



United Nations
Environment Programme



UNEP/GEF South China Sea
Project



Global Environment
Facility

***Reversing Environmental Degradation Trends
in the
South China Sea and Gulf of Thailand***

REPORT

**Fourth Meeting of the Regional Task Force
on Economic Valuation**

Xuan Thuy, Nam Dinh Province, Viet Nam, 27th – 30th March 2006

ANNEX 4

Amended Frameworks and Procedures for Valuing the Impacts of Land-Based Pollution

BACKGROUND

During the third Meeting of the Regional Task Force on Economic Valuation (RTF-E) in Fangchenggang, China, 18th – 21st April 2005, the Task Force reviewed the consultant report on existing literature for the valuation of the impacts of land-based pollution, and considered alternative approaches to formulating a framework and procedures for valuing the impacts of land-based pollution on the four coastal habitat types: mangroves, coral reefs, seagrass, and wetlands, which are of concern to the UNEP/GEF South China Sea Project.

During that meeting, the Task Force developed a framework for the valuation of land-based pollution on coastal habitats, including the following components:

- A checklist of the impacts of land-based pollution on coastal habitats, specifying types of pollutants and their specific impacts on the four habitats [mangroves, coral reefs, seagrass, and wetlands];
- A Framework for valuing the impacts of land-based pollution on the four habitat types, categorising the various specific impacts in the checklist into three categories, i.e. productivity, amenity, and human welfare;
- Procedures to undertake valuation of impacts of land-based pollution on the four habitat types, in which valuation techniques, indicator of measurement, data needed, and notes and assumptions were described for each specific impact identified in the checklist and framework.

The impact checklist, the framework, and the procedures for valuing the impact on the coastal habitats were reviewed and checked by the members of the Regional Working Groups during the sixth round of meetings. In general, the Regional Working Groups expressed their appreciation to the RTF-E¹ for the comprehensive and useful outputs produced. The Regional Working Groups provided some general comments and inquiries on some ambiguities, and also proposed changes to the original draft impact checklist, framework, and procedures for the economic valuation of land-based pollution impacts.

During the fourth meeting of the Regional Task Force on Economic Valuation, the Task Force reviewed and considered the comments and proposed amendments provided by the Working Groups. The Task Force decided to adopt most of the comments and proposed changes, and proceeded to amend the checklist, frameworks, and procedures for valuing land-based pollution, based on those comments.

Table 1 is the amended checklist for the impacts of land-based pollution on coastal habitats, Table 2 is a consolidated table, the contents of which reflect the contents of the original tables 2.1-2.4 and includes the amended frameworks for mangroves, coral reefs, seagrass, and wetlands, respectively. The original tables 3.1 - 3.4 which reflected the four habitats separately have been consolidated in the present text as Tables, 3, 4 and 5 covering the valuation techniques for the impacts of land-based pollution on: productivity, amenity value, and human welfare respectively.

¹ See the meeting reports of the sixth round of Regional Working Groups' meetings: UNEP/GEF/SCS/RWG-M.6/3, UNEP/GEF/SCS/RWG-C.6/3, UNEP/GEF/SCS/RWG-S.6/3, UNEP/GEF/SCS/RWG-W.6/3 (available on project website: www.unepscs.org).

Table 1 Amended Checklist of the Impacts of Land-based Pollution on Coastal Habitats.

