

1. Background

Wastewater improperly discharged to freshwater and coastal environments presents a variety of concerns, such as: (a) pathogens that may result in human health problems, (b) increase in suspended solids, (c) significant nutrient inputs, and (d) higher levels of biochemical oxygen demand (BOD). The state and the health of the oceans are closely related to ecosystem and public health concerns and food security issues. The sustainable use of oceans contributes in many countries significantly to the economy and the social wellbeing of the population. The income and nutrition of many people, particularly in poorer countries, depend directly on the use of coastal and marine resources - fishing and tourism being obvious examples.

As stated in the Recommendations for Decision-making on Municipal Wastewater (section 1.4 of UNEP/GPA/WGCAR.1/3), the costs to halt the pollution of water may seem prohibitive, but allowing pollution to continue causes damage and costs money. More and more evidence becomes available that pollution is associated with large, quantifiable direct costs to the existing economy and with even higher (missed) opportunity costs.

The UNEP/GPA Coordination Office commissioned two cost/benefit studies to explore the potential benefits of appropriate wastewater management options in coastal cities. Cases in three coastal cities in Eastern Africa have been analysed This document presents the preliminary results of these studies in a summarised format. The intention is to showcase the approach and the potential of this type of cost-benefit studies.

2. Methodology Cost-Benefit Valuation Approach

The first step in the development of Cost-Benefit Analysis is to define the valuation methods and the indicators guiding the quantitative or qualitative estimation of the impacts resulting from environmental changes.

There are three main categories of value relative to which costs and benefits are estimated: Direct use value, indirect use value and non-use (existence) value. Costs are associated with reduction of the use and non-use value of the environment, while benefits accrue from actions and investment that reduce or eliminate the costs and improve environmental quality. The valuation approach helps in establishing the link between information on environmental changes/impacts and their socio-economic significance and the estimate of the positive or negative values of these changes expressed as costs or benefits.

Table 1: Classification of Values (Costs and Benefits) for coastal areas

Category of value	Valuation approach and indicators
Direct Use Change in the productivity of activities that use environmental resources resulting from change in environment conditions / quality	
Tourism	Indicator: Change in tourism revenues and avoided losses
Fisheries	Indicator: Change in fisheries production and revenues and avoided losses
Human Health	Indicator: Treatment costs, loss of work-days and loss of life due to

	environment-related diseases
Property	Indicator: Increment / loss of property values
Indirect Use Changes in recreation, leisure and amenity opportunities, beach stability and quality offered to the public in and near coastal areas due to change in environmental conditions / quality	
Recreation and amenity	Indicator: Number of people and cost of visiting clean and unspoiled coastal sites reflecting people's valuation of recreation opportunities
Non-Use Existence value of environmental quality – biodiversity	
Preservation of coastal, marine and landscape quality, cultural and natural heritage	Indicator: People's willingness-to-pay for maintaining marine and coastal biodiversity (quantitative and qualitative information from surveys)

The first step in the application of the Cost-benefit Study is to assess, on the basis of the available information, the existing impacts from wastewater sources and estimate their approximate costs. These costs are essentially **the costs of inaction**. The importance and extent of the costs involved, which will grow without appropriate wastewater investment, provide the benchmark for cost-benefit evaluation of the priority for such investment and the effectiveness of alternative technical and investment solutions.

3. Summary Case study results for Eastern Africa (three cases)

The three Case Studies concern cities, and surrounding coastal settings, with common and diverse environmental, economic and social conditions. All studies share a strong focus on the evaluation of sewage impacts and the estimation of some of the main benefits of addressing them with capital-intensive sewerage infrastructure. It is well understood however that effective pollution management entails integrated actions that extend far beyond the core interventions of building and operating sewerage infrastructure. It could and should include coastal zone management geared towards sustainable development supported by institutional, legal and financial strategies tailored to the national and local social and institutional setting.

Often, evaluation of sewage treatment capital projects, because of their large scale and technical complexity, are approached as isolated pollution responses, evaluated in technical engineering terms that tend to disguise the demand-side options, cost implications and the synergies with the wider spectrum of coastal management initiatives. The Cost-Benefit Case Studies, notwithstanding data limitations, helps indicate ways of integrating socio-economic parameters into wastewater strategies and point to directions for future programme actions.

The Case Studies, despite differences in the scale and city context and the particular sewage issues, are developed within a **common methodological framework** based on the fundamental principles of economic valuation of environmental impacts and future project benefits focused on the direct and indirect economic losses and gains. A clarification is needed: Cost-benefit Analysis focuses on society's gains and losses and not, like conventional financial analysis, on the financial flows from the point of view of the implementing agencies.

It should be emphasised that most, if not all, Cost Benefit Case Studies are based on a partial assessment of the total costs and benefits, excluding, due to data and time constraints, the estimation of the elusive biodiveristy (non-use) costs and benefits. Some of the main environmental benefits are therefore **qualitative**. Also, Case Studies are rarely entirely conclusive and completely numerically accurate, as Cost-Benefit Analysis, unlike physical science measurements, concerns the **socio-economic impacts** of pollution and pollution abatement as reflected in productivity changes and people's preferences for environmental quality that can never be studies under strictly controlled "laboratory-type" conditions.

