Action Impact Matrix (AIM) Application to Climate Change

Adaptation – Users Guide

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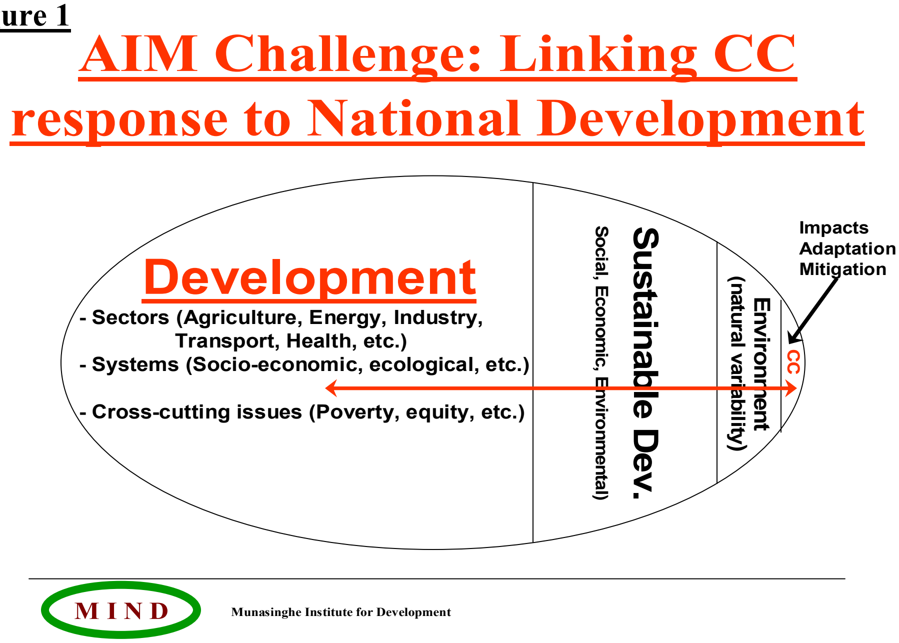
1. INTRODUCTION

Figure 1



Decision makers normally focus their attention on conventional development strategies like growth and poverty alleviation. As shown in Figure 1 above, sustainable development (SD) is considered a special (and rather obscure) subset of conventional development. The environment is only one aspect of SD, and finally climate change (including adaptation and mitigation or AM) is itself seen as a minor subset of the environment.

Need for Action Impact Matrix (AIM) Based Approach

Climate change adaptation measures ultimately must be implemented by nations, and will receive attention from decision makers only if they are successfully integrated into national sustainable development (SD) strategy. To facilitate this process, this guide describes how we use the Action Impact Matrix (AIM) as a strategic tool to better understand interactions among three key elements, at the country-specific level:
(a) national development policies and goals;
(b) key vulnerability areas (VA) – economic sectors, ecological systems, etc; and
(c) climate change adaptation.

First, the two-way linkages between elements (a) and (b) are explored, in the context of natural climate variability. Then, we impose the additional impacts of element (c) on the interactions between elements (a) and (b).

The AIM approach analyses key economic-environmental-social interactions to identify potential barriers to making development more sustainable (MDMS) - including climate change. It also helps to determine the priority macro policies and strategies in economic, environmental and social spheres that facilitate the implementation of climate change adaptation and mitigation to overcome the effects of climate change. Thus, such a matrix helps to promote an integrated view, meshing both development decisions and climate change effects.

The AIM methodology consists of the following key steps (see Figure 2):

a) Determine the most important national goals and policies.
b) Determine critically vulnerable areas (VA) relevant to climate change.
c) Incorporating climate change into the AIM
    - Determine status of VA subject to only natural climate variability
    - Determine impacts of climate change on VA (Impact 1 in Figure 2)
d) Identify how development goals/policies might affect VA (Effect 2 in Figure 2)
e) Identify how VA might affect development goals/policies (Effect 3 in Figure 2)
f) Prioritize most important interactions and determine appropriate remedial policies and measures.
g) Perform more detailed studies and analysis of key interactions and policy options identified in step f above.
h) Update and refine steps c to f above.

