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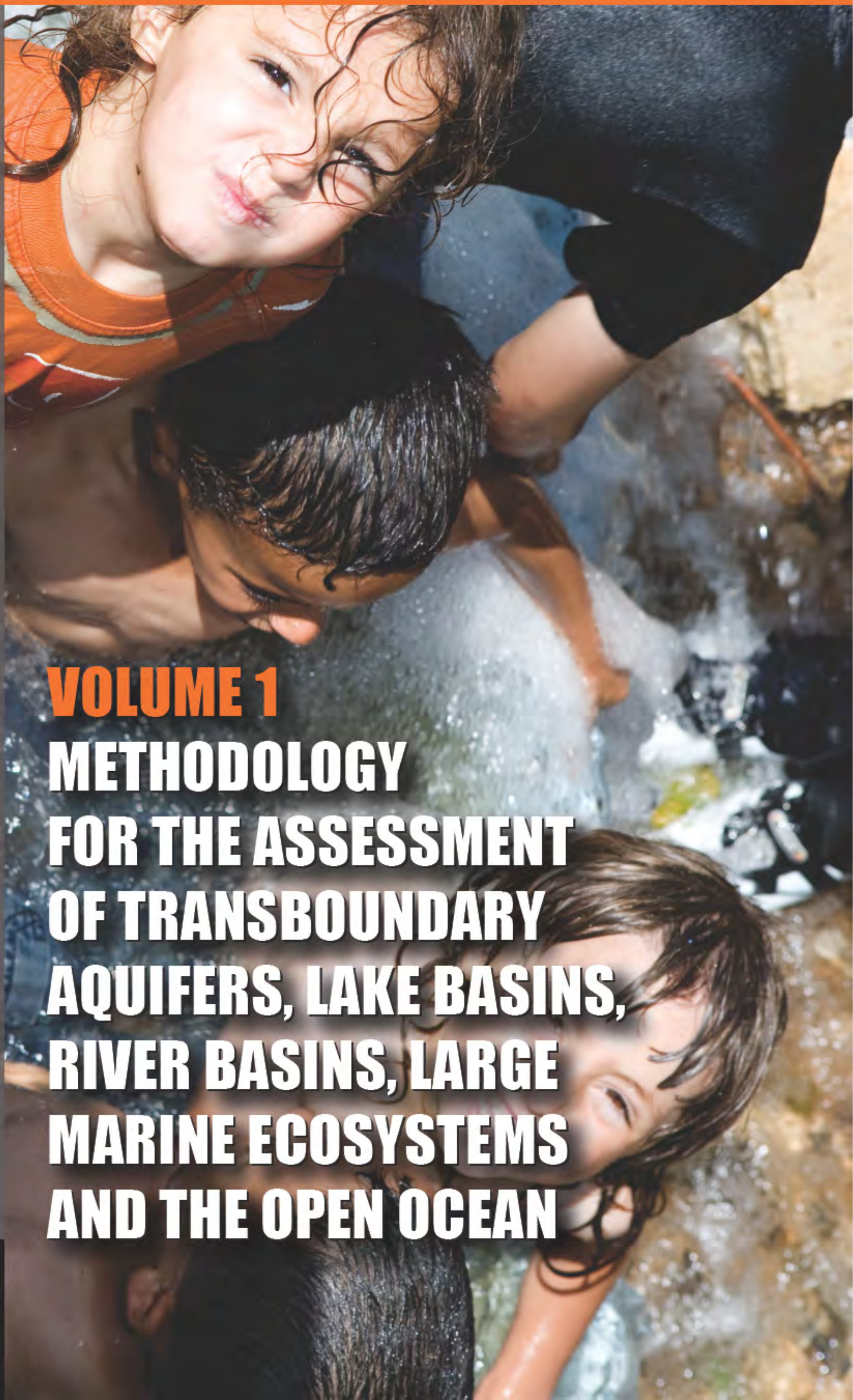

VOLUME 1

METHODOLOGY FOR THE ASSESSMENT OF TRANSBOUNDARY AQUIFERS, LAKE BASINS, RIVER BASINS, LARGE MARINE ECOSYSTEMS AND THE OPEN OCEAN

METHODOLOGY FOR THE GEF TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

This publication, *Methodology for the GEF Transboundary Waters Assessment Programme. Volume 1. Methodology for the Assessment of Transboundary Aquifers, Lake Basins, River Basins, Large Marine Ecosystems, and the Open Ocean* is prepared based on the texts of transboundary aquifers, lake basins, river basins, large marine ecosystems, and open ocean Working Groups methodology documents presented in volumes 2–6. Further details can be found in the respective volumes.

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METHODOLOGY FOR THE GEF TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

VOLUME 1

METHODOLOGY FOR THE ASSESSMENT OF TRANSBOUNDARY AQUIFERS, LAKE BASINS, RIVER BASINS, LARGE MARINE ECOSYSTEMS AND THE OPEN OCEAN

BGR

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

GESAMP

The Global Ocean Observing System

GPA

UNEP GRID Arendal
Environmental Knowledge for Change

igrac
international groundwater resources assessment centre

MINISTRY FOR FOREIGN AFFAIRS OF FINLAND

United Nations Educational, Scientific and Cultural Organization

World Water Assessment Programme

UN WATER

NOAA

IUCN

Regional Seas

SIWI

UNIVERSITY of the WESTERN CAPE

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Transboundary Lake Basins document (Volume 3) was reviewed by Eric K. Mugurusi, Peter Whalley, and Martin van der Knaap;

Transboundary River Basins document (Volume 4) was reviewed by Eric K. Mugurusi and Peter Whalley;

Large Marine Ecosystems document (Volume 5) was reviewed by Alexander Tkalin; and

Open Ocean document (Volume 6) was reviewed by Alexander Tkalin, Alberto Pacheco, and David Checkley.

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Foreword

The water systems of the world – aquifers, lakes/reservoirs, rivers, large marine ecosystems, and open ocean – support the socioeconomic development and wellbeing of the world's population. Many of these systems are shared by two or more nations and these transboundary resources are interlinked by a complex web of environmental , political, economic and security interdependencies.

These ecosystems are characterised by an array of ecological functions and processes essential to the regulation and continuous provision of ecosystem services of benefit to human welfare and society. However, these waters continue to be degraded by multiple and complex human-induced stresses, and the sustainability of their exploitation and environmental management is currently and profoundly challenged.

In a resource constrained world, there is an urgent need to focus and to prioritize limited financial resources to support the efforts of bodies such as the Global Environment Facility (GEF) and other international organizations. There is in reality a great deal of data already available on transboundary data, information, modelling results and expertise are presently scattered among different sources including governments, regional organisations, academic networks funded by governments, research programmes, the private sector and local and indigenous communities.

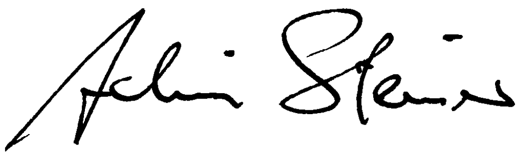
In order to address this challenge UNEP, under the auspices of the GEF, has coordinated the implementation of the Medium Size Project (MSP) Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme (TWAP).

It has involved many partners including the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including aquifers in small island developing states (SIDS); the International Lake Environment Committee (ILEC) for lake basins; the UNEP-DHI Centre for Water and Environment (UNEP-DHI) for river basins; and Intergovernmental Oceanographic Commission (IOC) of UNESCO for Large Marine Ecosystems and the open ocean.

UNEP and other UN organizations plan to use the results of this report to contribute to the global assessments carried out by each organization. Regional organisations may use the assessment results as a baseline and for tracking environmental improvements in shared water resource.

Finally, it affords national governments the opportunity to use the results to establish national programmatic priorities between transboundary and domestic water issues. In doing so, I am sure this report can play its part in assisting to accelerate sustainable development and the transition to a far more resource efficient, 21st Century Green Economy.

Achim Steiner



UN Under-Secretary General and
Executive Director of the
United Nations Environment Programme

Preface

The GEF Medium Size Project (MSP) *Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme,* approved in January 2009, was envisioned as a partnership among existing programmes, which was considered to be more cost effective than the conduct of an independent data and information gathering exercise. The Project Objective was to develop the methodologies for conducting a global assessment of transboundary waters for GEF purposes and to catalyse a partnership and arrangements for conducting such a global assessment.

This Project has been implemented by UNEP as Implementing Agency, UNEP Division of Early Warning and Assessment (DEWA) as Executing Agency, and the following lead agencies for each of the water systems: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including aquifers in small island developing states (SIDS); the International Lake Environment Committee (ILEC) for lake basins; UNEP-DHI Centre for Water and Environment (UNEP-DHI) for river basins; and Intergovernmental Oceanographic Commission (IOC) of UNESCO for LMEs and the open ocean.

This Project resulted in developed methodologies for the following five transboundary water systems: (i) groundwater aquifers; (ii) lake/reservoir basins; (iii) river basins; (iv) large marine ecosystems; and (v) open oceans.

The results of this Project are presented in the *TWAP MSP Publication, Methodology for the GEF Transboundary Waters Assessment Programme,* which consists of the following six volumes:

- *Volume 1 – Methodology for the Assessment of Transboundary Aquifers, Lake Basins, River Basins, Large Marine Ecosystems, and the Open Ocean;*
- *Volume 2 – Methodology for the Assessment of Transboundary Aquifers;*
- *Volume 3 – Methodology for the Assessment of Transboundary Lake Basins;*
- *Volume 4 – Methodology for the Assessment of Transboundary River Basins;*
- *Volume 5 – Methodology for the Assessment of Large Marine Ecosystems; and*
- *Volume 6 – Methodology for the Assessment of the Open Ocean.*

Volume 1 is a summary of the detailed methodologies described in volumes 2 – 6. At the back cover of this document is attached a DVD that contains electronic version of all six volumes.

Contents

List of Acronyms

BGR	German Federal Institute for Geosciences and Natural Resources
BMZ	German Federal Ministry of Development and Economic Cooperation
CBO	Community-based Organization
CCA	Causal Chain Analysis
CERMES	Centre for Resource Management and Environmental Studies
CIESIN	Centre for International Earth Science Information Network
CMAP	Center for Marine Assessment and Planning
CUNY	City University of New York
DEWA	Division of Early Warning and Assessment
DPSIR	Driver-Pressure-State-Impact-Response
ETH	Swiss Federal Institute of Technology Zurich
FAO	Food and Agriculture Organisation of the UN
FiB	Fishing-in-Balance Index
FSP	Full Size Project (GEF)
GAR	Global Assessment Report
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEMS	Global Environmental Monitoring System
GEO	Global Environment Outlook
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GIS	Geographic Information System
GIWA	Global International Waters Assessment
GOOS	Global Oceans Observing System
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
GRID	Global Resource Information Database
GW	Transboundary aquifers
HDI	Human Development Index
HDR	Human Development Report
IA	Implementing Agency
ICOLD	International Commission on Large Dams
ICSU	International Council for Science
IGBP	International Geosphere/Biosphere Programme
IGRAC	International Groundwater Resources Assessment Centre
IHP	International Hydrological Programme
ILBM	Integrated Lake Basin Management
ILEC	International Lake Environment Committee Foundation
IMAIG	Information Management and Interlinkages
IOC	Intergovernmental Oceanographic Commission
IPPC	Intergovernmental Panel on Climate Change
IRWS	International Recommendations for Water Statistics
ISARM	Internationally Shared Aquifer Resources Management
IUCN	International Union for the Conservation of Nature
IW	International Waters
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JMP WSS	WHO/UNICEF Joint Monitoring Pogramme for Water Supply and Sanitation
LBMI	Lake Basin Management Initiative

LME	Large Marine Ecosystem
LOICZ	Land-Ocean Interaction in the Coastal Zone
MA	Millennium Ecosystem Assessment
MDG	Millennium Development Goal
MSL	Mean Sea Level
MSP	Medium Size Project (GEF)
MTI	Marine Trophic Index
NASA	National Aeronautics and Space Administration
NEWS	Nutrient Export from WaterSheds
NIOMR	Nigerian Institute for Oceanography and Marine Research
NOAA	US National Oceanic and Atmospheric Administration
OAS	Organisation of American States
OSU	Oregon State University
PIC	Prior Informed Consent
POP	Persistent Organic Pollutant
PWCMT	Program in Water Conflict Management and Transformation
RAF	Resources Allocation Framework
RCSE	Research Center for Sustainability and Environment, Shiga University
RSP	Regional Seas Programme
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SAP	Strategic Action Programme
SIDS	Small Island Developing States
SIWI	Stockholm International Water Institute
TB	Transboundary
TBA	Transboundary Aquifers
TDA	Transboundary Diagnostic Analysis
TWAP	Transboundary Waters Assessment Programme
UBC	University of British Columbia
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP-DHI	UNEP-DHI Centre for Water and Environment
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Population Fund
UNGA	United Nations General Assembly
UNICEF	United Nations Children's Fund
USGS	United States Geological Survey
WB	World Bank
WCMC	World Conservation Monitoring Centre
WG	Working Group
WHO	World Health Organisation
WHYMAP	Worldwide Hydrogeological Mapping and Assessment Programme
WMO	World Meteorological Organization
WRM	Water Resources Management
WSSD	World Summit on Sustainable Developme
WWAP	World Water Assessment Programme
WWDR	World Water Development Report
WWF	World Wildlife Fund

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I. SUMMARY FOR DECISION MAKERS

1. THE TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME AND ITS MEDIUM SIZE PROJECT

The water systems of the world – aquifers, lakes/reservoirs, rivers, large marine ecosystems (LMEs), and open ocean areas – support the socioeconomic development and wellbeing of the world's population. Many of these systems are referred to as *transboundary waters* since they extend across, or lie beyond, national boundaries. These waters continue to be degraded by multiple and complex human-induced stresses, and the sustainability of their ecosystem services is at risk in many cases.

