IX Assessment of Investment & Financial Flows for Adaptation in the Water Management Sector

9.1 Introduction

The impacts of climate change on the hydrologic cycle are expected to cause significant changes in freshwater supply and quality. Higher temperatures, changes in the amounts and timing of precipitation, changes in evaporation and transpiration, increased melting of glaciers, changes in the timing of snowmelt, increase in glacier lakes outburst floods (GLOFs), and sea level rise will all affect surface and groundwater supplies, can exacerbate water pollution, water-borne diseases, salinization, and riverine and coastal siltation, and are likely to increase the risks of flooding and drought.[114] Climate change may also increase demand for freshwater, especially for agricultural production and for cooling at thermal power plants, resulting in increased competition for water supplies. Not only are human populations at risk, but also aquatic ecosystems. Regions that are already water-stressed and are experiencing rapid increases in population and water demand are particularly vulnerable to the impacts of climate change on freshwater resources. Significant changes in water supply and quality, and in the intensity and frequency of floods and droughts, will affect all aspects of human life, including agriculture, human health, energy supply, fisheries, water recreation, and infrastructure, as well as ecosystem health and biodiversity. On top of that, watersheds extending beyond the political borders of a country, or even across several sub-national jurisdictions, pose the additional challenge of sharing the water resources, which might be already conditioned by treaties that could be difficult to fulfill in a context of scarcity and continued development.

One of the challenges in water resources adaptation assessment stems from uncertainties in climate change projections at sub-continental spatial scales, especially for precipitation, which is the most important climatic driver of freshwater resources. Even with the same greenhouse gas emissions scenario, different General Circulation Models (GCMs) produce different sub-continental geographic patterns of climate change, especially precipitation change. In some cases, model results do not even agree on the sign of change (i.e., whether precipitation will increase or decrease).[115] Therefore, it is recommended that countries focus their I&FF assessments on adaptation measures that will increase the ability of water management systems to meet projected changes in water demand, and that address existing weaknesses in the water management sector. For example, countries that are already water supply constrained or drought prone may want to focus on measures to increase supply (i.e., through water harvesting structures) and/or improve the efficiency of

[114] IPCC (2007). 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. Perry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.), Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 976pp. Accessible at: http://www.ipcc.ch/ipccreports/assessments-reports.htm

[115] See Chapter 3 of Working Group III Report of the *IPCC Fourth Assessment Report* (full reference in footnote 1).

water use (i.e., through watershed management policies or wastewater re-use). Countries that are especially vulnerable to floods may want to focus on measures that prevent damages from flooding or that improve flood warning systems and emergency response measures. And countries with extensive low-lying coastal regions may want to focus on measures that address increased saltwater intrusion. While this approach implicitly assumes that past climate variability is at least a partial predictor of the future, this is a reasonable way to proceed in the absence of more certain projections of water basin-scale changes in the hydrologic cycle (following a sustainable 'no regrets approach').

Adaptation measures for the water management sector typically focus on increasing the supply of water, improving the quality of the water supply, improving the efficiency of water use, or reducing or alleviating the damages of extreme events (droughts and floods),[116] though some measures can address more than one issue.

Adaptation measures that increase freshwater supply include:

- Prospecting and extraction of groundwater, including installation of wells
- Increase surface water storage capacity by building or expanding reservoirs and dams
- Desalination of seawater
- Increase rainwater collection and storage
- Forest protection, afforestation, reforestation, terracing, and other land-use measures to improve groundwater recharge and reduce rapid runoff
- Eliminate leaks in water distribution systems
- Remove invasive plants from surface waters

Adaptation measures that improve the quality of freshwater supply include:

- Forest protection, afforestation, reforestation, terracing, riparian planting, riparian buffer zone protection, wetland restoration and other land-use measures to reduce siltation and pollutant runoff
- Improve/expand wastewater collection and treatment facilities (e.g., install/expand sewage lines to avoid overflows from flooding, install/enhance treatment systems to reduce contaminants such as bacteria, and nutrients such as phosphorus and nitrogen, in outflows)
- Improve solid waste management systems, and livestock waste management systems, to reduce pollutant and nutrient runoff
- Improve fertilizer use efficiency to reduce nutrient runoff

