

# The GIWA methodology

The specific objectives of the GIWA were to conduct a holistic and globally comparable assessment of the world's transboundary aquatic resources that incorporated both environmental and socio-economic factors and recognised the inextricable links between freshwater and marine environments, in order to enable the GEF to focus their resources and to provide guidance and advice to governments and decision makers. The coalition of all these elements into a single coherent methodology that produces an assessment that achieves each of these objectives had not previously been done and posed a significant challenge.

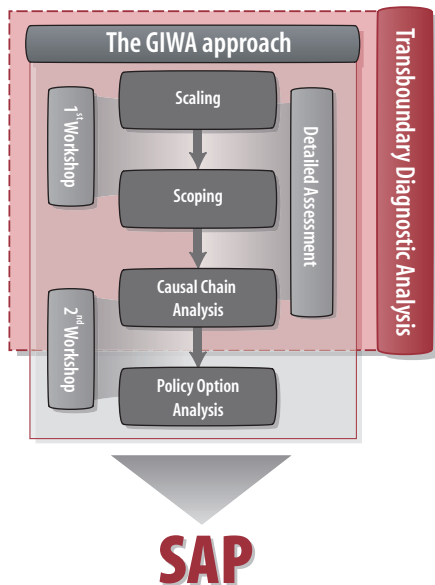
The integration of each of these elements into the GIWA methodology was achieved through an iterative process guided by a specially convened Methods task team that was comprised of a number of international assessment and water experts. Before the final version of the methodology was adopted, preliminary versions underwent an extensive external peer review and were subjected to preliminary testing in selected regions. Advice obtained from the Methods task team and other international experts and the lessons learnt from preliminary testing were incorporated into the final version that was used to conduct each of the GIWA regional assessments.

Considering the enormous differences between regions in terms of the quality, quantity and availability of data, socio-economic setting and environmental conditions, the achievement of global comparability required an innovative approach. This was facilitated by focusing the assessment on the impacts of five pre-defined concerns namely; Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources and Global change, in transboundary waters. Considering the diverse range of elements encompassed by each concern, assessing the magnitude of the impacts caused by these concerns was facilitated by evaluating the impacts of 22 specific issues that were grouped within these concerns (see Table 1).

The assessment integrates environmental and socio-economic data from each country in the region to determine the severity of the impacts of each of the five concerns and their constituent issues on the entire region. The integration of this information was facilitated by implementing the assessment during two participatory workshops that typically involved 10 to 15 environmental and socio-economic experts from each country in the region. During these workshops, the regional teams performed preliminary analyses based on the collective knowledge and experience of these local experts. The results of these analyses were substantiated with the best available information to be presented in a regional report.

**Table 1** Pre-defined GIWA concerns and their constituent issues addressed within the assessment.

Environmental issues	Major concerns
<ol style="list-style-type: none"> <li>1. Modification of stream flow</li> <li>2. Pollution of existing supplies</li> <li>3. Changes in the water table</li> </ol>	<b>I Freshwater shortage</b>
<ol style="list-style-type: none"> <li>4. Microbiological</li> <li>5. Eutrophication</li> <li>6. Chemical</li> <li>7. Suspended solids</li> <li>8. Solid wastes</li> <li>9. Thermal</li> <li>10. Radionuclide</li> <li>11. Spills</li> </ol>	<b>II Pollution</b>
<ol style="list-style-type: none"> <li>12. Loss of ecosystems</li> <li>13. Modification of ecosystems or ecotones, including community structure and/or species composition</li> </ol>	<b>III Habitat and community modification</b>
<ol style="list-style-type: none"> <li>14. Overexploitation</li> <li>15. Excessive by-catch and discards</li> <li>16. Destructive fishing practices</li> <li>17. Decreased viability of stock through pollution and disease</li> <li>18. Impact on biological and genetic diversity</li> </ol>	<b>IV Unsustainable exploitation of fish and other living resources</b>
<ol style="list-style-type: none"> <li>19. Changes in hydrological cycle</li> <li>20. Sea level change</li> <li>21. Increased uv-b radiation as a result of ozone depletion</li> <li>22. Changes in ocean CO2 source/sink function</li> </ol>	<b>V Global change</b>



**Figure 1** Illustration of the relationship between the GIWA approach and other projects implemented within the GEF International Waters (IW) portfolio.

The GIWA is a logical contiguous process that defines the geographic region to be assessed, identifies and prioritises particularly problems based on the magnitude of their impacts on the environment and human societies in the region, determines the root causes of those problems and, finally, assesses various policy options that addresses those root causes in order to reverse negative trends in the condition of the aquatic environment. These four steps, referred to as Scaling, Scoping, Causal chain analysis and Policy options analysis, are summarised below and are described in their entirety in two volumes: *GIWA Methodology Stage 1: Scaling and Scoping*; and *GIWA Methodology: Detailed Assessment, Causal Chain Analysis and Policy Options Analysis*. Generally, the components of the GIWA methodology are aligned with the framework adopted by the GEF for Transboundary Diagnostic Analyses (TDAs) and Strategic Action Programmes (SAPs) (Figure 1) and assume a broad spectrum of transboundary influences in addition to those associated with the physical movement of water across national borders.

