ANNEXES

Annex I:
Global International Waters Assessment
Origin, objectives, workplan, teams and products

THE NEED FOR A GLOBAL INTERNATIONAL WATERS ASSESSMENT

Water is a vital life supporting resource, necessary for agriculture and other economic purposes, and for generating hydropower. Marine and freshwater ecosystems provide valuable resources in terms of fish and other aquatic living resources.

Globally, anthropogenic activities are degrading the world's water bodies. Aquatic ecosystems and human well-being are negatively impacted by dramatic changes in the flow regime of river basins, increasingly severe natural disasters, such as floods and droughts, greater pollution loads, and the overexploitation of virtually every commercial fishery. Furthermore, freshwater and marine habitats are directly modified by urban and infrastructure development. There is a growing public awareness and concern regarding the declining quality and quantity of the world's aquatic resources, resulting in mounting pressure on governments and decision makers to initiate new and innovative approaches to managing these resources in a sustainable manner to ensure their availability for future generations.

The management of the world's aquatic resources for the mutual benefit of all societies and the environment is an extremely complex task. Without the construction of reservoirs, dams and canals, water is free to flow wherever the laws of nature dictate. Water is therefore a vector transporting not only a wide variety of valuable resources but also problems from one area to another. The effluents emanating from environmentally destructive activities in upstream drainage areas are propagated downstream and can affect areas a

THE GLOBAL ENVIRONMENT FACILITY (GEF)

The Global Environment Facility forges international cooperation and finances actions to address six critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, ozone depletion, land degradation, and persistent organic pollutants (POPs). The overall strategic thrust of GEF-funded international waters activities is to meet the incremental costs of:

- Assisting groups of countries to better understand the environmental concerns of their international waters and work collaboratively to address them;
- Building the capacity of existing institutions to utilise a more comprehensive approach for addressing transboundary water-related environmental concerns;
- Implementing measures that address the priority transboundary environmental concerns.

The goal is to assist countries in using the full range of technical, economic, financial, regulatory, and institutional measures needed to operationalise sustainable development strategies for international waters.

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

United Nations Environment Programme, established in 1972, is the voice for the environment within the United Nations system. The mission of UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP work encompasses:

- Assessing global, regional and national environmental conditions and trends;
- Developing international and national environmental instruments;
- Strengthening institutions for the wise management of the environment;
- Facilitating the transfer of knowledge and technology for sustainable development;
- Encouraging new partnerships and mind-sets within civil society and the private sector.

UNIVERSITY OF KALMAR

The University of Kalmar hosts the GIWA Coordination Office and provides scientific advice and administrative and technical assistance to GIWA. The University of Kalmar is situated on the coast of the Baltic Sea. The city has a long tradition of higher education; teachers and marine officers have been educated in Kalmar since the middle of the 19th century. Today, natural science is a priority area that gives Kalmar a unique educational and research profile compared with other small universities in Sweden. Of particular relevance for GIWA is an established research programme in aquatic and environmental science. Issues linked to the concept of sustainable development are implemented by the university's Natural Resources Management and Agenda 21 Research School.

Since its establishment GIWA has grown to become an integral part of University activities. The GIWA Coordination Office and GIWA Core team are located at the Kalmarsund Laboratory, the university centre for water-related research. Senior scientists appointed by the University are actively involved in the GIWA peer-review and steering groups. As a result of this cooperation the University can offer courses and seminars related to GIWA objectives and international water issues.

considerable distance away from the source. In the case of transboundary river basins, such as the Amazon, Nile and Niger, the impacts are transported across national borders, thus affecting more than one riparian country. In the case of large oceanic currents, the impacts can even be propagated between continents. The inextricable linkages within, and between, freshwater and marine environments requires a drainage basin approach to managing aquatic resources.

In addition, there is a growing appreciation of the incongruence between the transboundary nature of many aquatic resources and the traditional introspective, nationally focused approaches to managing these resources. Water, unlike laws and management plans, does not respect national borders and, as a consequence, if future management of water and aquatic resources is to be successful, a shift in focus towards international cooperation and intergovernmental agreements is required. Furthermore, the complexity of managing the world's water resources is exacerbated by the dependence of a great variety of domestic and industrial activities on these resources. As a consequence, cross-sectoral, multidisciplinary approaches that integrate environmental, socio-economic and development aspects into management must be adopted. Many assessments of aquatic resources are conducted by local, national, regional and international bodies. They often concentrate on specific themes, such as biodiversity or persistent toxic substances, or focus on marine or freshwater systems separately. A globally coherent assessment that embraces the inextricable links between transboundary freshwater and marine systems, and between environmental and societal issues, had never previously been undertaken but was clearly needed.

INTERNATIONAL CALL FOR ACTION

The need for a holistic assessment of transboundary waters was acknowledged by several international environmental organisations. The Global Environment Facility (GEF) recognised that its international waters component suffered due to the lack of a global assessment that could provide a clear understanding of the nature and root causes of international water problems, and that could indicate priorities for project intervention. The urgent need for an assessment of the causes of environmental degradation was also highlighted at

INTERNATIONAL WATERS AND TRANSBOUNDARY ISSUES

The term 'international waters', as used for the purposes of the GEF Operational Strategy, includes the oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries, as well as rivers, lakes, groundwater systems, and wetlands with transboundary drainage basins or common borders. The water-related ecosystems associated with these waters are considered integral parts of the systems.

The term 'transboundary issues' is used to describe the threats to the aquatic environment linked to globalisation, international trade, demographic changes and technological advancement, in addition to those created through transboundary movement of water. Single-country policies and actions inadequately cope with these transboundary problems.

The 'international waters area' includes numerous international conventions, treaties, and agreements. The architecture of marine agreements is especially complex, and a large number of bilateral and multilateral agreements exist for transboundary freshwater basins. Related conventions and agreements in other areas increase further the complexity. These initiatives provide a new opportunity for cooperating nations to integrate many different programmes and instruments into comprehensive regional approaches in order to address the challenges to international waters.

the UN General Assembly Special Session on the Environment in 1997, and demonstrated through commitments by the UN Commission on Sustainable Development on freshwater in 1998, and seas in 1999. In 1997, two international declarations, the 'Potomac Declaration: Towards Enhanced Ocean Security into the Third Millennium,' and the 'Stockholm Statement on Interaction of Land activities, Freshwater and Enclosed Seas,' also emphasised the need for an investigation of the root causes of the degradation of the transboundary aquatic environment and options for addressing them.

These interests finally led to the development of the Global International Waters Assessment (GIWA) and its inauguration in 1999. The importance of GIWA was further underscored by the United Nations Millennium Declaration adopted by the UN General Assembly in 2000, and particularly the Plan of Implementation of the World Summit on Sustainable Development (WSSD) in 2002. The Plan calls for inter alia: integrated river basin management and increased understanding of the long-term sustainability of freshwater, coastal and marine environments; integrated assessment at the global and regional levels for the conservation and management of living and non-living marine resources; and the use of environmental impact assessments in decision making processes. The GIWA project was intended to provide information to support the implementation of such plans.

CONCEPTUAL FRAMEWORK AND OBJECTIVES

The primary objectives of GIWA are:

- To provide a prioritising mechanism that allows GEF to focus its resources so that they are used in the most cost-effective manner to achieve significant environmental benefits, at national, regional and global levels; and
- To highlight areas in which governments can develop and implement strategic policies to reduce environmental degradation and improve the management of aquatic resources.

To meet these objectives and address some of the current inadequacies of international aquatic resources management, GIWA has incorporated four essential elements into its design:

UNEP WATER POLICY AND STRATEGY

The primary goals of the UNEP water policy and strategy are:

- Achieving greater global understanding of freshwater, coastal and marine environments by conducting environmental assessments in priority areas;
- Raising awareness of the importance and consequences of unsustainable water use;
- Supporting the efforts of governments in the preparation and implementation of integrated management of freshwater systems and their related coastal and marine environments;
- Providing support for the preparation of integrated management plans and programmes for aquatic environmental hotspots, based on the assessment results;
- Promoting the application by stakeholders of precautionary, preventive and anticipatory approaches.

- A broad transboundary approach that provides a truly regional perspective by incorporating expertise and existing information from all nations in the region, and by assessing the major factors that influence the aquatic resources of the region;
- A drainage basin approach integrating freshwater and marine systems;
- A multidisciplinary approach integrating environmental and socio-economic information and expertise; and
- A coherent assessment that provides globally comparable results.

GIWA builds on previous assessments implemented within the GEF International Waters portfolio but has developed and adopted a broader definition of transboundary waters to include factors that influence the quality and quantity of global aquatic resources. GIWA recognises the importance of hydrological units that would not normally be considered transboundary but exert a significant influence on transboundary waters, such as the Yangtze River in China, which discharges into the East China Sea, and the Volga River in Russia, which is principally responsible for changes to the Caspian Sea. Furthermore, GIWA is a regional assessment that has incorporated data from a wide range of sources and includes expert knowledge and information from a variety of sectors in each country of a region. The transboundary concept adopted by GIWA includes impacts caused by globalisation,

international trade, demographic changes and technological advances, and recognises the need for international cooperation to successfully address these issues.

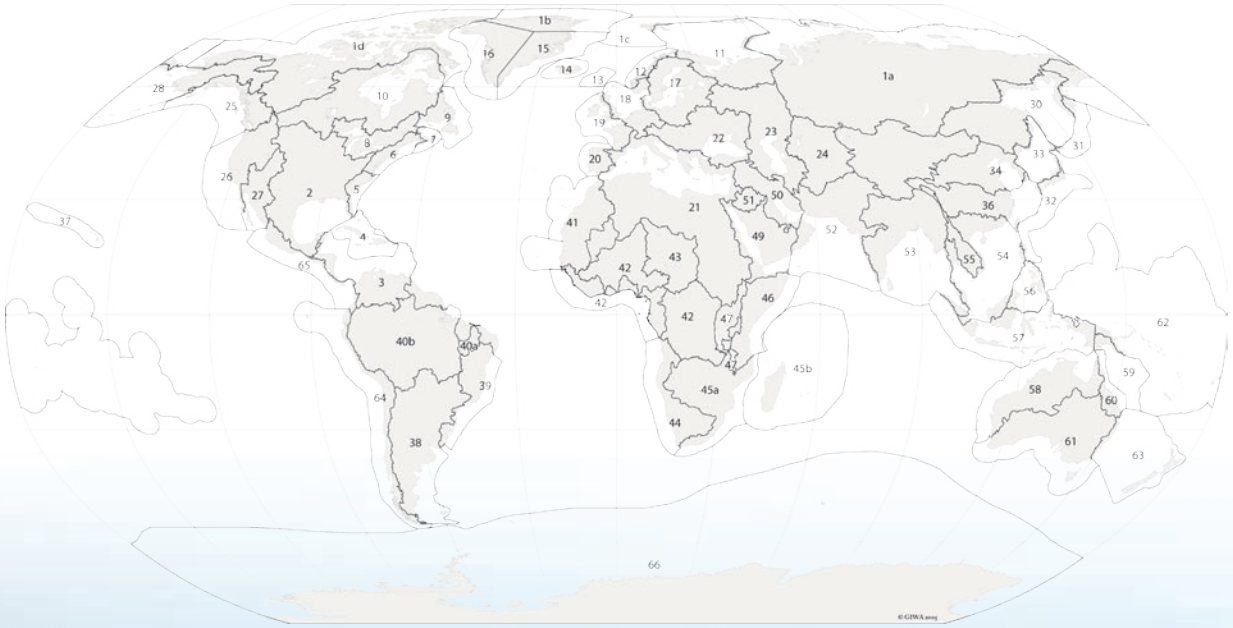
SCALE AND METHODOLOGY OF THE ASSESSMENT

In order to be consistent with the transboundary nature of many of the world's aquatic resources and the focus of GIWA, the geographical units being assessed have been designed according to the drainage basins of discrete hydrographic systems rather than political borders. The geographic units were determined during the preparatory phase of the project and resulted in the division of the world into 66 regions defined by the entire area of one or more catchments that drain into a single designated marine system. These marine systems often correspond to Large Marine Ecosystems (LMEs). Some of the regions were later reconfigured and divided into sub-systems which were assessed individually by separate teams. Not all of the 66 regions were assessed by GIWA. Priority was given to GEF-eligible regions, i.e. developing regions and regions with transitional economies.