Recognizing the importance of the management of transboundary waters and consequences of associated problems and being aware that a comprehensive assessment of transboundary waters has never been undertaken, nor are the required institutional arrangements in place, the Global Environment Facility (GEF) approved the GEF Medium Size Project (MSP) *Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme* (TWAP) in January 2009.

Currently there is no single global programme focusing on transboundary water assessment. Except for a very limited number of transboundary water bodies, there is no regular monitoring or assessment programme, or reference baselines for assessing the environmental status of these water bodies, or changes in them.

To facilitate a global assessment, TWAP defines five categories of transboundary water systems: aquifers, lake/reservoir basins, river basins, LMEs, and open ocean. The goals of the TWAP MSP were to:

(i) catalyze partnerships among organizations for conducting a global assessment that can be applied in multiple ecological and sociopolitical contexts;

(ii) develop the methodology for assessment for each of the five categories of transboundary water systems under the TWAP; and

(iii) establish the institutional arrangements needed to carry out a baseline transboundary waters assessment and the in-depth assessment of selected water bodies that might be conducted in the framework of the GEF TWAP Full Size Project (FSP), following completion of the TWAP MSP.

The TWAP MSP has been implemented by UNEP as Implementing Agency, UNEP Division of Early Warning and Assessment (DEWA) as Executing Agency, and the following lead agencies for each of the water systems: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including aquifers in small island developing states (SIDS); ILEC for lake basins including reservoirs, wetlands and all other lentic waters; UNEP-DHI Centre for Water and Environment (UNEP-DHI) for river basins; and Intergovernmental Oceanographic Commission (IOC) of UNESCO for LMEs and the open ocean. About 20 organisations acted as core partners in the implementation of this project.

The framework of the MSP, methodologies of the assessment of the five water systems, and partners and institutional arrangements are presented below in respective chapters. A short summary of the main achievements of each of the five water systems is given below.

Transboundary aquifers. Different from other water system types, the global inventory of Transboundary Aquifers remains limited to date, due to a number of reasons, including restrictions in the application of earth observation technology in the identification of groundwater bodies, and the high cost of collecting data in the subsurface. Based on the tremendous advance in data, information and knowledge related to transboundary aquifers that were made by UNESCO's Internationally Shared Aquifer Resources Management (ISARM) initiative, the Worldwide Hydrogeological Mapping and Assessment Programme (WHYMAP), International Groundwater Resources Assessment Centre (IGRAC), the UN World Water Assessment Programme (WWAP), Food and Agriculture Organisation of the United Nations (FAO) and many other partner organizations over the last decade, the TWAP Assessment of Transboundary Aquifers will compile and complement the available information at the global scale. The assessment will also include aquifers in SIDS. The methodology for the assessment of TBAs was developed by a group of international high-level experts under the lead of UNESCO-IHP, representing the relevant scientific disciplines (natural and social science) and institutions. The Groundwater Coalition, a partnership of national, regional and international players involved in Transboundary Aquifers (TBA) assessment and management, was established and is committed to carry out the baseline assessment, as well as ensure periodic follow-up assessments in the future, through their regular programmes. Data and information on TBAs and SIDS will be solicited through direct contacts with regional and national entities as well as from existing global data sets and from hydrological modelling and remote sensing, and will be stored in the ISARM web-based Geographic Information System (GIS) that will be linked to the central TWAP results viewing portal. The data and information management will be coordinated by IGRAC.

Lake basins. Major accomplishments of the Lake Basin Working Group include: (i) New, expanded definition of transboundary lakes. Traditionally, a lake was considered transboundary only if its surface water was intersected by an international border. However, the Lakes Group has shown the importance of the drainage basin and produced the new definition: "transboundary lakes are those whose drainage basins lie in more than one national jurisdiction". Importantly, this includes a lake's upstream as well as downstream and provides a key linkage with other water systems such as rivers, aquifers and LMEs; (ii) Identification of large number of transboundary lake basins. This new definition greatly expands the set of lakes for assessment. A partial analysis reveals more than 15,000 transboundary lake basins in Africa alone. Significantly, this means small and locally-important yet often internationally-overlooked lake basins will be addressed along with their larger, better-known cousins; and (iii) Creation of a suite of risk indictors based on the integrated lake basin management (ILBM) framework. The indicators are GIS-based and follow an iterative assessment approach. At their core is the ILBM concept that is based on governance and is stakeholder driven.

River basins. The River Basins Working Group developed an indicator-based approach to cover a variety of important issues which would enable a new comprehensive global assessment of transboundary river basins, based mainly on existing data that are currently scattered among multiple sources. Most of this data is found at the national level, and the approach enables the data to be re-aggregated at the transboundary river basin scale. This would provide an improved decision making platform for countries sharing a basin, and allow them to directly benchmark this with other transboundary basins. Leading partners have been identified to undertake the assessment of transboundary river basins, bringing their baseline programmes to the table. These existing programmes will be coordinated, and will both contribute to, and benefit from, the TWAP.

Large marine ecosystems. The world's coastal areas are divided into 64 LMEs, which provide enormous benefits to humans and contribute trillions of dollars annually to the global economy. These benefits – ecosystem services – are increasingly threatened by overfished and collapsed fish stocks, marine and land-based pollution, and habitat degradation. Building on existing approaches, the TWAP LMEs assessment methodology includes a conceptual framework that shows the links between human vulnerability and natural and anthropogenic stressors, ecosystem services and the consequences for humans and governance of LMEs. These components are expressed by a suite of ecological/ environmental indicators, including the interlinkages with transboundary rivers and the open ocean, as well as socioeconomic indicators. The methodology also harnesses ongoing initiatives on global water governance, bringing a new dimension to the assessment of LME governance. The assessment will consist of a baseline evaluation of the current status and trends as well as projections, where possible, to 2030 and 2050. Partners include a number of recognized experts and international organizations. The IOC of UNESCO coordinated the LMEs component.

Open ocean. The Open Ocean Working Group developed a methodology for the assessment that responds to the unique challenges of this space. The global open ocean is a multilateral global commons with thematic governance arrangements, with an area beyond national jurisdiction covering 50 per cent of the planet that is largely unobserved beyond basic physical and chemical variables for climate, but affects human wellbeing through remote impacts on the environment and ecosystem services. The methodology builds on a conceptual framework that places human wellbeing at its centre and describes the interaction of human and natural systems. The assessment has two parts, drawing on four natural system themes: climate, ecosystems and biodiversity, fisheries, and pollution. A mapping of available indicators will match human and natural system vulnerability with actual and projected stress. An expert assessment of issues with high uncertainty but high potential impact will be complemented by an expert assessment of ecosystem valuation and governance arrangements for the open ocean.

2. PROPOSAL FOR GEF TWAP FULL SIZE PROJECT

The GEF TWAP Full Size Project (FSP) will undertake the global assessments of the five transboundary water systems and will include interlinkages among these water systems. The assessment methodologies to be used will be those developed under the MSP and will be based on indicators and indices, including socioeconomic and governance ones. Each water body to be assessed will be described with a summary descriptor, geo-referenced map and a GIS database of attributes. An effort will be made to assess the areas at risk and transboundary hot spots. Groundwater in SIDS, even though not transboundary, will be included in the assessment and has been assigned to the transboundary aquifers component. It is expected that the FSP will assist the GEF set priorities for the allocation of its funds and to make more effective use of its resources for addressing higher priority water bodies. For a selected number of water bodies from all five water systems, an in-depth assessment will be carried-out.

The ability of the TWAP FSP to undertake an assessment of the world's major transboundary water systems depends on the wide array of existing regional and international research, monitoring, and ongoing assessment activities and initiatives around the globe. Therefore, TWAP includes such institutions, frameworks and programmes, so that the assessment process can be based on and sustained through these established bodies with a long-term mandate.

The objective of the FSP will be to identify and improve the understanding of key environmental, legal and institutional transboundary concerns inherent to the management of transboundary waters through the conduct of systematic and indicator based system assessments for transboundary aquifers, lake/reservoir basins, river basins, LMEs, and open ocean areas around the globe so as to allow the GEF to target its investments into priority transboundary water systems and to develop a sustainable process for periodic global assessment of transboundary waters through formalization of partnerships and institutional arrangements.

It is critical that the methodologies developed in the MSP be built on existing programmes so that a consortium of partners can be assembled that is committed to the success of the TWAP. The proposed partners all bring baseline programmes and associated investments to TWAP, without which it would not be feasible. Incremental GEF funding will add value to the baseline programmes and ensure that outputs are suitable for the objectives of TWAP.

During the FSP a Level 1 baseline assessment of each of the five transboundary water systems will be conducted, including projections of major stressors and their future impacts on the environment to years 2030 and 2050, where possible. Additionally during the FSP a Level 2 in-depth assessment will be conducted as a pilot effort for a limited number of areas or themes for each of the five water systems.

The FSP will support existing GEF International Waters (IW) projects and all future GEF IW projects, by assessing transboundary waters, developing sustainable partnerships for assessments and providing feasible assessment methodologies that can be adapted and implemented for all transboundary water systems. It will contribute to the ongoing development of methods for transboundary diagnostic analysis (TDA). The proposed FSP will be linked to planned and ongoing observation and assessment activities, including those to be conducted under the auspices of GEF projects. The FSP will provide a basis for identifying regional priorities within the defined assessment units, but will also capture national priorities and support the national and transboundary priorities in international waters. The project will be closely linked with the UNEP Regional Seas Programme (RSP), as well as with the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), the UN WWAP and World Water Development Report (WWDR), the United Nations

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General Assembly (UNGA) 60/30 Regular Process for global reporting and assessment of the state of the marine environment, including socioeconomic aspects and the ongoing UNESCO ISARM programme. The assessments will also support efforts towards achievement of the Millennium Development Goal (MDG) and the World Summit on Sustainable Development (WSSD) targets.

All organisations whose activities and programmes are particularly relevant to the project, are expected to participate in the FSP. The implementation of the FSP is proposed to be coordinated by UNEP and the activities will be carried out by a consortium of partners, through a lead organisation for each transboundary type and the overall guidance provided by a Project Steering Committee.

II. TWAP MEDIUM SIZE PROJECT

1. GENERAL INTRODUCTION

This volume is a summary of the detailed methodologies described in volumes 2 – 6 for transboundary aquifers, lake/reservoir basins, river basins, LMEs, and open ocean areas respectively.

1.1 Why is the TWAP needed?

The application of the agreed TWAP methodologies for periodic worldwide assessments of transboundary water systems will serve as a way of tracking changes in the status of and stresses on transboundary water systems over time. It will serve GEF purposes in setting priorities for its resource allocation based on an understanding of baseline environmental and water resource conditions and tracking the longer term relative results of its interventions. Also, it will provide guidance for the conduct of similar actions by regional institutions, national governments, and local organizations. In this manner, not only will the GEF make more effective use of its resources for addressing higher priority water bodies but, together with its partners also report on the impacts of the use of its funding. Key partners will benefit from the assessment by broadening their knowledge of transboundary water systems, new partnerships and cooperation established, and having access to the data and information management systems. Given the objective of TWAP to provide a basis for science-based allocation of financial resources from GEF and other donors, to priority transboundary water systems, countries and regions will benefit from increased transparency in funds allocation.

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The necessity for TWAP was recognised because of the need for more effective management of transboundary waters to help the stakeholders utilize such waters in a sustainable way. Currently, the sustainable, holistic management of transboundary waters is hampered because of the lack of adequate methodologies, national interests, and limitations in sharing data and information. Currently there is no single global programme focusing on transboundary water assessment. Except for a very limited number of transboundary water bodies, there is no regular monitoring or assessment programme, and baselines for assessing the health of these water bodies, or changes in them, have not been established.

Sustainability of the assessment process can be achieved, in part, through GEF IW projects, especially through those participating countries that will ultimately be involved in implementing the methodologies and whose capacity to conduct the assessment will be strengthened. It is hoped that developing countries, SIDS and countries with transition economies would integrate TWAP assessment protocols into their respective institutions. In this regard, rather than building the capacity of a single institution for implementing the TWAP assessment, the capacities of a number of regional institutions will be strengthened for conducting ongoing periodic assessments and assessments of non-transboundary waters within their jurisdictions.

1.2 The Transboundary Waters Assessment Programme and its Medium Size Project

The water systems of the world – aquifers, lakes/reservoirs, rivers, LMEs, and the open ocean – support the socioeconomic development and wellbeing of the world's population. Many of these systems or their drainage basins extend across, or lie beyond, national boundaries and are referred to as transboundary waters. These waters continue to be degraded by multiple and complex human-induced stresses, and the sustainability of their exploitation and environment management seems questionable for many of them.

Recognizing the importance of the management of transboundary waters and consequences of associated problems, the Technical Advisory Group for Strategy Development in the IW focal area of GEF identified the need for a TWAP in early 2007, and the GEF Council included such a programme in its approved GEF 4 Strategy for International Waters to assist in supporting results-based management for the future.