Types of Pollutants	Impacts	Mangroves	Coral Reefs	Seagrass	Wetlands
Heavy metals	• Water quality	v	v	v	v
	• Reduced reproductive capacity in molluscs	v	v	v	v
	• Contamination of human food sources	v	v	v	v
	• Bio-accumulation	v	v	v	v
Organic matter	• Water quality	-	v	v	v
Nutrients	• Eutrophication	-	v	v	v
	• Algal blooms and/or overgrowth	-	v	v	v
	• Anoxia – fish kills	-	v	v	v
	• Fish/shellfish poisoning	-	v	v	v
Oil and hydrocarbons	• Contamination/tainting of aquaculture and wild fish	v	v	v	v
	• Extreme spills smothering organisms	v	v	v	v
	• Water quality	v	v	v	v
Sediments	• Smothering of mangroves, coral reefs and seagrass	v	v	v	-
	• Reduced light penetration from increased turbidity leading to reduced primary production	-	v	v	v
	• Water quality	v	v	v	v
	• Change of water depth	v	v	v	v
	• Change of species composition of benthonic communities	v	v	v	v
POPs	• Water quality	v	v	v	v
	• Contamination of seafood	v	v	v	v
	• Reduced fish production	v	v	v	v
Solid waste (plastics)	• Smothering of organisms	v	v	v	v
	• Loss of amenity value	v	v	v	v
	• Biosorption of plasticizing agents	v	v	v	v
Thermal pollution	• Reduced productivity	v	v	v	v
	• Loss of species	v	v	v	v
Bacterial contamination	• Loss of amenity value	v	v	v	v
	• Contamination of human food sources	v	v	v	v
Acid Pollution	• Change of water and sediment quality	v	-	v	v
	• Loss of bio community (fish...)	v	-	v	v

Table 2 Framework for Valuing Impacts of Land-based Pollution on Coastal Habitats

Types of Pollutants	Impacts	Mangroves			Coral Reefs			Seagrass			Coastal Wetlands		
		Prod.	Amenity	Human welfare	Prod.	Amenity	Human welfare	Prod.	Amenity	Human welfare	Prod.	Amenity	Human welfare
Heavy metals	• Water quality	V	V	V	V	V	-	V	V	-	V	V	V
	• Reduced reproductive capacity in molluscs	V	-	-	V	-	-	V	-	-	V	-	-
	• Contamination of human food sources	-	-	V	-	-	V	-	-	V	-	-	V
	• Bio-accumulation	V	-	V	V	-	-	V	-	-	V	-	-
Organic matter	• Water quality	-	-	-	V	V	-	V	V	-	V	V	V
Nutrients	• Eutrophication	-	-	-	V	-	-	V	-	-	V	V	-
	• Algal blooms and/or overgrowth	-	-	-	V	-	-	V	-	-	V	V	-
	• Anoxia – fish kills	-	-	-	V	-	-	V	-	-	V	-	-
	• Fish shellfish poisoning	-	-	-	-	-	V	-	-	V	-	-	V
Oil and hydrocarbons	• Contamination/tainting of aquaculture and wild fish	V	V	V	-	-	V	-	-	V	-	-	V
	• Extreme spills smothering of organisms	V	V	-	V	V	-	V	V	-	-	-	-
	• Water quality	V	V	V	V	-	-	V	V	V	V	V	-
Sediments	• Smothering of benthic communities	V	V	-	V	V	-	V	V	-	V	V	-
	• Reduced light penetration from increased turbidity leading to reduced primary production	-	-	-	V	V	-	V	V	V	V	-	-
								V	V	-	V	-	-
	• Water quality	V	V	-	V	V	-	V	V	-	V	V	-
	• Change of water depth	V	V	-	V	V	-	V	V	-	V	V	-
POPs	• Change of species composition of benthic communities	V	V	-	V	V	-	V	V	-	V	V	-
	• Water quality	-	-	V	V	-	-	V	V	-	V	V	V
	• Contamination of seafood	-	-	V	-	-	V	-	-	V	-	-	V
Solid waste (plastics)	• Reduced fish reproductive capacity	V	-	-	V	-	-	V	-	-	V	-	-
	• Smothering of organisms	V	V	-	V	V	-	V	V	-	V	V	-
Thermal pollution	• Biosorption of plasticizing agent	V	-	V	V	-	V	V	-	V	V	-	V
	• Reduced productivity	V	-	-	V	-	-	V	-	-	V	-	-
Bacterial contamination	• Loss of species	V	V	-	V	-	-	V	V	-	V	V	-
	• Reduced use as bathing area	-	-	-	-	V	-	-	V	-	-	V	-
Change in pH	• Contamination of human food sources	V	-	V	-	-	V	-	-	V	-	-	V
	• Change of water and sediment quality	V	-	-	V	-	-	V	V	-	V	-	-
Acid Pollution	• Loss of species (fish)	V	V	-	V	V	-	V	V	-	V	V	-