### Scaling – Defining the geographic extent of the region

Scaling is the first stage of the assessment and is the process by which the geographic scale of the assessment is defined. In order to facilitate the implementation of the GIWA, the globe was divided during the design phase of the project into 66 contiguous regions. Considering the transboundary nature of many aquatic resources and the transboundary focus of the GIWA, the boundaries of the regions did not comply with

political boundaries but were instead, generally defined by a large but discrete drainage basin that also included the coastal marine waters into which the basin discharges. In many cases, the marine areas examined during the assessment coincided with the Large Marine Ecosystems (LMEs) defined by the US National Atmospheric and Oceanographic Administration (NOAA). As a consequence, scaling should be a relatively straight-forward task that involves the inspection of the boundaries that were proposed for the region during the preparatory phase of GIWA to ensure that they are appropriate and that there are no important overlaps or gaps with neighbouring regions. When the proposed boundaries were found to be inadequate, the boundaries of the region were revised according to the recommendations of experts from both within the region and from adjacent regions so as to ensure that any changes did not result in the exclusion of areas from the GIWA. Once the regional boundary was defined, regional teams identified all the transboundary elements of the aquatic environment within the region and determined if these elements could be assessed as a single coherent aquatic system or if there were two or more independent systems that should be assessed separately.

### Scoping – Assessing the GIWA concerns

Scoping is an assessment of the severity of environmental and socio-economic impacts caused by each of the five pre-defined GIWA concerns and their constituent issues (Table 1). It is not designed to provide an exhaustive review of water-related problems that exist within each region, but rather it is a mechanism to identify the most urgent problems in the region and prioritise those for remedial actions. The priorities determined by Scoping are therefore one of the main outputs of the GIWA project.

Focusing the assessment on pre-defined concerns and issues ensured the comparability of the results between different regions. In addition, to ensure the long-term applicability of the options that are developed to mitigate these problems, Scoping not only assesses the current impacts of these concerns and issues but also the probable future impacts according to the “most likely scenario” which considered demographic, economic, technological and other relevant changes that will potentially influence the aquatic environment within the region by 2020.

The magnitude of the impacts caused by each issue on the environment and socio-economic indicators was assessed over the entire region using the best available information from a wide range of sources and the knowledge and experience of the each of the experts comprising the regional team. In order to enhance the comparability of the assessment between different regions and remove biases in the assessment caused by different perceptions of and ways to communicate the severity of impacts caused by particular issues, the

results were distilled and reported as standardised scores according to the following four point scale:

- 0 = no known impact
- 1 = slight impact
- 2 = moderate impact
- 3 = severe impact

The attributes of each score for each issue were described by a detailed set of pre-defined criteria that were used to guide experts in reporting the results of the assessment. For example, the criterion for assigning a score of 3 to the issue Loss of ecosystems or ecotones is: *“Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.”* The full list of criteria is presented at the end of the chapter, Table 5a-e. Although the scoring inevitably includes an arbitrary component, the use of predefined criteria facilitates comparison of impacts on a global scale and also encouraged consensus of opinion among experts.

The trade-off associated with assessing the impacts of each concern and their constituent issues at the scale of the entire region is that spatial resolution was sometimes low. Although the assessment provides a score indicating the severity of impacts of a particular issue or concern on the entire region, it does not mean that the entire region suffers the impacts of that problem. For example, eutrophication could be identified as a severe problem in a region, but this does not imply that all waters in the region suffer from severe eutrophication. It simply means that when the degree of eutrophication, the size of the area affected, the socio-economic impacts and the number of people affected is considered, the magnitude of the overall impacts meets the criteria defining a severe problem and that a regional action should be initiated in order to mitigate the impacts of the problem.

When each issue has been scored, it was weighted according to the relative contribution it made to the overall environmental impacts of the concern and a weighted average score for each of the five concerns was calculated (Table 2). Of course, if each issue was deemed to make equal contributions, then the score describing the overall impacts of the concern was simply the arithmetic mean of the scores allocated to each issue within the concern. In addition, the socio-economic impacts of each of the five major concerns were assessed for the entire region. The socio-economic impacts were grouped into three categories; Economic impacts, Health impacts and Other social and community impacts (Table 3). For each category, an evaluation of the size, degree and frequency of the impact was performed and, once completed, a weighted average score describing the overall socio-economic impacts of each concern was calculated in the same manner as the overall environmental score.

**Table 2** Example of environmental impact assessment of Freshwater shortage.

Environmental issues	Score	Weight %	Environmental concerns	Weight averaged score
1. Modification of stream flow	1	20	Freshwater shortage	1.50
2. Pollution of existing supplies	2	50		
3. Changes in the water table	1	30		

**Table 3** Example of Health impacts assessment linked to one of the GIWA concerns.

Criteria for Health impacts	Raw score	Score	Weight %
Number of people affected	Very small 0 1 2 3 Very large	2	50
Degree of severity	Minimum 0 1 2 3 Severe	2	30
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	2	20
<b>Weight average score for Health impacts</b>			<b>2</b>

After all 22 issues and associated socio-economic impacts have been scored, weighted and averaged, the magnitude of likely future changes in the environmental and socio-economic impacts of each of the five concerns on the entire region is assessed according to the most likely scenario which describes the demographic, economic, technological and other relevant changes that might influence the aquatic environment within the region by 2020.