Among the constraints to the effective management of transboundary waters is the lack of a systematic and scientifically-robust methodology for assessing the changing conditions of five different types of system resulting from human and natural causes which would allow policy makers, the GEF and international organizations to set science-based priorities for financial resource allocation. Such a methodology would also facilitate the indications of positive changes in the environment and resource situations in the transboundary water systems resulting from interventions by national authorities and international/regional communities. Currently, assessment work globally is fragmented and not usable for conducting an integrated and coherent assessment of transboundary water systems. To address this situation, the GEF MSP Development of the Methodology and Arrangements for the GEF TWAP was approved in January 2009. The project was envisioned as a partnership among existing programmes, which was considered to be more cost effective than the conduct of an independent data and information gathering exercise.

Such a global, comprehensive assessment has never been undertaken before. The assessment is complex, with many agencies collecting different types of assessment information, and various global science organizations undertaking modelling and making projections based on the data collected. In addition, there is no GEF programme for capturing and analyzing the time series of data collected by GEF IW projects, which can be a valuable addition to a global assessment. The TWAP MSP, as a first step, aims to:

(i) develop the methodology for assessment for each of the five categories of transboundary water systems under the TWAP;

(ii) catalyse partnerships among organizations for conducting a global assessment that can be applied in multiple ecological and sociopolitical contexts; and

(iii) establish arrangements needed to carry out a baseline transboundary waters assessment and the in-depth assessment of selected water bodies that might be conducted within the framework of the GEF TWAP Full Size Project (FSP), following completion of the TWAP MSP. Periodic assessment would then be sustained in the future through the partnership of agencies and organizations, and would include relevant information collected by GEF IW projects. Such an assessment will respond to the need of GEF IW to prioritize and focus its scarce resources where they can be most cost-effective in addressing transboundary concerns. The assessment methodology will allow the monitoring of evolving trends, and provides means to assess the impacts of GEF IW programmes as well as those of other agencies and actors. It will bring to global attention the vulnerability of transboundary water systems and catalyse actions to maintain their sustainability.

The TWAP MSP has been implemented under the following organisational structure:

(i) Implementing Agency: United Nations Environment Programme (UNEP);

(ii) Executing Agency: UNEP Division of Early Warning and Assessment (DEWA);

(iii) Executing Partners:

(a) for transboundary aquifers: UNESCO-IHP (lead), IGRAC, ISARM, UN WWAP, FAO, Swiss Federal Institute of Technology (ETHZ), German Federal Ministry of Development and Economic Cooperation (BMZ)/German Federal Institute for Geosciences and Natural Resources (BGR), University of the Western Cape;

(b) for lakes/reservoirs: International Lake Environment Committee Foundation (ILEC) (lead);

(c) for river basins: UNEP-DHI Centre (lead), Stockholm International Water Institute (SIWI), International Union for the Conservation of Nature (IUCN);

(d) for LMEs: the IOC of UNESCO (lead), UNEP Division of Environmental Policy Implementation (DEPI), Global Resource Information Database (UNEP/GRID-Arendal), UNEP World Conservation Monitoring Centre (UNEP-WCMC), US National Oceanic and Atmospheric Administration (NOAA), University of British Columbia (UBC) Sea Around Us project, International Geosphere/Biosphere Programme (IGBP), Land-Ocean Interaction in the Coastal Zone project (LOICZ), Centre for Resource Management and Environmental Studies (CERMES), Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), among others; and

(e) for open ocean: the IOC of UNESCO (lead), UNEP-DEPI, UNEP/GRID-Arendal, NOAA, CERMES, CMAP, Dalhousie University, GESAMP, UBC Sea Around Us Project, WCRP and UNEP-WCMC.

The Executing Agency established five working groups (WGs), one for each of the five water systems, for the development of the methodology and institutional arrangements for the implementation of the TWAP MSP; the members of all five WGs are listed in the Annex I. Also, at the MSP level, the Information Management and Interlinkages (IMAIG) Working Group was established to promote integration between the water system approaches, and the Steering Committee of the TWAP MSP was established to oversee the implementation of the project. The Steering Committee comprised representatives of the Implementing and Executing Agencies, the Executing Partners, and the GEF Secretariat. In order to have a common terminology, the TWAP Glossary of terms was prepared and is attached as Annex II.

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1.3 Contribution of the TWAP MSP to existing global assessments

The TWAP MSP adds value to the array of existing and planned national, regional and international water assessment activities and programmes by developing a framework within which to produce a global assessment of major transboundary water systems based on data and information generated by mostly ongoing activities. By focusing the assessment process on data and information management, new assessment results can be obtained in a timely, cost-effective manner, and sustained by regularly updated and revised data and information. In this regard, the use of relevant indicators forms an important element of the assessment methodology.

The ability to undertake an assessment of the world's major transboundary water ecosystems depends on the wide array of existing regional and international research, monitoring, and assessment activities and initiatives around the globe. Therefore, the framework includes such institutions and frameworks and programmes, so that the assessment process can be sustained through these established bodies.

The TWAP FSP will benefit from and at the same time also contribute to the global and regional assessments, such as:

(i) UNEP's Global Environment Outlook (GEO), a global assessment process on the state and trends of the environment, future outlooks and policy options;

(ii) the UN-wide World Water Development Report of UN WWAP, a coordinating umbrella for existing UN initiatives on freshwater assessment coordinated by UNESCO;

(iii) the UNGA Regular Process for Global Reporting and Assessment of the State of the Marine Environment including socioeconomic aspects;

(iv) the United Nations Development Programme's Human Development Report (UNDP HDR), strongly linked to available natural resources, including water resources, and how they are governed;

(v) the International Recommendations for Water Statistics (IRWS), a multi-purpose framework which can be applied flexibly by countries at different stages of development of environment statistics and environmental-economic accounting;

(vi) the GEF Transboundary Diagnostic Analysis (TDA), a scientific and technical analysis which is an objective assessment showing relative importance of causes and impacts of transboundary water problems;

(vii) the GEF Strategic Action Programme (SAP) that addresses policy, legal and institutional reforms, and investments needs-assessment process;

(viii) the Rio+20 Earth Summit for which UN-Water will produce a status report for the UN Commission on Sustainable Development meeting in Rio de Janeiro in 2012 on the application of integrated approaches to the development, management and use of water resources with the intention of providing the first step towards a regular global monitoring mechanism for the management of water resources;

(ix) the Global Oceans Observing System (GOOS), a permanent global system for observations, modelling and analysis of marine and ocean variables to support operational ocean services worldwide;

(x) UNESCO's International Hydrological Programme (IHP), an international scientific cooperative programme in water research, water resources management, education and capacity-building;

(xi) the Food and Agriculture Organisation of the UN (FAO), involving various activities worldwide related to the monitoring of freshwater and fisheries resources and the promotion of responsible fisheries;

(xii) the UNESCO IHP Internationally Shared Aquifer Resources Management (ISARM) programme, a global multi-agency programme aimed at improving the knowledge and understanding of scientific, socioeconomic, legal, institutional and environmental issues related to the management of transboundary aquifers;

(xiii) the Land-Ocean Interaction in the Coastal Zone (LOICZ) project that has developed scientific knowledge and tools which address global change in the coastal zone, focusing on material fluxes and human dimensions at regional and global scales;

(xiv) the Regional Seas Programmes (RSPs);

(xv) the Global Programme of Action for the Protection of the Marine Environment from Land-based Sources (GPA); and

(xvi) the data and information systems of the UN agencies, including the Global Resource Information Database-GRID (UNEP), Global Environmental Monitoring System (GEMS)/Water (UNEP), Global Runoff Data Centre (World Meteorological Organization (WMO) and FAO), AQUASTAT (FAO's global information system on water and agriculture), IGRAC (WMO and UNESCO), and the water supply and sanitation databases (World Health Organization (WHO) and United Nations Children's Fund (UNICEF)).

It is expected that UNEP, as well as other organizations, will incorporate the TWAP methodology, as well as the results of the assessments, within the above mentioned and other cooperative global assessment processes and programmes. The TWAP will strengthen these processes by developing a foundation for acquiring the required data and information related to transboundary water systems on a regular basis, as well as making available a methodology for use in assessing transboundary and other water systems.

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2. CONCEPTUAL FRAMEWORK OF THE TWAP Medium Size Project

2.1 Framework at the project level

Building conceptual frameworks is a prerequisite in developing an indicator-based methodology for assessing transboundary water systems. The TWAP MSP project document provided basic guidance with which to develop these, including a phased approach for implementing the assessment within the TWAP. The assessment methodology aims to evaluate human and ecosystem uses of water resources, highlighting current states and showing levels of system impairment. To do so would require the development of indicators that describe and quantify states, processes and stress factors at water system scale, as well as those that capture the social, economic and governance factors associated with human appropriation of water systems.

While the methodologies and assessments will be developed and implemented independently for the five transboundary water systems, the interlinkages among them are addressed by common indicators to the extent feasible. These common indices are based on system connectivities within a common hydrologic cycle that has been grossly modified by human use, and which form critical components in assessing present and future water system states. In addition, the methods enable projections of the environmental status and use of water resources to be made to 2030 and 2050. GEF envisions that contemporaneous assessments and future projections should allow for targeted policy interventions to mitigate system degradation and prevent irreversible collapse in the near and long terms.[1]

There will be two levels of assessment, described in more detail in section III.

Level 1 involves a global baseline assessment for each of the five water systems, with some projections to 2030 and 2050.

Level 2 involves a more detailed analysis of a small selection of transboundary units within each water system – approximately 4 – building on existing analyses such as TDA and including a causal-chain analysis, identification of hot spots, and elucidation of interlinkages between water systems. The Open Ocean Level 2 assessment will involve the impact of open ocean conditions on specific locations.

2.2 Frameworks at the water system level

A summary of the conceptual framework for each water system is provided here, emphasizing the overall approach taken by each WG in organizing information and in identifying and developing indicators. At the outset, four WGs developed place-based frameworks where system boundaries were more or less defined, while the Open Ocean Working Group used a thematic, issue-based approach for its conceptual framework. Given the basic guidance above, each framework reflects the unique properties of the water system it addresses and the ways in which the specific water system connects with the others. Common issues have been identified and each WG addressed them with varying emphases based on their relevance to each of the water systems. For brevity, the conceptual diagrams shown in the respective methods volumes are not reproduced here. (See volumes 2-6).

2.2.1 Transboundary aquifers

To date there is no complete inventory of transboundary groundwater resources. The delineation of aquifer system boundaries is a fundamental element of the transboundary aquifers assessment, and is fraught with significant uncertainty in over half of the inventoried transboundary aquifers in the world.

As such, the mapping and inventory of transboundary aquifer systems will represent a major task for TWAP. The Transboundary Aquifers Working Group has adopted the aquifer regions used by UNESCO's programme for ISARM. The assessment will also include groundwater systems of SIDS. The national segments of the

[1] Inception Meeting Report, June 30 to July 2, 2009, and First Meeting of the Data Managment and Indicators Working Group, December 16-17, 2009.

transboundary aquifer system define the scale at which indicators are used (i.e. national). Both time-independent, for example lithology, recharge and discharge conditions and time-dependent for example demography, climate, economy, land use, groundwater use data are used to describe each system. Time-dependent indicators follow the Driver-Pressure-State-Impact-Response (DPSIR) framework. Relevant cross-cutting issues include dissolved nutrient inflows and outflows, as well as socioeconomic and institutional factors that influence aquifers and other water systems in the same region. The extended version of TWAP's conceptual framework for the TWAP global assessment of transboundary aquifers is presented in Figure 1.

