# XIV Assessment of Investment & Financial Flows for Adaptation in the Coastal Zones Sector

## 14.1 Introduction

The coast is where ocean and land meet, but the natural processes that shape the coast are highly dynamic, varying in both space and time. Coastal areas contain both land and ocean components; have land and ocean boundaries that are determined by the degree of influence of the land on the ocean and vice versa; and are constantly changing in width, depth or height.[176]

Coastal resources comprise all the natural ecological and physical systems within the coastal zone. The term can also be used to refer to the economic and subsistence value of these systems.[177] Coastal systems are dynamic in nature, undergoing adjustments of form and process at different temporal and spatial scales in response to geomorphological and oceanographical factors. Human activity exerts additional pressures that may dominate over natural processes[178]. As a result, this requires a focus on the sustainable management of coastal zones to handle the pressures of today's population, as well as the impacts of climate change.

The impacts of climate change on coastal systems are likely to multiple: sea level rise, higher sea water temperatures, changes in precipitation and run-off patterns, changes in storm tracks, frequency, and intensity, and changes in ocean chemistry, particularly acidification. These changes will have a number of different physical and ecological effects on coastal systems: permanent inundation, flood and storm damage, permanent loss of wetlands, coastal erosion, saltwater intrusion, coral bleaching and rising water tables. Therefore, climate change will affect the physical and biological characteristics of the sea and their coastal areas, modifying their ecosystem structure and functioning. In its 2007 Fourth Assessment Report, the IPCC has concluded that "impacts [on coastal zones) are virtually certain to be overwhelmingly negative".

Rising surface water temperatures, for example, are likely to cause increased coral bleaching and the migration of coastal species toward higher latitudes. Changes in precipitation and

[176] Kay, Robert and Alder, Jacqueline. Coastal Planning and Management (Second Edition) (2005). Tayor and Francis, London.
[177] UNFCCC, Resource Guide for Preparing the National Communications of non-Annex I Parties, Module 2: Vulnerability and Adaptation.
[178] Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe (2007): Coastal systems and low-lying areas. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 315-356.

storm patterns will alter the risks of flooding and storm damages. Mangroves and coastal lagoons are expected to undergo rapid change and perhaps be lost altogether as functioning ecosystems in vulnerable locations. Low-lying coastal areas and associated wetlands could also be displaced by salt water habitats, disrupting fresh-water based ecosystems. Such changes are likely to result in the dislocation of migratory birds and aquatic species, not tolerant to increased salinity or flooding.

Significant changes in coastal zones will affect virtually all aspects of human life, including agriculture, human health, freshwater supply and quality, energy supply, fisheries, tourism, industrial productivity, and infrastructure, as well as ecosystem and biodiversity [179].

Accordingly, the potential socio-economic effects of sea level rise are:

- Direct loss of economic, ecological, cultural and subsistence values through loss of land, infrastructure and coastal habitats.
- Increased flood risk to people, land and infrastructure and the values stated above.
- Other effects relating to changes in water management, salinity and biological activity, such as loss of tourism, loss of coastal habitats and effects on agriculture and aquaculture.

Although autonomous adaptation is very likely to happen in different manners, given the current and future impacts of climate change on coastal systems, there is an urgent need for planned adaptation to address climate change adverse effects, integrated with wider coastal management. Of particular importance in organizing the adaptation efforts is to understand the extent to which natural coastal systems can adapt and therefore continue to provide essential life-supporting services to society.

Examples of initiatives that embrace planned adaptation for climate change are the adoption of strengthened and improved physical planning and development control regulations, and include those related to Integrated Coastal Zone Management (ICZM) and Shoreline Management Planning. They can also include implementation of systematic and continuous environmental impact assessments and coastal disaster management.

Integrated coastal zone management (ICZM) is a process for the management of coastal lands and water and their resources using an integrated approach, regarding all aspects of the coastal zone, including geographical and political boundaries, to achieve sustainability (Kay & Alder, 2005).