LARGE MARINE ECOCSYSTEMS

Large Marine Ecosystems (LMEs) are ocean regions encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margin of the major current systems. They are relatively large regions on the order of 200 000 km^2 or greater, characterised by distinct: (i) bathymetry; (ii) hydrography; (iii) productivity; and (iv) trophically dependent populations.

The Large Marine Ecosystems strategy is a global effort for the assessment and management of international coastal waters. It was developed in direct response to a declaration at the 1992 Rio Summit. As part of the strategy, the World Conservation Union (IUCN) and National Oceanic and Atmospheric Administration (NOAA) have cooperated in an action programme to assist developing countries in planning and implementing an ecosystem-based strategy that is focused on LMEs as the principal assessment and management unit for coastal ocean resources. The LME concept has also been adopted by GEF, which recommends the use of LMEs and their contributing freshwater basins as the geographic area for integrating sectoral economic activities.



1a Russian Arctic (4 LMEs)
1b Arctic Greenland (LME)
1c Arctic European/Atlantic
1d Arctic North American
2 Gulf of Mexico (LME)
3 Caribbean Sea (LME)
4 Caribbean Islands (LME)
5 Southeast Shelf (LME)
6 Northeast Shelf (LME)
7 Scotian Shelf (LME)
8 Gulf of St Lawrence
9 Newfoundland Shelf (LME)
10 Baffin Bay, Labrador Sea, Canadian Archipelago
11 Barents Sea (LME)
12 Norwegian Sea (LME)
13 Faroe plateau
14 Iceland Shelf (LME)
15 East Greenland Shelf (LME)
16 West Greenland Shelf (LME)
17 Baltic Sea (LME)
18 North Sea (LME)
19 Celtic-Biscay Shelf (LME)
20 Iberian Coastal Sea (LME)
21 North Africa and Nile River Basin (LME)
22 Black Sea (LME)
23 Caspian Sea
24 Aral Sea
25 Gulf of Alaska (LME)
26 California Current (LME)
27 Gulf of California (LME)
28 Bering Sea (LME)
30 Sea of Okhotsk (LME)
31 Oyashio Current (LME)
32 Kuroshio Current (LME)
33 Sea of Japan (LME)
34 Yellow Sea (LME)
36 East China Sea (LME)
37 Hawaiian Archipelago (LME)
38 Patagonian Shelf (LME)
39 Brazil Current (LME)
40a Northeast Brazil Shelf (2 LMEs)
40b Amazon
41 Canary Current (LME)
42 Guinea Current (LME)
43 Lake Chad
44 Benguela Current (LME)
45a Agulhas Current (LME)
45b Indian Ocean Islands
46 Somali Coastal Current (LME)
47 East African Rift Valley Lakes
49 Red Sea and Gulf of Aden (LME)
50 Euphrates and Tigris River Basin
51 Jordan
52 Arabian Sea (LME)
53 Bay of Bengal
54 South China Sea (2 LMEs)
55 Mekong River
56 Sulu-Celebes Sea (LME)
57 Indonesian Seas (LME)
58 North Australian Shelf (LME)
59 Coral Sea Basin
60 Great Barrier Reef (LME)
61 Great Australian Bight
62 Pacific Islands
63 Tasman Sea
64 Humboldt Current (LME)
65 Eastern Equatorial Pacific (LME)
66 Antarctic (LME)

FIGURE 1. THE TRANSBOUNDARY REGIONS ASSESSED BY THE GIWA PROJECT

In consideration of the objectives of GIWA and the elements incorporated into its design, a innovative methodology for the implementation of the assessment was developed during the initial phase of the project.

A holistic, region-by-region assessment of the world's transboundary aquatic resources had never been undertaken before and therefore a new methodology was required. A multidisciplinary, multi-sectoral, multinational approach was developed. The methodology is now available as a platform for future international assessments of aquatic resources.

The methodology focuses on five major environmental concerns; freshwater shortage, pollution, overfishing and other threats to aquatic living resources, habitat and community modification, and global change. The root causes, including global trends, policy, legislation, governance, institutional capacity and knowledge, are also analysed. Wherever possible, the causal chain analysis was followed by policy option analysis which outlined potential courses of action that aim to mitigate or resolve environmental and socio-economic problems in the region.

For a detailed description of the GIWA methodology, see Annex II.

GIWA REGIONAL ASSESSMENTS

The regional reports

The results of the GIWA assessment for each region are presented in the regional reports. These reports provide a brief physical and socio-economic description of the most important features of the region. The remaining sections of the report present the results of each stage of the assessment. Each regional report is reviewed by at least two external reviewers in order to ensure scientific validity and applicability.

The project has published 23 regional and thematic assessments in printed form (or in preparation for print) and on the web, and a further 12 are available online at www.giwa.net (see list below and the fold-out map inside of the front cover).

Regional reports printed or in preparation for print

Region 1a. Russian Arctic
Region 3a. Caribbean Sea/Small Islands
Region 3b/c. Caribbean Sea/Orinoco, Magdalena, Catatumbo/Central America, Mexico
Region 4. Caribbean Islands
Region 11. Barents Sea
Region 17. Baltic Sea
Region 23. Caspian Sea
Region 24. Aral Sea
Region 30. Sea of Okhotsk
Region 31. Oyashio Current
Region 38. Patagonian Shelf
Region 39. Brazil Current
Region 40b. Amazon
Region 43. Lake Chad
Region 45b. Indian Ocean Islands
Region 47. East African Rift Valley Lakes
Region 54. South China Sea
Region 55. Mekong River
Region 62. Pacific Islands
Region 64. Humboldt Current
Region 65. Eastern Equatorial Pacific

Printed thematic reports

Region 22. Black Sea. Transboundary waters in the Black Sea – Danube region; legal and financial implications.
Region 22. Black Sea. Eutrophication in the Black Sea region – impact assessment and causal chain analysis.

Published on web

Region 1b. Arctic Greenland
Region 13. Faroe Plateau
Region 15. East Greenland Shelf
Region 16. West Greenland Shelf
Region 27. Gulf of California
Region 36. East China Sea
Region 34. Yellow Sea
Region 41. Canary Current
Region 42. Guinea Current
Region 44. Benguela Current
Region 56. Sulu-Celebes Sea
Region 57. Indonesian Seas

To obtain copies of the printed reports, please contact:
Division of Early Warning and Assessment,
United Nations Environment Programme,
PO Box 30552, Nairobi 00100, Kenya,
Tel: +254 20 762-4299, Fax: +254 20 762-4269,
Email: dewainfo@unep.org.

The global network

In each of the GIWA regions, the assessment was conducted by a team of local experts led by a Focal Point (Figure 2). The Focal Point can be an individual, institution or organisation that has been selected on the basis of their scientific reputation and experience in implementing international assessment projects. The Focal Point is responsible for assembling members of the team and ensuring that it has the necessary expertise and experience in a variety of environmental and socio-economic disciplines. The selection of the team members is one of the most critical elements for the success of GIWA. In order to ensure that the most relevant information is incorporated into the assessment, team members were selected from a variety of institutions, such as universities, research institutes, government agencies and the private sector. The teams included representatives from each country in the region.

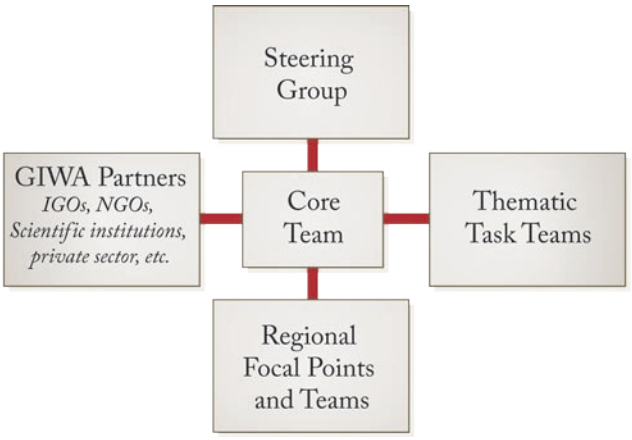


FIGURE 2. THE ORGANISATION OF THE GIWA PROJECT

In total, almost 1 500 experts contributed to the GIWA project, building strong local ownership for the reports and creating a global network of experts and institutions that can facilitate the exchange of experiences and expertise.