Adaptation measures that improve the efficiency of water use include:

- Improve irrigation efficiency (e.g., repair leaks, convert from spray to drip irrigation, improve irrigation scheduling), shift crops

[116] The lists of adaptation options below are based in part on Chapter 3 of Working Group III Report of the *IPCC Fourth Assessment Report* (full reference in footnote 1). The lists do not include policy and/or regulatory adaptation measures since they are not directly relevant to estimating investment and financial flows. Policy and/or regulatory water adaptation measures would include, for example, restrictions of residential construction and other forms of development in flood prone areas, water pricing and metering to encourage conservation, water permitting to restrict use, wastewater discharge regulations to reduce contaminants. Policy and regulatory measures applicable to influencing I&FF are discussed at the end of the chapter.

- Alter crop type mix in agricultural systems, and plant type mix in landscaping, to reduce water demand
- Water conservation/efficiency improvement measures in residential, commercial, and industrial use (e.g., water recycling, higher water efficiency appliances and fixtures, higher water efficiency industrial production processes)
- Reduce water waste in residential, commercial, and industrial facilities (e.g., repair leaking water lines, faucets, toilets, showerheads)
- Improved operation of facilities such as using weather forecasting and real-time operation

Adaptation measures that reduce or alleviate the damages of droughts and floods include:
Improve/expand seasonal weather forecasting and early warning systems:

- Improve/expand glacier and glacial lake monitoring
- Forest protection, afforestation, reforestation, terracing, and other land-use measures to prevent landslides
- Construction of dykes
- Improve/expand flood hazard mapping
- Measures to maintain dam effectiveness, including dam structural integrity inspection and repair, and improving effectiveness of water storage and release in anticipation of flood and drought events
- Improve/expand disaster management systems to mitigate further damages from disaster (emergency medical care, evacuation plans, distribution of clean water, provision of emergency sanitation facilities)
- Improve/expand systems for rapid and effective recovery from disasters such as improving systems for reconstruction of water management infrastructure

In addition to these adaptation measures, water-related extension and training programs, and public education and outreach programs, can be implemented to disseminate information about, promote, and provide training in, these measures.

9.2 Application of I&FF Methodology to Water Sector Adaptation Strategies

This section describes how the I&FF methodology described in Chapter II would be applied to adaptation in the water sector. Some of the information provided in Chapter II that is relevant to all sectors is not repeated here, so the reader should read Chapter II before reading this chapter.

Step #1: Establish key parameters of assessment

>>> *Define detailed scope of the sector*

In this step, the precise components of the water sector for which I&FF are to be assessed must be defined. Depending on their priorities, countries may choose to evaluate I&FF for just supply side options, or demand side options, or both, and may or may not include water quality improvement options and flood and drought risk management options[117]. Countries may also choose to focus on only certain water basins, certain types of supply (e.g., reservoirs versus wells versus desalination systems versus rainwater collection systems), and/or certain components of demand (e.g., agricultural demand, industrial demand, residential urban demand, residential rural demand). Within the UNDP I&FF Assessment Programme, the sectoral scope could have been decided at this point, based on the results of adaptation assessments that have been completed. Which components of water management are included should depend on national circumstances, especially as is discussed above, which components are already stressed or are likely to be stressed given projections of demand[118], and the current supply situation, including frequency and severity of extreme events. Even if a country chooses to focus on supply options, an understanding of how demand is likely to evolve over the assessment period will be needed in order to assess how supplies should be altered.