Planned and therefore proactive adaptation is aimed at reducing a system's vulnerability by either minimizing risk or maximizing adaptive capacity. Initially, three main groups of options were considered for coastal zones[180]:

[179] Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe (2007): Coastal systems and low-lying areas. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 315-356.

1) retreat (e.g. property relocation),
2) accommodation (e.g. natural disaster management),
3) protection (e.g. hard and soft engineering options[181]).

Each of these options is designed to protect human use of the coastal zone, and, if applied appropriately, each has different consequences for coastal ecosystems and has associated different costs and benefits, as well as social impacts.

Retreat and accommodation help to maintain the dynamic nature of the coastline and allow coastal ecosystems to migrate inland unhindered, and therefore to adapt naturally. In contrast, protection leads to coastal squeeze and loss of habitats, although this can be minimized using soft approaches to defence, such as beach nourishment.

While these options still remain valid today, coastal zone adaptation is increasingly being conceived in ways that allow a direct link to be made into a nation's current coastal management system.

Adaptation measures to address the range of impacts include, inter alia:

a) For inundation, flood and storm damage
   - Dyke/surge barriers (P)
   - Building codes/building (A)
   - Land use planning/hazard delineation (A/R)

b) For wetland loss (and change):
   - Land use planning (A/R)
   - Managed realignment/forbid hard defenses (R)
   - Nourishment/sediment management (P)

c) For erosion (direct and indirect change) are:
   - Coast defenses (P)
   - Nourishment (P)
   - Building setbacks (R)

d) For saltwater intrusion are:
   - Saltwater intrusion barriers (P)
   - Change water abstraction (A)
   - Freshwater injection (P)

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[180] Klein, R.J.T., Aston, J., Buckley, E.N., Capobinco, M., Mizutani, N., Nicholls, R.J., Nunn, P.D. & Ragoonaden, S. (2000). Coastal Adaptation. In: B. Metz, O.R. Davidson, J.W. Martens, S.N.M. van Rooijen and L.L. Van Wie McGrory (eds.), IPCC Special Report on Methodological and Technological Issues in Technology Transfer, Cambridge University Press, Cambridge, UK, 349–372.

[181] UNFCCC, Resource Guide for Preparing the National Communications of Non-annex I Parties, Module 2: Vulnerability and Adaptation to Climate Change. 2008. Bonn, Germany.

e) For rising water tables and impeded drainage are:
   - Upgrade drainage systems (P)
   - Polders (P)
   - Change land use (A)
   - Land use planning/hazard delineation (A/R)

## 14.2 Application of I&FF Methodology to Adaptation in the Coastal Zones Sector

This section describes how the I&FF methodology presented in Chapter II would be applied to adaptation in the coastal zones sector. However, conceptually there is an important difference between the coastal zones chapter and those pertaining to other sectors that are addressed in the general methodological guidance through specific chapters. While coastal zones sector is considered as such for evaluation purposes and in order to conduct the assessment of I&FF, as selected by countries, coastal zones is the only place-based, geographically defined chapter. For example, there are no chapters on upland areas, or rangelands. National teams should bear in mind this difference when deciding on the operational approach to the sector.

### Step #1: Establish key parameters of assessment

*>>> Define detailed scope of sector*

In this step, the precise components of the coastal zone sector that are to be included in the I&FF assessment must be defined. This primarily entails determining which processes, activities, entities, and geographic regions are included in the sector.

Important direct linkages between the coastal zone and other sectors should be noted to avoid double counting of I&FF. This is because inconsistent results could result between sectoral assessments and assessment of adaptation measures that would result in significant damages in other sector.

Some adaptation measures and activities will also result in mitigation benefits in the same sector or another sector. The focus on adaptation does not imply that mitigation opportunities and potential for emission reductions are unimportant or irrelevant in the coastal zones sector. Within the I&FF assessment, these additional benefits would be assessed qualitatively, not quantitatively.