The regional assessments would have been impossible without the remarkable efforts of all regional task teams. UNEP appreciates the work and contributions of the teams to GIWA, particularly the focal points:

Russian Arctic ..... Alla Tsyban
Arctic Greenland..... Mogens Dyhr-Nielsen
Gulf of Mexico ..... Alejandro Yáñez-Arancibia
Caribbean Sea..... Francisco A. Arias-Isaza
Caribbean Islands..... Antonio Villasol Nunez
Barents Sea ..... Natalia Golubeva
East Greenland Shelf ... Mogens Dyhr-Nielsen
West Greenland Shelf .. Mogens Dyhr-Nielsen
Baltic Sea ..... Ain Lääne
Black Sea..... Felix Stolberg, Olena Borysova, Valery Michailov
Caspian Sea..... Felix Stolberg, Olena Borysova, Rovshan Mahmudov
Aral Sea ..... Felix Stolberg, Olena Borysova, Igor Severskiy
Gulf of California..... Edgar Arias Patron, Omar Vidal
Bering Sea..... Suzanne Marcy
Sea of Okhotsk ..... Arkady V. Alekseev
Oyashio Current..... Arkady V. Alekseev
Kuroshio Current ..... Roger Juliano
Sea of Japan..... Arkady V. Alekseev
Yellow Sea..... Teng Seng-Keh
East China Sea ..... Jing Zhang
Patagonian Shelf..... Ana Mugetti
Brazil Current..... Marcia Marques
Northeast Brazil Shelf .. Maria Irles de Oliveira Mayorga
Amazon ..... Ronaldo Borges Barthem
Canary Current ..... Mhammed Tayaa
Guinea Current ..... Jean Folack, Julius Wellens-Mensah
Lake Chad ..... Johnson A. Oguntola
Benguela Current ..... Kim Prochazka
Agulhas Current..... Chris Magadza
Indian Oceans Islands .. Rolph Antoine Payet
Somali Coastal Current Renison K. Ruwa
East African Rift Valley Lakes..... Eric Odada
Red Sea & Gulf of Aden..... Habib N. El-Habr, Najah T. Mistafa
Euphrates and Tigris River Basin ..... Habib N. El-Habr, Najah T. Mistafa
Jordan..... Habib N. El-Habr
Bay of Bengal..... Jayampathy Samarakoon
South China Sea..... Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
Mekong River..... Anond Snidvongs
Sulu-Celebes Sea ..... Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
Indonesian Seas ..... Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
North Australian Shelf. Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
Coral Sea Basin ..... Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
Great Barrier Reef..... Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
Great Australian Bight. Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
Pacific Islands..... Fabián Eguiguren Valdivieso
Tasman Sea..... Clive Wilkinson, Lyndon DeVantier, Russell Reichelt
Humboldt Current ..... Ulises Munaylla Alarcón
Eastern Equatorial Pacific..... Ulises Munaylla Alarcón

MANAGEMENT OF GIWA

The project was implemented by the United Nations Environment Programme (UNEP), in collaboration with the University of Kalmar, Sweden, with financial support from GEF (68%), the Swedish International Development Cooperation Agency (Sida) (18%), the Ministry for Foreign Affairs of Finland (10%), the Norwegian government, the Municipality of Kalmar, the University of Kalmar and UNEP. The funds were mainly used to support assessments of GEF-eligible regions. Assessments of GEF non-eligible regions were conducted by various international and national organisations as in-kind contributions to GIWA.

The GIWA project, managed by the UNEP/GIWA Core team, was comprised of the following staff:
Scientific Director: Dag Daler (2000-2005), Per Wramner (1999-2000).
Coordinator for the Northern Hemisphere: Elina Rautalahti-Miettinen (2000-2005).
Coordinator for the Southern Hemisphere: Juan Carlos Belausteguigoitia (2002-2005), Nick Mandeville (1999-2000).
Coordinator for Sub-Saharan Africa: Edith Mussukuya (2001-2004).

Officers from the UNEP Headquarters who liaised with the GIWA core team included Salif Diop, Ahmed Djoghlaf, Vladimir Mamaev, John Pernetta, Takehiro Nakamura, Pinya Sarasas, Dik Tromp, Isabelle Vanderbeck.

The GIWA project was guided by a Steering Group consisting of representatives from the following agencies and scientific bodies:
UNEP/DEWA as chair of the Steering Group: Dan Claasen, Timothy Foresman, Steve Lonergan.
UNEP/DGEF: John Pernetta, Vladimir Mamaev.
GEF Secretariat: Alfred M. Duda.
GEF/STAP: Angela Wagener, Alexei Maximov.
ACOPS: Jubomir Jeftic, Viktor Sebek.
ANA: Jerson Kelman.
CAS: Jing Zhang.
Ministry for Foreign Affairs of Finland: Eero Kontula.
GESAMP: Stjepan Keckes, Michael E. Huber.
GWP: Kahlid Mohtadullah, Emilio Gabrielli, Erik Skoglund, Björn Guterstam.
Municipality of Kalmar: Anders Engström, Lars Malmborg.
Ministry of the Environment, Norway: Per W. Schive, Hanne-Grethe Nilsen.
NOAA: Kenneth Sherman.
SCOPE: Gotthilf Hempel who also served as the GIWA Ambassador.
SEI: Arno Rosemarin.
Sida: Kent Blom, Mats Segnestam, Bengt Johansson, Mats Eriksson.
University of Kalmar: Åke Hagström.
UNDP: Andrew Hudson.
The World Bank: Inesis Kiskis, Stephen F. Lintner.
WWC: Vanessa Lemaire-Drinkwater.

During the development of GIWA, a number of experts made significant contributions, especially in the development of its unique methodology. UNEP would like to acknowledge the following:

Olena Borysova, John Dixon, William Hogland, Norman Lee, Olof Lindén, Marcia Marques, Laurence Mee, Anond Snidvongs, Felix Stolberg, Galina Titova.

A special acknowledgement is extended to the University of Kalmar, which served as the executing agency, for its outstanding team of hardworking and devoted staff comprising of the following individuals:

Scientific team for the regional reports:
Scientific Advisor: Erik Arrhenius (1999-2001), Olof Lindén, who also served as Acting Coordinator for the Southern Hemisphere (2000-2001, 2005), Ulla Li Zweifel (2002-2003, 2005).

Supporting scientific team
Petre Badulescu (1999-2000), Ye Chun, (2001-2002), Sara Gräslund (2001), Bertil Hägerhäll also served as acting Coordinator for the Northern Hemisphere (1999-2000), Linda Holm (2001), Marcia Marques (2000-2004), Göran Rudbäck, Liaison Officer (1999-2001), Susanna Stymne Airey (2001), Bo Wiman (1999-2000).

Editorial team for the regional reports:
Scientific Editor: Ulla Li Zweifel (2002-2004).
Supporting editors: Kristin Bertilius (2003-2005), Pierre Blime (2004), Johanna Egerup (2003-2005), Giovanna Fistarol Salomon (2004), Matthew Fortnam (2003-2005), Rasmus Göransson (2005), Niklas Holmgren (2003-2005), Malin Karlsson (2002-2005), Marianne Lindström (2003-

2005), Eva Lövbrand (2002-2003), Najah Mistafa (2002-2005), Sanna Mels (2004-2005), Joakim Palmqvist (2001-2005), George Roman (2004), David Souter (2001-2004), Monique Stolte (2003, 2005).

Information & web team
Åse Allberg (2001-2002), Peter Dietrich (2000-2001), Britt Hägerhäll (1999-2000), Elisabet Idermark (2002-2005).

Administration team
Elisabeth Andersson (2003-2004), Maria Carlson (2002), Niklas Carlsson (2004), Lena Månsson (2000-2005), Caisa Oskarsson (1999-2005).

University of Kalmar administration & scientific support:
Björn Lange (2002-2005), Ulf Lidman (2002-2005), Bengt Sedvall (1999-2001).

Between 2002 and 2005, 10 interns from various parts of the world participated in the GIWA project to learn and gain experience in the field of international waters.

Special thanks are also given to: the UNEP Collaborating Centre on Water and Environment for its in-kind contribution to a number of regional assessments and for its staff, in particular Per Bögelund-Hansen, Mogens Dyhr-Nielsen and Niels Ipsen; UNEP Grid Arendal, in particular Hugo Ahlenius, Lars Kullerud, Philippe Rekacewicz and Svein Tveitdahl; and to David Aubrey, Mike Bewer, Johan Holmberg, Jeff Thornton.

Annex II: GIWA methodology

The specific objective of GIWA was to conduct a holistic and globally comparable assessment of the world's transboundary aquatic resources. To achieve this, the assessment incorporated both environmental and socio-economic factors and recognised the inextricable links between freshwater and marine environments. GIWA enables GEF to focus its resources and provide guidance to governments and decision-makers. The combination of all these elements into a single coherent methodology had not previously been attempted and therefore posed a significant challenge.

The GIWA methodology was achieved through an interactive process, guided by a Methods Task team comprised of experts with water, environmental assessment and socio-economic backgrounds. The preliminary versions of the methodology underwent extensive external peer reviews and preliminary testing in selected regions, the results of which were incorporated into the final GIWA methodology.

TABLE 1. PRE-DEFINED GIWA CONCERNS AND THEIR CONSTITUENT ISSUES ADDRESSED WITHIN THE ASSESSMENT

GIWA concerns	Environmental issues
Freshwater shortage	Modification of stream flow Pollution of existing supplies Changes in the water table
Pollution	Microbiological Eutrophication Chemical Suspended solids Solid wastes Thermal Radionuclide Spills
Overfishing and other threats to aquatic living resources	Overexploitation Excessive by-catch and discards Destructive fishing practices Decreased viability of stock through pollution and disease Impact on biological and genetic diversity
Habitat and community modification	Loss of ecosystems Modification of ecosystems
Global change	Changes in hydrological cycle Sea level change Increased UV-B radiation as a result of ozone depletion Changes in ocean CO_2 source/sink function

Considering the significant regional disparities in terms of the quality, quantity and availability of data, and socio-economic and environmental conditions, an innovative approach was required to achieve global comparability. The assessment focuses on the impacts of five pre-defined concerns in transboundary waters: freshwater shortage, pollution, habitat and community modification, overfishing and other threats to aquatic living resources, and global change. These encompass a diversity of issues which were grouped under the five concerns. In total, the impacts of 22 issues were evaluated (see Table 1).

The assessment integrated 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. The assessment was implemented by conducting 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 their collective knowledge and experience. The results were substantiated with the best available information, which is presented in the regional reports.

The GIWA methodology can be divided into four logical steps: i) Scaling defines the geographic extent of the region; ii) Scoping identifies and prioritises problems based on the magnitude of their impacts on the environment and human societies in the region; iii) Causal chain analysis (CCA) determines the root causes of those problems; and iv) Policy options analysis (POA) assesses various policy options that address those root causes in order to reverse negative trends in the condition of the aquatic environment. These four steps are summarised below and are fully described in two documents: 'GIWA Methodology Stage 1: Scaling and Scoping' and 'GIWA Methodology: Detailed Assessment, Causal Chain Analysis and Policy Options Analysis' (Figure 1).