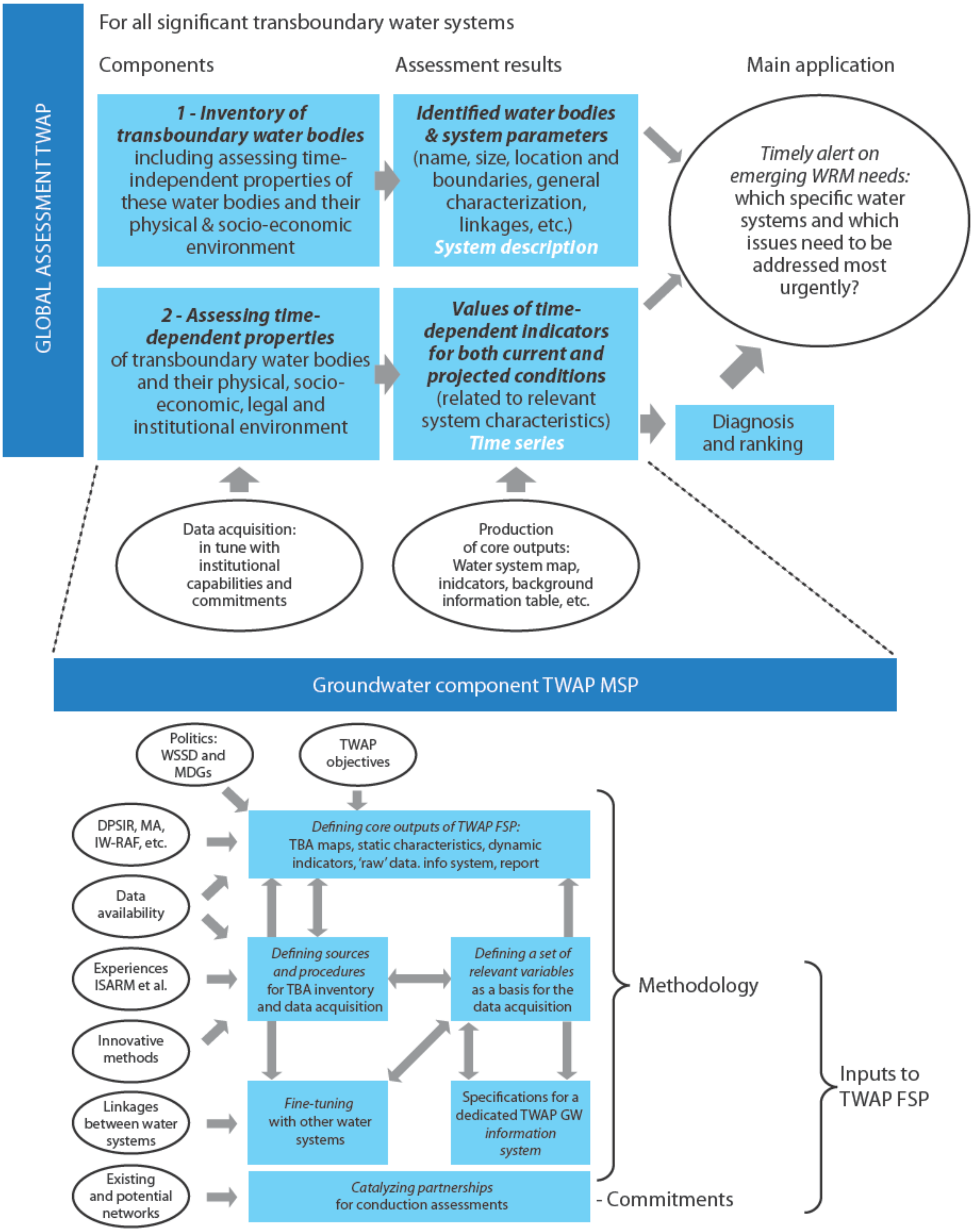


Figure 1. Conceptual framework for TWAP global assessment of transboundary aquifers. (Source: Volume 2)

2.2.2 Transboundary lake basins

Given the integrating nature, long water residence times, and the complex dynamics of lake basins, which hold 90 per cent of surface liquid freshwater of the planet, their assessment, focused on their provisioning and regulating services, is of the utmost importance. For an organizing framework, the ILBM paradigm is adopted with the lake basin as the unit of assessment. The essential components of lake basin governance, based on previous case studies, are represented in Figure 2, and discussed further in the "Guidelines for Lake Brief Preparation" (RCSE, Shiga University, and ILEC, 2010).

An inventory of transboundary lake basins is a major challenge since there is currently no complete inventory. Indicators would address issues that include: understanding the situation (biophysical conditions, human use), meeting the governance challenge (institutions, policy, people, technology, information and finance), and synthesis of issues and approaches (planning). For lakes, the key linkages are with rivers, and, on a case-by-case basis, with aquifer systems and LMEs. The assessment examines cross-cutting issues of water quantity, nutrients and cyanotoxicity, as well as mercury and Hg-associated neurotoxicity.

Figure 2. The ILBM framework. (Source: Volume 3)

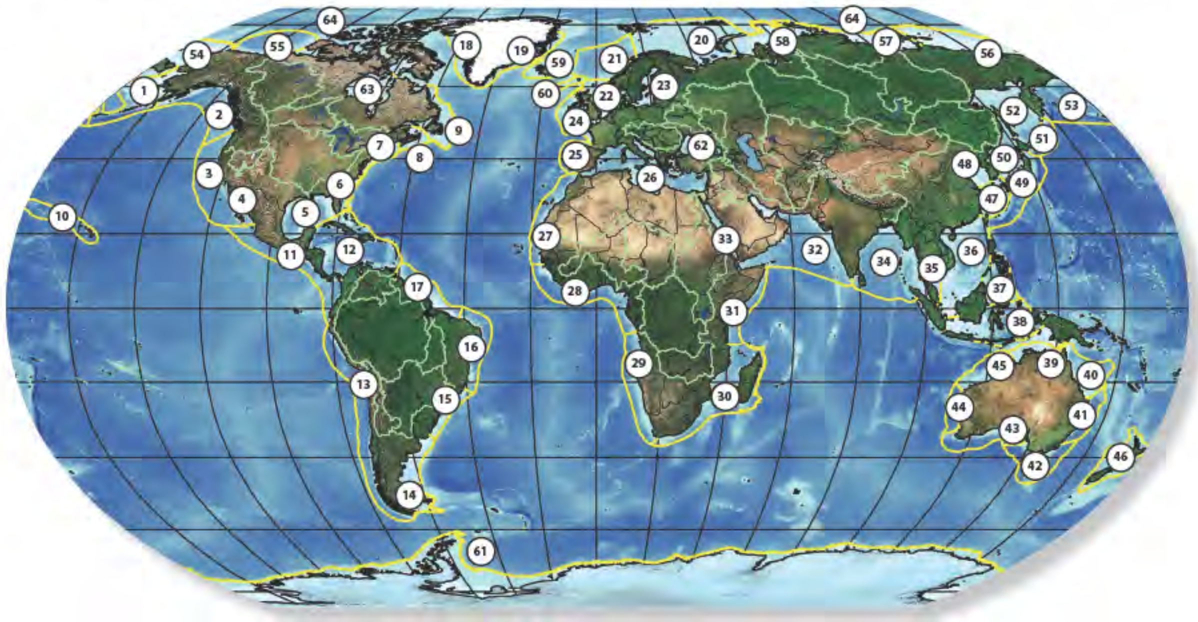
2.2.3 Transboundary river basins

The River Basins Working Group has developed an issues-based framework based on the DPSIR approach and its further modification by the Millennium Ecosystem Assessment. To assess the status of about 265 transboundary rivers, five indicator clusters that address water quantity, water quality, ecosystem attributes, governance, and socioeconomic features, will be used. Projected transboundary stress states for years 2030 and 2050 will be defined using indicators of environmental water stress, human water stress, nutrient pollution, population density and river basin resilience. Interlinkages with transboundary aquifers, lakes and LMEs that exist through hydrologic connectivity, as well as through socioeconomic and governance interactions, will be examined. Cross-cutting issues of nutrients and mercury will be examined to the extent that data and modelling tools allow in the context of river systems.

2.2.4 Large marine ecosystems

Based on work of Sherman (2005), the LME Working Group developed a framework that focuses on human-environment interactions that cause changes in ecosystem state and ecosystem services, and alter the vulnerability of human communities and ecosystems to external perturbations. The unit of assessment is each of the 64 LMEs (Fig. 3) delineated by Sherman *(1994)* and the Pacific Warm Pool. In addition, transboundary deltas are of particular interest, and a deltas-at-risk index will be developed under the FSP.

Four categories of indicators will be used to assess LMEs: transboundary stress indicators, transboundary environmental status indicators, socioeconomic indicators (indicators of anthropogenic drivers of ecosystem change and socioeconomic impacts of these changes), and governance/policy response indicators. The coastal boundaries of most LMEs belong to more than two coastal states, so that LME assessments will require aggregating national indicators to describe LME-scale phenomena. Nutrients and mercury are cross-cutting issues, particularly between LMEs and Rivers.



1	East bering Sea	17	North Brazil Shelf	33	Red Sea	49	Kuroshio Current
2	Gulf of Alaska	18	West Greenland Shelf	34	Bay of Bengal	50	Sea of Japan
3	California Current	19	East Greenland Shelf	35	Gulf of Thailand	51	Oyashio Current
4	Gulf of California	20	Barents Sea	36	South China Sea	52	Okhotsk Sea
5	Gulf of Mexico	21	Norwegian Shelf	37	Sulu-Celebes Sea	53	West Bering Sea
6	Southeast U. S. Continental Shelf	22	North Sea	38	Indonesian Sea	54	Chukchi Sea
7	Northeast U. S. Continental Shelf	23	Baltic Sea	39	North Australian Shelf	55	Beaufort Sea
8	Scotian Shelf	24	Celtic-Biscay Shelf	40	North Australian Shelf Great Barrier Reef	56	East Siberian Sea
9	Nefoundland-Labrador Shelf	25	Iberian Coastal	41	East-Central Australian Shelf	57	Laptev Sea
10	Insular Pacific-Hawaiian	26	Mediterranean Sea	42	Southeast Australian Shelf	58	Kara Seas
11	Pacific Central-American Coastal	27	Canary Current	43	Southwest Australian Shelf	59	Iceland Shelf
12	Caribbean Sea	28	Guinea Current	44	West-Central Austalian Shelf	60	Faroe Plateau
13	Humboldt Current	29	Benguela Current	45	Northwest Austalian Shelf	61	Antarctic
14	Patagonian SHelf	30	Agulhas Current	46	New Zealand Shelf	62	Black Sea
15	South Brazil Shelf	31	Somali Coastal Current	47	East China Sea	63	Hudson Bay
16	East Brazil Shelf	32	Arabian Sea	48	Yellow Sea	64	Arctic Ocean

Figure 3. Map of the world's 64 Large Marine Ecosystems and their linked watersheds. (Source: Volume 5)

2.2.5 Open ocean

The open ocean lies mostly in the high seas and beyond national jurisdictional boundaries. This transboundary global commons cover 50 per cent of the surface of the planet, and forms the single largest transboundary space. The Open Ocean Working Group adopted a conceptual framework presented in Figure 4, similar to that used by the LME Working Group. It identified thematic issues that assessments will address because governance of human activities in the open ocean is thematic. The four major themes that will be assessed are: (1) climate change, variability, and impacts; (2) ocean ecosystems, habitats and biodiversity; (3) open ocean fisheries; and (4) pollution. Cross-cutting issues include the assessment of global ocean policy cycles and their links with regional and national arrangements, and the underpinning observational, and governance capabilities to support their implementation.

2.3 Common framework elements

The hydrologic and human connections across the five water systems justify explicit inclusion of cross-cutting elements in assessing these. Nutrients and mercury are waterborne and atmospherically deposited substances that are transported through all water systems. All water systems assessments will address nutrients and mercury with the exception of mercury in transboundary aquifers systems, as this is currently not an issue globally.

Human usage of the water systems generates livelihoods and degrades ecosystems where this proceeds with inadequate or a total lack of ecosystem-based regulation. A core set of indicators for both socioeconomic and governance issues has been identified by the Socioeconomics and Governance Corresponding Group of the MSP, and which the five transboundary water system assessments will address to the extent possible. An economic cluster of indicators will quantify the gross domestic product (GDP) generated by water ecosystem services and the vulnerability of economic activities in relation to climate-related natural disasters. The social cluster of indicators quantifies human wellbeing by providing measurements of access to improved drinking water and sanitation, for example, and of vulnerability of human populations to climate-related natural disasters. Finally, a governance index will be derived from the evaluation across all water systems of the presence or absence of governance architecture to address water issues. Brief explanations of the cross-cutting socioeconomic indicators and governance index are found in Annexes III and IV.