To facilitate the assessment the analysis should include the following information: (i) a clear identification of the problem; (ii) a brief description of the present situation; (iii) the expectations about the evolution of the problem in the future; (iv) a brief description of linkages between the coastal zones sector and other water and non-water sectors; (v) the evaluation about how climate change will influence the coastal zones.

*>>> Specify assessment period and base year*

This methodology recommends a 30-year assessment period and 2005 as the base year. If another year must be used for the base year due to data limitations or other national circumstances, it is recommended that the assessment period should still be 30 years in length because of the long lifetimes of capital stock and infrastructure in the sector.

*>>> Identify preliminary adaptation measures*

A preliminary set of adaptation options must be identified for each component of the coastal zones sector included in the assessment, which will inform the design of the analytical approach. The selection of options should be based primarily on the sectoral scope, prior analysis of adaptation options, national and sectoral development plans and goals, and the technical feasibility, logistical feasibility, and cultural acceptability of the options. Consideration should also be given to potential economic, social, and non-GHG environmental benefits and costs of the options. The adaptation options that are chosen should be much more specific than those listed above so that I&FF, and O&M costs, can be estimated in Step 6.

Climate change will impact on coastal zones through a diversity of direct and indirect pathways whose importance will vary depending on the type of ecosystem considered as shown in the pathways identified in Table 14-1.

**Table 14-1: Examples of potential impact pathways**

| Climate factor | Direction of change | Bio-geophysical effects | Potential impacts |
|---|---|---|---|
| Wave climate | Poorly known, but significant temporal and spatial variability expected | Changed patterns of erosion and accretion; changed storm impacts | Sediment supply |
| Storm track, frequency, and intensity | Poorly known, but significant temporal and spatial variability expected | Changed occurrence of storm flooding and storm damage | Wave and storm climate, morphological changes, sediment supply<br>Sediment supply, flood management, morphological changes, land claim<br>Catchment management and land use |
| Precipitation intensity / runoff | Intensified hydrological cycle, with wide regional variations | Changed fluvial sediment supply; changed flood risk in coastal lowlands | $CO_2$ fertilization, sediment supply<br>Sediment supply, migration space, direct destruction |

*Source*: Nicholls, R.J. and C. Small. 2002. Improved Estimates of Coastal Population and Exposure to Hazards Released. EOS Transactions.

Given the numerous linkages between the coastal zones and other sectors, the potential for synergies between coastal zones adaptation, and mitigation and adaptation in other sectors, is large. For example, forest conservation measures in upland catchments may reduce potential flood damages downstream in coastal lowlands. It is not expected that countries will undertake

integrated I&FF assessments (i.e., integrated across sectors), but countries should be alert to such synergies and cross sectoral impacts, and discuss them qualitatively in their reports.
As mentioned above, options for policy-based adaptation to climate change have been identified for coastal zones:

- Public awareness and outreach activities: the public is informed of the danger of living in coastal lowlands that are at risk of being affected by climate change impacts.

- Increase in height of coastal infrastructure and urban growth planning: physical planning and building control measures and regulations should be instituted and implemented. For example, allocation of land that is likely to be flooded should be avoided. People located in high risk areas could be offered incentives to relocate out of these areas. Policies could be instituted that allow the use of high risk areas as natural preserves or for low value use. Marginal increases in the height of the infrastructures during construction phase and redirecting growth away from sensitive lands are relatively inexpensive options for reducing the impacts of sea level rise and risk of flooding, especially in areas that are undeveloped. Policies that may lead to relocation from high risk areas will reduce the need and cost of disaster relief in the future.

- Habitat preservation, declare areas as protected, discouraging exploitation of resources in them.

- Coastal zone management plan, land use planning in coastal zones, such as the use of building setbacks or allocating low lying vulnerable lands to lower value used (e.g. parks rather than housing), would help reduce the overall vulnerability to sea level rise. Other land use planning mechanisms, such as construction standards, reduce risks of living in coastal areas. Additional risk measures can be encouraged trough appropriate financial mechanisms. Each of these policies reduces the risk from climatic variability and protects against potential sea level rise impacts. When put together in the form of a program, they constitute a coastal zone management plan.