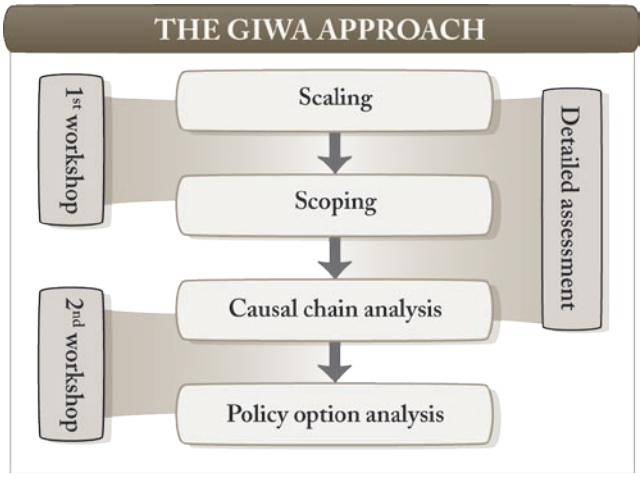


FIGURE 1. THE GIWA ASSESSMENT APPROACH

Scaling – Defining the geographic extent of the region

Scaling defines the geographic scale of the assessment. The world was divided into 66 contiguous regions that are generally defined by a large but discrete drainage basin and its adjacent coastal waters, rather than political boundaries. In many cases, the boundaries of the marine areas coincided with those of Large Marine Ecosystems (LMEs) as defined by the US National Oceanic and Atmospheric and Administration (NOAA). During scaling, the regional teams inspected the boundaries proposed for the region during the preparatory phase of GIWA. If necessary, they revised the boundaries to remove important overlaps or gaps with neighbouring regions. The regional teams identified all the transboundary elements of the region's aquatic environment and determined whether they could be assessed as a single coherent aquatic system or if there were two or more independent systems that should be assessed separately. Other regional teams decided to merge their region with an adjacent region. The following changes were made:

- The Arctic/1 was divided into the Russian Arctic/1a, Arctic Greenland/1b, Arctic European/Atlantic/1c and Arctic North America/1d.
- The Amazon/40 was divided into the Northeast Brazil Shelf/40a and Amazon/40b.
- The Agulhas Current/45 was divided into Agulhas Current/45a and Indian Ocean Islands/45b.
- The East Bering Sea/28 and West Bering Sea/29 were merged into the Bering Sea/28.
- The Yellow Sea/34 and Bohai Sea/35 became the Yellow Sea (Yellow Sea/34a) and Yellow Sea (Bohai Sea/34b).
- The Gulf of Aden/48 and Red Sea/49 were merged into the Red Sea and Gulf of Aden/49.

Some regional teams decided to undertake separate assessments for transboundary water systems identified within their region. Often this included assessing the LME separately from the transboundary river basin. The Guinea Current/42 regional team, for example, assessed five sub-systems: Comoe Basin/42a; Volta Basin/42b; Niger Basin/42c; Congo Basin/42d; and Guinea Current LME/42e. Altogether, assessments were undertaken in 74 regions and sub-systems.

When analysing the results of the GIWA assessments in this global synthesis, the regions were grouped into the following mega-regions: Arctic Rim; Europe & Central Asia; North America; Central America; South America; Sub-Saharan Africa; North Africa & the Middle East; Northeast Asia; Southeast Asia; Australia & Pacific Islands; and the Antarctic.

Scoping – Assessing the GIWA concerns

Scoping assessed the severity of environmental and socio-economic impacts caused by each of the five pre-defined GIWA concerns and their constituent issues. It is not designed to provide an exhaustive review of water-related problems that exist within each region, but instead identified the most urgent transboundary problems in the region and prioritised the most important issues for remedial actions. The priorities determined by Scoping are one of the main outputs of the GIWA project.

Focusing on pre-defined concerns and issues ensures comparability between the assessment results of the different regions. The magnitude of the environmental and socio-economic impacts caused by each issue was assessed for the entire region using the best available information obtained from a wide range of sources and the knowledge and experience of the regional experts. In order to increase the global comparability of the results, to remove bias caused by different perceptions of the severity of the impacts, and to encourage consensus amongst the team, the issues were evaluated using a standardised scoring system involving a four-point scale:

0 = no impact reported
1 = slight impact
2 = moderate impact
3 = severe impact

Each issue was scored according to a detailed set of pre-defined criteria that are used to guide experts in the assessment. For example, the criteria for assigning a score of 3 to the issue 'loss of ecosystems or ecotones' is: permanent destruction of at least one habitat, reducing its surface area by >30% over the last 2-3 decades. The full list of criteria for environmental and socio-economic impacts is presented in Tables 7-16 at the end of this Annex.

A trade-off associated with assessing the impacts of each concern and their constituent issues for an 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 for an entire region, it does not mean that the entire region suffers from 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 the degree of eutrophication, the size of the area affected, the socio-economic impacts and the number of people affected are of sufficient overall severity to meet the criteria defining a severe problem and that regional actions should be initiated in order to mitigate the impacts of this problem.

Once each issue has been scored, it is weighted according to the relative contribution it makes to the overall environmental impacts of the concern and a weighted average score for each of the five concerns is calculated (Table 2).

The socio-economic impacts are assessed for each concern, not each issue. The socio-economic impacts are grouped into three categories; economic impacts, health impacts and other social and community impacts (Table 3-5). For each category, the size, degree and frequency of the impact is evaluated and a weighted average score is calculated for the overall socio-economic impacts of each concern.

In addition, to ensure the long-term applicability of the options that were developed to mitigate these aquatic concerns, Scoping not only assessed the current impacts of these concerns and issues but also predicted the future impacts according to the "most likely scenario", which considers demographic, economic, technological and other relevant changes that will potentially influence the aquatic environment in the region by 2020.

In order to identify which concern is the top priority for the region, a final overall score is calculated based on the present and future scores of the environmental and socio-economic impacts of each concern. The prioritised concern is then analysed further in the CCA and POA. In the example presented in Table 6, the scoping assessment indicated that habitat and community modification was the priority concern in this region. The top priority concern(s) identified by the numerical outcome should correspond with the knowledge of the experts in the team and should be substantiated with supporting information.

However, in cases where the numerical results did not yield consensus among the regional experts in terms of

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 ECONOMIC IMPACT ASSESSMENT OF FRESHWATER SHORTAGE

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small ◄ Very large 0 1 2 3	2	50
Degree of impact (cost, output changes etc.)	Minimum ◄ Severe 0 1 2 3	2	30
Frequency/Duration	Occasional/Short ◄ Continuous 0 1 2 3	2	20
Weight average score for Economic impacts		**2**	

TABLE 4. EXAMPLE OF HEALTH IMPACT ASSESSMENT OF FRESHWATER SHORTAGE

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

TABLE 5. EXAMPLE OF OTHER SOCIAL AND COMMUNITY IMPACT ASSESSMENT OF FRESHWATER SHORTAGE

Criteria for Other social and community impacts	Raw score	Score	Weight %
Number and/or size of community affected	Very small ◄ Very large 0 1 2 3	2	50
Degree of severity	Minimum ◄ Severe 0 1 2 3	2	30
Frequency/Duration	Occasional/Short ◄ Continuous 0 1 2 3	2	20
Weight average score for Other social and community impacts		**2**	

TABLE 6. EXAMPLE OF THE COMPARATIVE ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF EACH MAJOR CONCERN, AT PRESENT AND BY 2020

Concern	Type of impact								
	Environmental score		Economic score		Human health score		Social and community score		Overall 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	2.3
Pollution	1.5	2.0	2.0	2.3	1.8	2.3	2.0	2.3	2.0
Overfishing and other threats to aquatic living resources	1.8	2.2	2.0	2.1	2.0	2.1	2.4	2.5	2.1
Habitat and community modification	2.0	3.0	2.4	3.0	2.4	2.8	2.3	2.7	2.6
Global change	0.8	1.0	1.5	1.7	1.5	1.5	1.0	1.0	1.2

the ranking of priorities, the team continued by assigning weights to the relative importance of present and potential future impacts. Similarly, the team assigned weights indicating the relative contribution of environmental and socio-economic factors. The team should then recalculate the weighted average score for each concern taking into account both present and future impacts and environmental and socio-economic factors. The outcomes of these additional analyses are then subjected to further discussion to identify the overall priorities of the region.

The assessment recognises that the five GIWA concerns interact with each other. For example, pollution can destroy aquatic habitats that are essential for fish reproduction, which in turn can cause a decline in fish stocks and subsequent overexploitation. Once the priority concern for the region is agreed, the team should highlight the links between the concerns in order to identify where strategic interventions could be applied to yield the greatest benefits for the environment and human societies in the region.

Causal chain analysis

The causal chain analysis (CCA) traces the cause-effect pathways of the prioritised transboundary issues; from the socio-economic and environmental impacts back to their root causes. The CCA aims to identify the most important drivers of the aquatic concerns, so that they can be targeted by policy measures in order to prevent further degradation of the region's aquatic environment.

Root causes are not always easily identifiable because they are often separated, spatially or temporally, 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 varying local circumstances, the GIWA CCA is not a rigidly structured analysis but rather a guiding framework. Ideally, the CCA would be conducted 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. It was therefore necessary to develop a relatively simple and practical analytical CCA model.

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 difficulties in developing broadly applicable policy strategies, the GIWA CCA focuses on a particular system and the issues that have been prioritised during the scoping assessment. The prioritised issue and its related environmental and socio-economic impacts are the starting point for the CCA. The next element in the 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 include:

- Increased nutrient inputs and concentrations
- Trapping of nutrients in stagnant water
- River and stream alterations
- Run-off and storm water

The sectors of human activity that contribute most significantly to the immediate cause are then determined. Assum-

ing that the most important immediate cause in the example is increased nutrient concentrations, the most likely source of those nutrients would be from the agricultural, urban or industrial sectors. After identifying the sectors that are primarily responsible for the immediate causes, the root causes acting on these sectors are established. For example, if agriculture is found to be primarily responsible for the increased nutrient concentrations, the root causes may be:

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

Policy options

Despite considerable efforts by many governments and other organisations to address transboundary water problems, there is still much to be done. An important characteristic of GIWA's policy option analysis is that its recommendations are firmly based on a better understanding of the root causes of the problems. Freshwater scarcity, water pollution, overfishing, and habitat modification are complex phenomena. The policy options analysis (POA) consists of two tasks:

Construct policy options

Policy options are different courses of action that aim to solve or mitigate environmental and socio-economic problems in the region. Although a variety of policy options could be constructed to address each root cause identified in the CCA, only those with the greatest likelihood of success were analysed by GIWA.

Select and apply the criteria against 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 GIWA are envisioned as contributions to a larger policy process. As such, the GIWA methodology, which was developed to test the performance of various options under various circumstances, was kept simple and broadly applicable.

GIWA ASSESSMENT CRITERIA FOR SOCIO-ECONOMIC IMPACTS

Socio-economic impact categories:

- **Economic impacts:** The key economic and public service sectors that are affected by the degradation of the aquatic environment should be identified and their relative importance to the regional economy assessed. The degree to which the quantity and quality of their output has been reduced and their costs of operation increased should be similarly assessed. Finally, the frequency and duration of the impacts should be determined.
- **Human health impacts:** The approximate number and types of people affected should be identified, the nature and degree of severity of the health impacts should be assessed and the frequency and duration of the impacts should be determined.
- **Other social and community impacts:** The number, size and principal characteristics (e.g. presence of vulnerable groups) of the affected communities should be determined, as well as the aspects of community life affected. The extent to which community life is affected and the frequency of these impacts should also be assessed.

Three broad criteria are considered when scoring the degree of severity (0-3) of the impacts:

- Size of the population or economic and public sectors affected (categorised as: very small; small; medium; and large).
- Degree of severity of the socio-economic impacts experienced (minimum; small; moderate; severe).
- Likely duration of the impacts (ranging from very occasional/very short-term to continuous/long-term).