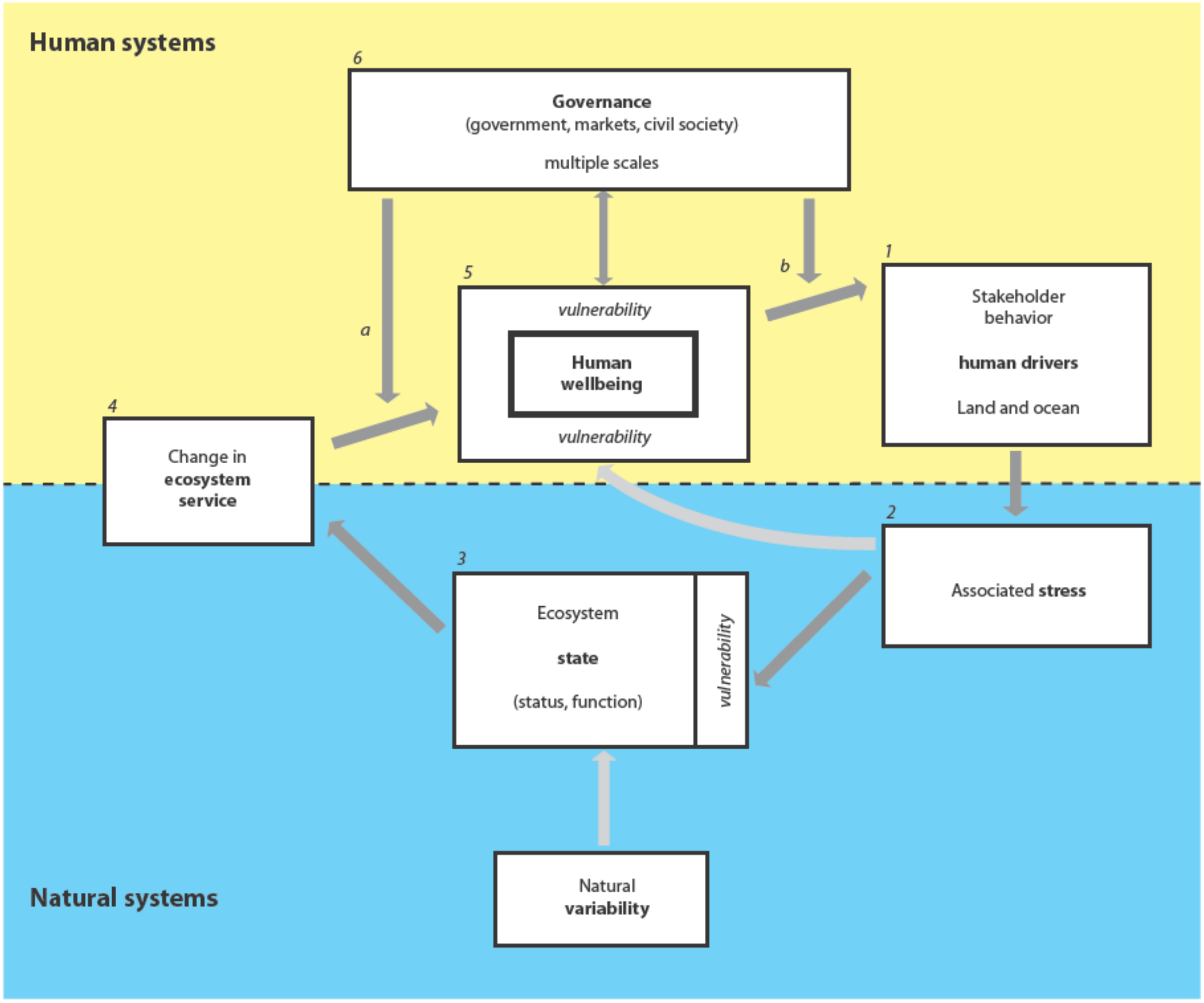
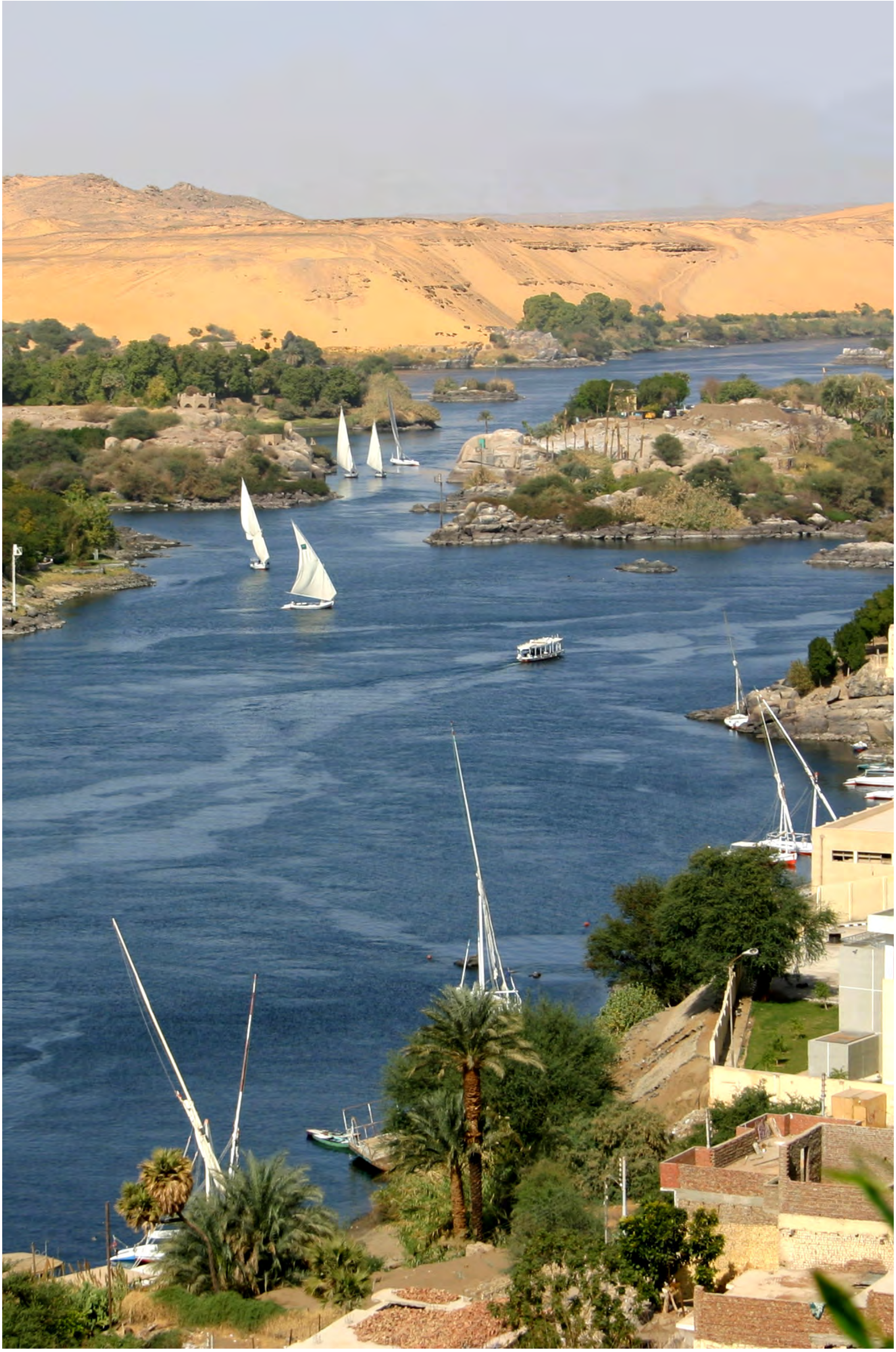


Figure 4. Conceptual framework for the Open Ocean and LME assessments, describing the relationship between human systems and natural systems from the point of view of ecosystem services and its consequences for people expressed as human wellbeing. Within TWAP this allows an identification of data sources and gaps, of assumptions made, of some factors peripheral to the central framework that may come into play, and of natural points of intervention for management. (Source: Volumes 5 and 6)



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3. METHODOLOGIES OF ASSESSMENT OF THE FIVE TRANSBOUNDARY WATER SYSTEMS

3.1 Introduction and identification of transboundary water systems

During the MSP, the five working groups were tasked with developing indicator-based assessment methodologies. Building on lessons learned from the Global International Waters Assessment (GIWA), which designed a single integrated methodology for the global assessment of international waters, TWAP involves five distinct methodologies, each tailored for the respective water system. This was deemed necessary given the differences in physical nature, data availability, and assessment unit sizes within each system. Furthermore, with varying levels of existing knowledge of the five water systems at the global scale, the methodology depends on the starting point of each system. Nonetheless, synergies between the methodologies have been identified where possible, as described further in section 3.4.

The methodologies were developed within the frameworks described in chapter 2. Consequently the methodologies endeavor to build on existing data and programs where possible, and use a mixture of measured data, modelled data, questionnaires and expert analysis. Furthermore, all groups have proposed that indicators be geo-referenced where possible, and that smaller assessment units within each transboundary 'unit' also be considered. The outline of each methodology is provided in the sub-sections below, but the details on each of the five methodologies can be found in volumes 2-6.

3.1.1 Transboundary aquifers

The methodology utilizes a regional approach with nominated regional coordinators and experts heavily involved in the assessment. The regional approach will better allow the capture of existing expertise and the creation of partnerships with regional organizations and networks, which form the cornerstones of TWAP TBA execution arrangements. The assessment will also include aquifers on SIDS. The regional approach assessment is supplemented with data and information coming from global data sets and global modelling exercises when considered essential.

Identification and characterization of Transboundary Aquifers (TBAs) involves collecting a set of data that, combined, gives a first description of the present hydro-geological, environmental, socioeconomic, and governance conditions, and of their interactions with adjoining water-bodies and ecosystems. This will draw heavily on the ISARM experience. The approach will strive to directly involve all countries likely to share aquifers. Country involvement is considered an essential element of the TBA assessment methodology, given the need to improve data availability, and to achieve visibility of aquifers and mutual recognition of their shared nature. More than 300 TBAs have currently been identified.

The final choice of transboundary aquifers will be undertaken during the FSP. Three main sources have been identified during the MSP which will be used for the identification of transboundary aquifers: (a) UNESCO-IHP ISARM's *Atlas of Transboundary Aquifers* (2009); (b) IGRAC's *Transboundary Aquifers of the World* (2009); and (c) WHYMAP's *Transboundary Aquifers of the World* (2006). Based on these sources, a provisional list of aquifers can be prepared. The following steps are foreseen to convert this list to a list of transboundary aquifers selected for the TWAP: (a) harmonization of information; (b) regional approach; (c) country involvement; and (d) acquisition of information. Two to four pilot systems will be selected for the in-depth assessment at Level 2, based on data availability as well as criteria that reflect the current GEF strategy for its International Waters Programme.

3.1.2 Transboundary lake basins

Because of the large number of transboundary lake basins, the WG adopted an iterative approach consisting of three levels (1.1, 1.2, and 1.3) for the Level 1 baseline assessment, with each level reducing the number of basins assessed, but increasing the detail in the assessment. The GEF is involved at each iteration to ensure GEF goals are being met – which countries are prioritized, the desirable cut-off size of lake basin, special issues such as high altitude lakes that should receive attention, etc.

In Level 1.3 stakeholders will be heavily involved in the assessment through questionnaires and workshops. This is necessary to: (1) ground-truth indicator results; (2) capture local expertise; and (3) add legitimacy and ownership to the process which will be catalytic in starting future GEF-funded and other projects utilizing the assessment results. Level 1.1 will assess more than 10,000 lake basins; Level 1.2, 500-1,000 basins; and Level 1.3 approximately 50-100 lake basins. The international drainage lake basins that contain at least one of the SWBD lakes are presented in Figure 5. The Level 2 in-depth assessment will follow the general TWAP approach.

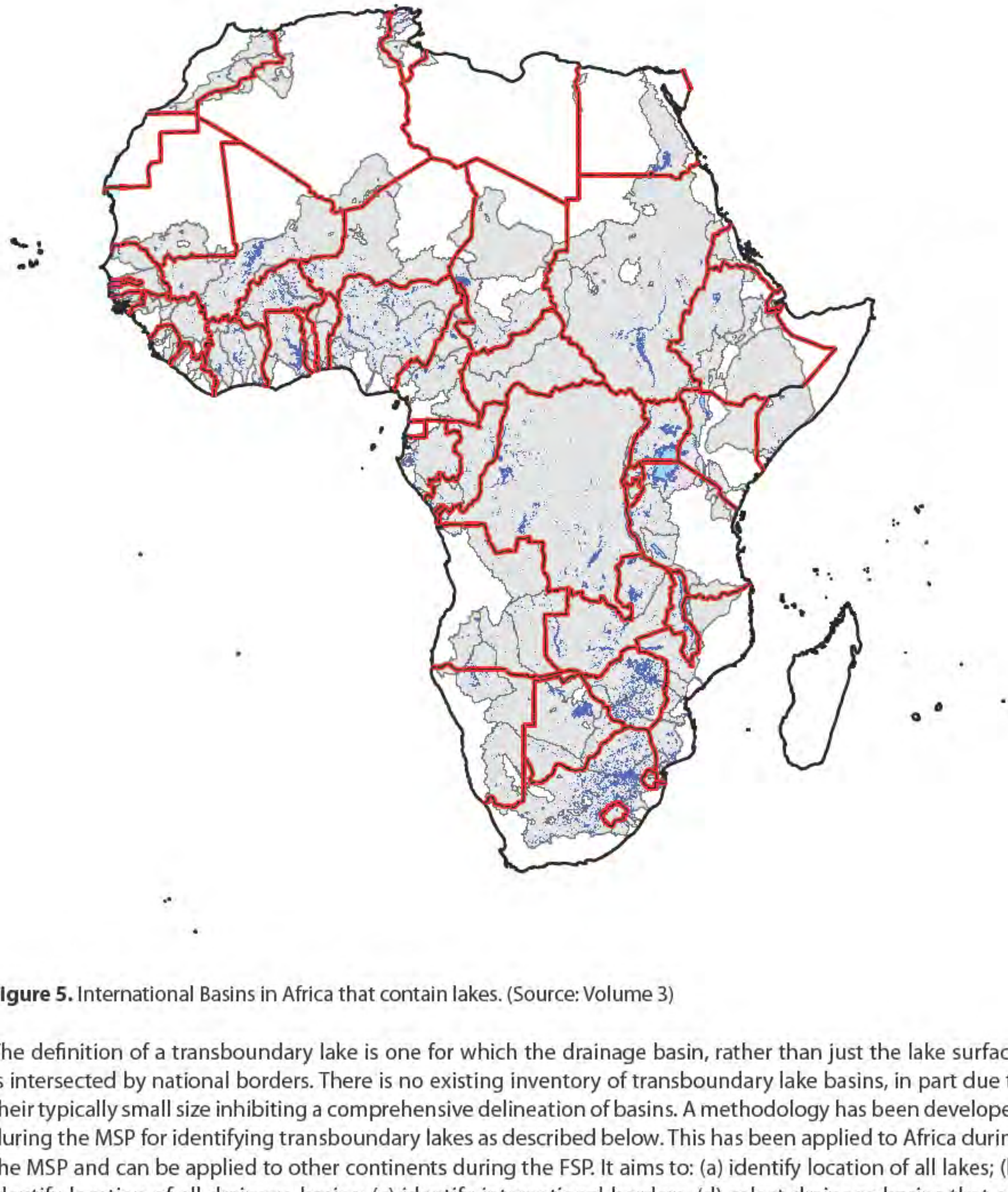

Figure 5. International Basins in Africa that contain lakes. (Source: Volume 3)

The definition of a transboundary lake is one for which the drainage basin, rather than just the lake surface, is intersected by national borders. There is no existing inventory of transboundary lake basins, in part due to their typically small size inhibiting a comprehensive delineation of basins. A methodology has been developed during the MSP for identifying transboundary lakes as described below. This has been applied to Africa during the MSP and can be applied to other continents during the FSP. It aims to: (a) identify location of all lakes; (b) identify location of all drainage basins; (c) identify international borders; (d) select drainage basins that are intersected by international borders; (e) determine which of these international drainage basins contain lakes; (f) count the number of lakes; and (g) delineate each lake's immediate drainage basin.