In order to prioritise among GIWA concerns within the region and identify those that will be subjected to causal chain and policy options analysis in the subsequent stages of the GIWA, the present and future scores of the environmental and socio-economic impacts of each concern are tabulated and an overall score calculated. In the example presented in Table 4, the scoping assessment indicated that concern III, Habitat and community modification, was the priority concern in this region. The outcome of this mathematic process was reconciled against the knowledge of experts and the best available information in order to ensure the validity of the conclusion.

In some cases however, this process and the subsequent participatory discussion did not yield consensus among the regional experts regarding the ranking of priorities. As a consequence, further analysis was required. In such cases, expert teams continued by assessing the relative importance of present and potential future impacts and assign weights to each. Afterwards, the teams assign weights indicating the relative contribution made by environmental and socio-economic factors to the overall impacts of the concern. The weighted average score for each concern is then recalculated taking into account

**Table 4** Example of comparative environmental and socio-economic impacts of each major concern, presently and likely in year 2020.

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.3	2.3	2.7	2.8	2.6	3.0	1.8	2.2	<b>2.3</b>
Pollution	1.5	2.0	2.0	2.3	1.8	2.3	2.0	2.3	<b>2.0</b>
Habitat and community modification	2.0	3.0	2.4	3.0	2.4	2.8	2.3	2.7	<b>2.6</b>
Unsustainable exploitation of fish and other living resources	1.8	2.2	2.0	2.1	2.0	2.1	2.4	2.5	<b>2.1</b>
Global change	0.8	1.0	1.5	1.7	1.5	1.5	1.0	1.0	<b>1.2</b>

the relative contributions of both present and future impacts and environmental and socio-economic factors. The outcome of these additional analyses was subjected to further discussion to identify overall priorities for the region.

Finally, the assessment recognises that each of the five GIWA concerns are not discrete but often interact. For example, pollution can destroy aquatic habitats that are essential for fish reproduction which, in turn, can cause declines in fish stocks and subsequent overexploitation. Once teams have ranked each of the concerns and determined the priorities for the region, the links between the concerns are highlighted in order to identify places where strategic interventions could be applied to yield the greatest benefits for the environment and human societies in the region.

### Causal chain analysis

Causal Chain Analysis (CCA) traces the cause-effect pathways from the socio-economic and environmental impacts back to their root causes. The GIWA CCA aims to identify the most important causes of each concern prioritised during the scoping assessment in order to direct policy measures at the most appropriate target in order to prevent further degradation of the regional aquatic environment.

Root causes are not always easy to identify because they are often spatially or temporally separated from the actual problems they cause. The GIWA CCA was developed to help identify and understand the root causes of environmental and socio-economic problems in international waters and is conducted by identifying the human activities that cause the problem and then the factors that determine the ways in which these activities are undertaken. However, because there is no universal theory describing how root causes interact to create natural resource management problems and due to the great variation of local circumstances under which the methodology will be applied, the GIWA CCA is not a rigidly structured assessment but

should be regarded as a framework to guide the analysis, rather than as a set of detailed instructions. Secondly, in an ideal setting, a causal chain would be produced by a multidisciplinary group of specialists that would statistically examine each successive cause and study its links to the problem and to other causes. However, this approach (even if feasible) would use far more resources and time than those available to GIWA<sup>1</sup>. For this reason, it has been necessary to develop a relatively simple and practical analytical model for gathering information to assemble meaningful causal chains.

### Conceptual model

A causal chain is a series of statements that link the causes of a problem with its effects. Recognising the great diversity of local settings and the resulting difficulty in developing broadly applicable policy strategies, the GIWA CCA focuses on a particular system and then only on those issues that were prioritised during the scoping assessment. The starting point of a particular causal chain is one of the issues selected during the Scaling and Scoping stages and its related environmental and socio-economic impacts. The next element in the GIWA chain is the immediate cause; defined as the physical, biological or chemical variable that produces the GIWA issue. For example, for the issue of eutrophication the immediate causes may be, inter alia:

- Enhanced nutrient inputs;
- Increased recycling/mobilisation;
- Trapping of nutrients (e.g. in river impoundments);
- Run-off and stormwaters

Once the relevant immediate cause(s) for the particular system has (have) been identified, the sectors of human activity that contribute most significantly to the immediate cause have to be determined. Assuming that the most important immediate cause in our example had been increased nutrient concentrations, then it is logical that the most likely sources of those nutrients would be the agricultural, urban or industrial sectors. After identifying the sectors that are primarily

<sup>1</sup>This does not mean that the methodology ignores statistical or quantitative studies; as has already been pointed out, the available evidence that justifies the assumption of causal links should be provided in the assessment.

responsible for the immediate causes, the root causes acting on those sectors must be determined. For example, if agriculture was found to be primarily responsible for the increased nutrient concentrations, the root causes could potentially be:

- Economic (e.g. subsidies to fertilisers and agricultural products);
- Legal (e.g. inadequate regulation);
- Failures in governance (e.g. poor enforcement); or
- Technology or knowledge related (e.g. lack of affordable substitutes for fertilisers or lack of knowledge as to their application).

Once the most relevant root causes have been identified, an explanation, which includes available data and information, of how they are responsible for the primary environmental and socio-economic problems in the region should be provided.