Important direct linkages between the water sector and other sectors should be noted to avoid double-counting of I&FF, inconsistent results between sectoral assessments, and assessment of adaptation measures that would result in significant damages in other sectors. These overlaps could be with the agricultural sector through agricultural demand for freshwater (for both production and processing) and through agricultural contamination of water supply (e.g., fertilizer and pesticide runoff, waste spills from confined animal operations); to the energy sector through hydropower production, through demand for water at thermal power plants, and through the energy demand associated with certain adaptation options (desalinization, pumping); to the public health sector through the supply of clean water; to the waste management sector through contamination from wastewater and solid waste discharges and overflows, and to ecosystem health through pollutant and nutrient runoff and siltation.

The scope definition 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 this water sector and other water and non-water sectors; (v) the evaluation about how climate change will influence the problem. In particular, the following issues should be addressed:

- geographic scope;
- what components of supply and demand are included;
- whether and how flooding and/or droughts are included.
- environmental impacts

Moreover, subdivisions could be introduced; e.g., supply could be divided into public versus private (each of which could be subdivided into technology types), urban versus rural, etc.

[117] Double counting should be avoided.

[118] It is not straightforward to separate between projected demand due to factors associated with climate change impacts, and those linked to other socio-economic factors, as they are inter-twinned.

>>> *Specify assessment period and base year*

Year 2005 is recommended as a base year (or, alternatively, other recent year where data is available), and the time horizon should be 2030 (i.e., the assessment period would be about 25 years long).

>>> *Identify preliminary adaptation options*

A preliminary set of adaptation options must be identified for each component of the water management sector included in the assessment[119]. The selection of options should be based on previous studies and research. 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.

Given the numerous linkages between the water management and other sectors, the potential for synergies between water management adaptation, and mitigation and adaptation in other sectors, is large. For example, forest conservation measures may reduce potential flood damages and protect water supplies. On the other hand, the construction of dams and expansion of reservoirs may result in methane emissions. 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.

>>> *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 following table contains a list of water models that can be used to evaluate how water supply may change over time due to changes in climate variables and water management approaches and technologies, and to evaluate optimal water management adaptation measures given likely evolution of supply and demand[120].

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119 There are possibilities that one adaptation option could address more than one component, and, conversely, that one component may require more than one adaptation option. Such complications should be taken into consideration in the accounting system.

120 This list is compiled from lists in the UNFCCC CGE Non-Annex I National Communications Training Package for Vulnerability and Adaptation and the UNFCCC Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change. The CGE Training Package is accessible at: http://unfccc.int/resource/cd_roms/na1/start.htm. The Compendium, which provides descriptions of some of these models, is accessible at
http://unfccc.int/adaptation/nairobi_ workprogramme/compendium_on_methods_tools/items/2674.php; go to the link for “Sector-specific tools” at the bottom of the page for water sector tools.

Table 9-1: Water sector analytical tools and models

Application	Name of model	Web site
Watershed Hydrology	WEAP21	http://www.weap21.org
	SWAT:	http://www.brc.tamus.edu/swat/
	HEC-HMS	http://www.hec.usace.army.mil/
	USGS MMS-PRMS	http://wwwbrr.cr.usgs.gov/projects/SW_precip_runoff/mms/
	MIKE-SHE	http://www.dhisoftware.com/mikeshe/
	HYMOS	http://www.wldelft.nl/soft/intro/
Hydraulic Simulation and Forecasting	HEC-RAS	http://www.hec.usace.army.mil/software/hec-ras/
	MIKE Water Resources	http://www.dhigroup.com/Software/WaterResources.aspx/
	Delft3d, SOBEK, and Delft-EWS	http://www.wldelft.nl/soft/intro/
Water Resource Management Models (planning and operation)	WEAP21	http://www.weap21.org
	Aquarius	http://www.fs.fed.us/rm/value/aquariusdwnld.html
	RIBASIM	http://www.wldelft.nl/soft/intro/
	MIKE BASIN	http://www.dhisoftware.com/mikebasin/Download/
	HEC-ResSim	http://www.hec.usace.army.mil/software/hec-ressim/hecressim-hecressim.htm
	WaterWare	http://www.ess.co.at/WATERWARE/
	RiverWare	http://cadswes.colorado.edu/riverware/
	IRAS	Marshall Taylor, Res. Plan. Assoc., Inc., NY, USA
	STREAM	http://www.geo.vu.nl/users/ivmstream/