Table 3 Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Productivity of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Heavy metals	Water quality	On site sale value for marketed goods using net price For directly used goods, use market values for equivalent goods. If not available use indirect opportunity cost approach (using wages forgone for harvesting goods)	Total annual value of production for each product (US\$)	For direct valuation: <ul style="list-style-type: none"> On site market price of each product (before and after) Quantities of products harvested, sold, given away and used (before and after) Total areas under consideration (before and after) Concentration level of heavy metals Exchange rates and the years of data collected For indirect valuation: <ul style="list-style-type: none"> Price per unit for equivalent goods Cost of material inputs Time spent harvesting/gathering/ culturing product Equivalent local wage for labour On site market price of each product (before and after degradation of water quality) 	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price.
	Reduced reproductive capacity	On site sale value for human food sources using net price	Loss of income due to decreased production of food sources	<ul style="list-style-type: none"> Prices before and after pollution Change in production before and after heavy metal pollution 	Change of productivity is caused only by heavy metals
	Contamination of human food sources	On site sale value for human food sources using net price	Drop in price due to the decrease in demand	<ul style="list-style-type: none"> Prices before and after pollution Quantities of products harvested, sold, given away and used (before and after) 	<ul style="list-style-type: none"> People are aware of the polluted food sources Market price changes reflect the changes in demand All externalities are identified and included in the price.
	Bio-accumulation	On site sale value for marine food products	Drop in price due to the decrease of demand	<ul style="list-style-type: none"> Prices of marine food before and after pollution 	<ul style="list-style-type: none"> People are aware of the bio-accumulation of marine food products Market price changes reflect the changes in demand

Table 3 cont. Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Productivity of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Organic Matter	Water quality	On site sale value for marketed goods using net price For directly used goods, use market values for equivalent goods. If not available use indirect opportunity cost approach (using wages forgone for harvesting goods)	Total annual value of production for each product (US\$)	For direct valuation: <ul style="list-style-type: none"> On site market price of each product (before and after) Quantities of products harvested, sold, given away and used (before and after) Total areas under consideration (before and after) Concentration level of heavy metals Exchange rates and the years of data collected For indirect valuation: <ul style="list-style-type: none"> Price per unit for equivalent goods Cost of material inputs Time spent harvesting/gathering/ culturing product Equivalent local wage for labour On site market price of each product (before and after degradation of water quality) 	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price.
Nutrients	Eutrophication Algal blooms Anoxia, fish kills	On site sale value for marketed goods using net price For directly used goods, use market values for equivalent goods. If not available use indirect opportunity cost approach (using wages forgone for harvesting goods)	Total annual value of production for each product (US\$)	For direct valuation: <ul style="list-style-type: none"> On site market price of each product (before and after) Quantities of products harvested, sold, given away and used (before and after) Total areas under consideration (before and after) Concentration level of heavy metals Exchange rates and the years of data collected For indirect valuation: <ul style="list-style-type: none"> Price per unit for equivalent goods Cost of material inputs Time spent harvesting/gathering/ culturing product Equivalent local wage for labour On site market price of each product (before and after degradation of water quality) 	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price.