Two matrices are derived as shown in Figure 2.
1. DEV – development effects on VA (effect 2 + impact 1)
2. VED – VA effects on development (effect 3 + impact 1)

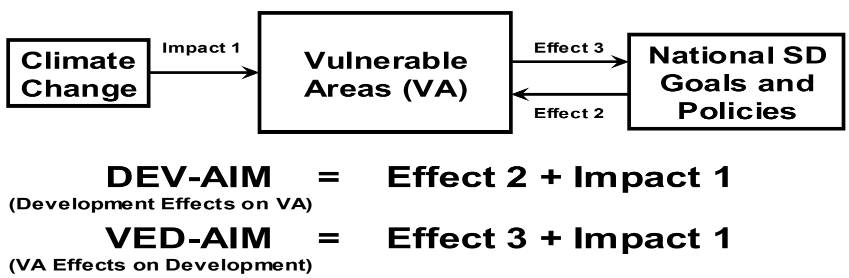


Figure 2. Interaction between climate change, vulnerable areas and development, showing derivation of DEV and VED Action Impact Matrices.

The preliminary matrices identify broad relationships, provide a qualitative idea of the magnitudes of the key interactions, help to prioritize the most important links, and facilitate integration of climate change adaptation responses within the overall national sustainable development strategy.

The AIM methodology relies on a fully participative stakeholder exercise to generate the AIM itself. Up to 35 experts are drawn from government, academia, civil society and the private sector, who represent various disciplines and sectors relevant to both sustainable development and climate change. In the initial exercise, they usually interact intensively over a period of about two days, to build a preliminary AIM. This participative process is as important as the product (i.e., the AIM), since important synergies and cooperative team-building activities emerge. The collaboration helps participants to better understand opposing viewpoints, resolves conflicts, and ultimately facilitates implementation of agreed policy remedies. On subsequent occasions, the updating or fine-tuning of the initial AIM can be done within a few hours by the same group, since they are already conversant with the methodology.

Sustainomics Principles Underlying Action Impact Matrix (AIM)

The AIM methodology draws on the following basic principles of the sustainomics framework [Munasinghe 1992, 2002b]:

(a) **MDMS approach**
The step-by-step approach of "making development more sustainable" (MDMS) becomes the prime objective, while sustainable development is defined as a process (rather than an end point)[1]. Although MDMS is incremental, it does not imply any limitation in scope (e.g., restricted time horizon or geographic area).

(b) **Sustainable development triangle**
SD requires integration of three main perspectives: social, economic and environmental (Figure 3). Each viewpoint corresponds to a domain (and system) that has its own distinct driving forces, objectives, and indicators. The economy is geared mainly towards improving human welfare, primarily through increases in the consumption of goods and services. The environmental domain focuses on maintaining the integrity and resilience of ecological systems. The social domain emphasizes the enrichment of human relationships and achievement of individual and group aspirations. The balance among the three domains will be location-specific -- depending on the stakeholders involved. The sides of the triangle also represent key interactions. For example, the economy-environment interface leads to valuation and internalization of environmental externalities, and trade-offs between economic and environmental goals.

(c) **Trans-boundary approach**
The analysis transcends conventional boundaries imposed by discipline, space, time, stakeholder viewpoints, and operationality. The scope is broadened and extended in all domains, to ensure a comprehensive view.

(d) **Full cycle application of integrative tools**
Two complementary approaches based on "optimality" and "durability" may be used to integrate across economic, social and environmental sub-models, within an integrated assessment modeling framework.

A policy mapping method would help to translate actions in the environmental and social domains, into the conventional national economic planning and implementing mechanisms within line ministries and departments.

The Action Impact Matrix (AIM) process is the key link from initial data gathering to practical policy application and feedback. Ecosystems and their services are integrated into SD strategy in two main ways: an upward link where ecosystem concerns are embedded in the macro-strategy of a country via the medium- to long-term sustainable development path; and a downward link where ecosystem concerns are integrated into the national development strategy in the short- to medium-term, by carrying out sustainable development assessments (SDA) of micro-level ecosystem-related projects and policies.