Therefore, data and measurement methods are inherently **orders-of-magnitude**, subject to margins of error.

Nevertheless, the results generated from the Case Studies highlight important conclusions about a key cluster of costs and benefits that would otherwise remain vague, or ignored as "non-measurable" and left out of the decision-making process. The well-meaning critics of Cost-Benefit Analysis should appreciate that the choice is between using approximate values to estimate damages and benefits, or, by default, applying a zero value for lack of accurate data. Assuming a zero value is certainly unhelpful as an approach to deal with the costs of pollution and the consequences of inaction. The contributions of Cost-Benefit Analysis lie in the approach to the evaluation of environmental proposals despite having to settle for a measure of statistical inaccuracy.

CBA is essentially a matter of depth: the more detailed the data, the deeper and more accurate the results. The **quantitative** results of the Case Studies are, as expected, sensitive to the quality of the available data, particularly those concerning the most important benefits, such as tourism, fisheries and health.

Table 2: Summary of the main characteristics and results of the Case Studies

Characteristics	**Mombasa (Kenya)**	**Dar-es-Salaam (Tanzania)**	**Beau Vallon (Seychelles)**
Nature of Study Area	Major coastal urban centre	Capital city and major coastal urban centre	Bay area and main tourism location in Mahe
Size of Study Area	282 sq. km	1,350 sq. km.	1,100 ha
Population (1999)	650,000	3,500,000	7,000
Estimated per capita Income	$750	$650	$7,000
Main income source	Informal sector jobs and tourism	Informal sector jobs and tourism	Tourism and fisheries
State of the environment	Serious pollution impacts	Serious pollution impacts	Threats of imminent pollution impacts
Main resource affected	Settlements, rivers and coastal/marine environment	Settlements, rivers and coastal/marine environment	Rivers, the bay area and coastal/marine environment
Main socio-economic consequence	Mainly health, also tourism, property values and coastal environment	Mainly health, also tourism, property values and coastal environment	Mainly threat to tourism industry
Main pollution control response	Sewerage and treatment system	Sewerage and treatment system	Sewerage System
Associated strategic environmental objective	Sustainable coastal management	Sustainable coastal management	Sustainable coastal management
Estimated Project Investment Cost	$100	$222	$15.0
Estimated partial annual cost of pollution (excluding qualitative impacts)	$48 million	$65 million	$21 million (2004)
Net Present Value	$291 million	$565 million	$202 million
Qualitative benefits not quantified	Indirect recreation, mangroves and non-use biodiversity value	Indirect recreation, mangroves and non-use biodiversity value	Indirect recreation and non–use biodiversity value

4. Detailed information on case studies

4.1 Mombasa (Kenya)

Table 3: Estimated Annual Cost of Environmental Impacts in Monetary Values for Mombasa

Impacts	Annual cost in million US$	Comments
Direct costs:		
1. Fisheries	0.5	Half of the reported production losses
2. Tourism	15.0	Based on half of the revenue losses estimated for other countries. Income is 300 million p.y.
3. Property	26.7	Estimated loss of value due to proximity to polluted areas
4. Health	2.4 3.3	Diarrhoea and skin diseases only Child death–human capital valuation for loss of income only
Indirect costs:		
5. Recreation		Qualitative benefits, not quantified
6. Mangroves	0.1	Tentative estimates of mangrove losses
7. Biodiversity		Qualitative benefits, not quantified
Total	**48.0**	

Table 4: Cost – Benefit Analysis Mombassa ($ million)

Estimated Capital Cost of Sewage System	100.0
Plus: Annual operating cost capitalised at 10% for 25 years	45.0
Total Investment Cost	145.0
Estimate value of annual benefits (avoided cost)	48.0
Present Value of estimated benefits (10% for 25 years)	435.7
Net Present Value	**290.7**
Benefit / Cost Ratio	**3.0**
Sensitivity Analysis assuming 25% variance:	
Estimated Investment Cost 25% higher	145.0 x 1.25 = 181.2
Estimated Benefits 25% lower	435.7 x 0.75 = 326.8
Net Present Value	**145.6**
Benefit / Cost Ratio	**1.8**

4.2 Dar-es-Salaam (Tanzania)

Table 5: Estimated Annual Costs of Environmental Impacts in Monetary Values for Dar-es-Salaam

Impacts	Annual cost in million US$	Comments
Direct Costs:		
1. Fisheries	1.0	Loss of production
2. Tourism	9.0	Loss of tourism income (which is 190 million p.y.)
3. Property	34.4	Reduction of value or lack of appreciation
4. Health	3.1 17.3	Treatment costs and loss of earnings Human capital loss from death
Indirect Costs:		
5. Recreation	Qualitative impacts	Not quantified
6. Mangroves	Qualitative impacts	Not quantified
7. Biodiversity	Qualitative impacts	Not quantified
Total	**64.8**	**Partial estimate**

Table 6: Cost - Benefit Analysis Dar-es-Salaam ($ million)