### **Policy option analysis**

Despite considerable effort of many Governments and other organisations to address transboundary water problems, the evidence indicates that there is still much to be done in this endeavour. An important characteristic of GIWA's Policy Option Analysis (POA) is that its recommendations are firmly based on a better understanding of the root causes of the problems. Freshwater scarcity, water pollution, overexploitation of living resources and habitat destruction are very complex phenomena. Policy options that are grounded on a better understanding of these phenomena will contribute to create more effective societal responses to the extremely complex water related transboundary problems. The core of POA in the assessment consists of two tasks:

#### **Construct policy options**

Policy options are simply different courses of action, which are not always mutually exclusive, to solve or mitigate environmental and socio-economic problems in the region. Although a multitude of different policy options could be constructed to address each root cause identified in the CCA, only those few policy options that have the greatest likelihood of success were analysed in the GIWA.

#### **Select and apply the criteria on which the policy options will be evaluated**

Although there are many criteria that could be used to evaluate any policy option, GIWA focuses on:

- Effectiveness (certainty of result)
- Efficiency (maximisation of net benefits)
- Equity (fairness of distributional impacts)
- Practical criteria (political acceptability, implementation feasibility).

The policy options recommended by the GIWA are only contributions to the larger policy process and, as such, the GIWA methodology developed to test the performance of various options under the different circumstances has been kept simple and broadly applicable.

## ***Global International Waters Assessment***

**Table 5a: Scoring criteria for environmental impacts of Freshwater shortage**

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
<p><b>Issue 1: Modification of stream flow</b>                      “An increase or decrease in the discharge of streams and rivers as a result of human interventions on a local/ regional scale (see Issue 19 for flow alterations resulting from global change) over the last 3-4 decades.”</p>	<ul style="list-style-type: none"> <li>No evidence of modification of stream flow.</li> </ul>	<ul style="list-style-type: none"> <li>There is a measurably changing trend in annual river discharge at gauging stations in a major river or tributary (basin &gt; 40 000 km<sup>2</sup>); or</li> <li>There is a measurable decrease in the area of wetlands (other than as a consequence of conversion or embankment construction); or</li> <li>There is a measurable change in the interannual mean salinity of estuaries or coastal lagoons and/or change in the mean position of estuarine salt wedge or mixing zone; or</li> <li>Change in the occurrence of exceptional discharges (e.g. due to upstream damming).</li> </ul>	<ul style="list-style-type: none"> <li>Significant downward or upward trend (more than 20% of the long term mean) in annual discharges in a major river or tributary draining a basin of &gt;250 000 km<sup>2</sup>; or</li> <li>Loss of &gt;20% of flood plain or deltaic wetlands through causes other than conversion or artificial embankments; or</li> <li>Significant loss of riparian vegetation (e.g. trees, flood plain vegetation); or</li> <li>Significant saline intrusion into previously freshwater rivers or lagoons.</li> </ul>	<ul style="list-style-type: none"> <li>Annual discharge of a river altered by more than 50% of long term mean; or</li> <li>Loss of &gt;50% of riparian or deltaic wetlands over a period of not less than 40 years (through causes other than conversion or artificial embankment); or</li> <li>Significant increased siltation or erosion due to changing in flow regime (other than normal fluctuations in flood plain rivers); or</li> <li>Loss of one or more anadromous or catadromous fish species for reasons other than physical barriers to migration, pollution or overfishing.</li> </ul>
<p><b>Issue 2: Pollution of existing supplies</b>                      “Pollution of surface and ground fresh waters supplies as a result of point or diffuse sources”</p>	<ul style="list-style-type: none"> <li>No evidence of pollution of surface and ground waters.</li> </ul>	<ul style="list-style-type: none"> <li>Any monitored water in the region does not meet WHO or national drinking water criteria, other than for natural reasons; or</li> <li>There have been reports of one or more fish kills in the system due to pollution within the past five years.</li> </ul>	<ul style="list-style-type: none"> <li>Water supplies does not meet WHO or national drinking water standards in more than 30% of the region; or</li> <li>There are one or more reports of fish kills due to pollution in any river draining a basin of &gt;250 000 km<sup>2</sup>.</li> </ul>	<ul style="list-style-type: none"> <li>River draining more than 10% of the basin have suffered polysaprobic conditions, no longer support fish, or have suffered severe oxygen depletion</li> <li>Severe pollution of other sources of freshwater (e.g. groundwater)</li> </ul>
<p><b>Issue 3: Changes in the water table</b>                      “Changes in aquifers as a direct or indirect consequence of human activity”</p>	<ul style="list-style-type: none"> <li>No evidence that abstraction of water from aquifers exceeds natural replenishment.</li> </ul>	<ul style="list-style-type: none"> <li>Several wells have been deepened because of excessive aquifer draw-down; or</li> <li>Several springs have dried up; or</li> <li>Several wells show some salinisation.</li> </ul>	<ul style="list-style-type: none"> <li>Clear evidence of declining base flow in rivers in semi-arid areas; or</li> <li>Loss of plant species in the past decade, that depend on the presence of ground water; or</li> <li>Wells have been deepened over areas of hundreds of km<sup>2</sup>; or</li> <li>Salinisation over significant areas of the region.</li> </ul>	<ul style="list-style-type: none"> <li>Aquifers are suffering salinisation over regional scale; or</li> <li>Perennial springs have dried up over regionally significant areas; or</li> <li>Some aquifers have become exhausted</li> </ul>