TABLE 7. SCORING CRITERIA FOR THE ENVIRONMENTAL IMPACTS OF FRESHWATER SHORTAGE

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 1: Modification of stream flow "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."	■ No evidence of modification of stream flow.	■ There is a measurably changing trend in annual river discharge at gauging stations in a major river or tributary (basin >40 000 km²); or ■ There is a measurable decrease in the area of wetlands (other than as a consequence of conversion or embankment construction); or ■ There is a measurable change in the interannual mean salinity of estuaries or coastal lagoons and/or change in the mean position of an estuarine salt wedge or mixing zone; or ■ Change in the occurrence of exceptional discharges (e.g. due to upstream damming.	■ 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 >250 000 km²; or ■ Loss of >20% of flood plain or deltaic wetlands through causes other than conversion or artificial embankments; or ■ Significant loss of riparian vegetation (e.g. trees, flood plain vegetation); or ■ Significant saline intrusion into previously freshwater rivers or lagoons.	■ Annual discharge of a river altered by more than 50% of the long-term mean; or ■ Loss of >50% of riparian or deltaic wetlands over a period of not less than 40 years (through causes other than conversion or artificial embankment); or ■ Significant increased siltation or erosion due to changes in flow regime (other than normal fluctuations in flood plain rivers); or ■ Loss of one or more anadromous or catadromous fish species for reasons other than physical barriers to migration, pollution or overfishing.
Issue 2: Pollution of existing supplies "Pollution of surface and ground fresh water supplies as a result of point or diffuse sources"	■ No evidence of pollution of surface and groundwaters.	■ Any monitored water in the region does not meet WHO or national drinking water criteria, other than for natural reasons; or ■ There have been reports of one or more fish kills in the system due to pollution within the past five years.	■ Water supplies do not meet WHO or national drinking water standards in more than 30% of the region; or ■ There are one or more reports of fish kills due to pollution in any river draining a basin of >250 000 km² .	■ Rivers draining more than 10% of the basin have suffered polysaprobic conditions, no longer support fish, or have suffered severe oxygen depletion ■ Severe pollution of other sources of freshwater (e.g. groundwater)
Issue 3: Changes in the water table "Changes in aquifers as a direct or indirect consequence of human activity"	■ No evidence that abstraction of water from aquifers exceeds natural replenishment.	■ Several wells have been deepened because of excessive aquifer draw-down; or ■ Several springs have dried up; or ■ Several wells show some salinisation.	■ Clear evidence of declining base flow in rivers in semi-arid areas; or ■ Loss of plant species in the past decade that depend on the presence of groundwater; or ■ Wells have been deepened over areas of hundreds of km²;or ■ Salinisation over significant areas of the region.	■ Aquifers are suffering salinisation over regional scale; or ■ Perennial springs have dried up over regionally significant areas; or ■ Some aquifers have become exhausted

TABLE 8. SCORING CRITERIA FOR SOCIO-ECONOMIC IMPACTS OF FRESHWATER SHORTAGE

Loss of agricultural uses (crops, livestock, aquaculture)	Reduced availability of fish as food	Increased damage to water-related equipment
Loss of human drinking water supplies	Loss of waste assimilative capacity	Damage to infrastructure
Loss of recreational use or aesthetic values	Increased costs of alternative water supplies	Increased costs of deepening wells and pumping
Loss of hydroelectric power production	Reduction in future use options	Population migration
Loss of coastal harbours and inland transport	Human health impacts	Transboundary implications
Loss of industrial uses	Reduced agriculture productivity (crops, livestock, aquaculture)	Increased vulnerability to sea level rise
Increased potential for upstream/downstream conflicts	Increased intake treatment costs	

TABLE 9. 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
Issue 4: Microbiological pollution "The adverse effects of microbial constituents of human sewage released to water bodies."	■ Normal incidence of bacterial related gastroenteric disorders in fisheries products for consumers and no fisheries closures or advisories.	■ There is a minor increase in incidence of bacterial related gastroenteric disorders in fisheries products for consumers but no fisheries closures or advisories.	■ Public health authorities aware of marked increase in the incidence of bacterial related gastroenteric disorders in fisheries products for consumers; or ■ There are limited area closures or advisories reducing the exploitation or marketability of fisheries products.	■ There are large closure areas or very restrictive advisories affecting the marketability of fisheries products; or ■ There exists widespread public or tourist awareness of hazards resulting in major reductions in the exploitation or marketability of fisheries products.
Issue 5: Eutrophication "Artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients, including cultural eutrophication in lakes."	■ No visible effects on the abundance and distributions of natural living resource distributions in the area; and ■ No increased frequency of hypoxia or fish mortality events or harmful algal blooms associated with enhanced primary production; and ■ No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality; and ■ No evident abnormality in the frequency of algal blooms.	■ Increased abundance of epiphytic algae; or ■ A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (>20 year) data sets; or ■ Measurable shallowing of the depth range of macrophytes.	■ Increased filamentous algal production resulting in algal mats; or ■ Medium frequency (up to once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.	■ High frequency (>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 ■ Significant changes in the littoral community; or ■ Presence of hydrogen sulphide in historically well oxygenated areas.

Issue 6: Chemical pollution "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."	■ No known or historical levels of chemical contaminants except background levels of naturally occurring substances; and ■ No fisheries closures or advisories due to chemical pollution; and ■ No incidence of fisheries product tainting; and ■ No unusual fish mortality events. If there is no available data use the following criteria: ■ No use of pesticides; and ■ No sources of dioxins and furans; and ■ No regional use of PCBs; and ■ No bleached kraft pulp mills using chlorine bleaching; and ■ No use or sources of other contaminants.	■ Some chemical contaminants are detectable but below threshold limits defined for the country or region; or ■ Restricted area advisories regarding chemical contamination of fisheries products. If there is no available data use the following criteria: ■ Some use of pesticides in small areas; or ■ Presence of small sources of dioxins or furans (e.g. small incineration plants or bleached kraft/pulp mills using chlorine); or ■ Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns; or ■ Presence of other contaminants.	■ Some chemical contaminants are above threshold limits defined for the country or region; or ■ Large area advisories by public health authorities concerning fisheries product contamination but without associated catch restrictions or closures; or ■ High mortalities of aquatic species near outfalls. If there is no available data use the following criteria: ■ Large-scale use of pesticides in agriculture and forestry; or ■ Presence of major sources of dioxins or furans such as large municipal or industrial incinerators or large bleached kraft pulp mills; or ■ Considerable quantities of waste PCBs in the area with inadequate regulation or has invoked some public concerns; or ■ Presence of considerable quantities of other contaminants.	■ Chemical contaminants are above threshold limits defined for the country or region; and ■ 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 ■ Large-scale mortalities of aquatic species. If there is no available data use the following criteria: ■ Indications of health effects resulting from use of pesticides; or ■ Known emissions of dioxins or furans from incinerators or chlorine bleaching of pulp; or ■ Known contamination of the environment or foodstuffs by PCBs; or ■ Known contamination of the environment or foodstuffs by other contaminants.
Issue 7: Suspended solids "The adverse effects of modified rates of release of suspended particulate matter to water bodies resulting from human activities"	■ No visible reduction in water transparency; and ■ No evidence of turbidity plumes or increased siltation; and ■ No evidence of progressive riverbank, beach, other coastal or deltaic erosion.	■ 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 ■ Some evidence of changes in benthic or pelagic biodiversity in some areas due to sediment blanketing or increased turbidity.	■ Markedly increased or reduced turbidity in small areas of streams and/or receiving riverine and marine environments; or ■ Extensive evidence of changes in sedimentation or erosion rates; or ■ Changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity.	■ 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 ■ Major change in pelagic biodiversity or mortality due to excessive turbidity.
Issue 8: Solid wastes "Adverse effects associated with the introduction of solid waste materials into water bodies or their environs."	■ No noticeable interference with trawling activities; and ■ No noticeable interference with the recreational use of beaches due to litter; and ■ No reported entanglement of aquatic organisms with debris.	■ Some evidence of marine-derived litter on beaches; or ■ Occasional recovery of solid wastes through trawling activities; but ■ Without noticeable interference with trawling and recreational activities in coastal areas.	■ Widespread litter on beaches giving rise to public concerns regarding the recreational use of beaches; or ■ High frequencies of benthic litter recovery and interference with trawling activities; or ■ Frequent reports of entanglement/suffocation of species by litter.	■ Incidence of litter on beaches sufficient to deter the public from recreational activities; or ■ Trawling activities untenable because of benthic litter and gear entanglement; or ■ Widespread entanglement and/or suffocation of aquatic species by litter.
Issue 9: Thermal "The adverse effects of the release of aqueous effluents at temperatures exceeding ambient temperature in the receiving water body."	■ No thermal discharges or evidence of thermal effluent effects.	■ Presence of thermal discharges but without noticeable effects beyond the mixing zone and no significant interference with migration of species.	■ Presence of thermal discharges with large mixing zones having reduced productivity or altered biodiversity; or ■ Evidence of reduced migration of species due to thermal plume.	■ Presence of thermal discharges with large mixing zones with associated mortalities, substantially reduced productivity or noticeable changes in biodiversity; or ■ Marked reduction in the migration of species due to thermal plumes.
Issue 10: Radionuclide "The adverse effects of the release of radioactive contaminants and wastes into the aquatic environment from human activities."	■ No radionuclide discharges or nuclear activities in the region.	■ Minor releases or fallout of radionuclides but with well regulated or well-managed conditions complying with the Basic Safety Standards.	■ 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.	■ 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 ■ Some indication of situations or exposures warranting intervention by a national or international authority.
Issue 11: Spills "The adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities."	■ No evidence of present or previous spills of hazardous material; or ■ No evidence of increased aquatic or avian species mortality due to spills.	■ Some evidence of minor spills of hazardous materials in small areas with insignificant small-scale adverse effects one aquatic or avian species.	■ 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 ■ Some evidence of aquatic or avian species mortality through increased presence of contaminated or poisoned carcasses on beaches.	■ Widespread contamination by hazardous or aesthetically displeasing materials from frequent spills resulting in major interference with aquatic resource exploitation or coastal recreational amenities; or ■ Significant mortality of aquatic or avian species as evidenced by large numbers of contaminated carcasses on beaches.