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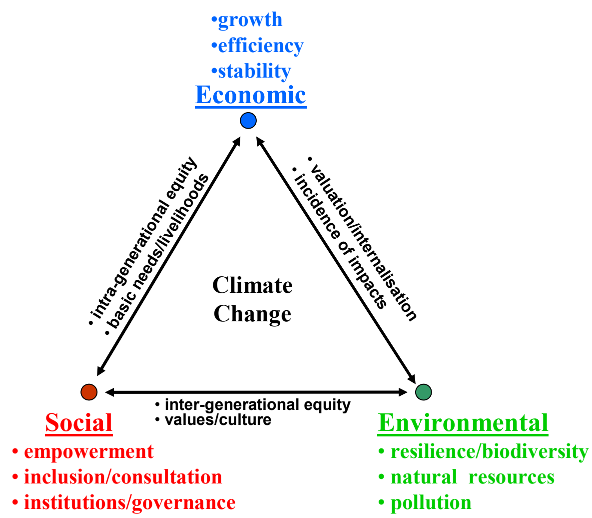
[1] Sustainable development is defined as a "process for improving the range of opportunities that will enable individual human beings and communities to achieve their aspirations and full potential over a sustained period of time, while maintaining the resilience of economic, social and environmental systems" (Munasinghe 1992)

Figure 3. Sustainable development triangle – key elements and interconnections (corners, sides, centre). Climate change affects all dimensions of sustainable development.



Source: Munasinghe [1992], Rio Earth Summit

2. ACTION IMPACT MATRIX (AIM) METHODOLOGY AND APPLICATIONS

The AIM is a strategic tool policy analysis, which helps to study the inter-linkages that exists among seemingly independent elements such as for example macro-economic policies, key vulnerability areas (VA), and climate change.

At the national level, the linkage may be made in two complementary and interlinked ways:

(a) Upward link: where vulnerable areas are embedded in the macro-level national development strategy of a country via the medium- to long-term sustainable development path, including building-up of adaptive capacity.

(b) Downward link: where vulnerable areas are integrated into the subnational-level development strategy in the short- to medium-term, by carrying out sustainable development assessments aimed at making specific projects and policies more sustainable.

The AIM has been widely used since the early 1990s, and originally was presented as part of the Sustainomics methodological framework, at the 1992 Rio Earth Summit – see Annex 1 [Munasinghe, 1992]. Initially, it was used in Brazil, Chile, Ghana, Philippines, and Sri Lanka to integrate a range of environmental concerns into development planning [Munasinghe 1994, 1997, 2002a, 2005]. Subsequently, expanding and "adapting" the AIM approach to address ecosystem-SD interactions, was a logical next step [Munasinghe 2002b; MIND 2005, URL: <www.mindlanka.org>].

The AIM approach may be used to better understand two-way interactions between (a) development policies and goals; and (b) key vulnerable areas relevant to climate change. First, the effects of development policies and goals on vulnerable areas are explored, and then the reverse effects of vulnerable areas on sustainable development prospects are identified. The AIM cells provide a qualitative idea of the magnitude of the row-column interactions, so that appropriate policy interventions could be formulated. Each AIM exercise would require **two** matrices in order to look at linkages flowing both ways (i.e., impacts of columns on rows and vice versa):

The AIM approach analyses key economic-environmental-social interactions to identify potential barriers to making development more sustainable (MDMS), including progressive degradation of already vulnerable areas. It also helps to determine the priority strategies, policies and projects in the economic, environmental and social spheres that facilitate implementation of measures to manage vulnerable areas and restore damaged ecosystem services. After completing a national level AIM exercise, it is possible to apply the process at a subnational or community level, to fine-tune the analysis.