**Table 5b: Scoring criteria for environmental impacts of Pollution**

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
<p><b>Issue 4: Microbiological pollution</b>                      “The adverse effects of microbial constituents of human sewage released to water bodies.”</p>	<ul style="list-style-type: none"> <li>Normal incidence of bacterial related gastroenteric disorders in fisheries product consumers and no fisheries closures or advisories.</li> </ul>	<ul style="list-style-type: none"> <li>There is minor increase in incidence of bacterial related gastroenteric disorders in fisheries product consumers but no fisheries closures or advisories.</li> </ul>	<ul style="list-style-type: none"> <li>Public health authorities aware of marked increase in the incidence of bacterial related gastroenteric disorders in fisheries product consumers; or</li> <li>There are limited area closures or advisories reducing the exploitation or marketability of fisheries products.</li> </ul>	<ul style="list-style-type: none"> <li>There are large closure areas or very restrictive advisories affecting the marketability of fisheries products; or</li> <li>There exists widespread public or tourist awareness of hazards resulting in major reductions in the exploitation or marketability of fisheries products.</li> </ul>
<p><b>Issue 5: Eutrophication</b>                      “Artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients, including cultural eutrophication in lakes.”</p>	<ul style="list-style-type: none"> <li>No visible effects on the abundance and distributions of natural living resource distributions in the area; and</li> <li>No increased frequency of hypoxia<sup>1</sup> or fish mortality events or harmful algal blooms associated with enhanced primary production; and</li> <li>No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality; and</li> <li>No evident abnormality in the frequency of algal blooms.</li> </ul>	<ul style="list-style-type: none"> <li>Increased abundance of epiphytic algae; or</li> <li>A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (&gt;20 year) data sets; or</li> <li>Measurable shallowing of the depth range of macrophytes.</li> </ul>	<ul style="list-style-type: none"> <li>Increased filamentous algal production resulting in algal mats; or</li> <li>Medium frequency (up to once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.</li> </ul>	<ul style="list-style-type: none"> <li>High frequency (&gt;1 event per year), or intensity, or large areas of periodic hypoxic conditions, or high frequencies of fish and zoobenthos mortality events or harmful algal blooms; or</li> <li>Significant changes in the littoral community; or</li> <li>Presence of hydrogen sulphide in historically well oxygenated areas.</li> </ul>