Estimated Investment Cost	222
Annual Operating Cost capitalised at 10% for 25 years	91 (10 x annuity factor 9.0)
Total Estimated Investment Cost	313
Present Value of Estimated Benefits at 10% for 25 years	878
Net Present Value (25 years at 10%)	565
Benefit / Cost ratio	**2.8**
Sensitivity Analysis assuming 25 % variance	
Estimated Investment cost by 25% higher	313 x 1.25 = 391
Estimated benefits by 25% lower	878 x 0.75 = 659
Benefit / Cost ratio	**1.7**

4.3 Beau Vallon (Seychelles)

Table 7: Estimated Potential Annual Costs of Pollution without Sewerage Infrastructure for Beau Vallon

Impacts	Million US$	%
Direct costs:		
1. Tourism	2.85	14
2. Fisheries	3.00	14
3. Health	0.90	4
4. Property	14.20	68
Indirect costs:		
5. Recreation	0.06	< 1
6. Biodiversity		-
Total (excluding non-use/ existence benefits)	**21.0**	**100**

Table 8: Cost- Benefit Analysis Beau Vallon ($ million)

Estimated Investment Cost	15.0
Annual Operating Cost capitalised at 10% for 24 years	10.24
Total Estimated Investment Cost	25.24
Present Value of Estimated Benefits at 10% for 24 years	227.88
Net Present Value	202.64
Benefit / Cost ratio	**9**
Sensitivity Analysis assuming 25 % variance:	
Estimated Investment cost by 25% higher	25.0 x 1.25 = 31.0
Estimated benefits by 25% lower	228.0 x 0.75 = 171.0
Benefit / Cost ratio	**5.5**

5. Other case studies:

A similar approach has been used in the early 1990's in two case studies in the Mediterranean.

1. Cost and Benefits of Measures for the Protection of the Environment from land-Based Sources of Pollution: Case Study of the Island of Rhodes, Glafkos Constantinides, UNEP/MAP Technical Report Series No. 72, 1992.

Population: 106,500 – growth rate 1971-81 2.2% p.a.
Area: 1,400 sq. km.

Location: Greece, south-eastern corner of the Aegean Sea
Main economic activity: Tourism – arrivals 981,000 (1990)
The estimated monetised effects / damages of pollution was approximately $15.2 million, representing about 3% of the island's GDP.

Costs and Benefits of Projects for the Protection of the Marine Environment

Costs of Investment	Amount ($ million)
Rhodes city sewerage system	46.0
Annual operating cost 1.6 million – capitalised at 10% for 30 years	15.0
Total Investment Cost	61.0
Estimated annual benefits from: • Cost savings • Property value increase • Tourism income Total annual benefits	 4.6 (28.5%) 7.5 (46.5%) 4.0 (25%) 16.1 (100%)
Present Value (30 years / 10%)	152.0
Net Present Value	91.0
Benefit-Cost Ratio	2.5

This case study illustrates at least two fundamental issues:
First, that investment for reducing the degradation of the coastal environment from land-based sources is associated with significant direct and indirect benefits which can be estimated in approximate monetary values. **Second**, that despite numerous estimation and measurement problems, cost-benefit analysis can and should be fully introduced as an instrument for the preparation of environmental management programmes focusing attention on the benefits justifying the required expenditure.

2. Costs and Benefits of measures for the protection of Degradation of the Environment from Land-Based Sources of Pollution: Case Study of the Bay of Izmir, T.I. Balkas and F. Juhasz, UNEP/MAP, Technical Report Series No. 72, 1992

Population: 1.8 million (1992), 2000 projected 2.3 million
Area: The urban conurbation around the bay (Izmir Metropolitan Municipality) is 88,000 ha
Location: Turkey, western part of the Aegean Sea
Main economic activity: Industrial, commercial, tourism and port centre

Cost and benefits of the restoration of the Bay

Cost of Investment	Amount ($ million)
Sewerage System for domestic and industrial wastes	938.0
Annual operating costs 75.0 million – capitalised at 10% for 25 years	680.0
Total Investment costs	1,618
Estimated discounted benefits (conservative scenario) from: • Tourism • Fisheries • Salt production • Ground water • Corrosion • Recreation • Health (water use) Total	 3,412 (71%) 133 (3%) 843 (18%) 70 (1%) 25 (0.5%) 225 (5%) 65 (1.5%) 4,773 (100%)
Net Present Value	3,155
Benefit Cost Ratio	3.0

Preliminary assessment suggests that the benefits of the proposed sewerage system for Izmir and the implementation of the protocols of the Barcelona Convention could significantly outweigh the costs of the control measures by a factor of 3. The result is based on tourism-led future development of the Bay which appears to be environmentally the least damaging and economically the most beneficial.

References:

UNEP/MAP, Costs and benefits of measures for the reduction of degradation of the environment from land-based sources of pollution in coastal areas. MAP Technical Report Series No. 72, Athens, Greece, 1992

Cost- benefit analysis case studies for the GPA Strategic Action Plan on sewage. Glakos Constantinides in cooperation with IMS, Final Draft, October 2000.