*>>> Select analytical approach*

Countries need to determine the analytical approach that will be used to develop baseline and adaptation scenarios, and associated streams of annual IF, FF, and O&M costs.

The analytical approaches that could be used for an I&FF assessment of adaptation in the coastal zones sector range from simple spreadsheet models that can be built by members of the project team to very sophisticated multi-agent dynamic models that identify or highlight the interactions between economic and ecological dynamic systems. A combination of approaches, e.g. a bio-economic model supplemented with spreadsheet analyses, however, could also be used. For example, elaboration of climate, environmental and socio-economic

scenarios applied in coastal zones using the Special Report on Emissions Scenarios (SRES)[182] and thus, interpretation of adaptation priorities and the I&FF flows associated with them.

Uncertainties in coastal hazards create a need to assess a range of climate and socio economic scenarios within a vulnerability assessment. These scenarios need to embrace the range of potential change.

The aim of screening and vulnerability assessments is to focus attention on critical issues concerning the coastal zone rather than to supply precise predictions. Planning assessments of different responses to coastal hazards within ICZM are part of the continuous management process, which ideally aims to integrate responses to all existing and potential problems of the coastal zone, including minimizing vulnerability to long-term effects of climate change.

A screening assessment can initially be qualitative, and should be followed up by semi-quantitative assessment. Analysis of the four major impacts of climate change on the coastal zone are usually included: inundation, erosion, flooding and salinization. Impacts on the socio-economics of the area can be assessed using a matrix containing biophysical and socio-economic impacts, and it should be possible to factor in any major contemporary problems, such as beach mining and development on the coast such as harbors.

Vulnerability assessment allows the analyst to carry out a more in-depth assessment of one particular area. The ultimate goal of a vulnerability assessment is to produce recommendations on actions to reduce vulnerability and includes the assessment of both anticipated impacts and available adaptation options.

For vulnerability analysis, the first step is the development and use of scenario data (climate and/or socioeconomic) in the vulnerability and adaptation assessment process. For example, SimCLIM which is a software package that links data and models in order to simulate the impacts of climatic variations and change, including extreme climatic events on coasts.[183]

After the scenario is set, the decision tools assist analysts in making choices between adaptation options. The Tool for Environmental Assessment and Management (TEAM), which compares the relative strengths of adaptation strategies using both quantitative and qualitative criteria, can be used.

The vulnerability analysis should also include stakeholder approaches, which ensure that the decisions to be analyzed, how they are analyzed and the actions taken as a result of this analysis are driven by those who are affected by climate change and those who would be involved in the implementation of adaptation.

[182] Nicholls, Robert J.; Wong, Poh Poh; Burkett, Virginia; Woodroff, Colin D.; Hay, John (2008). Climate change and coastal vulnerability assessment: scenarios for integrated assessment, January 2008.
[183] UNCCC (2008). Compendium of methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change, UNFCCC Secretariat, February 2008.

Specific methods employed for coastal resources in vulnerability analysis are concerned with establishing the current physical condition of the coast, considering variability of each condition in the face of ongoing natural environmental factors, and evaluating the likely response to climate change and associated impacts.

Different methods to assess the vulnerability of coastal areas are available[184], including the following:

- United Nations Environment Programme handbook methodology
- Shoreline planning method
- Coastal vulnerability indices
- Community vulnerability assessment tool
- Dynamic interactive vulnerability analysis
- CoastClim and SimClim
- Smartline
- Community vulnerability and adaptation assessment and action

Of these approaches, the Dynamic interactive vulnerability analysis (DIVA) is a broadly applicable vulnerability assessment method that provides an overview of climatic and socio-economic scenarios. It also provides adaptation policies on broad regional scales. However, it is not able to be customized using national data.

However, if countries do not already have extensive experience with a particular model or models, it is recommended that other approaches be used for developing their scenarios.

Simpler approaches, like sound extrapolation of trends from historical evolution, may be applicable, though they need to be based on expert knowledge in order to ensure a degree of reliability.