<p><b>Issue 6: Chemical pollution</b> “The adverse effects of chemical contaminants released to standing or marine water bodies as a result of human activities. Chemical contaminants are here defined as compounds that are toxic or persistent or bioaccumulating.”</p>	<ul style="list-style-type: none"> <li>■ No known or historical levels of chemical contaminants except background levels of naturally occurring substances; and</li> <li>■ No fisheries closures or advisories due to chemical pollution; and</li> <li>■ No incidence of fisheries product tainting; and</li> <li>■ No unusual fish mortality events.</li> </ul> <p>If there is no available data use the following criteria:</p> <ul style="list-style-type: none"> <li>■ No use of pesticides; and</li> <li>■ No sources of dioxins and furans; and</li> <li>■ No regional use of PCBs; and</li> <li>■ No bleached kraft pulp mills using chlorine bleaching; and</li> <li>■ No use or sources of other contaminants.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some chemical contaminants are detectable but below threshold limits defined for the country or region; or</li> <li>■ Restricted area advisories regarding chemical contamination of fisheries products.</li> </ul> <p>If there is no available data use the following criteria:</p> <ul style="list-style-type: none"> <li>■ Some use of pesticides in small areas; or</li> <li>■ Presence of small sources of dioxins or furans (e.g., small incineration plants or bleached kraft/pulp mills using chlorine); or</li> <li>■ Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns; or</li> <li>■ Presence of other contaminants.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some chemical contaminants are above threshold limits defined for the country or region; or</li> <li>■ Large area advisories by public health authorities concerning fisheries product contamination but without associated catch restrictions or closures; or</li> <li>■ High mortalities of aquatic species near outfalls.</li> </ul> <p>If there is no available data use the following criteria:</p> <ul style="list-style-type: none"> <li>■ Large-scale use of pesticides in agriculture and forestry; or</li> <li>■ Presence of major sources of dioxins or furans such as large municipal or industrial incinerators or large bleached kraft pulp mills; or</li> <li>■ Considerable quantities of waste PCBs in the area with inadequate regulation or has invoked some public concerns; or</li> <li>■ Presence of considerable quantities of other contaminants.</li> </ul>	<ul style="list-style-type: none"> <li>■ Chemical contaminants are above threshold limits defined for the country or region; and</li> <li>■ Public health and public awareness of fisheries contamination problems with associated reductions in the marketability of such products either through the imposition of limited advisories or by area closures of fisheries; or</li> <li>■ Large-scale mortalities of aquatic species.</li> </ul> <p>If there is no available data use the following criteria:</p> <ul style="list-style-type: none"> <li>■ Indications of health effects resulting from use of pesticides; or</li> <li>■ Known emissions of dioxins or furans from incinerators or chlorine bleaching of pulp; or</li> <li>■ Known contamination of the environment or foodstuffs by PCBs; or</li> <li>■ Known contamination of the environment or foodstuffs by other contaminants.</li> </ul>
<p><b>Issue 7: Suspended solids</b> “The adverse effects of modified rates of release of suspended particulate matter to water bodies resulting from human activities”</p>	<ul style="list-style-type: none"> <li>■ No visible reduction in water transparency; and</li> <li>■ No evidence of turbidity plumes or increased siltation; and</li> <li>■ No evidence of progressive riverbank, beach, other coastal or deltaic erosion.</li> </ul>	<ul style="list-style-type: none"> <li>■ Evidently increased or reduced turbidity in streams and/or receiving riverine and marine environments but without major changes in associated sedimentation or erosion rates, mortality or diversity of flora and fauna; or</li> <li>■ Some evidence of changes in benthic or pelagic biodiversity in some areas due to sediment blanketing or increased turbidity.</li> </ul>	<ul style="list-style-type: none"> <li>■ Markedly increased or reduced turbidity in small areas of streams and/or receiving riverine and marine environments; or</li> <li>■ Extensive evidence of changes in sedimentation or erosion rates; or</li> <li>■ Changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity.</li> </ul>	<ul style="list-style-type: none"> <li>■ Major changes in turbidity over wide or ecologically significant areas resulting in markedly changed biodiversity or mortality in benthic species due to excessive sedimentation with or without concomitant changes in the nature of deposited sediments (i.e., grain-size composition/redox); or</li> <li>■ Major change in pelagic biodiversity or mortality due to excessive turbidity.</li> </ul>
<p><b>Issue 8: Solid wastes</b> “Adverse effects associated with the introduction of solid waste materials into water bodies or their environs.”</p>	<ul style="list-style-type: none"> <li>■ No noticeable interference with trawling activities; and</li> <li>■ No noticeable interference with the recreational use of beaches due to litter; and</li> <li>■ No reported entanglement of aquatic organisms with debris.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some evidence of marine-derived litter on beaches; or</li> <li>■ Occasional recovery of solid wastes through trawling activities; but</li> <li>■ Without noticeable interference with trawling and recreational activities in coastal areas.</li> </ul>	<ul style="list-style-type: none"> <li>■ Widespread litter on beaches giving rise to public concerns regarding the recreational use of beaches; or</li> <li>■ High frequencies of benthic litter recovery and interference with trawling activities; or</li> <li>■ Frequent reports of entanglement/suffocation of species by litter.</li> </ul>	<ul style="list-style-type: none"> <li>■ Incidence of litter on beaches sufficient to deter the public from recreational activities; or</li> <li>■ Trawling activities untenable because of benthic litter and gear entanglement; or</li> <li>■ Widespread entanglement and/or suffocation of aquatic species by litter.</li> </ul>
<p><b>Issue 9: Thermal</b> “The adverse effects of the release of aqueous effluents at temperatures exceeding ambient temperature in the receiving water body.”</p>	<ul style="list-style-type: none"> <li>■ No thermal discharges or evidence of thermal effluent effects.</li> </ul>	<ul style="list-style-type: none"> <li>■ Presence of thermal discharges but without noticeable effects beyond the mixing zone and no significant interference with migration of species.</li> </ul>	<ul style="list-style-type: none"> <li>■ Presence of thermal discharges with large mixing zones having reduced productivity or altered biodiversity; or</li> <li>■ Evidence of reduced migration of species due to thermal plume.</li> </ul>	<ul style="list-style-type: none"> <li>■ Presence of thermal discharges with large mixing zones with associated mortalities, substantially reduced productivity or noticeable changes in biodiversity; or</li> <li>■ Marked reduction in the migration of species due to thermal plumes.</li> </ul>
<p><b>Issue 10: Radionuclide</b> “The adverse effects of the release of radioactive contaminants and wastes into the aquatic environment from human activities.”</p>	<ul style="list-style-type: none"> <li>■ No radionuclide discharges or nuclear activities in the region.</li> </ul>	<ul style="list-style-type: none"> <li>■ Minor releases or fallout of radionuclides but with well regulated or well-managed conditions complying with the Basic Safety Standards.</li> </ul>	<ul style="list-style-type: none"> <li>■ Minor releases or fallout of radionuclides under poorly regulated conditions that do not provide an adequate basis for public health assurance or the protection of aquatic organisms but without situations or levels likely to warrant large scale intervention by a national or international authority.</li> </ul>	<ul style="list-style-type: none"> <li>■ Substantial releases or fallout of radionuclides resulting in excessive exposures to humans or animals in relation to those recommended under the Basic Safety Standards; or</li> <li>■ Some indication of situations or exposures warranting intervention by a national or international authority.</li> </ul>
<p><b>Issue 11: Spills</b> “The adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities.”</p>	<ul style="list-style-type: none"> <li>■ No evidence of present or previous spills of hazardous material; or</li> <li>■ No evidence of increased aquatic or avian species mortality due to spills.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some evidence of minor spills of hazardous materials in small areas with insignificant small-scale adverse effects on aquatic or avian species.</li> </ul>	<ul style="list-style-type: none"> <li>■ Evidence of widespread contamination by hazardous or aesthetically displeasing materials assumed to be from spillage (e.g. oil slicks) but with limited evidence of widespread adverse effects on resources or amenities; or</li> <li>■ Some evidence of aquatic or avian species mortality through increased presence of contaminated or poisoned carcasses on beaches.</li> </ul>	<ul style="list-style-type: none"> <li>■ Widespread contamination by hazardous or aesthetically displeasing materials from frequent spills resulting in major interference with aquatic resource exploitation or coastal recreational amenities; or</li> <li>■ Significant mortality of aquatic or avian species as evidenced by large numbers of contaminated carcasses on beaches.</li> </ul>