Table 3 cont. Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Productivity of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Oil and hydrocarbons	Water quality	On site sale value for marketed goods using net price For directly used goods, use market values for equivalent goods. If not available use indirect opportunity cost approach (using wages forgone for harvesting goods)	Total annual value of production for each product (US\$)	For direct valuation: <ul style="list-style-type: none"> On site market price of each product (before and after release of oil and hydrocarbon) Quantities of products harvested, sold, given away (before and after) Total areas under consideration (before and after) Exchange rates and the years of data collected For indirect valuation: <ul style="list-style-type: none"> Price per unit for equivalent goods Cost of material inputs Time spent harvesting/gathering/ culturing product Equivalent local wage for labour On site market price of each product (before and after degradation of water quality) Exchange rates and the years of data 	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities identified & included in the price.
	Contamination tainting of cultured products and wild fish	On site sale value of aquaculture products and wild fish	Drop in price due to the decrease in demand	<ul style="list-style-type: none"> Prices before and after pollution 	<ul style="list-style-type: none"> People are aware of the polluted food sources Market price changes reflect the changes in demand
	Extreme spills smothering of organisms	On site sale value of reduced production	Loss of income due to decreased production of food sources	<ul style="list-style-type: none"> Prices of aquaculture and wild fish Production before and after oil/hydrocarbon 	<ul style="list-style-type: none"> Change of production is caused only by oil/hydrocarbon
Sediments	Smothering of mangroves	On site sale value of reduced production	Loss of income due to decreased production of human food sources	<ul style="list-style-type: none"> Prices of aquaculture and wild fish Production before and after smothering 	<ul style="list-style-type: none"> Change of production is caused only by sediments
	Change in water depth & species composition of benthic communities	On site sale value of changed production	Changes in income due to changes in production	<ul style="list-style-type: none"> Prices of aquaculture and wild fish Production before and after increased sediment loading 	
Solid Waste	Smothering of organisms	On site sale value of reduced production	Loss of income due to decreased production	<ul style="list-style-type: none"> Prices of aquaculture and wild fish Production before and after smothering 	<ul style="list-style-type: none"> Change of production is caused only by solid wastes
	Biosorption of plasticizing agents reduced production	On site sale value of reduced production	Loss of income due to decreased production of food sources	<ul style="list-style-type: none"> Prices of aquaculture and wild fish Production before and after smothering 	<ul style="list-style-type: none"> Change of production is caused only by biosorption of plasticising agents
POPs	Water quality, reduced biological production	On site sale value of reduced production	Total annual value of production for each product (US\$)	For direct and Indirect valuations see above	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities identified & included in the price.

Table 3 cont. Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Productivity of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Thermal pollution	Reduced production	On site sale value for marketed goods using net price For directly used goods, use market values for equivalent goods. If not available use indirect opportunity cost approach (using wages forgone for harvesting goods)	Total annual value of production for each product (US\$)	For direct valuation: <ul style="list-style-type: none"> On site market price of each product (before and after thermal pollution) Quantities of products harvested, sold, given away (before and after) Total areas under consideration (before and after) For indirect valuation: <ul style="list-style-type: none"> Price per unit for equivalent goods Cost of material inputs Time spent harvesting/gathering/ culturing product Equivalent local wage for labour 	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price. Exchange rates and the years of data collected
	Loss of species	On site price for marketed products Substitute price of non-marketed products*	Total annual value of production for each product (US\$)	For all approaches: <ul style="list-style-type: none"> Species identified before and after Quantities of equivalent products harvested, sold, given away (before and after) For direct valuation: <ul style="list-style-type: none"> On site market price of each product (before and after thermal pollution) Total areas under consideration (before and after) For indirect valuation (incl. substitute price approach): <ul style="list-style-type: none"> Price per unit for equivalent goods Cost of material inputs Time spent harvesting/gathering/ culturing product Equivalent local wage for labour 	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price. Exchange rates and the years of data collected Substitute material acceptable Market values not distorted
pH change-acid pollution	Change in water & sediment quality, loss of spp.	On site sale value for marketed goods using net price For directly used goods, use market values for equivalent goods. If not available use indirect opportunity cost approach (using wages forgone for harvesting goods)	Total annual value of production for each product (US\$)	For direct valuation: <ul style="list-style-type: none"> On site market price of each product (before and after thermal pollution) Quantities of products harvested, sold, given away (before and after) Total areas under consideration (before and after) For indirect valuation: <ul style="list-style-type: none"> Price per unit for equivalent goods Cost of material inputs Time spent harvesting/gathering/ culturing product Equivalent local wage for labour 	<ul style="list-style-type: none"> Values prior to the impact to be determined. Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price. Exchange rates and the years of data collected
Bacterial contamination	Contamination of human food sources	On site sale value for human food sources using net price	<ul style="list-style-type: none"> Drop in price due to the decrease of demand Loss of income due to decreased demand 	<ul style="list-style-type: none"> Prices before and after contamination 	<ul style="list-style-type: none"> People are aware of the contamination of food sources Market price changes reflect the changes in demand