A national level AIM is generated through a fully participative, consensus-building, stakeholder exercise involving 10-50 experts drawn from government, academia, civil society and the private sector, who represent various disciplines and sectors relevant to both sustainable development and climate change. In the initial exercise, they usually interact intensively over a period of about two days, to build a preliminary AIM. This participative process is as important as the product (i.e., the AIM), since important synergies and cooperative team-building activities emerge. The transparent stakeholder collaboration helps participants to better understand opposing viewpoints, and resolves conflicts. It promotes cooperation and ownership across decision making agencies, and ultimately facilitates implementation of agreed policy remedies. On subsequent occasions, the updating or fine-tuning of the initial AIM can be done within a few hours by the same group, since members are already conversant with the methodology and familiar with each others viewpoints.

For maximum effectiveness, the AIM meeting needs careful preparation in terms of trained instructors to conduct the exercise, documentation (e.g., AIM Guide), screening and pre-selection of a balanced group of participants, and advance gathering of relevant background data.

3. METHODOLOGY WITH A SAMPLE APPLICATION TO SRI LANKA AT THE NATIONAL LEVEL

We illustrate this approach by sketching out a very preliminary application to Sri Lanka at the national level. ***The examples provided below are only indicative***, and need to be re-checked and validated by a full-blown AIM stakeholder exercise involving a variety of experts.

The AIM process involves several key practical steps:

3.1. Step (a): Determine the most important national goals and policies

The Millennium Development Goals [UNDP 2003] provide a generic starting list, but they need to be tailored on a country specific basis. In order to focus attention on key priorities, the list needs to be restricted to less than 10 items. In the case of Sri Lanka, a brief perusal of past and recent national development documents help to identify the following dominant national goals and policies [GOSL 2002, 2004]:

- economic growth,
- poverty alleviation,
- food security,
- employment,
- trade and globalization,
- budget deficit reduction,
- privatization.

3.2. Step (b): Determine vulnerable areas relevant to climate change

The broad areas identified by the TAR provide a useful generic starting point. However, they need to be fine-tuned on a country specific basis. Again, in order to focus attention on key priorities, the list needs to be restricted to less than 10 items. In the case of Sri Lanka, a review of past and recent reports and documents indicate the following vulnerable areas:

- Agriculture
- Hydro Energy
- Forest Resources
- Biodiversity (flora & fauna)
- Wetlands & coastal ecosystems
- Water resources (excluding hydro use)
- Impoverished communities
- Human health
- Infrastructure, transport and communication
- Industry and tourism

3.3. Step (c) Incorporating the impacts of Climate Change

Climate change will impact on the column components of the matrix, i.e. the key vulnerable areas. The areas which are vulnerable to climate change have to adapt, to overcome the harmful effects of climate change.

We need to include a new row (S0) in the matrix as shown below, to indicate the current status of the vulnerable areas due to current natural climate variability. For example the current status of agricultural output is a low negative, since output has been declining regardless of climate change. This row is important in order to determine the impacts of climate change on the vulnerable areas in the next step.

Figure 4:

	Vulnerable Areas (VA)			
	Economic		Environmental	Social
	(1) Agricultural output	(2) Industrial Activity	(3) Water Resources	(4) Health
(S0) Status (only natural variability)	-1			

Scoring Key

(Cells should contain one of the following values or be left blank if here is no linkage)

-3 = High negative (undesirable) impact/effect
-2 = Medium negative (undesirable) impact/effect
-1 = Low negative (undesirable) impact/effect
0 = No impact/effect
1 = Low positive (desirable) impact/effect
2 = Medium positive (desirable) impact/effect
3 = High positive (desirable) impact/effect

Once participants have analysed the impact of natural climate variability on the vulnerable areas, they need to now include a new row in the matrix -S1, which indicates the cumulative impact of climate change on the vulnerability areas including natural variablity. For example, agricultural output in the tropics, is likely to decrease with changing weather patterns and increase in temperatures due to climate change. Therefore a value (-2) is assigned.