**Table 5c: Scoring criteria for environmental impacts of Habitat and community modification**

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
<b>Issue 12: Loss of ecosystems or ecotones</b> "The complete destruction of aquatic habitats. For the purpose of GIWA methodology, recent loss will be measured as a loss of pre-defined habitats over the last 2-3 decades."	<ul style="list-style-type: none"> <li>There is no evidence of loss of ecosystems or habitats.</li> </ul>	<ul style="list-style-type: none"> <li>There are indications of fragmentation of at least one of the habitats.</li> </ul>	<ul style="list-style-type: none"> <li>Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by up to 30% during the last 2-3 decades.</li> </ul>	<ul style="list-style-type: none"> <li>Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by &gt;30% during the last 2-3 decades.</li> </ul>
<b>Issue 13: Modification of ecosystems or ecotones, including community structure and/or species composition</b> "Modification of pre-defined habitats in terms of extinction of native species, occurrence of introduced species and changing in ecosystem function and services over the last 2-3 decades."	<ul style="list-style-type: none"> <li>No evidence of change in species complement due to species extinction or introduction; and</li> <li>No changing in ecosystem function and services.</li> </ul>	<ul style="list-style-type: none"> <li>Evidence of change in species complement due to species extinction or introduction</li> </ul>	<ul style="list-style-type: none"> <li>Evidence of change in species complement due to species extinction or introduction; and</li> <li>Evidence of change in population structure or change in functional group composition or structure</li> </ul>	<ul style="list-style-type: none"> <li>Evidence of change in species complement due to species extinction or introduction; and</li> <li>Evidence of change in population structure or change in functional group composition or structure; and</li> <li>Evidence of change in ecosystem services<sup>2</sup>.</li> </ul>

<sup>2</sup> Constanza, R. et al. (1997). The value of the world ecosystem services and natural capital, Nature 387:253-260.

**Table 5d: Scoring criteria for environmental impacts of Unsustainable exploitation of fish and other living resources**

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
<b>Issue 14: Overexploitation</b> "The capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock."	<ul style="list-style-type: none"> <li>No harvesting exists catching fish (with commercial gear for sale or subsistence).</li> </ul>	<ul style="list-style-type: none"> <li>Commercial harvesting exists but there is no evidence of over-exploitation.</li> </ul>	<ul style="list-style-type: none"> <li>One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits.</li> </ul>	<ul style="list-style-type: none"> <li>More than one stock is exploited beyond MSY or is outside safe biological limits.</li> </ul>
<b>Issue 15: Excessive by-catch and discards</b> "By-catch refers to the incidental capture of fish or other animals that are not the target of the fisheries. Discards refers to dead fish or other animals that are returned to the sea."	<ul style="list-style-type: none"> <li>Current harvesting practices show no evidence of excessive by-catch and/or discards.</li> </ul>	<ul style="list-style-type: none"> <li>Up to 30% of the fisheries yield (by weight) consists of by-catch and/or discards.</li> </ul>	<ul style="list-style-type: none"> <li>30-60% of the fisheries yield consists of by-catch and/or discards.</li> </ul>	<ul style="list-style-type: none"> <li>Over 60% of the fisheries yield is by-catch and/or discards; or</li> <li>Noticeable incidence of capture of endangered species.</li> </ul>
<b>Issue 16: Destructive fishing practices</b> "Fishing practices that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities."	<ul style="list-style-type: none"> <li>No evidence of habitat destruction due to fisheries practices.</li> </ul>	<ul style="list-style-type: none"> <li>Habitat destruction resulting in changes in distribution of fish or shellfish stocks; or</li> <li>Trawling of any one area of the seabed is occurring less than once per year.</li> </ul>	<ul style="list-style-type: none"> <li>Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment; or</li> <li>Trawling of any one area of the seabed is occurring 1-10 times per year; or</li> <li>Incidental use of explosives or poisons for fishing.</li> </ul>	<ul style="list-style-type: none"> <li>Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment; or</li> <li>Trawling of any one area of the seabed is occurring more than 10 times per year; or</li> <li>Widespread use of explosives or poisons for fishing.</li> </ul>
<b>Issue 17: Decreased viability of stocks through contamination and disease</b> "Contamination or diseases of feral (wild) stocks of fish or invertebrates that are a direct or indirect consequence of human action."	<ul style="list-style-type: none"> <li>No evidence of increased incidence of fish or shellfish diseases.</li> </ul>	<ul style="list-style-type: none"> <li>Increased reports of diseases without major impacts on the stock.</li> </ul>	<ul style="list-style-type: none"> <li>Declining populations of one or more species as a result of diseases or contamination.</li> </ul>	<ul style="list-style-type: none"> <li>Collapse of stocks as a result of diseases or contamination.</li> </ul>
<b>Issue 18: Impact on biological and genetic diversity</b> "Changes in genetic and species diversity of aquatic environments resulting from the introduction of alien or genetically modified species as an intentional or unintentional result of human activities including aquaculture and restocking."	<ul style="list-style-type: none"> <li>No evidence of deliberate or accidental introductions of alien species; and</li> <li>No evidence of deliberate or accidental introductions of alien stocks; and</li> <li>No evidence of deliberate or accidental introductions of genetically modified species.</li> </ul>	<ul style="list-style-type: none"> <li>Alien species introduced intentionally or accidentally without major changes in the community structure; or</li> <li>Alien stocks introduced intentionally or accidentally without major changes in the community structure; or</li> <li>Genetically modified species introduced intentionally or accidentally without major changes in the community structure.</li> </ul>	<ul style="list-style-type: none"> <li>Measurable decline in the population of native species or local stocks as a result of introductions (intentional or accidental); or</li> <li>Some changes in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).</li> </ul>	<ul style="list-style-type: none"> <li>Extinction of native species or local stocks as a result of introductions (intentional or accidental); or</li> <li>Major changes (&gt;20%) in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).</li> </ul>