Table 4 Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Amenity Value of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Heavy metals	Water quality	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	Data from visitors survey (before and after water contamination) <ul style="list-style-type: none"> Socio-economic variables Geographic origin Time spent travelling Expenditures incurred in visiting the site Frequency and duration of visits Number of visitor-days for the site 	Assumptions <ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
		Contingent valuation: willingness to pay for good water quality	Recreational value of the site as valued by willingness to pay by users (US\$) Total cost value	Answers to valuation questions from survey/bidding game technique/ dichotomous choice	<ul style="list-style-type: none"> Subjects understand choices offered and give meaningful and honest answers Subject have sufficient information to give informed choices Sample is representative and captures the full spectrum of users who value the site No free riders No strategic bias/influences
		Replacement cost: cost to clean up heavy metals	Total cost value	<ul style="list-style-type: none"> Type of pollutants Sources of pollutants 	Technologies to clean up the pollutants are available and the cost of technologies is affordable
Organic matter	Water quality	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	Data from visitors survey (before and after water contamination) <ul style="list-style-type: none"> Socio-economic variables Geographic origin Time spent travelling Expenditures incurred in visiting the site Frequency and duration of visits Number of visitor-days for the site 	Assumptions <ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
Oil and hydrocarbons	Contamination /tainting of aquaculture and wild fish	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	Data from visitors survey (before and after water contamination) <ul style="list-style-type: none"> Socio-economic variables Geographic origin Time spent travelling Expenditures incurred in visiting the site Frequency and duration of visits Number of visitor-days for the site 	Assumptions <ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted

Table 4 cont. Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Amenity Value of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Oil and hydrocarbons continued	Extreme spills smothering of organisms	Travel Cost	Annual recreational value of the site	Data from visitors survey (before and after water contamination) <ul style="list-style-type: none"> Socio-economic variables Geographic origin Time spent travelling Expenditures incurred in visiting the site Frequency and duration of visits Number of visitor-days for the site 	Assumptions <ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
		Contingent valuation: willingness to pay for good water quality	Recreational value of the site as valued by willingness to pay by users (US\$)	Answers to valuation questions from survey/bidding game technique/ dichotomous choice	<ul style="list-style-type: none"> Subjects understand choices offered and give meaningful and honest answers Subject have sufficient information to give informed choices Sample is representative and captures the full spectrum of users who value the site No free riders No strategic bias/influences
	Water quality	Replacement cost: cost to clean up oil and hydrocarbons	Total cost value	Type of pollutants Sources of pollutants Concentration level of oil and hydrocarbons	Technologies to clean up the pollutants are available and the cost of technologies is affordable
		Opportunity cost	Total value of best alternative uses	Potential alternative uses of the resources Investments in the best alternative uses	Stakeholders agree on the best uses of the resources
Sediments	Smothering of mangroves	Travel cost/opportunity cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	Data from visitors survey (before and after water contamination) <ul style="list-style-type: none"> Socio-economic variables Geographic origin Time spent travelling Expenditures incurred in visiting the site Frequency and duration of visits Number of visitor-days for the site 	Assumptions <ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
	Water quality	Contingent valuation: willingness to pay for good water quality	Recreational value of the site as valued by willingness to pay by users (US\$)	Answers to valuation questions from survey/bidding game technique/ dichotomous choice	<ul style="list-style-type: none"> Subjects understand choices offered and give meaningful and honest answers Subject have sufficient information to give informed choices Sample is representative and captures the full spectrum of users who value the site No free riders No strategic bias/influences
	Change of water depth/species composition of benthic communities	Replacement cost: cost to dredge sediments	Total cost value	<ul style="list-style-type: none"> Type of pollutants Sources of pollutants Concentration level of oil and hydrocarbons 	Cost is affordable