Two sources are especially relevant to decide on the conditions for selecting the analytical approach for the coastal zones sector in developing countries; the information provided in the UNFCCC Compendium of methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change (e.g. IPCC Common methodology, UNEP Handbook Methodology, SURVAS, etc.) and national plans, whether they be short, medium or long term.

### Step #2: Compile historical I&FF data and other input data for scenarios

*>>> Compile annual historical IF and FF data, disaggregated by investment entity and source*

The methodology recommends that countries compile 10 years of historical I&FF data, i.e., for the base year and the previous nine years. At a minimum, countries should collect at least three years of data (i.e., for the base year and two years during the previous decade).

[184] See UNFCCC Resource Guide, Module 2.

The I&FF data needed will likely reside in several national locations (e.g., national accounts, ministry records and plans, industry records, statistical agencies, extension agencies, research institutions). Note that sectoral and subsectoral definitions and disaggregations will vary among data sources, so assumptions may need to be made to reconcile datasets and extract needed data from aggregated and/or disaggregated categories.

Of particular interest towards data collection are the national statistical agencies in the participating countries and national research institutes. There are also studies including comparative analysis of investment and operational costs for very specific investment decisions, for example, cost effectiveness analysis for flood protection.

After the information has been collected and compiled, the national team has to decide on how to organize the available information and complete Table 2.4, which specifies the amount of I&FF per year, for each kind of investment type, according to the policies and measures, plans, actions, programs, activities, and projects that are being implemented regarding adaptation in coastal zones, considering the origin of these investments according to the categories indicated in the methodology chapter of the Guidebook.

To facilitate the task, the following table (Table 14-2) lists the different investment and financial flow types that are suitable in the coastal zones sector. It is necessary to bear in mind that the purpose of this table is simply to organize the information that is going to constitute the set of inputs to complete Table 2-4., as presented in the General Methodology chapters 1 &2.

**Table 14-2: Examples of investment flows and financial flows in the coastal zones sector.**

| **Year 2005** | | |
|---|---|---|
| **List of investment flows and financial flows** | **IF (2005 US$)** | **FF (2005 US$)** |
| **Government** | | X |
| **Policies and measures**<br>Relocation allowances<br>Fiscal incentives<br>Emergency funds<br>Contingency plans<br>Public awareness and outreach activities<br>Urban growth planning<br>Coastal zone management plan<br>Shoreline management plan<br>Coastal disaster management | | |
| **Regulations**<br>Concessions<br>Limits in the access to resources<br>Habitats preservation | | X |
| **Government / private** | X | |
| **Inundation, flood and storm damage**<br>Dyke/surge barriers (P)<br>Building codes/building (A)<br>Land use planning/hazard delineation (A/R) | <br>X | <br>X<br>X |

| Year 2005 | | |
|---|---|---|
| **List of investment flows and financial flows** | **IF (2005 US$)** | **FF (2005 US$)** |
| **Wetland loss** | | |
| Land use planning (A/R) | | X |
| Managed realignment/forbid hard defenses (R) | X | |
| Nourishment/sediment management (P) | X | |
| **Erosion** | | |
| Coast defenses (P) | X | |
| Nourishment (P) | X | |
| Building setbacks (R) | X | |
| **Saltwater intrusion** | | |
| Saltwater intrusion barriers (P) | X | |
| Change water abstraction (A) | X | |
| Freshwater injection (P) | X | |
| **Rising water tables and impeded drainage** | | |
| Upgrade drainage systems (P) | X | |
| Polders (P) | X | |
| Change land use (A) | | X |
| Land use planning/hazard delineation (A/R) | | X |
| **Government / private** | X | |
| **Training** | | X |
| Job diversification | | |
| Use of new technologies | | |
| Management | | |
| Public | | |
| **Insurance** | | X |
| Cluster insurance | | |
| Pooling of risks | | |
| Financial instruments | | |
| **Research** | | X |
| Forecasting | | |
| Risk analysis | | |
| Resource monitoring | | |

X Indicates likely type of flow

*>>> Compile annual historical O&M data, disaggregated by investment entity and source*

Historical O&M data are also needed to provide a historical basis from which to estimate future O&M costs for new physical assets, as well as to provide data for the first year of the scenarios.