Figure 5:

	Vulnerable Areas (VA)			
	Economic		Environmental	Social
	(1) Agricultural output	(2) Industrial Activity	(3) Water Resources	(4) Health
(S0) Status (only natural variability)	-1			
(S1) Status (with climate change)	**-2**			

Note: - The values of SO and S1 should be common to both matrices AED and DEA

3.4. Step (d): Identify how development goals/policies affect Vulnerable areas (DEV-AIM)

The two lists determined by consensus in steps (a) and (b) above, may be put together to establish the basic AIM framework (see sample figure below, for Sri Lanka). For convenience of presentation, the row and column headings are given concisely, but the full spreadsheet will contain detailed notes describing each category in further detail. Thus, within each column, all relevant ecosystem services would be considered as sub-categories (although not shown, for brevity of presentation).

We seek to identify the impacts of national goals and policies on vulnerable areas, as indicated by the direction of the arrows at the top left hand corner of the figure. As an example, a few shaded cells have been selected to illustrate some key effects. The numbers are qualitative and represent net outcomes due to a variety of impacts, including trade-offs among different services. Brief explanations of the relevant linkages are provided for each cell.

Typical examples include:

Cell A5 = [-2] Loss: Growth would have a negative impact on wetlands and coastal systems due to increased activity in these areas, such as increased tourism, fishing etc.

Cell C6 = Net [-2] Loss:

[+1] Gain: modern agricultural practices such as drip irrigation help conserve water

[-3] Loss: increased demand for water due to agriculture would result in a shortage of water available for other uses (e.g., drinking water)

Such summaries are usually supplemented by longer text descriptions (several pages), giving details of mechanisms involved, and citing relevant reports and research studies.

Figure 6: Sri Lanka sample AIM – Development Effects on Vulnerable Areas (DEV-AIM)

		Vulnerable Areas (VA)									
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Agriculture	Hydro Energy	Forest Resources	Bio-diversity (flora & fauna)	Wetlands, coastal ecosystems	Water resources (excl. hydro use)	Impoverished communities	Human health	Infrastructure, transport & communication	Industry & Tourism
(S0)	**Status (No CC impacts) ***	**-1**	**0**	**-2**	**-1**	**-1**	**-2**	**-1**	**0**	**2**	**2**
Dev. Goals/Policies (No CC Impacts) =>											
(A)	Growth	-1	0	0	0	**-2**	-1	-1	2	2	2
(B)	Poverty alleviation	1		-1		0	1	1	1	1	
(C)	Food Security	2		-1		0	**-2**	1	2		
(D)	Employment	**-2**		0		-1	-1	1	1		
(E)	Trade & Globalisation	0	0	1	-1		-1	0	1	2	2
(F)	Budget Deficit Reduction	-1	0	-1			-1	**-2**	**-2**	**-2**	0
(G)	Privatisation	0	0	1		0		0	0	2	2
(S1)	**Status (+CC Impacts =>)**	**-2**	**-1**	**-2**	**-2**	**-2**	**-3**	**-2**	**-1**	**1**	**1**

(highlighted) effects that cause significant damage

3.5. Step (e): Identify how vulnerable areas might affect development goals/policies (VED-AIM)

Next, we seek to identify the impacts of vulnerable areas on national goals and policies, as indicated by the direction of the arrows at the top left hand corner of Figure 6. Once again, a few shaded cells provide examples of key issues, and brief summaries of the relevant linkages are provided in each cell.

Examples include:

Cell A1 = [-2] Loss: A decrease in agricultural output due to climate change, would have a negative impact on growth by decreasing the income from agricultural produce, increasing food imports.