Table 4 cont. Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Amenity Value of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
POPs	Water quality	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	Data from visitors survey (before and after water contamination) • Socio-economic variables • Geographic origin • Time spent travelling • Expenditures incurred in visiting the site • Frequency and duration of visits • Number of visitor-days for the site	<ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
		Contingent valuation: willingness to pay for good water quality	Recreational value of the site as valued by willingness to pay by users (US\$)		<ul style="list-style-type: none"> Subjects understand choices offered and give meaningful and honest answers Subject have sufficient information to give informed choices Sample is representative and captures the full spectrum of users who value the site No free riders No strategic bias/influences
Solid waste (plastics)	Smothering of organisms	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	Data from visitors survey (before and after water contamination) • Socio-economic variables • Geographic origin • Time spent travelling • Expenditures incurred in visiting the site • Frequency and duration of visits • Number of visitor-days for the site	<ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
	Loss of amenity value	Hedonic Pricing	Differences in the value of the assets/real estates of the same quality	Prices of assets and real estates in different locations	Different prices of the assets/real estates of the same quality are influenced only by the surrounding habitats
		Replacement cost: cost to clean up solid waste	Total cost value (US\$)	<ul style="list-style-type: none"> Sources of solid waste Volume of solid waste 	Technologies to clean up the pollutants are available and the cost of technologies is affordable
Thermal Pollution	Loss of species	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	Data from visitors survey (before and after water contamination) • Socio-economic variables • Geographic origin • Time spent travelling • Expenditures incurred in visiting the site • Frequency and duration of visits • Number of visitor-days for the site	<ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
		Hedonic Pricing		Answers to valuation questions from survey/bidding game technique/ dichotomous choice	

Table 4 cont. Procedures to Undertake Valuation of Impacts of Land-based Pollution on the Amenity Value of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Bacterial contamination	Loss of amenity	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	<ul style="list-style-type: none"> Data from visitors survey (before and after water contamination) Socio-economic variables Geographic origin Time spent travelling Expenditures incurred in visiting the site Frequency and duration of visits Number of visitor-days for the site 	<ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
	Contamination of recreational areas	Contingent valuation: willingness to pay for good water quality	Recreational value of the site as valued by willingness to pay by users (US\$)		<ul style="list-style-type: none"> Subjects understand choices offered and give meaningful and honest answers Subject have sufficient information to give informed choices Sample is representative and captures the full spectrum of users who value the site No free riders No strategic bias/influences
		Prevention cost	Total cost to prevent bacterial contaminati	<ul style="list-style-type: none"> Cost of constructing facilities for individual economic activities Cost of volumes of projected waste Size of impacted areas Sources of contaminants 	
Acid Pollution	Change of water and sediment quality	Travel cost: Amount of money and time spent on the site	Annual recreational value of the site (US\$)	<ul style="list-style-type: none"> Data from visitors survey Socio-economic variables Geographic origin (before and after) Time spent travelling (before and after) Expenditures incurred in visiting the site (before and after) Frequency and duration of visits (before and after) Number of visitor-days for the site (before and after site) 	<ul style="list-style-type: none"> Access to the site is available to all Visits have a single purpose Demand function relationship can be specified No factors aside from travel cost influence site use Market prices used in valuation are not distorted
	Loss of biological communities	Contingent valuation: willingness to pay for good water quality	Recreational value of the site as valued by willingness to pay by users (US\$)	<ul style="list-style-type: none"> Answers to valuation questions from survey/bidding game technique/ dichotomous choice 	<ul style="list-style-type: none"> Subjects understand choices offered and give meaningful and honest answers Subject have sufficient information to give informed choices Sample is representative and captures the full spectrum of users who value the site No free riders No strategic bias/influences