Annual O&M costs for the physical assets that are in operation during the historical period should be collected (or estimated) for the same years for which historical I&FF data are collected. Information about the expected lifetimes of assets that are in operation during the historical period, and annual fluctuations in O&M costs (if any), also need to be collected. O&M data should be collected at a level of disaggregation consistent with the I&FF data, and the O&M data for assets purchased during the historical period should be tracked separately from the O&M data for assets purchased before the historical period (see Table 2-4 in Chapter II).

The O&M data that need to be collected may reside in one or more of same locations for I&FF data (e.g., national accounts, ministry records and plans, industry records, statistical agencies, utilities, research institutions). If such data are not available, countries should utilize one of the following approaches to derive estimates (see methodology chapter of the Guidebook):

- Adopt O&M cost data from similar assets in other countries, and adjust the O&M data to in-country production and consumption rates.
- Derive estimates from proportional relationships between O&M costs and total costs, or between O&M costs and capital costs (e.g., 10%, 25%, or 75%).
- Use either standard assumptions about proportional relationships, or proportional relationships observed in other countries.

*>>> Compile other input data for scenarios*

What other input data are needed will depend on the analytical approach chosen, the sectoral scope, and whether I&FF for mitigation or for adaptation measures are to be assessed. If a model is to be used, for example DIVA, SimCLIM, Shoreline Management Planning; basic socioeconomic and technological data may be needed for model inputs (e.g., population and economic growth projections, demand forecasts for products and services, technology development forecasts). Also, development of appropriate adaptation scenarios will require information about expected future impacts and sector vulnerabilities.

If a country chooses to include subsidies explicitly in the I&FF assessment, annual costs of subsidies for each type of investment during the historical period should be collected (or estimated) for the same years for which historical I&FF data are collected. Subsidies should be compiled separately for IF, FF, and O&M (see Table 2-5 in Chapter II).

Information on subsidies may be available from relevant government ministries or agencies, statistical agencies, research organizations, academic institutions, and private sector entities.

In addition to historical I&FF and O&M cost data, the characterization of the scenarios and estimation of annual costs for the scenarios will require the collection of other historical and non-historical data relevant to the sector. What data are needed will depend on the sectoral scope and analytical approach. For the kind of information that will be needed (for developing the baseline scenario, identifying potential adaptation investments, developing the adaptation scenario) see the methodology chapter of the Guidebook.

### Step #3: Define baseline scenario

This step entails describing what is likely to occur in each coastal zone component without adaptation to climate change over the assessment period. It should reflect current sectoral and national plans, expected socioeconomic trends, and expected investments in the components. It should include a quantitative description of the socioeconomic factors that affect the components (e.g., demographic change, economic growth), as well as other relevant characteristics (e.g., environmental considerations). The baseline scenario description should

include specific information about equipment, facility, and infrastructure investments that are expected (and as is relevant) in each component, as well as research, education, assistance, and institutional investments.

The national team should ensure that the analysis of the evolution of the baseline scenario is not a static one by considering the expected trends in the key variables that constitute the main elements that define the baseline scenario. For the baseline scenario a set of assumptions on the likely evolution of those variables should be defined on the understanding that the historical trends will persist with no substantial changes other than the potential deterioration of the conditions which determine the current situation.

For this purpose the team can use vulnerability assessment methods and tools, according to the Compendium of methods and tools. The vulnerability analysis allows the team to develop climate and socioeconomic scenarios. For example:

- **IPCC Common methodology**, which is very useful as an initial, baseline analysis for country level studies where little is known about coastal vulnerability.
- **UNEP Handbook methodology**, comprise the first study or follow earlier studies, such as those completed using the above methodology.
- **SURVAS**, for the assessment of coastal natural susceptibility and socio-economic vulnerability and the resilience to impact of climate change.
- **DIVA**, for broad scale national, regional and global scale analysis of coastal vulnerability, including consideration of strategic adaptation issues.