TABLE 10. SCORING CRITERIA FOR SOCIO-ECONOMIC IMPACTS OF POLLUTION

Increased risks to human health
Increased costs of human health protection
Loss of water supplies (e.g. potable water)
Increased costs of water treatment
Costs of preventive medicine
Costs of medical treatment
Costs of clean-up
Loss of tourism or recreational values
Loss of aesthetic values
Loss in fisheries
Costs of increased fisheries product processing
Change in fisheries value
Reduced options for aquaculture development
Risk to aquaculture
Loss of property values

Costs of weed control
Loss of wildlife sanctuaries
Costs of increased navigational clearance, navigational surveys or dredging activities
Increased costs of fish surveillance in the case of toxin incidence
Costs of reduced fish marketability due to aesthetic perceptions
Loss of protected areas
Reduction in options for other uses of freshwater
Potential for international conflicts
Loss of reservoir storage capacity
Damage to equipment (e.g. particle impacts)
Increased costs of coastal protection from waves/ storm surges/erosion
Costs of cleaning intakes
Endangerment of species

Increased costs of animal protection (esp. endangered species)
Displacement of valued species
Avoidance of amenities and products due to perceptions of effects of contamination
Costs of public reassurance
Maintenance of monitoring and radiological protection activities for public reassurance purposes
Costs of preventive measures (e.g. tanker design/ construction)
Costs of contingency measures
Costs of litigation
Costs of insurance
Costs of disruption to shipping, marine reserves and marine scientific activities during survey and clean-up of spills

TABLE 11. SCORING CRITERIA FOR ENVIRONMENTAL IMPACTS OF OVERFISHING AND OTHER THREATS TO AQUATIC LIVING RESOURCES

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 14: Overexploitation "The capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock."	■ No harvesting of fish with commercial gear for sale or subsistence.	■ Commercial harvesting exists but there is no evidence of overexploitation.	■ One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits.	■ More than one stock is exploited beyond MSY or is outside safe biological limits.
Issue 15: Excessive by-catch and discards "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."	■ Current harvesting practices show no evidence of excessive by-catch and/or discards.	■ Up to 30% of the fisheries yield (by weight) consists of by-catch and/or discards.	■ 30-60% of the fisheries yield consists of by-catch and/or discards.	■ Over 60% of the fisheries yield is by-catch and/or discards; or ■ Noticeable incidence of capture of endangered species.
Issue 16: Destructive fishing practices "Fishing practices that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities."	■ No evidence of habitat destruction due to fisheries practices.	■ Habitat destruction resulting in changes in distribution of fish or shellfish stocks; or ■ Trawling of any one area of the seabed occurs less than once per year.	■ Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment; or ■ Trawling of any one area of the seabed occurs 1-10 times per year; or ■ Incidental use of explosives or poisons for fishing.	■ Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment; or ■ Trawling of any one area of the seabed occurs more than 10 times per year; or ■ Widespread use of explosives or poisons for fishing.
Issue 17: Decreased viability of stocks through contamination and disease "Contamination or diseases of feral (wild) stocks of fish or invertebrates that are a direct or indirect consequence of human action."	■ No evidence of increased incidence of fish or shellfish diseases.	■ Increased reports of diseases without major impacts on the stock.	■ Declining populations of one or more species as a result of diseases or contamination.	■ Collapse of stocks as a result of diseases or contamination.
Issue 18: Impact on biological and genetic diversity "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."	■ No evidence of deliberate or accidental introductions of alien species; and ■ No evidence of deliberate or accidental introductions of alien stocks; and ■ No evidence of deliberate or accidental introductions of genetically modified species.	■ Alien species introduced intentionally or accidentally without major changes in the community structure; or ■ Alien stocks introduced intentionally or accidentally without major changes in the community structure; or ■ Genetically modified species introduced intentionally or accidentally without major changes in the community structure.	■ Measurable decline in the population of native species or local stocks as a result of introductions (intentional or accidental); or ■ Some changes in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).	■ Extinction of native species or local stocks as a result of introductions (intentional or accidental); or ■ Major changes (>20%) in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).

TABLE 12. SCORING CRITERIA FOR SOCIO-ECONOMIC IMPACTS OF OVERFISHING AND OTHER THREATS TO AQUATIC LIVING RESOURCES

Reduced economic returns	Loss of food sources (e.g. sources of protein) for human or animal consumption	Increased risks of predation, competition and/or disease for commercially valuable species
Loss of employment / livelihood	Reduced earnings in one area by destruction of juveniles in other areas (migrating populations)	Inter-generational equity issues (access to resources)
Potential new employment possibilities	Loss of protected species	Possible human health impacts
Improved catch/earnings	Reduced commercial value resulting from tainting	
Conflict between user groups for shared resources including space		

TABLE 13. 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
Issue 12: Loss of ecosystems or ecotones "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."	■ There is no evidence of loss of ecosystems or habitats.	■ There are indications of fragmentation of at least one of the habitats.	■ Permanent destruction of at least one habitat is occurring such as to have reduced the surface area by up to 30 % during the last 2-3 decades.	■ Permanent destruction of at least one habitat is occurring such as to have reduced the surface area by >30% during the last 2-3 decades.
Issue 13: Modification of ecosystems or ecotones, including community structure and/or species composition "Modification of pre-defined habitats in terms of extinction of native species, occurrence of introduced species and changes in ecosystem function and services over the last 2-3 decades."	■ No evidence of change in species complement due to species extinction or introduction; and ■ No changes in ecosystem function and services.	■ Evidence of change in species complement due to species extinction or introduction	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure; and ■ Evidence of change in ecosystem services[1].

[1] CONSTANZA ET AL. (1997).

TABLE 14. SCORING CRITERIA FOR SOCIO-ECONOMIC IMPACTS OF HABITAT AND COMMUNITY MODIFICATION

Reduced capacity to meet basic human needs (food, fuel) for local populations	Loss of opportunity for investment income and foreign exchange from former ecosystem (e.g. loss of materials for potential pharmaceutical products)	Costs of responding to risks
Changes in employment opportunities for local populations and associated changes in social structures	Human conflicts, national and international	Intergenerational inequity
Loss of aesthetic values / recreational values for local populations	Loss of educational and scientific values	Modification or loss of cultural heritage
Loss of existing income and foreign exchange from fisheries, tourism, etc.	Increased risks to human population and capital investment	Costs of controlling invasive species
	Loss of land due to loss of physical protection	Costs of restoration of modified ecosystems

TABLE 15. 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
Issue 19: Changes in hydrological cycle and ocean circulation "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."	■ No evidence of changes in hydrological cycle and ocean/coastal current due to global change.	■ 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 ■ Some evidence of changes in ocean or coastal currents due to global change but without a strong effect on ecosystem diversity or productivity.	■ Significant trend in changing terrestrial or sea ice cover (in comparison with a long-term time series) without major downstream effects on river/ocean circulation or biological diversity; or ■ Extreme events such as flood and drought are increasing; or ■ Aquatic productivity has been altered as a result of global phenomena such as ENSO events.	■ Loss of an entire habitat through desiccation or submergence as a result of global change; or ■ Change in the tree or lichen lines; or ■ Major impacts on habitats or biodiversity as the result of increasing frequency of extreme events; or ■ Changes 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 ■ Significant changes in thermohaline circulation.
Issue 20: Sea level change "Changes in the last 2-3 decades in the annual/seasonal mean sea level as a result of global change."	■ No evidence of sea level change.	■ Some evidences of sea level change without major loss of populations of organisms.	■ Changed pattern of coastal erosion due to sea level rise has became evident; or ■ 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).	■ Major loss of coastal land areas due to sea level change or sea level induced erosion; or ■ Major loss of coastal or intertidal populations due to sea level change or sea level induced erosion.
Issue 21: Increased UV/B radiation as a result of ozone depletion "Increased UV/B flux as a result of polar ozone depletion over the last 2-3 decades."	■ No evidence of increasing effects of UV/B radiation on marine or freshwater organisms.	■ Some measurable effects of UV/B radiation on behaviour or appearance of some aquatic species without affecting the viability of the population.	■ Aquatic community structure is measurably altered as a consequence of UV/B radiation; or ■ One or more aquatic populations are declining.	■ Measured/assessed effects of UV/B irradiation are leading to massive loss of aquatic communities or a significant change in biological diversity.
Issue 22: Changes in ocean CO_2 source/sink function "Changes in the capacity of aquatic systems, ocean as well as freshwater, to generate or absorb atmospheric CO_2 as a direct or indirect consequence of global change over the last 2-3 decades."	■ No measurable or assessed changes in CO_2 source/sink function of aquatic system.	■ Some reasonable suspicions that current global change is impacting the aquatic system sufficiently to alter its source/sink function for CO_2.	■ Some evidence that the impacts of global change have altered the source/sink function for CO_2 of aquatic systems in the region by at least 10%.	■ Evidence that the changes in source/sink function of the aquatic systems in the region are sufficient to cause measurable change in global CO_2 balance.

TABLE 16. SCORING CRITERIA FOR SOCIO-ECONOMIC IMPACTS OF GLOBAL CHANGE

Freshwater availability	Human migration	Loss of income and employment
Food security	Damage to human life and property	Loss of property & capital assets
Employment security	Response costs for extreme events	Loss of incomes and foreign exchange from fisheries
Changes in productivity of agriculture, fisheries and forestry	Costs for avoiding navigational hazards	Loss of opportunity for investments (both domestic and foreign)
Changes in resources distribution and political jurisdiction over them	Increased costs of coast protection and emergency response/forecast	Increased costs of human health care

Annex III: GIWA's key: Causal chain and policy options analysis in a theoretical perspective

GIWA was created "to develop a comprehensive, strategic framework for the identification of priorities for remedial and mitigatory actions in international waters". Establishing priorities for actions implies not only an assessment of the severity of the problems but also an analysis of what can be done to solve or mitigate these problems. One of the salient characteristics of the GIWA assessment is that its recommendations are based on understanding the root causes of the problems. Freshwater scarcity, water pollution, unsustainable exploitation of living resources and habitat destruction are complex phenomena. Policy options that are grounded in a better understanding of these problems will contribute to the creation of more effective responses to the extremely complex water-related transboundary problems.

ROOT CAUSES

In order to identify root causes, GIWA regional teams conducted causal chain analyses. A causal chain is a series of hypotheses that link a problem with its effects and causes. The GIWA causal chain methodology includes immediate and root causes. Immediate causes are physical, biological or chemical factors that directly influence the system under analysis. Two examples of immediate causes are increased nutrients (in the case of eutrophication) and water diversions (in the case of freshwater shortage). A root cause operates in an indirect way by forcing immediate causes to exert a greater pressure on the system. Root causes may be divided into three groups. The first group contains the factors that explain policy failures. The second group encompasses factors that shape the behaviour of those who consume water and water-related resources. The last group includes general trends and conditions that affect the demand for and supply of water and water-related resources. Figure 1 illustrates the links among immediate causes, root causes, environmental problems and human welfare.