Remotely sensed images such as those from National Aeronautics and Space Administration (NASA)'s Landsat Program, as well as the questionnaires and stakeholder meetings described in section 3.1.2, will be used to populate the indicators.

3.1.3 Transboundary river basins

Compared to transboundary aquifers and lake basins, there is perhaps a greater existing body of work on which transboundary river basin assessments can draw. Consequently, the rivers methodology focuses on building on existing global data and institutions to the greatest possible extent. Level 1 consists of a characterization and comparative assessment of approximately 270 transboundary basins as defined by the International River Basin Register maintained by Oregon State University (OSU), whilst it is expected that Level 2 will undertake a more detailed assessment of approximately 4 basins. Existing stakeholder networks will be drawn on in Level 1 particularly through the governance indicators, and further involved in Level 2. The results for the majority of indicators will be made available on a 50 km x 50 km grid, thereby enabling analysis at the sub-basin level as well.

3.1.4 Large marine ecosystems (LMEs)

Through programmes such as UNEP's RSP (since 1974), LMEs have reasonably well-established partnerships. The 64 well-documented and delineated LMEs and the Pacific Warm Pool will be assessed during level 1 of the FSP, which will be a global comparative baseline assessment of current LME state and stressors as well as future projections to 2030 and 2050 of key stressors and likely impacts using indicators within the five LME modules: (i) productivity; (ii) fish and fisheries; (iii) pollution and ecosystem health; (iv) socioeconomics; and (v) governance. Smaller assessment units within LMEs will also be considered. These will include particular habitats, including coral reefs, mangroves, seamounts, and deltas, which will be assessed and reported by LMEs as well as across LMEs in a global comparative analysis. Transboundary hotspots will also constitute a smaller assessment unit within LMEs and are to be identified during the assessment. Mapping the cumulative human impact on LMEs is also proposed, following the approach of Halpern, et al. (2008), which would also serve to validate the results of the Level 1 comparative assessment.

Level 2 will consist of a desk study of two LMEs in developed regions and two in developing regions to identify indicator and assessment best practices that could be adopted in GEF LME projects. These LMEs will be identified during project preparation.

3.1.5 Open ocean

In contrast to the other four groups, the open ocean assessment takes a global thematic approach, as opposed to a geographic one, primarily because governance and management arrangements for the open ocean are largely thematic, multilateral, and global. These governance arrangements will be a focus for future interventions in the management of the open ocean. Marine ecosystem services do not follow political boundaries drawn in the oceans, and so the approach is global and scalable. The oceans are also relatively deep, harbouring very different surface and bottom ecosystems, for example, which cover distinct regions. The four themes are: climate, ecosystems, fisheries, and pollution. There will also be a cross-cutting governance assessment that starts by looking at the policy cycle at the global level, and their links to regional and national arrangements. Underlying the whole process will be an assessment of the adequacy of the observational and management/ governance capabilities at multiple scales. This aspect is of key value to the UNESCO-IOC.

Implementing the assessment will require two major activities: (1) mapping of indicators; and (2) expert assessments. During the MSP the TWAP Open Ocean WG emphasized that an assessment approach exclusively based on metrics, indicators, and indices was not feasible for the open ocean due to a lack of data. Therefore, expert assessments will review and assess the most recent scientific, technical and socioeconomic information produced worldwide and relevant to the understanding of human wellbeing connected to the open ocean through ecosystem services and direct impacts. The assessment will allow for the identification of particular geographic areas of concern, where the vulnerability of natural or human systems maps to the greatest current or projected future stress. To complement the global Level 1 analysis mapping selected indicators and providing an expert assessment across the four themes, a Level 2 analysis will focus on one specific region, and identify how the open ocean environment remotely impacts the wellbeing of a local human population.

3.2 Indicators

It is first important to define indicators and their various permutations as used in TWAP. Most groups have identified three levels of indicator (in wider sense) as follows, with generally increasing complexity and aggregation:

- metric: e.g., GDP per capita. Metrics usually have units;
- indicator: generally a combination of two or more metrics (e.g., economic dependency on water resources). Indicators may or may not have units, depending on how they are formed; and
- index: a combination of two or more indicators (e.g., socioeconomic index). Indices are generally dimensionless and usually have normalized scores. During the MSP, the groups reached varying stages in recommending the combination of indicators into indices, as well as the potential creation of a single overall index for each water system. Stakeholder feedback[2] has stressed the importance of transparent criteria for the weighting of each metric or indicator in forming indices. As such, this will need to be finalized during the FSP with partner and stakeholder involvement.

All five groups have used similar criteria for the selection of indicators, which can be broadly summarized as relevant to a particular issue; easy to understand and communicate; data available on a global scale; acceptable to stakeholders; and feasible to aggregate at different scales. Similarly, all groups have attempted to build on existing data and indicators where possible, though updates to existing datasets have also been recommended, as well as new indicators identified where data gaps exist. In this process each group has undertaken an extensive survey of globally available data, indicators, and relevant partners, and the details of these surveys can mostly be found in the annexes of volumes 2-6.

The GEF Secretariat advised that the total number of indicators should be kept to a minimum in order to communicate the most important information clearly. They also recommended that approximately 12 core indicators should be identified which could be assessed globally, and that additional indicators could be recommended for units where data and funding are available. Following this advice groups have reduced the overall number of indicators and have considered options for combining indicators into indices. The GEF Secretariat also recommended that indicators be placed in two groups: (1) current state indicators; and (2) projected status for 2030 and 2050. The common framework for governance and socioeconomic assessment as discussed in section 2.3 provided a useful platform for inter-group discussions which helped groups work towards a common understanding that can be built on in the FSP preparation phase and during the FSP itself. The frameworks are discussed in more detail in Annexes III and IV.

The descriptions of indicators, the current approaches and global data sets that support the evaluation of these, and the data sources are detailed in volumes 2-6.

3.2.1 Transboundary aquifers

There are 12 current and four projected core indicators (to be assessed for all TBAs), with 13 additional indicators to be assessed in those TBAs where data are available. The items below are potential indices, which could be created by combining the numbered indicators below them. The indicators with Arabic numbering (e.g. 1, 2) are core indicators, and indicators with Roman numerals numbering (e.g. i, ii) are additional potential indicators.

<u>Current State</u>

1. **Transboundary aquifers value and functions:** (1) Mean annual groundwater (gw) recharge or Total annual gw abstraction over Mean annual gw recharge; (2) Annual amount of renewable gw resources per capita; (i) Aquifer storage; (3) gw quality, (ii) Arsenic and fluoride variables; (iii) gw treatment requirements; and (4) gw vulnerability.

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[2] Stakeholder feedback received during the joint TWAP Rivers and Lakes stakeholder workshop in the Mekong Basin as described in section 6.2 of volume 4.

2. **Human and environmental dependency on groundwater:** (5) Human dependency on groundwater (divided into domestic, agricultural and industrial sectors if data available), and (6) Ecosystem dependency on groundwater.
3. **Aquifer vulnerability to stress:** (7) Groundwater depletion; (8) Groundwater pollution; and (9) Climate variability and change.
4. **Socioeconomics:** (10) Water use values and costs; (iv) socioeconomic drivers; (v) Cross-cutting economic cluster; and (vi) Cross-cutting social cluster.
5. **Governance:** (11) Performance of legal instruments and of institutional arrangements in a transboundary context; (12) Performance of domestic legislation and national government water resources administrations; (vii) Transboundary legal framework; (viii) Transboundary institutional framework; (ix) Domestic legal framework; (x) Domestic institutional framework; (xi) Formal and informal (ground)water user-level groups; (xii) Specialized Water Courts, and the regular courts of law; and (xiii) Economic governance.

Projected stress

6. **Quantity:** (1) Total groundwater abstraction/Mean annual groundwater recharge indicator; (2) Annual amount of renewable gw resources per capita indicator; and (3) Population dependency on gw.
7. **Quality:** (4) One of: level of drinking water standards; composite value of variables (electrical conductivity, chloride and nitrate); individual variable (electrical conductivity, chloride, or nitrate).

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3.2.2 Transboundary lake basins

The summary of proposed indicators for lake basins is presented in the following table.

ILBM theme	Level 1.1* (>10,000 basins)	Level 1.2* (500-1,000 basins)	Level 1.3* (50-100 basins) (C&P=current and projected 2030 and 2050)
1. Biophysical conditions	(1) Hydrological position	As L1.1	(1) Hydrological position (C&P);
	(2) Lenticity	As L1.1	(2) Lenticity (C&P); (3) Estimated lake volume;
	(3) Lake to basin area	As L1.1	(4) Lake to basin area (C&P);
2. Human use	(4) Relative population pressure	As L1.1	(5) Relative population pressure; projected population pressure;
	(5) Human development Index (HDI)	As L1.1	(6) HDI;
	(6) Jurisdictional fragmentation	As L1.1	(7) Jurisdictional fragmentation;
	(7) Linguistic diversity	As L1.1	(8) Linguistic diversity;
	(8) Landscape alteration	Cropland area	(9) Irrigated cropland area; (10) Non-irrigated cropland area;
		Urban area	(11) Impervious surface area; (12) Forest area; (13) Alteration of littoral zone;
	(9) Flow alteration	As L1.1	(14) Flow alteration; (15) Relative flow diversion; (16) Water level change;
	(10) Relative water stress	As L1.1	(17) Relative water stress;
3. Institutions	(11) Government effectiveness	As L1.1	(18) Government effectiveness; (19) Control of corruption; (20) Lake basin specific institution; (21) Degree of coordination; (22) Local community governance; (23) Degree of international involvement;
	(12) Control of corruption	As L1.1	
4. Policies	(13) Rule of law	As L1.1	(24) Rule of law; (25) Ambient standards/goal; (26) Effluent standards; (27) Zoning regulations; (28) Effectiveness of implementation; (29) Transboundary (TB) coordination;
5.Participation	(14) Voice & accountability	As L1.1	(30) Voice and accountability; (31) Integration of stakeholder inputs in the decision making process; (32) Level of education/awareness raising; (33) Role of NGOs/Community-based Organizations (CBOs); (34) Indigenous and gender representation;
6. Technology	(15) Access to improved sanitation	As L1.1	(35) Access to improved sanitation; (36) Industrial pollution control; (37) Solid waste control; (38) Non-point source control; (39) In-lake interventions; (40) Impact from resource development interventions;
7. Information	(16) Coverage in literature	As L1.1	(41) Coverage in literature; (42) Extent of monitoring programmes; (43) Resident scientific institutes; (44) Citizens/indigenous knowledge input; (45) Degree of international sharing; (46) Sufficiency of information; (47) Freedom of access;
8. Finance	(17) Gross national income; (18) International development support	As L1.1	(48) Gross national income; (49) International development support; (50) Sufficiency of funds; (51) Payment for ecosystem services; (52) Local retention of funds;
9. Planning	(19) National IWRM plans	As L1.1	(53) National IWRM plans; (54) SAP or equivalent; and (55) Integration of plans.

Table 1. Summary of problems facing the 28 LBMI lake basins.[1]

Lake Basin	In-lake					Littoral				Basin origin							Regional/ Global		
	Unsustainable fishing practices	Introduced faunal species	Salinity changes	Weed infestations	Nutrients from fish cages	Shoreline effluent discharges	Shoreline industrial discharges	Shoreline water extraction	Loss of wetlands	Excess sediment inputs	Non-point source nutrients	Agro-chemicals	Water abstraction	Changes in run-off	Effluent and stormwater	Industrial pollution	Atmospheric nutrients	Atmospheric industrial contaminants	Climate change
Aral Sea			→						→				→						
Baikal						↓	→			↓								→	
Baringo	→									↓			↓	↓					↓
Bhoj Wetland				→		→	↓			→	→	→			→				
Biwa									↓		→	→	↑[2]		↑				↓
Chad									↓	↓			↓						↓
Champlain						↑					↑				↑			→	
Chilika Lagoon			↑	↑						↓	↓	↓	↓		↓				
Cocibolca/Nicaragua						↓				↓		↓			↓				
Constance		↓				↓			→		→	→			→				
Dianchi					↑	→	→		↓	↓[3]	↓[3]	↓[3]	↓		↓			→	
Great Lakes (N. American)		↓				↑	↑				↓	↓			↑	→		→	
Issyk-Kul		→								↓	↓	↓				↓[4]			↓
Kariba Reservoir					↓	→					↓								↓
Laguna de Bay	→	↓	→	→	↓	→	→			↓	↓				↓	→			
Malawi/Nyasa	↓[5]			↓						↓	↓	↓		↓	↓		↓		↓
Naivasha	↑	→		↑		↓		→	→	↓							↓		
Nakuru										→	→		↓	↓	↓				
Ohrid	→	↓				→	↓		↓	↓	↓	↓			↓				
Peipsi/Chudskoe	↓			→		→					→[6]				↓	→[6]			
Sevan	↓	↓				↓			↓	↓			↓						
Tanganyika	↓[5]					↓	↓			↓					↓				↓
Titicaca		↓				→	↓			↓					↓	↓			
Toba	↓	↓		↓	↓	→			↓	→	→	↓	↓	→	↓		↓		
Tonie Sap	↓	↓								↑[7]					↓				
Tucurui Reservoir				→						→									
Victoria	→	↓[8]		↑		↓	↓		↓	↓	↓				↓	↓[4]	↓		
Xingkai/Khanka	↓					→	→		↓	↓		↓			↓	↓[9]			
Total Occurrences	12	11	3	9	4	18	10	1	11	21	16	12	9	4	19	7	4	4	7

Legend A symbol ↓ means that the problem is not improving significantly; a symbol → means that it has improved somewhat; and a symbol ↑ means that there has been significant improvement.