The potential climate change driven large-scale climate-related changes in coastal zones will likely bring either increased economic hardship or missed opportunities for countries that depend upon coastal resources but lack capacity to adapt. However, measures that would be introduced to address some of the current circumstances and conflicts, as improved standards, management decisions on market approaches, codes of conduct and others, if currently being under consideration or implemented should also be included in the baseline scenario.

A model can be used in the analysis, to develop and define the baseline scenario. Otherwise a sector plan, a projection of trends, or the current situation (assuming no change), or some combination, can be used as the basis of the projection. An ICZM plan may have been developed by the relevant ministry or government agency, or if sector investments are dominated by private sector entities, investment plans may be available from those entities.

In cases in which countries are increasingly aware of climate change adverse effects and have already made progress in addressing climate change, these measures should be reflected in the baseline scenario, rather than trying to separate out current action on climate change. This is particularly important given the desired outcome of the analysis, specifically the additional resources needed to address climate change, i.e., above and beyond resources already invested in mitigation and adaptation.

### Step #4: Derive I&FF estimates for baseline scenario

*>>> Derive annual IF and FF estimates, disaggregated by investment entity and source*

In this step, the IF and FF for each of the options and measures identified in the previous step will be estimated. The source of these data, or method of derivation, will depend on the analytical approach to be used, the scope, and the types of investment entities that are relevant for coastal zones.

As discussed in Chapter II, costs should be in real terms (i.e., inflation adjusted), ideally in constant 2005 US$, should be reported in the year in which they are expected to be incurred, and should be discounted using appropriate public and private discount rates.

The annual IF and FF estimates for each investment type should be disaggregated by investment entity and funding source, and also be divided into investment flows and financial flows.

The output of this step will be a stream of annual investment flows and/or financial flows for each investment type in each subsector for the entire assessment period, by investment entity and funding source. These data should be organized as in Table 2-3 in Chapter II.

*>>> Derive annual O&M estimates, disaggregated by investment entity and source*

Annual estimates of O&M costs for assets purchased during the assessment period, and for assets purchased before the assessment period and that are expected to still be in operation, need to be collected (or derived) for each component (inundation, flood and storm damage; wetland loss; erosion; saltwater intrusion; rising water tables and impeded drainage).

If a country chooses to include subsidies explicitly in the I&FF assessment, annual subsidy costs should be estimated for each relevant investment type, and for all categories of cost (IF, FF, and O&M), in the baseline scenario (see section 2.2.1 of Chapter II).

### Step #5: Define adaptation scenario

This step entails developing a description of what is likely to occur in each relevant coastal zone component, over the assessment period, with implementation of additional adaptation measures. This would include comprehensive descriptions of the specific adaptation measures that could be implemented (e.g. increase in height of the living surfaces of coastal houses constructed) and the implications of those measures for the evolution of the components (e.g., reduction of houses affected by inundation through planned relocation). The vulnerabilities that the adaptation measures are designed to reduce, and the climate changes from which vulnerabilities were assessed, should be described as well.

The adaptation measures need to be defined clearly and completely so that IF, FF, and O&M costs can be estimated in the next step. This should include specific information about facility and infrastructure investments that would occur in each component (e.g. coastal defence

structures), as well as non-asset investments (e.g., education program). In-country expertise, and prior work on climate change adaptation (e.g., National Communications, National Adaptation Programmes of Action (NAPAs)), should be utilized in this step.

### Step #6: Derive I&FF for adaptation

*>>> Derive annual IF and FF estimates, disaggregated by investment entity and source*

In this step, annual IF for the adaptation scenario facility and infrastructure investments, and annual FF for the adaptation scenario research, education, assistance, and institutional investments, are estimated for each component. As discussed in Chapter II, costs should be in real terms (i.e., inflation adjusted), ideally in constant 2005 US$, should be reported in the year in which they are expected to be incurred, and should be discounted using appropriate public and private discount rates. The annual IF and FF estimates for each investment type should be disaggregated by investment entity and funding source, and also be divided into investment flows and financial flows.