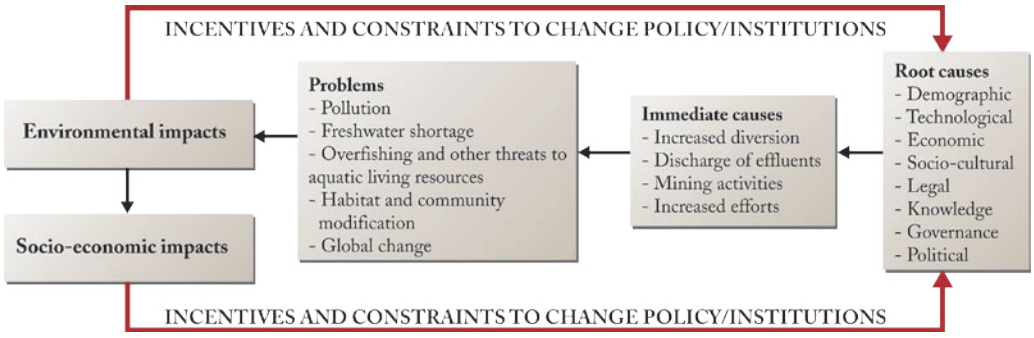


FIGURE 1. THE GIWA CAUSAL CHAIN ANALYSIS

Policy-related root causes

Policy-related root causes refer to the reasons why government actions (or the lack of them) contribute to increased pressures on aquatic ecosystems. Policy-related root causes attempt to explain two forms of policy failure. The first one refers to policy interventions that create or aggravate an environmental problem. A public project of low but inflated economic return and high (but underestimated or neglected) environmental impacts, and an energy or fuel subsidy to extract groundwater are two examples of this form of policy failure. The second form of policy failure refers to the lack of interventions when they are needed and could be realised in an efficient, effective and equitable way. What are the causes of these two forms of policy failure?

The GIWA regional reports look at failures of government policies to perform three essential functions: (i) detecting signals and distributing information; (ii) reaching agreements

that balance stakeholder interests; and (iii) implementing, as well as enforcing, these agreements (World Bank 2003). In order to perform these essential functions, governments require enabling legal and organisational frameworks, as well as the ability to mobilise the required financial resources.

Detecting changes

The first vital institutional function is the ability to detect signals of changes and trends that affect the status of human activities and their impact on aquatic ecosystems. Signals take various forms. In the Volta Basin (Guinea Current 42/b), in Sub-Saharan Africa, the combination of climatic changes and increased damming led to a reduction of 30% of the region's headwaters, with an associated reduction of up to 50% of the stream flow in some catchments, while the water demand increased by 600%. The governments of Burkina Faso and Ghana failed to take into account this drastic change. In just a few years, water scarcity and misuse of the remaining supplies had translated into a negative trade balance for agricultural products, farmland loss, as well as the resettlement and migration of a large percentage of the population. Monitoring the balance of ecosystems between their status and the human demand for their services, as well as detecting signals of such changes and predicting their potential impact, could have triggered the right policy response at the right time (World Bank 2003).

Providing information

In addition to the collection and monitoring of key aquatic ecosystem data, such as stocks, flows and quality, as well as information on all the human-environment mechanisms affecting them, the proper and timely distribution of information to the right stakeholders is essential. This is why local assessments are so important. Local assessments allow institutional organisations not only to gather knowledge, but also to distribute it to key stakeholders, allowing them in turn to make well-informed decisions. In a transboundary water context, 'providing information' also means that governments need to share data and decisions that will affect their common aquatic resources.

Balancing interests

The failure to balance interests in international waters is a frequent cause of environmental and socio-economic problems. The balancing of interests has several dimensions. The most obvious is the international dimension, but balancing the interests of different sectoral users (e.g. agriculture, energy, industry, fisheries, households, etc.) is also a clear dimension. Perhaps the most difficult balance is between direct use to meet human needs and environmental preservation. Human uses need to be allocated in a way that ensures the sustainability of ecological and hydrological systems.

This balancing of interests should be conducted at different levels. At a project planning level, water infrastructure projects should contain a complete evaluation of social, economic and environmental costs and benefits. During the allocation decision making process, the interests of the different users and the environment should be voiced. In the course of court processes or private negotiations, information should be used to establish an understanding of the sufferers of a transboundary pollution problem and the contributors to that problem.

Executing decisions and inducing compliance

The execution of policy decisions is essential in order to have their intended impact; decision making alone is clearly not enough. Even if a more efficient and equitable legal and organisational framework for water allocation is adopted, if there are no incentives for users, or the authorities lack the commitment to penalise or reverse transgressions, the implementation of that decision will probably fail. How are policy decisions implemented and enforced? Much environmental regulation has been 'command and control', where governments require or prohibit specific actions or technologies, with potential fines or jail terms for those who do not follow the rules. If sufficient resources are made available for monitoring and enforcement, command and control approaches are effective. But when governments lack the will or resources to guard 'protected areas', when major environmental damage comes from hard-to-detect sources, and when there is a need to encourage innovation in behaviours or technologies rather than to require or prohibit familiar ones, command and control approaches are less effective. Other approaches may be more effective. Voluntary approaches and those based on information disclosure have only begun to receive the attention they deserve as supplements to other tools. Success appears to depend on the existence of incentives that benefit leaders in volunteering over laggards and on the simultaneous use of other strategies, particularly ones that create incentives

for compliance. The difficulties created by sanctioning pose major problems for international agreements.

Behavioural root causes

Environmental problems in international waters (freshwater shortage, pollution, overfishing and habitat modification) are, to a great extent, the result of human activities that use natural resources and produce pollution. Environmental problems in international waters are not the result of a conspiracy of any specific group, nor are they attributable simply to negligence, ineptitude or malevolence. They are the result of ordinary people doing ordinary things; farmers irrigating their lands, fishermen catching fish, and households and industry using water. Problems are aggravated by faulty social coordination mechanisms. Users do not take into account the impact that their actions impose on other people. Water is particularly difficult to manage because all life and all sectors of the economy depend on water and, because of this, all users are interdependent. This basic fact gives rise to two questions: (i) what are the factors that determine/influence the ways in which people use water and water-related resources?; and (ii) how can user behaviour that threatens social welfare and environmental sustainability be discouraged, and behaviour that enhances social welfare and environmental sustainability be encouraged? This section answers the first question and provides the foundations for the policy options section to answer the second.

Culture and sense of community

Culture and sense of community affect the way people relate to aquatic ecosystems. There are at least three ways in which culture impacts this relationship. Firstly, culture can have a major impact on economic behaviour through its effect on work ethics, motivation, and attitudes towards risk, among other factors. Secondly, culture influences political participation. The culture of participation can be essential to the management of aquatic ecosystems. Finally, culture moulds social solidarity and association. Apart from economic and political interactions, the preservation and guardianship of common assets (like community-managed fisheries) is largely influenced by what members of a social group may voluntarily do for each other.

Laws

The way in which people use natural resources depends on a number of issues, but one critical aspect is the property rights that govern the use of those resources. In this context, property rights refer to a bundle of entitlements that define the owner's privileges and limitations on the use of the resource. Property rights can be vested with different agents, for example, individuals, the state and in groups of people. Each of these has numerous subtypes, and a myriad of hybrids exists as well. Regulations affect people's behaviour by proscribing certain conduct (as in the case of a mandatory technology) or performance (as in the cases of limits on fish catches or pollution effluents). Both laws and regulations are enforced by the threats of administrative penalties (fines, loss of licenses, etc.) or, in some cases, imprisonment.

Education and training

Education and training can alter attitudes and beliefs about environmental problems. They shape the behaviour of individuals by increasing their knowledge of a problem, by convincing them that the severity of the problem calls for their personal involvement, and by preparing the person to be able to take specific actions to help mitigate the problem.

Economic considerations

Economic considerations (especially prices and wealth) affect people's production and consumption decisions. Prices play three critical roles in market economies: (i) they match supply and demand of goods and services (as a commodity becomes dearer, consumers reduce consumption and producers increase supply); (ii) they allocate goods and services; and (iii) they prevent wasteful use of resources (input prices can have a considerable effect on their usage). Unfortunately, in the case of environmental services, the price system often fails to perform these functions.

Economic possibilities

People's behaviour depends on their economic situation. The role of poverty deserves special attention. Establishing causal links between poverty and environmental degradation is complex and debatable. There are many examples of poor communities that have managed their resources in a sustainable way. The impact of poverty on the environment ultimately depends on the alternatives that poor people have to generate income, invest in conservation and procure food, water and energy. These alternatives in turn depend on institutional factors like the definition of property rights (uncertainties of property rights are common among poor farmers

and poor fishermen) and access to markets (access to credit seems particularly important in this context).

Technology

Finally, with regard to technology, GIWA case studies have focused on the reasons why environmentally friendly technologies are not used. Lack of enforcement of environmental regulations is the first, and most obvious, explanation. Insufficient information is another natural explanation. Information is a public good and, as such, markets will in general fail to provide it. The way in which sectors are organised may also pose a problem for the efficient diffusion of environmentally friendly technologies (e.g. fishermen may get their gear from processing firms or from traders). Uncertainty is another potential reason for the slow adoption of environmentally friendly technologies. Producers and consumers may wonder whether new technologies will perform as expected. Lack of access to credit to finance the acquisition of innovative technologies may also play a part, especially in the case of the poor. Finally, cultural conformity and inertia may also be part of the explanation for the slow (or non) adoption of innovative environmentally friendly technologies.

General conditions

General conditions include population dynamics (growth, geographical distribution and migration), economic growth and natural phenomena (e.g. El Niño). A larger population requires more goods and services, which in turn requires more water for food, energy and industrial production. Half of the Earth's population lives in coastal areas, and that proportion is expected to grow. This trend, coupled with urbanisation, will exert additional pressure on fragile aquatic ecosystems. Economic growth also affects the demand for goods and services provided by aquatic ecosystems. Trade, one of the engines of economic growth, poses special challenges and opportunities for resource management.

POLICY OPTIONS ANALYSIS

The last step in identifying "priorities for remedial and mitigatory actions in international waters" consists of analysing policy options to address the priority problems. The GIWA policy analysis is preliminary; it is designed to screen options that deserve a more detailed assessment which will be transferred to stakeholders so that the options can be further analysed in the decision-making processes. The analysis summarises the views of regional experts in different disciplines and is meant to provide policy makers with a practical and systematic way to evaluate the pros and cons of different policy instruments. Policy analysis must be tailor-made to suit the particular conditions (environmental, economic, social, political and administrative) of the problem. The GIWA methodology is based on a list of tasks and choices designed to make the methods and conclusions transparent. Accordingly, each regional team followed this approach.

The task list contains the following items:

- Problem definition;
- Assembling evidence and information;
- Identifying instruments;
- Selecting evaluation criteria and evaluating outcomes; and
- Selection of actions.

The definition of the problem is the link between the policy options analysis and the rest of the GIWA methodology. The scoping phase identifies the priority problem and the causal chain analysis establishes the immediate and root causes. The problem definition combines the priority problem and its most important immediate causes. For example, in the case where pollution results from eutrophication, and run-off from fertilizers is the only immediate cause, the problem definition might be: "there is too much nutrient run-off from fertilizers".

The second task is to assemble evidence and information about the environmental and the socio-economic context of the problem. The information gathered should help answer the following questions:

- Who are the stakeholders and what are their interests?
- What is the institutional background for the situation (laws, regulations, norms, traditions, authorities, etc.)?
- What are the roles, responsibilities and capabilities of different authorities (e.g. sub-national and national governments)?
- What is the status of the ecosystem and what are the important ecosystem processes for the area of concern?