Source: Elaboration by the autors

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. For example, monthly or seasonal water balances for critical watersheds, stemming from primary (i.e, measured) and secondary (i.e., estimated from primary) data, would be a sound basis for analysis, as projections could be performed for estimated evolution of demand (e.g., due to urban development) and supply (affected by climate change). Other simpler approaches, like sound extrapolation of trends from historical evolution, may work, though they need to be done based on expert knowledge in order to be reliable. Simple loading functions can be used to estimate nonpoint source pollutions. Dilution analysis can be used for conservative pollutants.

Previous work on baseline development for Vulnerability and Adaptation (V&A) assessments should also be utilized. Although baselines for V&A assessments are not the same as I&FF assessment baselines,[121] as long as the sectoral scopes are similar, much of the data requirements are likely to be the same. V&A assessments do not include an adaptation scenario; however, information about adaptation options that resulted from V&A assessments should be utilized as well.

For the purpose of a conceptual illustration of the methodological procedure, a very simplified, conceptual example, in which the needed information is reduced to a minimum, is presented in this document. The simplified example is introduced in the following for Step #1 (and further developed in following steps).

[121] Although V&A baselines have evolved from simple scenarios of population and economic growth to more comprehensive socioeconomic scenarios, they tend to be for longer periods than is used in this methodology (hence, the multiple storyline approach), and are constructed for assessing the impacts of climate change rather than the costs of adaptation measures.

SIMPLIFIED EXAMPLE

Step #1: Establish key parameters of assessment

>>> Define detailed scope of the sector

The specific problem to be addressed is industrial and residential urban demand of water from the Metropolitan Region of ‘Anywhere City’. Present provision is from two sources: a reservoir located on River Anywhere, and a net of wells. These sources are already under stress.

It is expected that population growth and industrial development will lead to an increase of the demand over the next 30 years. Furthermore, agricultural development through irrigation by aspersion in the upper basin of River Anywhere, is already leading to an increment of groundwater consumption which directly affects the groundwater level in the pumping area, hence reducing the efficiency of the extraction. The extra water to fill the demand gap is expected to be extracted from the reservoir, through adjustments in the management policy.

Pollution of River Anywhere, downstream from the reservoir, due to uncontrolled discharges from the urban area, is a related problem that would need attention, as it is expected to grow in intensity (due to both increase of loads and decrease of river discharge, the latter effect related to the increase in water supply from the reservoir), unless a specific pollutant management program is formulated and implemented.

Climate Change predictions from GCM, for different future scenarios, consistently indicate a decrease of precipitation in the water basin, which implies a reduction of the potential water supply both from River Anywhere and from groundwater, thus increasing the stress on those water resources.

>>> Specify assessment period and base year

The assessment period is 26 years long, taking 2005 as the base year.

>>> Identify preliminary adaptation options

The following adaptation option was selected as feasible: building a new reservoir upstream of the present one. The reservoir characteristics are a priori the following: capacity = XX hm^3; surface area = XX m^2. The dam characteristics are the following: material = XX; height = XX m; length = XX m. The reservoir could eventually be used to manage flood risk (synergy). As a drawback, the reservoir construction will imply increasing methane emissions.

>>> Select analytical approach

Continuous records of daily water levels are available for a station of River Anywhere close to the selected new reservoir site, for the last 5 years. Some discharge measurements are also available for different river stages, which has lead to the establishment of a water level-discharge relationship for that station. Hence, a hydrograph (time series of water discharge) can be built from the daily water records. This is being used to drive a hydraulic model of the stretch of river where the old reservoir stands (and the new one will stand), which provides results on the optimum management strategy for the discharge from the reservoir in order to supply water, while maintaining an adequate ecological discharge downstream.