Cell B1 = [-2] Loss: Poor agricultural output will increase poverty due to lack of alternative livelihoods

Cell C1 = [-3] Loss: low agricultural output would put stress on food security causing a need to import

Figure 7: Sri Lanka sample AIM –Vulnerable Areas Effects on Development (VED-AIM)

		Vulnerable Areas (VA)									
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Agriculture	Hydro Power	Deforestation	Bio-diversity (flora & fauna)	Wetlands, coastal ecosystems	Water resources	Impoverished communities	Human health	Infrastrastructure	Industries & Tourism
(S0)	**Status (No CC impacts)***	**-1**	**0**	**-2**	**-1**	**-1**	**-2**	**-1**	**0**	**2**	**2**
(S1)	**Status (+CC Impacts)****	**-2**	**-1**	**-2**	**-2**	**-2**	**-3**	**-2**	**-1**	**-1**	**-1**
Dev. Goals/Policies (+CC Impacts)											
(A)	Growth	-2	-1	-1	-1	-1	-2	-2	-1	-1	-1
(B)	Poverty alleviation	-2	0	-1	-1	-1	-2	-2	-2	-1	-1
(C)	Food Security	-3	0	-1	-1	-1	-3	-1	-1	0	0
(D)	Employment	-1	0	-1	0	-1	-2	-1	-2	-1	-2
(E)	Trade & Globalisation	-2	-1	0	0	0	-1	-1	0	-2	-1
(F)	Budget Deficit Reduction	-1	-1	0	0	0	0	0	-2	0	-1
(G)	Privatisation	0	1	1	0	0	1	0	0	-1	-1
(H)	Other										

effects that are most damaging
effects that cause significant damage

3.6 Step (f): Prioritize most important interactions and determine appropriate remedial policies and measures (preliminary AIM)

Several simple methods of prioritizing are discussed below. There is no rigorous mathematical procedure to fit all situations, and sound practical judgment plays an important role. The next few exercise will take you through a simple method of prioritizing areas that need to be analysed in depth by policy makers.

As an illustrative example, we select one priority linkage (among many) to identify a range of appropriate policy options for further analysis – the nexus of water resources and food security.

Water resources and food security

- Increase efficiency of water use in agriculture
    - efficient irrigation systems & technology
    - Desilting of tanks & reservoirs

- Introduce drought resistant crop varieties & crops that do not need large amounts of water
- Rain water harvesting
- Introduction of cropping systems to retain water and soil moisture (e.g., mulching, ground cover)

A cross-sectoral focus is urgently needed from policy- and decision-makers that emphasizes securing water resources in the context of achieving food security to make development more sustainable and improve human well-being. Governments and water managers are faced with the need to increase water supply to meet a still expanding population's increasing demand for food and water, while at the same time ensuring that the water supply is sustainable and that ecosystems contributing to that sustainability are protected. Management of water resources and associated ecosystems are most successfully addressed through integrated management at the river basin (or lake or aquifer) scale.

In regions where water is already stressed or scarce, meeting increasing demand for all water uses including ecosystem management becomes increasingly difficult and expensive. However, there are many options for providing the necessary water, many of which may be better and cheaper than constructing new projects. Some options are listed below.

Supply-side management options:
- constructing additional water storage and distribution systems;
- making better use of natural systems, such as wetlands and ground cover, to reduce erosion, store and filter water, and recharge aquifers;
- improving the efficiency of existing storage and distribution systems (especially O&M activities);
- improving water management techniques and institutions;

Demand-side management options:
- increasing water productivity (e.g., recycling and multiple-pass through);
- improving water pricing;
- applying water quotas;
- using economic incentives to reduce withdrawals and pollution;
- improving water quality regulations;
- introducing a pollution permits market;
- importing more food rather than growing it;
- encouraging less water-intensive crops.

Water Pricing in Irrigated Agriculture
Water pricing is one of the most important elements of recent water management frameworks, because it is the basis for achieving efficient allocation of water resources. Conversely, inappropriate water prices could encourage inefficient use of water and contribute to water shortages or depletion of water resources in the long run and degradation of the environment and the ecosystems.

Typically water prices in agriculture, when they exist, cover more or less the variable cost of water supply, while public authorities cover fixed costs. Sometimes prices are set according to some notion of farmers' "ability to pay." The structure of water pricing systems usually takes one of the following forms: standard volumetric and fixed tariffs, area-pricing, tiered or block-rate pricing, land betterment levy pricing or passive trading, volumetric pricing with bonus, or water markets.