The third task is to identify policy instruments. It is useful to divide policy instruments into two groups, depending on whether or not they are aimed at changing human behaviour. The policy instruments aimed at changing human behaviour can in turn be divided into the following categories (World Bank 1997):

- Using markets;
- Creating markets;
- Using environmental regulations;
- Engaging the public; and
- Developing international environmental agreements.

Using existing markets to provide economic incentives to change people's behaviour may be very effective. Unfortunately, prices often do not promote sustainable use of natural resources, for two reasons. Firstly, certain subsidies lower the financial cost of overexploiting a natural resource or polluting the environment. The other reason is that usually when it comes to goods and services linked to natural resources and the environment, market prices only reflect private costs and benefits, disregarding the effects on other people or on the environment. The prices of pesticides and fertilizers that pollute watercourses do not reflect the social and environmental costs that their use imposes on others. The main categories of instruments that rely on existing markets and some examples of their use are shown in Table 1.

TABLE 1. INSTRUMENTS FOR USING EXISTING MARKETS

Instrument	Example
Subsidies reduction	Energy to pump groundwater Pesticides
Targeted subsidies	Payment for non-marketable ecological services
Taxes	Pesticides Effluent taxes
User charges	Irrigation water
Deposit refund systems	Plastic bottles
Performance bonds	Tourism development of coastal areas Hazardous pollutants management

Policy instruments based on existing markets have two positive characteristics: Firstly, they are, frequently, easy to implement and they may have positive fiscal impacts (as in the case of reducing subsidies or levying taxes on goods or services that have a negative environmental impact). The main disadvantage of this family of instruments is that most of them are politically difficult to implement because they impose an additional financial burden on users of water and water-related resources. An additional disadvantage is that existing markets sometimes only target the real problem in an indirect way (e.g. using the markets of agro-chemicals to address pollution).

Creating markets can also provide positive incentives for people to alter their behaviour in a socially and environmentally positive way. Many environmental goods (or problems like pollution) and services do not have their own markets. This lack of markets discourages the production of environmental services and encourages the creation of environmental problems. If the owners of wetlands were paid for the environmental services that their properties offer, land use changes would diminish. Similarly, if polluters had to pay for the amount of pollution they generate, pollution would decrease. The main categories of instruments that rely on creating markets and some examples of their use are shown in Table 2.

TABLE 2. INSTRUMENTS FOR CREATING NEW MARKETS

Instrument	Example
Establishing property rights	Water markets
Tradable permits and rights	Tradable fishing quotas Tradable effluent rights

The main advantage of these types of instruments is that they target the actual problem in a direct way, getting the incentives right and encouraging cost-effective solutions for environmental problems. Their main disadvantages are that they require solid institutions for their implementation and that they may be costly to implement.

Regulations are the most common type of instrument to address environmental and natural resource problems. The reasons for this are mainly due to their intuitive simplicity and to the fact that they frequently match the interests of both the authorities and the regulated community. The main categories of instruments that rely on regulations and some examples of their use are shown in Table 3.

TABLE 3. INSTRUMENTS FOR REGULATIONS

Instrument	Example
Action (technology) standards	Boat and mesh sizes Zoning Bans
Performance standards	Effluent standards Total allowable catch quotas

Conditions that favour the use of regulations include:

- Unacceptably high costs of even minor quantities of a pollutant (or any undesired effect);

- A minimal number of polluters;
- Monitoring results is expensive while monitoring technologies is simple; and
- There is one clearly superior technology.

Perhaps the most important disadvantage of regulations is that authorities misuse them easily (because of their intuitive appeal) when regulators do not consider all the direct and indirect costs that regulations impose. An additional problem is the risk that regulators may identify themselves with the interests of the regulated community rather than with the interests of society as a whole (including the regulated community).

Engaging the public means providing people with more information and giving stakeholders the opportunity to participate in the decision-making process. Lack of information can be an obstacle to more environmentally friendly behaviour because the links between individual behaviours and their environmental impacts may be difficult to understand from personal experiences. Providing more information allows the public to act in the economic and political arenas to demand better environmental quality. In the economic arena, consumers can affect production processes by demanding environmentally friendly products. In the political arena, information can trigger political demands for a better environment. Information can also help producers improve their environmental performance, as in the case of best practices and information on the environmentally correct application of certain inputs, like pesticides.

Public participation in decision-making processes is the other major way to engage the public to solve or mitigate environmental problems. One of the main features of environmental problems is that some decision-making processes may not always consider the interests of all stakeholders. Increased participation to improve environmental quality may be achieved at different levels (project planning, monitoring and evaluation of large infrastructure; operation of irrigation infrastructure; management of small scale natural resources; court processes etc.). The main categories of instruments that rely on engaging the public and some examples of their use are shown in Table 4.

Providing information is not enough to guarantee a change in people's behaviour. Furthermore, better information is only likely to induce behavioural changes that are not very expensive to the people and that are compatible with their deeper values. Information-based instruments work best when they are coupled with other instruments. Similarly, a call for increased participation is on its own not likely to be effective. Instruments based on participation require solid institutions to balance the interests of the different stakeholders.

TABLE 4. INSTRUMENTS FOR ENGAGING THE PUBLIC

Instruments	Examples
Information for consumers	Eco-labelling Information disclosure
Information for producers	Best practices dissemination Compliance promotion
Participation	River basin councils Irrigation management Community management

Economic, social and demographic dynamics are increasing the interdependency of nations. The use of water, its pollution, the destruction of aquatic ecosystems and the unsustainable exploitation of fisheries have local, national and frequently regional and even global effects. Addressing regional environmental problems requires cooperation. International environmental agreements offer a framework for cooperative management of aquatic ecosystems. However, effective international environmental agreements are neither easy to craft nor implement. There is no problem in discussing an agreement but the combination of self-interest and sovereignty may keep important countries out of the agreement. Moreover, it may happen that signatories to such an agreement may not uphold their responsibilities.

Non-behavioural interventions

Direct government involvement, including different forms of government investment, plays an important role in both actual and potential interventions. Funding protected natural areas, financing improved understanding of natural phenomena, investing in infrastructure and financing research are some of the major categories of direct government intervention. Economies of scale and the public-good nature of many environmental and natural resource services are the main reasons to include instruments based on government investment on a list of effective actions to solve or mitigate problems in international waters. Public goods provide services that communities enjoy in common, such as unpolluted water. Government intervention is required to produce public goods because most people would not voluntarily pay for a service that they can get for free. The funds raised by voluntary contribu-

tions to finance large infrastructure projects (e.g. water treatment plants) would not be enough to finance the required project at its optimal scale. The scale of these projects may require the taxing and borrowing capacities of governments to raise the necessary funds. The main categories of instruments that rely on direct government involvement and some examples of their use are shown in Table 5.

TABLE 5. INSTRUMENTS FOR DIRECT GOVERNMENT INVOLVEMENT

Instruments	Examples
Understanding, describing and predicting	Meteorological systems
Infrastructure	Municipal water treatment plants
Protection	Protected areas
Research	

The main drawback of policy instruments based on government investment is the lack of funding due to the fiscal situation of governments (especially in developing countries) and their inability (again, mainly in developing countries) to charge beneficiaries for the positive outcomes that these interventions generate.

The next task is selecting evaluation criteria and evaluation outcomes to assess the expected results of the selected options. The methods used to test the performance of options under the different criteria are practical and simple because the GIWA policy option analysis is only meant to provide options for further analysis and discussion.

There are several criteria that can be used to evaluate the outcomes of policy interventions. A combination of the following criteria is frequently used:

- Effectiveness (certainty of result);
- Efficiency (maximisation of net benefits) or cost effectiveness (achieving a set policy goal at minimum cost);
- Equity (fairness in the division of costs and benefits); and
- Practical criteria (political acceptability, implementation feasibility).

To evaluate the effectiveness of an instrument, it is useful to think about situations that could hinder its successful implementation, as well as the likelihood that these situations will occur. The list of adverse situations is unfortunately long: bureaucratic resistance, lack of political will, "capture" of policy benefits by an undeserving group; excessive administrative costs; lack of enforcement; waste; abuse that undermines political support; etc. Robustness is a useful criterion to apply when some of these situations are likely to occur.

Efficiency refers to the maximisation of net benefits. A full evaluation of efficiency is beyond the mandate (and resources) of the GIWA. However, most regional GIWA teams did include lists of the costs and benefits of the options they analysed. Even in this limited and unquantified form, a list of costs and benefits serves a useful purpose: it reminds policy makers of the potential impacts (both positive and negative) of a policy decision.

Equity is not usually the main objective of environmental and natural resource policy. However, we should question the justification of any measures designed to improve environmental conditions in international waters whose costs are disproportionately paid by the poor. Furthermore, unfair patterns of incidence may erode the political support necessary for policy interventions. The GIWA methodology instructs regional teams to evaluate the fairness in the distribution of costs and benefits of the analysed options. It also advises regional teams to suggest compensating measures in certain cases.

A policy option may have great theoretical appeal, but its eventual impact will be determined by what happens to the option as it goes through the decision-making and policy implementation processes. Practical criteria are meant to assess the prospect of a successful transit through these processes. The most widely used practical criteria are political acceptability and administrative feasibility.

A quick (and preliminary) way to assess the political acceptability of an intervention is to look at who gains and who looses from it, and to estimate the expected actions and impacts of the opposing and supporting groups. Administrative feasibility includes considerations about the legality of an intervention, as well as the capacity (technological, financial and operative) of the implementing organisation.

The last task is to choose actions from the list of analysed options. In most circumstances, instruments are complementary and a combination of incentives, regulations, information and direct government involvement is the best way to address a problem. Consider the case of pollution. A good programme to improve water quality would probably include regulations (e.g. banning certain pollutants in water effluents and setting acceptable ranges for others), incentives to induce the required reductions in pollution discharges, information

on best practices, and the provision of collective infrastructure (e.g. treatment facilities).

Options have to be prioritised when they are substitutes or when restrictions (budgetary or otherwise) do not allow the implementation of all the interventions that would have a positive impact on the problem. If one of the policy options under consideration is expected to produce a better result than any of the other options with regard to every evaluative criterion, the choice is obvious. However, this is not always the case. It may also happen that under a specific criterion one instrument outperforms another but the relation is reversed if another criterion to evaluate performance is used. In these cases, what option(s) is (are) chosen depends on the relative weights of the different criteria and on the differences in performance under each criterion.

The relative weights of the criteria may depend on the conditions of each particular problem. Equity considerations will probably not be influential if the problem affects a society with an even distribution of wealth and modest implementation costs. In contrast, if the problem takes place in a context of a skewed distribution of wealth, and the implementation of an option would entail net losses for the poor, equity should be strongly weighted. Regardless, effectiveness should be weighted heavily.