Table 5 Procedures to Undertake Valuation of Impacts on Human Welfare of Land-based Pollution of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Heavy metals	Water quality	Cost of illness	Total I value of lost human labour (US\$), total cost of treatment	<ul style="list-style-type: none"> Salaries/wages for labour Duration of illness and recovery (number of days lost) Hospitalisation and treatment cost 	<ul style="list-style-type: none"> Health and productivity can be restored to previous levels
	Contamination of human food sources	Substitute price approach: cost of sourcing food elsewhere/cost of equivalent food	Total annual cost of sourcing food from alternative sites/equivalent food	<ul style="list-style-type: none"> Quantity of food consumed Price per unit quantity of food sourced elsewhere/equivalent food Duration and cost of finding new sources of food. Transport cost of new sources of food. 	<ul style="list-style-type: none"> Equivalent and substitute food available Food consumed reaches minimum standards set by governments.
	Bio-accumulation	Cost of illness	Total I value of lost human labour (US\$), total cost of treatment	<ul style="list-style-type: none"> Salaries/wages for labour Duration of illness and recovery (number of days lost) Hospitalisation and treatment cost 	<ul style="list-style-type: none"> Health and productivity can be restored to previous levels
Nutrients	Harmful algal blooms shellfish poisoning	Substitute price approach: cost of sourcing food elsewhere/cost of equivalent food	Total annual cost of sourcing food from alternative sites/equivalent food	<ul style="list-style-type: none"> Quantity of food consumed Price per unit quantity of food sourced elsewhere/equivalent food Duration and cost of finding new sources of food. Transport cost of new sources of food 	<ul style="list-style-type: none"> Equivalent and substitute food available
Oil and hydrocarbons	Water quality Contamination/ tainting of mariculture and wild fish	Substitute price approach: cost of sourcing food elsewhere/cost of equivalent food	Total annual cost of sourcing food from alternative sites/equivalent food	<ul style="list-style-type: none"> Quantity of food consumed Price per unit quantity of food sourced elsewhere/equivalent food Duration and cost of finding new sources of food. Transport cost of new sources of food 	<ul style="list-style-type: none"> Equivalent and substitute food available
Sediments	Water quality	Cost of illness	Total I value of lost human labour (US\$), total cost of treatment	<ul style="list-style-type: none"> Salaries/wages for labour Duration of illness and recovery (number of days lost) Hospitalisation and treatment cost 	<ul style="list-style-type: none"> Health and productivity can be restored to previous levels
POPs	Water quality	Cost of illness	Total I value of lost human labour (US\$), total cost of treatment	<ul style="list-style-type: none"> Salaries/wages for labour Duration of illness and recovery (number of days lost) Hospitalisation and treatment cost 	<ul style="list-style-type: none"> Health and productivity can be restored to previous levels
	Contamination of seafood	Substitute price approach: cost of sourcing food elsewhere/cost of equivalent food	Total annual cost of sourcing food from alternative sites/equivalent food	<ul style="list-style-type: none"> Quantity of food consumed Price per unit quantity of food sourced elsewhere/equivalent food Duration and cost of finding new sources of food. Transport cost of new sources of food. 	<ul style="list-style-type: none"> Equivalent and substitute food available Food consumed reaches minimum standards set by governments.

Table 5 cont. Procedures to Undertake Valuation of Impacts on Human Welfare of Land-based Pollution of Coastal Habitats and Resources.

Types of Pollutants	Impacts	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Solid waste	Bioasorption of plasticizing agents	Cost of illness	Total I value of lost human labour (US\$), total cost of treatment	<ul style="list-style-type: none"> Salaries/wages for labour Duration of illness and recovery (number of days lost) Hospitalisation and treatment cost Salaries/wages for labour Duration of illness and recovery (number of days lost) Hospitalisation and treatment cost 	<ul style="list-style-type: none"> Subjects understand choices offered and give meaningful and honest answers Subject have sufficient information to give informed choices Sample is representative and captures the full spectrum of users who value the site No free riders No strategic bias/influences Health and productivity can be restored to previous levels
Bacterial Contamination	Contamination of human food sources	Cost of illness	Total I value of lost human labour (US\$), total cost of treatment	Same as above	Same as above
		Substitute price approach: cost of sourcing food elsewhere/cost of equivalent food	Total annual cost of sourcing food from alternative sites/equivalent food	<ul style="list-style-type: none"> Quantity of food consumed Price per unit quantity of food sourced elsewhere/equivalent food Duration and cost of finding new sources of food. Transport cost of new sources of food. 	<ul style="list-style-type: none"> Equivalent and substitute food available Food consumed reaches minimum standards set by governments