Water markets have become an increasingly important mechanism for efficient and flexible water allocation. Water markets and tradable water rights give water a value separate from land and provide incentives to use water more efficiently, since water saving can be sold for extra revenues or can be used to further increase production. Water markets are promoted by international organizations such as the World Bank and have been pursued within many developing countries.

In developing countries, the practicality and true ecological and livelihood impact of water pricing and markets is under scrutiny. Given this, a broader term of economic incentives will certainly be important. These could include positive incentives for farmers to save water, rather than penalizing the rural poor when it is often the urban wealthy who benefit from low food prices and could better afford the cost of dealing with negative externalities.

Water Pollution
Agriculture is the single largest user of water resources. Except for water lost through evapo-transpiration, agricultural water is recycled back to surface water and/or groundwater. However, agriculture is both a cause and a victim of water pollution. It is a cause through its discharge of pollutants and sediment into surface and/or groundwater; net loss of soil from poor agricultural practices; salinization and water logging of irrigated land; and through salt water intrusion in coastal aquifers due to over pumping. It is a victim through use of wastewater and polluted surface and groundwater, which contaminate crops and transmit diseases to consumers and farm workers. Furthermore, pollution of both fresh and brackish water also harms natural ecosystems.

The inadequacy of the standard instruments of environmental policy to deal with pollution has led, in recent years, to the development of policy schemes, which can be divided into two broad categories: (1) ambient taxes where the scheme is based on the observed ambient pollution, and (2) input based schemes, where the policy scheme consists of taxes applied to observable polluting inputs. Common policies against water pollution include user charges for sewerage and sewage treatment, water effluent charges, and charges in agriculture, along with a number of more specific policies.

Charges in agriculture are a more profound case of input-based schemes. Charges on fertilizers as applied in many countries are based on the nitrogen and phosphorus content of fertilizers, which are the main contributors to pollution in surface water. A number of off-farm management methods also exist for reducing phosphorus runoff such as vegetation buffer stripes, riparian zones, and dredging of the lake sediment. More specific policies aimed at addressing pollution problems, especially in relation to agriculture also exist. For example, in Austria there are groundwater protection zones in which, if the water quality is reduced, farmers have to comply with certain management practices or change land use. Spain has zonal programs for reducing fertilizers, the Netherlands has a manure and ammonia policy, England and Wales have codes which give farmers guidance on maintaining good agricultural practices. Ireland has a voluntary scheme for farmers to follow a specific nutrient management plan.

3.7. Step (g): Perform more detailed studies and analyses of key interactions and policies options identified in step (e) above.

The critical issues, policy options and measures identified in step (e) may be subject to further analysis and research, to provide greater confidence to decision makers before they begin to implement such remedial measures. A variety of macro-, regional or local models are usually applied, that focus on the specific questions at hand (Munasinghe 1994, 1997, 2002a). This procedure helps us to evaluate appropriate country-specific vulnerable area management options.

In our water-food example for Sri Lanka, further multi-scale exploration is needed. At the national level, integrated spatial water basin models linked with a multi-sector macroeconomic model (with disaggregated water uses including irrigation, drinking water, hydropower, ecosystem use, etc.), would be used to test some of the ecosystem management policy options. At the micro-level, more detailed models of local areas and communities would also be helpful to assess specific agricultural and/or irrigation projects.

3.8. Step (h): Update and refine steps (c) to (f) above -- revised AIM

The results of the detailed research and analysis in step (f) are introduced into the AIM process, to update and refine the information in the cells, and begin the next stage of implementing remedial actions. A package of policies and projects would be assembled, based on modeling and detailed studies, to address the most important linkages in the AIM. When testing and validating policy alternatives, those that give rise to win-win outcomes (e.g., simultaneously addressing economic, social and environmental objectives), would have the highest priority. In other cases, trade-offs among conflicting objectives need to be carefully assessed. Finally, practical and political constraints need to be kept in mind.

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