**Table 5: Scoring criteria for environmental impacts of Global change**

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
<p><b>Issue 19: Changes in hydrological cycle and ocean circulation</b>                      “Changes in the local/regional water balance and changes in ocean and coastal circulation or current regime over the last 2-3 decades arising from the wider problem of global change including ENSO.”</p>	<ul style="list-style-type: none"> <li>■ No evidence of changes in hydrological cycle and ocean/coastal current due to global change.</li> </ul>	<ul style="list-style-type: none"> <li>■ Change in hydrological cycles due to global change causing changes in the distribution and density of riparian terrestrial or aquatic plants without influencing overall levels of productivity; or</li> <li>■ Some evidence of changes in ocean or coastal currents due to global change but without a strong effect on ecosystem diversity or productivity.</li> </ul>	<ul style="list-style-type: none"> <li>■ Significant trend in changing terrestrial or sea ice cover (by comparison with a long-term time series) without major downstream effects on river/ocean circulation or biological diversity; or</li> <li>■ Extreme events such as flood and drought are increasing; or</li> <li>■ Aquatic productivity has been altered as a result of global phenomena such as ENSO events.</li> </ul>	<ul style="list-style-type: none"> <li>■ Loss of an entire habitat through desiccation or submergence as a result of global change; or</li> <li>■ Change in the tree or lichen lines; or</li> <li>■ Major impacts on habitats or biodiversity as the result of increasing frequency of extreme events; or</li> <li>■ Changing in ocean or coastal currents or upwelling regimes such that plant or animal populations are unable to recover to their historical or stable levels; or</li> <li>■ Significant changes in thermohaline circulation.</li> </ul>
<p><b>Issue 20: Sea level change</b>                      “Changes in the last 2-3 decades in the annual/seasonal mean sea level as a result of global change.”</p>	<ul style="list-style-type: none"> <li>■ No evidence of sea level change.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some evidences of sea level change without major loss of populations of organisms.</li> </ul>	<ul style="list-style-type: none"> <li>■ Changed pattern of coastal erosion due to sea level rise has become evident; or</li> <li>■ Increase in coastal flooding events partly attributed to sea-level rise or changing prevailing atmospheric forcing such as atmospheric pressure or wind field (other than storm surges).</li> </ul>	<ul style="list-style-type: none"> <li>■ Major loss of coastal land areas due to sea-level change or sea-level induced erosion; or</li> <li>■ Major loss of coastal or intertidal populations due to sea-level change or sea level induced erosion.</li> </ul>
<p><b>Issue 21: Increased UV-B radiation as a result of ozone depletion</b>                      “Increased UV-B flux as a result polar ozone depletion over the last 2-3 decades.”</p>	<ul style="list-style-type: none"> <li>■ No evidence of increasing effects of UV/B radiation on marine or freshwater organisms.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some measurable effects of UV/B radiation on behavior or appearance of some aquatic species without affecting the viability of the population.</li> </ul>	<ul style="list-style-type: none"> <li>■ Aquatic community structure is measurably altered as a consequence of UV/B radiation; or</li> <li>■ One or more aquatic populations are declining.</li> </ul>	<ul style="list-style-type: none"> <li>■ Measured/assessed effects of UV/B irradiation are leading to massive loss of aquatic communities or a significant change in biological diversity.</li> </ul>
<p><b>Issue 22: Changes in ocean CO<sub>2</sub> source/sink function</b>                      “Changes in the capacity of aquatic systems, ocean as well as freshwater, to generate or absorb atmospheric CO<sub>2</sub> as a direct or indirect consequence of global change over the last 2-3 decades.”</p>	<ul style="list-style-type: none"> <li>■ No measurable or assessed changes in CO<sub>2</sub> source/sink function of aquatic system.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some reasonable suspicions that current global change is impacting the aquatic system sufficiently to alter its source/sink function for CO<sub>2</sub>.</li> </ul>	<ul style="list-style-type: none"> <li>■ Some evidences that the impacts of global change have altered the source/sink function for CO<sub>2</sub> of aquatic systems in the region by at least 10%.</li> </ul>	<ul style="list-style-type: none"> <li>■ Evidences that the changes in source/sink function of the aquatic systems in the region are sufficient to cause measurable change in global CO<sub>2</sub> balance.</li> </ul>