Step #2: Compile Historical IF, FF, and O&M Cost Data, Subsidy Cost Data (if included explicitly), and Other Input Data for Scenarios

>>> Compile historical annual IF & 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 decades). Data should be compiled for each investment type, and should be annual, be disaggregated by investment entity, and, if possible, by funding source, and also be divided into investment flows and financial flows (see Table 2-3 in Chapter II).

In the water management sector, investment flows would include assets such as hydraulic works (e.g., dams, dykes, pumping stations, wells, pluvial systems, water mains), sanitary works (e.g., wastewater treatment plants), machinery (e.g., irrigation equipments, pumps, turbines), land purchase (e.g., for watershed protection), fixtures and appliances (for residential and commercial use), equipments for research, education, assistance, and institutional adaptation (e.g., computers, hydro-meteorological gages, vehicles). Financial flows would include non-asset investments in research, education, assistance, and institutional adaptation (e.g., labour costs). In the following table some IF and FF are identified, according to the type of problem to be solved.

Table 9-2: IF and FF examples for the water sector

Problem	IF	FF
Water Supply	Intake works	Water management plan
	Well systems	Superficial and groundwater extraction regulations
	Reservoirs[A]	
	Potabilization plants	
	Water mains	
	Desalination systems	
	Irrigation systems[B]	
Water Quality	Sewage systems	Pollution control plan
	Treatment plants	Effluents regulations
	Monitoring systems	
Water Efficiency	Reparation of leaks from water systems	Education programs
	Residential and commercial fixtures and appliances	Fare rates policy
Floods	Pluvial systems	Contingency plans
	Channelization	Land use regulations
	Dykes	
	Detention reservoirs	
	Warning systems	
Droughts	Water harvesting structures	Contingency plans
Wetlands Preservation	Land acquisition	Wetlands management plans

[A] It could intersect with the energy sector
[B] It intersects with the agronomic sector

The I&FF data needed will likely reside in several domestic 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.

>>> Compile historical annual O&M cost 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 such as dams, water distribution mains, sewage systems, etc., 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 most significant O&M costs for the water sector are likely to be operation and maintenance of hydraulic works (which dimensions are usually large), including associated salaries. Energy costs may be a significant portion of the OM costs – thus improved management can also lead to GHG reductions. As, for example, irrigation systems also constitute hydraulic works, care should be taken so that this cost is not already taken care of by the agriculture sector. This type of corroboration should be performed for all sectors linked with the water sector. The O&M data that need to be collected may reside in one or more of the same locations as I&FF data (e.g., national accounts, ministry records and plans, industry records, statistical agencies, extension agencies, and research institutions). If such data are not available, countries should utilize one of the estimation approaches described in Chapter II. In-country experts may be particularly useful for supplying cost estimates.

>>> Compile historical annual subsidy cost data, if subsidies are included explicitly in the assessment

There are numerous types of water management subsidies, the most significant one being usually discounts in fare rates due to construction and OM subsidies. 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.

>>> Compile other input data for scenarios

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. The kinds of information that will be needed may include:

For developing the baseline scenario:

- Relevant contacts, reports, and databases at national/international agencies and other organizations
- Types of models that are suitable for your country
- Current inventory of water resources characteristics, including dams, wells, surface water, rainfall, sewer and drainage networks, opportunities for dual quality water distribution systems and other pertinent information
- Data for 10-year period prior to Reference Year of the assessment (or longer data quality permitting) in as great a level of detail as possible
- National (and/or utility) water availability forecasts to 2030 by region/province, as possible
- Schedule of capital improvements to 2030
- Major recent policies or expected actions that might affect Reference Case projections
- Information on resource potentials and costs for alternative water management strategies
- Commissioning and retirement dates for existing infrastructure (to ensure that any replacement and upgrades are factored into the baseline scenario)
- Demand forecasts

For identifying potential adaptation investments:

- Available databases on the characteristics of alternative water resource management strategies (e.g. drip irrigation) capable of functioning under projected climate changed conditions (rainfall, temperature) in your country.
- Potential models that could be used to analyze the introduction of new water management strategies, practices, and technologies into national water management plans
- International studies or projections that may have been developed regarding reducing the vulnerability of water resources (e.g., IPCC Assessment reports for Working Group II).
- Available national/international databases on technologies to promote water conservation

For developing the adaptation scenario:

- Relevant contacts, reports, and databases at agencies, utilities, and other organizations that focus on improving water management
- National studies or projections that may have been developed regarding adapting to climate change in the water sector (e.g., First National Communications, NAPA, Vulnerability and Adaptation Strategies)
- Information on any public/private partnerships for water investments and/or new water management demonstration projects
- Major recent policies or expected actions that might affect Adaptation Scenario projections

These data and information may be available from the domestic sources mentioned above for I&FF and O&M cost data. A potential information source is Cap-Net, which is a network for capacity building in Integrated Water Resources Management (IWRM). In addition, FAO maintains AQUASTAT[122], which is an information system for the collection, analysis, and dissemination of data and information on water resources and agricultural water management by country and by region; it also includes data on dams, irrigation system investment costs, and irrigated areas.

In case I&FF and O&M costs are not available, they have to be estimated. The following table illustrates how to estimate costs associated to a specific measure. The specific measure is a flood control plan for a water basin. Channelization works are developed through dredging; maintenance costs may be high. Detention reservoirs mainly involve excavation and filling; maintenance works may be more sporadic. Control structures include dams, gates and spillways. Longitudinal dykes are defence works for dense urban zones. The control system, for gate operation, and the flood warning system include not only equipment and software (IF), but also model-based expertise for design, checking, and eventual modification (FF). The education program is aimed at the population under flood risk.

Table 9-3: Indicative example of estimating I&FF and O&M costs

Items	IF	FF	O&M
Channelization	XXX		XXX
Detention reservoirs	XXX		XXX
Control structures	XXX		XXX
Longitudinal dykes	XXX		XXX
Control system	XXX	XXX	XXX
Warning system	XXX	XXX	XXX
Education program		XXX	
TOTAL	XXX	XXX	XXX

A control plan for GLOFs would include only a few of the previous items: the warning system and education program; possibly, also some longitudinal dykes.

[122] http://www.fao.org/nr/water/aquastat/main/index.stm

The simplified example is continued next, to illustrate Step #2.

SIMPLIFIED EXAMPLE

Step #2: Compile Historical IF, FF, and O&M Cost Data, Subsidy Cost Data (if included explicitly), and Other Input Data for Scenarios

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

IF, and FF for the present reservoir (built 7 year ago) are available from the Basin Authority, which is the investment entity. The main funding source was an external loan, complemented with contributions from the National Government annual budget.

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

Historical O&M data for the present reservoir (since its construction, 7 year ago) are available from the Basin Authority, which is also the operation entity. The funding sources are the Basin Authority itself, through fares for water provision, and the National Government, from its annual budget.

>>> Compile historical annual subsidy cost data, if subsidies are included explicitly in the assessment

The annual contribution from the National Government constitutes a subsidy, in order to maintain fare rates at levels compatible with present social acceptance.

>>> Compile other input data for scenarios

Studies presented within the Second National Communication on Climate Change, shows that the combined effects of reduction in total precipitation and increase in mean temperature on the Anywhere River basin could lead to a reduction of 30% in runoff by 2030.

Step #3: Define Baseline Scenario

This step entails describing what is likely to occur in each water management 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 simplified example is continued next, to illustrate Step #3.

SIMPLIFIED EXAMPLE

***S*tep #3: Define Baseline Scenario**

Taking into account the expected runoff decrease in Anywhere River basin, it is concluded that the future situation would be best represented by a hydrograph with a uniform 30% attenuation with respect to the present ones. The model shows that the extra water demand will not be satisfied at all times with the present reservoir, even at the cost of reducing somewhat the ecological discharge.