1 The lake briefs are not exhaustive in their description of problems; a blank cell in the table does not mean that the lake does not experience the problem. In many lake briefs, there is only limited information on the extent of improvement of a problem; the direction of change shown in the table is based on this information.
2 Most water abstraction for Kyoto/Osaka/Kobe is downstream of Lake Biwa.
3 Despite considerable investment, nutrient and chemical concentrations in Lake Dianchi have yet to show improvements. There is some evidence that COD is improving.
4 Mining in the basin is the source of toxic chemicals reaching the lake.
5 Includes loss of fi sh biodiversity through overharvesting for aquarium trade.
6 Improvements in the nutrient and pollutant status of the lake are the result of a decline in use of nutrients in agriculture and industrial production following the collapse of the Soviet Union rather than from a deliberate policy intervention.
7 There is a large amount of sediment deposited around Tonle Sap each year, but this is regarded as an essential service rather than as a problem.
8 Introduced species, particularly Nile perch and Nile tilapia, have contributed to the loss of many native species as well as providing a valuable source of income for the regional community. Here they have been assessed for their effect on the lake's biodiversity.
9 High copper (Cu) concentrations are recorded in Lake Xingkai/Khanka, but the origins are unknown.

Lakes, as standing (lentic) bodies of water, are highly valuable but also highly vulnerable to human activities at four main scales: in-lake (such as overfishing), littoral zone (such as destruction of shoreline wetlands), basin level (such as sediment input from deforested areas) and regional/global (such as mercury deposition from fossil fuel combustion sources located far away). Based on a previous global-scale ILEC study on lake basin management (ILEC, 2005), the table below shows the extent to which these four scales present challenges.

3.2.3 *Transboundary river basins*

There are 14 core 'current' indicators and five projected indicators.

Cluster	Indicator
Transboundary status	
Water Quantity	(1) Environmental water stress; (2) Human water stress; (3) Agricultural water stress;
Water Quality	(4) Nutrient pollution; (5) Urban water pollution;
Ecosystems	(6) Biodiversity and habitat loss; (7) Ecosystem degradation; (8) Fish threat;
Governance	(9) Governance architecture; (10) River basin resilience; (11) Water legislation;
Socioeconomic	(12) Economic dependence; (13) Societal wellbeing; and (14) Vulnerability.
Projected Transboundary Stress (2030/2050)	
	(1) Environmental water stress; (2) Human water stress; (3) Nutrient pollution; (4) Population density; and (5) River basin resilience.

3.2.4 *Large marine ecosystems (LMEs)*

The below are 'current' indicators, with projections to be made where possible.

Productivity	Fish & Fisheries	Pollution & Ecosystem health	Socioeconomics	Governance
(1) Primary productivity; (2) Chlorophyll a; (3) Sea surface temperature;	(4) Reported landings; (5) Value of reported landings; (6) MTI and FiB; (7) Ecological Footprint of Fisheries; (8) Stock-status plots;	(9) Mercury; (10) Nutrients; (11) PoPs (Plastic resin pellets); (12) Shipping density; (13) Seamounts at risk; (14) Change in Protected Area coverage; (15) Change in extent of mangrove habitat; (16) Reefs at risk index; (17) Deltas at risk index;	(18) GDP fisheries; (19) % GDP international tourism; (20) Urban and rural populations living within 10 m coastal elevation; (21) HDI; (22) Deaths per 100,000 caused by climate related natural disasters; and	(23) Institutional arrangements.

3.2.5 *Open ocean*

There are approximately 23 mapped indicators. C&P (below) stands for current and projected (for 2030 and 2050).

1. **Climate change, variability, and impacts:** (1) sea level (C&P) (see Fig. 6); (2) ocean heat storage (including impact on corals, extremes, and primary productivity); (3) rainfall-drought changes linked to ocean; (4) sea ice; (5) ocean deoxygenation (C&P); (6) ocean uptake of carbon dioxide (CO_2) (C&P); and (7) ocean acidification (C&P).
2. **Ocean ecosystems, habitats, and biodiversity:** (8) primary productivity; (9) zooplankton; (10) food web/trophic level changes; (11) ecologically and biologically significant areas; (12) seamounts at risk; and (13) ecosystem service valuation.
3. **Open ocean fisheries: impacts and sustainability:** (14) demersal fishing effort; (15) open ocean fisheries sustainability; and (16) fish catch value (see Fig. 7).

4. **Pollution as stressor of marine ecosystems:** (17) shipping; (18) plastics; (19) seabed mining; (20) nutrient inputs (atmospheric); (21) mercury input (atmospheric); and (22) pollution watch.

5. **Cross-cutting assessment of governance.**

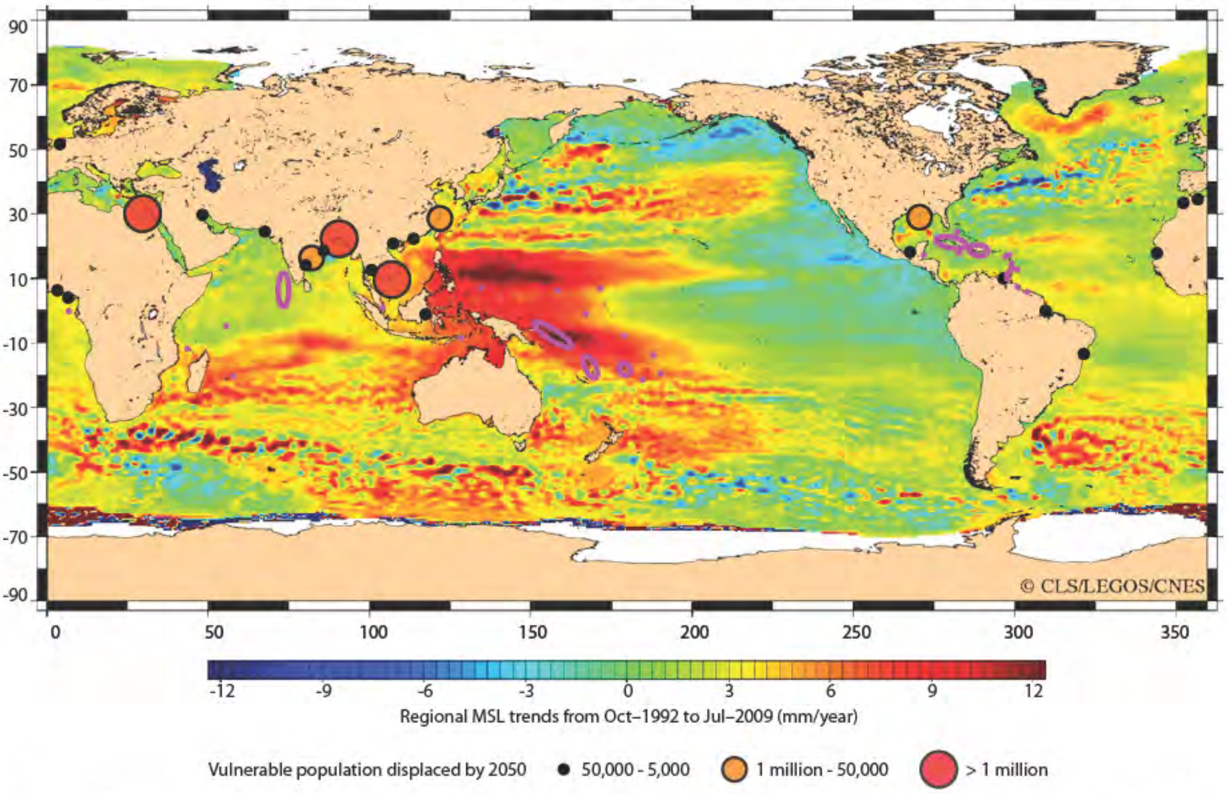

Figure 6. An example of the global mapping of open ocean-related indicators, mapping environmental state with human vulnerability: regional mean sea level trends from 1992 through 2009, showing areas where sea level is rising much faster or slower than the mean global rate, with the vulnerabilities of key coastal population in large river delta areas shown as circles. Vulnerability of these populations is also based on local capacity to adapt, a socioeconomic assessment. Additional vulnerabilities are faced by SIDS (represented here by the AOSIS members in magenta) based on their capacity for adaptation and the centrality of coastal zones to those countries. (Source: IPCC (2007) and Ericson, et al. (2006), Volume 6)

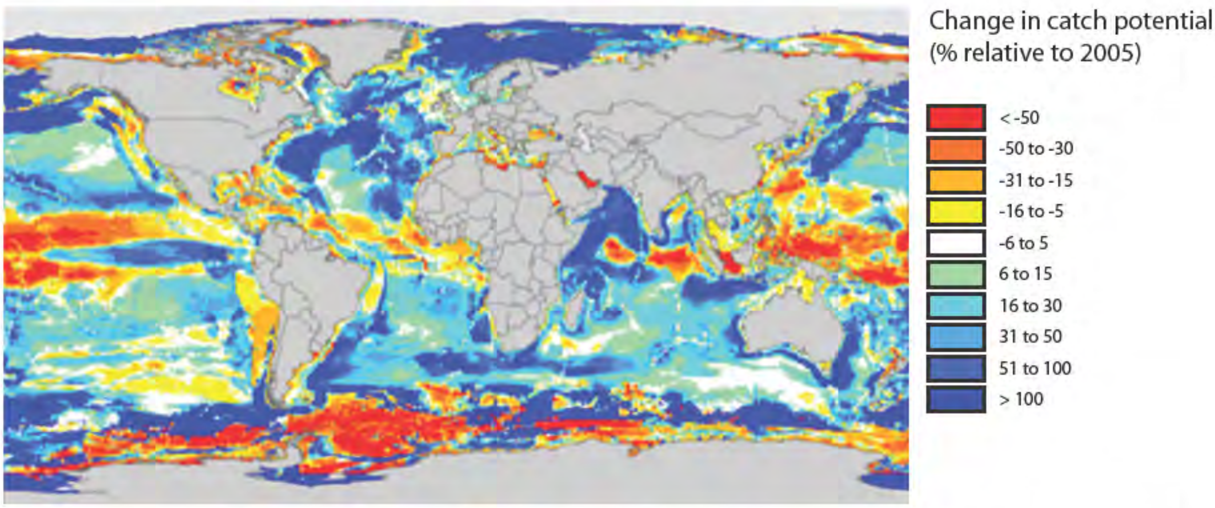

Figure 7. An example of a global mapping of an open ocean indicator that requires expert assessment of competing models due to uncertainty and approximations: change in catch potential in 2055 relative to 2005, based on a model. Many areas in the tropics and the Southern Ocean will have reduced catch potential according to this model, but other subpolar areas will be winners. (Source: Cheung, et al. (2010), Volume 6)

3.3 Scoring

All five groups have devised similar approaches to scoring of indicators. It is also important that scoring systems are transparent and can be understood by end users.

For each system, numerical absolute scores will be created where possible, and these will be used to rank transboundary units for each indicator. However, the indicators will generally be presented in relative scoring categories to meet the objective of TWAP for creating a basis for comparison between transboundary units. The relative scoring approaches are summarized as follows:

- Transboundary aquifers: three or more categories ranging from very high through medium to very low.
- Lake basins: scores of between zero and one using a statistical approach based on creating Cumulative Distribution Functions (CDF), with four or five categories to facilitate comparison.
- River basins: five asymmetric categories from one to five to identify the most at-risk river basins, whilst also identifying the least at-risk basins. These may provide some information on best practices.
- LMEs: five asymmetric categories from one to five, similar to the Rivers approach.
- Open ocean: a relative scoring approach will be based on a mapping of cumulative human impact. The expert assessment will provide an independent check.

3.4 Interlinkages and cross-cutting issues among water systems

Understanding interlinkages among transboundary water systems, including the influences of human use and governance, is critical in determining the baseline and projected status of these systems and identifying the sources or origin of certain pressures. At the level of each transboundary water system, expert groups examined the relevant connectivities with other water systems that each assessment could examine. At the project level, nutrients and mercury were identified as cross-cutting issues relevant to all five transboundary water systems, although mercury in aquifers is not generally seen as a global problem.[3] For nutrients, input and output flux analyses may be used to assess the eutrophication state of a water system, with a focus on nitrate levels for systems that have marine influence, and on phosphate for freshwater systems. Three other issues including water quantity, vulnerability to climate change, and biological productivity are potential interlinkages themes that each water system could examine if deemed significant to the focal transboundary water system. From a human dimension view, a Governance and Socioeconomics Correspondence Working Group was established to discuss and identify a broadly common set of indicators for examining social, economic and policy influences on the ecological states of transboundary water systems. Annexes III and IV provide detailed discussions of approaches and indicators.