The output of this step will be a stream of annual investment flows and/or financial flows for each investment type in each subsector for the entire assessment period, by investment entity and funding source. These data should be organized as in Table 2-3 in Chapter II.

*>>> Derive annual O&M estimates, disaggregated by investment entity and source*

Annual estimates of O&M costs, during the assessment period and before the assessment period that are expected to still be in operation, need to be collected (or derived) for each of the options and measures identified in the previous step. For example, the O&M incurred in the land use planning programme developed during the assessment period.

The output of this step will be a stream of annual O&M costs for each investment type for the entire assessment period, disaggregated by investment entity and source.

If a country chooses to include subsidies explicitly in the I&FF assessment, annual subsidy costs should be estimated for each relevant investment type, and for all categories of cost (IF, FF, and O&M), in the baseline scenario (see section 2.2.1 of Chapter II).

### Step #7: Estimate changes in I&FF needed to implement adaptation

The changes in IF, FF, and O&M costs that are needed to implement the adaptation measures in each component are calculated in this step by subtracting baseline scenario costs from adaptation costs. There are two primary objectives of this step: 1) to determine how cumulative IF, FF, and O&M costs would change; and 2) to determine how annual IF, FF, and O&M costs would change. These calculations, which should be completed for each subsector, are described in detail in Chapter II.

### Step #8: Evaluate policy implications

The purpose of this step is to evaluate the policy implications of the results of the previous step for the sector. The analyses in the previous step estimate the magnitudes and timing of changes in IF, FF, and O&M by each investment entity and from each funding source that would be needed to implement the adaptation measures in each subsector. For example, Identifying Adaptation Options, a high level tool which supports decision and policy makers who are faced with identifying and appraising the selection and implementation of adaptation measures that address identified climate risks on coastal zones. Other methodologies, more specific for coastal zones are, for example:

- **SimCLIM**, a tool to aid decision-making under changed climatic conditions.
- **Coastal Zone Simulation Model (COSMO),** decision support tool of adaptation to climate change in coastal zone management.
- **Shoreline Management Planning**, "living" plan that stimulates the development of long term coastal management appropriate to responding to climate change.
- **Reef resilience toolkit**, appropriate for tropical coastal and marine resource managers, and especially helpful to coral reef and fisheries managers to design protection areas and developing monitoring programmes.

The evaluation should allow the formulation and implementation of appropriate policies at the national and also at the regional scale, considering the broader view of exposure and vulnerability patterns in the country, leading to an integrated coastal zone management plan.
In that regard there is a critical need for design and implementation of sound public policies to minimize impacts of climate change and enhance adaptive capacity in the coastal zones sector by, inter alia:

a) Building institutional and legal frameworks that acknowledge climate change impacts and consider them in conjunction with other existing pressures on coastal zone as well as with other relevant sectors at the country level.

b) Identify and quantifying the linkages between the demands generated by human population growth and income level and their effects on a range of natural resources.

c) Analyzing the specific impacts on livelihoods related to coastal zones, the exposure and vulnerability of coastal resources and the direct and indirect of climate change on food access and security.

d) Identifying, formulating and testing a range of policy options, including a framework of policy incentives, instruments and measures directed at ensuring food and infrastructure security, while preserving the environment.

e) Using and monitor environmental impacts of those and related activities in a context of increasing environmental stresses, while considering the principles and standards of the code of conduct for responsible tourism actors, for example.

f) Supporting initiatives, such as creation of property rights and other incentive mechanisms, and linking appropriate financing instruments for change.

g) Eliminating harmful subsidies and perverse incentives, that serves to allow unprofitable companies to continue operating and further depresses the state of the coastal zones.

h) Strengthening future management policies by providing comprehensive, long-term view of the dynamics of production and demand for resources.