No infrastructure investments are planned for this scenario, as only a change of management policy is performed.

Step #4: Estimate Annual IF, FF, and O&M Costs, and Subsidy Costs if included explicitly, for Baseline Scenario

>>> Estimate annual IF and FF for each investment type, disaggregated by investment entity and funding source

In this step, annual IF for the baseline scenario facility and infrastructure investments, and annual FF for the baseline scenario research, education, assistance, and institutional investments, are estimated for each subsector. 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. Data sources could include model output, and/or government and private sector planning documents, or estimates might be derived from historical data.

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.

>>> Estimate annual O&M costs for each IF, disaggregated by investment entity and funding 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 subsector. Costs should be in real terms, ideally in constant 2005 US$, should be reported in the year in which they are expected to be incurred, and should be discounted. The annual O&M estimates for each investment type should be disaggregated by investment entity and funding source (as in Table 2-4 in Chapter II), and also be divided into O&M for assets purchased during the assessment period, and for assets purchased prior to the assessment period. For those assets purchased during the assessment period that are expected to still be in operation after the last year of the assessment period, annual O&M costs for each additional year the assets will be in operation should be estimated, up to an additional five years after the last year of the assessment period. Possible data sources include those described above for IF and FF.

>>> Estimate annual subsidy costs for each investment type and for IF, FF, and O&M costs, if subsidies are included explicitly in the assessment

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).

The simplified example is continued next, to illustrate Step #4

SIMPLIFIED EXAMPLE

Step #4: Estimate Annual IF, FF, and O&M Costs, and Subsidy Costs if included explicitly, for Baseline Scenario

>>> Estimate annual IF and FF for each investment type, disaggregated by investment entity and funding source

As there will be no investments for this scenario, IF and FF will be zero.

>>> Estimate annual O&M costs for each IF, disaggregated by investment entity and funding source

O&M costs are estimated based on sound extrapolation from historical O&M data, assuming no changes in fares policy.

>>> Estimate annual subsidy costs for each investment type and for IF, FF, and O&M costs, if subsidies are included explicitly in the assessment

No changes in fares policy means that the annual contribution from the National Government (subsidy) is assumed to continue in the future.

Step #5: Define Adaptation Scenario

This step entails developing a description of what is likely to occur in each relevant water management component, over the assessment period, with implementation of additional adaptation measures. This would include comprehensive descriptions of the specific adaptation measures that would be implemented, and the implications of those measures for the evolution of the components (e.g., satisfaction of projected water demand). The vulnerabilities that the adaptation measures are designed to reduce, and the climate changes from which vulnerabilities were assessed, should be described as well even though they were part of earlier V&A analysis.

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., dams, dykes), as well as non-asset investments (e.g., education program to reduce water consumption). 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.

In determining and defining the set of adaptation measures that would be implemented, the preliminary set of the adaptation measures that were identified in step #1 should be re-evaluated, given the analytical approach chosen in step #1, the other input data compiled in step #2, and the baseline analysis completed in step #3. It is also recommended that countries undertake an initial prioritization of the adaptation measures, which will be re-evaluated later in step #8.

As part of the re-evaluation and initial prioritization of adaptation measures, countries should assess qualitatively the environmental and socioeconomic benefits, as well as potential non-investment costs (negative externalities), of the adaptation measures. Potential environmental and socioeconomic benefits might include reduction of wastewater flow, fulfilment of ecological discharges, reduction of flood risk, etc.

The simplified example is continued next, to illustrate Step #5.

SIMPLIFIED EXAMPLE

Step #5: Define Adaptation Scenario

The new reservoir is introduced into the model, driven by the attenuated hydrograph. The model shows that the extra water demand can now be satisfied at all times with the present reservoir, without reducing the ecological discharge. Moreover, the model allows to re-evaluate the reservoir dimensions initially considered (volume, surface area, height of dam, length of dam) in order to optimize its efficiency. Additionally, the model is used to analyze the increase in reservoir dimensions necessary to increase the ecological discharge, and to define the reservoir management policy that could provide some attenuation to floods downstream from the dam.

This structural measure will be complemented with an education program, in order to promote an efficient use of water for both the domestic and industrial sectors.

Step #6: Estimate Annual IF, FF, and O&M Costs, and Subsidy Costs if included explicitly, for Adaptation Scenario

>>> Estimate annual IF and FF for each investment type, disaggregated by investment entity and funding 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. Data sources include the sources listed above.

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.

>>> *Estimate annual O&M costs for each IF, disaggregated by investment entity and funding 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. Costs should be in real terms, ideally in constant 2005 US$, should be reported in the year in which they are expected to be incurred, and should be discounted. The annual O&M estimates for each investment type should be disaggregated by investment entity and funding source (as in Table 2-4 in Chapter II), and also be divided into O&M for assets purchased during the assessment period, and for assets purchased prior to the assessment period. For those assets purchased during the assessment period that are expected to still be in operation after the last year of the assessment period, annual O&M costs for each additional year the assets will be in operation should be estimated, up to an additional five years after the last year of the assessment period. Possible data sources include those described above for IF and FF.

>>> *Estimate annual subsidy costs for each relevant investment type and for IF, FF, and O&M costs, if subsidies are included explicitly in the assessment*

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).

The simplified example is continued next, to illustrate Step #6.

SIMPLIFIED EXAMPLE

Step #6: Estimate Annual IF, FF, and O&M Costs, and Subsidy Costs if included explicitly, for Adaptation Scenario

>>> Estimate annual IF and FF for each investment type, disaggregated by investment entity and funding source

IF and FF are estimated based on surveys made on construction companies. The funding source is assumed to be an external loan to the National Government.

>>> Estimate annual O&M costs for each IF, disaggregated by investment entity and funding source

O&M costs are estimated based on O&M costs for the present reservoir.

>>> Estimate annual subsidy costs for each investment type and for IF, FF, and O&M costs, if subsidies are included explicitly in the assessment

As for the present reservoir, some annual contribution from the National Government is assumed to exist in the future in order not to change the fares policy.

Step #7: Calculate the Changes in IF, FF, and O&M Costs, and in Subsidy Costs if included explicitly, 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.

The simplified example is continued next, to illustrate Step #7.

SIMPLIFIED EXAMPLE

Step #7: Calculate the Changes in IF, FF, and O&M Costs, and in Subsidy Costs if included explicitly, needed to Implement Adaptation

The changes in IF and FF are equal to the values of IF and FF for the Adaptation Scenario, while O&M costs will arise from the difference between those associated to the Adaptation Scenario and the Baseline Scenario.

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.

It is recommended that countries first re-evaluate their initial prioritization of the adaptation measures that was undertaken in step #5, based upon the incremental cost estimates, and determine which investment entities are responsible for the most significant (largest and/or highest priority) changes in I&FF, and the predominant sources of their funds. Then, the policy measures that might be used to induce those entities to implement the proposed measures and change their investment patterns, and the additional sources of funds that might be utilized to meet new investment needs, need to be evaluated. It will be particularly important to distinguish between public and private sources of finance, as well as between domestic and foreign sources. Policy measures include a variety of instruments, including economic instruments (e.g., taxes), regulatory instruments (e.g., fuel portfolio standards), voluntary agreements, information dissemination and strategic planning, and research, development, and demonstration (RD&D).

The simplified example is continued next, to illustrate Step #8.

SIMPLIFIED EXAMPLE

Step #8: Evaluate Policy Implications

The changes in IF, FF and O&M costs are high enough for leading to consider alternative funding sources and fare rates policies. The participation of the private sector in building the dam and operating the reservoir, and a progressive increment of fare rates, are next analyzed as possible combined actions to diminish the costs gap.