The following summaries by water system highlight the approaches taken by each expert group in addressing these interlinkages and cross-cutting issues. More importantly, the nuanced limitations, because of spatial scale, number and geographical distribution of water bodies within each water system, are highlighted. This way, the diversity and complexity inherent in the study of each water system is kept in focus while the assessments attempt to examine common issues that connect one system to another.

3.4.1 Cross-cutting issues: nutrients and mercury

Transboundary aquifers. Groundwater can discharge into lakes, rivers as part of base flow and LMEs. Conversely, aquifers can receive freshwater recharges from overlying lakes and rivers; and saltwater intrusion from LMEs. Also, links between transboundary aquifers and open ocean exist, but may partly be indirect such as the contribution of non-renewable or fossil groundwater resources to global sea level rise. These potential physical links can be established in a Level 1 TWAP assessment. In terms of analysing physical fluxes of water and materials into and out of transboundary aquifers at this level of assessment, aggregated data is insufficient

[3] First Meeting Report of the Information Management and Indicators Working Group (IMAIG), 12-14 July 2010.

to determine inflows and outflows. The often multiple geomorphological connections between aquifers and other water bodies, and the lack of common boundaries, make estimating fluxes using aggregated data impossible in most cases. Indicators that will be assessed include nitrate concentration, total dissolved solids and ground level decline (subsidence). Mercury is of little relevance to transboundary aquifer systems, and the Transboundary Aquifers Working Group suggests that arsenic is of greater relevance.

Transboundary lake basins. Changing patterns of rainfall and runoff influence nutrient loading and dynamics in lakes, and can cause shifts in species and trophic dynamics. In freshwater systems, excessive amounts of nutrients, notably phosphorus, can lead to cyanobacterial (often referred to as blue-green algal) blooms. While nitrogen may be assessed for purposes of determining lake inputs to nitrogen budgets of receiving waters where data are available, phosphorus is often of greater importance in determining lake nutrient state. Lake-river interlinkages are strongest compared to other water systems. However, the spatial scale of many lake basins does not allow for coarse-scale modelling of nutrient fluxes, such as those generated using the Global Nutrient Export from WaterSheds (NEWS) dataset, and assessment at lake basin scale necessitates fine scale empirical studies to generate the needed data. Indicators of water quality and ecosystem health will need to be evaluated on a case-by-case basis given large data gaps as well as site-specific characteristics.

Transboundary river basins. Rivers are tightly linked with the underlying groundwater system, the lakes into which these flow, and the LMEs into which they empty. Data for transboundary rivers will be evaluated using a global grid, as such links with finer scale water systems lake lakes and transboundary aquifer systems, requiring higher spatially resolved data, would not be possible with coarsely resolved data. It is proposed to use the Global NEWS model (common with the LME approach) to assess the risk of nutrient pollution in river basins, and provide this information to the LME group. For mercury in rivers, an option is to use a modelling approach where risks for deposition of wet and dry mercury are calculated on a 30-minute grid for both soluble divalent and particulate mercury (Vörösmarty, et al., 2010).

Large marine ecosystems. LMEs interact with open ocean and rivers, and to a certain extent, aquifers through saline intrusion. The Global NEWS modelling approach will be used to evaluate nutrient fluxes from rivers (outflows) to coastal areas of LMEs (inputs). Transboundary deltas will be of particular importance in assessing interlinkages between LMEs and rivers. Sea level rise (Open Ocean) and its impacts on coastal areas and human communities adjacent to the LMEs will also be included in assessing interlinkages.

Open ocean. For open ocean, the primary connectivity in terms of water and material transfers is with the atmosphere, and those with other water systems are secondary. Nutrient input and mercury remain issues for open ocean ecosystems. Their present and projected future impact will be estimated from models.

3.4.2 Socioeconomic issues

As in the case of assessing nutrient and mercury fluxes into and out of transboundary water systems, the assessment of social and economic features and projected states of water systems are equally nuanced by the challenges imposed by the geospatial and temporal scales of available data. As such, the Correspondence Working Group on Governance and Socioeconomics vetted a broadly defined core set of social and economic indicators common to all five water system expert groups. Because this exercise was done rather late and after each WG had defined their indicators independently of one another, it was critical to use the opportunity as a means to highlight commonly identified indicators while embracing the unique human and geomorphologic contexts for each transboundary water system.

The cross-cutting social issues addressed the urban and rural distribution of human populations and their corresponding growth rates, their access to improved drinking water and to sanitation, adult literacy and life expectancy. The latter three indicators have been subsumed by UNDP HDI, which has been estimated globally at the national scale for decades. Vulnerability to climate related-national disasters has been included among the core social indicators. Undoubtedly, the availability of data at a transboundary water system scale is a major challenge for all water systems because computation of basin-relevant indicators requires sub-basin (i.e. subnational) scale data. This must then be combined at the water system scale that inevitably includes two or more countries. For transboundary lakes and aquifers, which are often smaller in size, finer-scale data (i.e. at the provincial or district levels) may be required, but are often not available at such a local scale. The cross-cutting economic issues focus on reliance on the ecological services provided by water systems especially as they

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relate to livelihoods. The latter include the gamut of economic activities such as fisheries, agriculture, energy (fossil fuels, hydroelectric), water transportation, and tourism and basic domestic household consumption.

More details on the approach towards the socioeconomic issues are presented in Annex III of this document and volumes 2-6.

3.4.3 Governance

The Correspondence Working Group on Governance and Socioeconomics provides an overview of an approach and indicators to be implemented in the assessment of the governance of transboundary water bodies. The Level 1 assessment focuses on determining the existence, not performance, of governance arrangements that address issue categories such as water quantity, water distribution, water quality, fisheries, biodiversity, habitat destruction, and climate change mitigation. The Level 2 assessment proposes to evaluate the functionality and performance of governance arrangements following an agreed set of criteria. Governance functions including preparation of policy advice, decision-making process for policy setting, management decision-making, implementation, implementation review, and provision of data and information are targeted for evaluation. More information on the approach to governance issues are presented in Annex IV of this document and volumes 2-6.

3.4.4 Capacity building needs

An integral component of baseline assessments is an evaluation of capacities needed to sustain periodic evaluation of transboundary water systems, including the generation of data and knowledge to support subsequent assessments. Each of the WGs underscored capacity building needs for particular areas where expertise, data and knowledge are acutely needed. More information is presented in volumes 2-6.

3.5 Partnerships and institutional arrangements

The development of the methodologies proposed for use during the conduct of a future transboundary waters assessment was based upon the combined experience of more than 50 individuals and institutions around the world. These individuals and institutions are named in Annex I. Early in the process of formulating this approach, the decision was taken that each of the working groups, representing transboundary aquifers, lakes and reservoirs, rivers, LMEs, and open ocean, would develop a methodology that was best suited to:

(i) addressing issues of concern within the specific subject waters; and (ii) addressing a number of cross-cutting issues of concern that affect or impact several of the water systems. Consequently, the methodologies developed for use in the transboundary waters assessment reflect a consensus of experts actively involved in the management of each of the transboundary water systems.

Institutionally, the GEF Implementing Agency (IA), the UNEP, identified key partners who would spearhead the development of the methodologies within each of the water systems. For each of the WGs the lead organizations and executing partners are presented in the section 1.2 of this document.

3.5.1 Partnerships developed for the formulation of the transboundary waters assessment methodologies (MSP)

Transboundary aquifers. UNESCO, through its IHP, provided a central coordinating role in the development of the methodological framework for transboundary aquifers. UNESCO-IHP has been implementing the ISARM programme aimed at improving the understanding of scientific, socioeconomic, legal, institutional and environmental issues related to the management of transboundary aquifers, to which governmental and nongovernmental partners have contributed, since 2002. UNESCO-IHP is cooperating closely with IGRAC, operating under the auspices of UNESCO and WMO during 1999, and from the UN Water, WWAP hosted by UNESCO, formed during 2000, in order to provide recommendations, develop case studies, enhance assessment capacity at a national level and inform the decision-making process. Information and data on these resources are maintained in IGRAC's Global Groundwater Information System (GGIS). A number of additional partners, including BGR, FAO, the Swiss Federal Institute of Technology (ETHZ), and the UNESCO Chair and University of the Western Cape, South Africa, have actively contributed to the TWAP MSP Transboundary Aquifers component.

Transboundary lake basins. ILEC provided the central coordinating role for the development of methodologies related to lakes and reservoirs (hereinafter "lakes"). Drawing on its Scientific Committee (SciCom), and building on an ongoing initiative funded by the Government of Japan, ILEC worked to refine its ILBM approach as a key analytical approach to managing lakes in the context of their basins or watersheds.

Transboundary river basins. The UNEP-DHI Centre was identified as the lead agency, in partnership with IUCN and SIWI. The proposed institutional arrangement for the River Basins component is shown in Figure 8.

Large marine ecosystems. UNESCO-IOC coordinated the development of the assessment methodology for LMEs in collaboration with a number of institutional partners and experts (see LME methodology document for details).

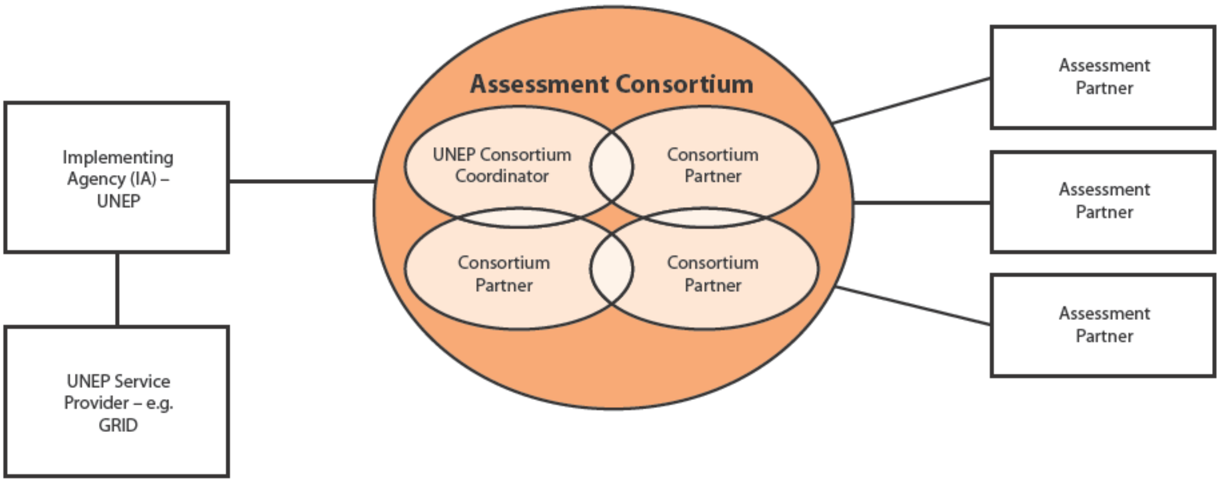

Figure 8. Proposed instititutional arrangment for the FSP for the River Basins Working Group (Source: Volume 4)

Open ocean. UNESCO-IOC coordinated the development of the open ocean assessment protocol, adopting an approach that included consideration of both direct impacts on the open ocean as well as indirect impacts of the open ocean on coastal areas.

3.5.2 Partnerships proposed for the conduct of a transboundary waters assessment (FSP)

All of the working groups identified various potential partnerships that would be beneficial for the conduct of a transboundary waters assessment. These partnerships generally were comprised of a core group who would coordinate data acquisition and analysis; assessment partners who primarily would be involved with the assessment process; and, data partners who would primarily provide the data and information upon which the assessment would be based.

Transboundary aquifers. The TWAP Groundwater Coalition will be comprised of three categories of partners based on their specific roles and functions:

1. the core group, led by UNESCO-IHP, and consisting of IGRAC, FAO, UN WWAP, and the global network of UNESCO water related centres and chairs;
2. the assessment partners, consisting of regional coordinators and expert networks; and
3. the data partners, consisting of key providers of expertise and data.

The core group will be supported by an advisory panel, including international experts from academia, professional organizations and associations, and national geological surveys around the world. IGRAC is to manage the information management system and a task force on remote sensing and modelling. Regional inputs are foreseen from existing regional entities such as the Organization of American States (OAS), the Southern Africa Development Community (SADC), and the various Regional UN Economic Commissions.

Transboundary lake basins. ILEC will convene the core group. In this role, ILEC will continue its ongoing programme of information and data gathering, education, and provision of ILBM implementation assistance in partnership with national governments. These governmental partners, including China, India, Japan, Kenya, the Philippines, and Russia, as well as Malaysia, Mexico, Nepal, and others, would form the assessment partners. For the purposes of a future transboundary lakes assessment, the following data partners are envisioned: US NASA, US Geological Survey (USGS), US Oak Ridge National Laboratory, the US Department of Agriculture, and the US National Geospatial-Intelligence Agency; UNDP, the World Bank (WB), United Nations Population Fund (UNFPA), and the Global Water Partnership; OSU, Columbia University, and University of New Hampshire; the World Wildlife Fund (WWF); the Wildlife Conservation Fund; and, Global Mapping International.

Transboundary river basins. The UNEP-DHI Centre, with assistance from IUCN and SIWI, will form the core group. They will coordinate the Assessment Partners, made up of: the City University of New York (CUNY), the Universities of Kassel and Frankfurt, OSU, IGBP, Global NEWS, and Centre for International Earth Science Information Network (CIESIN), with potential involvement of the International Water Management Institute (IWMI), and the IMAGE team currently based within the Netherlands Environmental Assessment Agency. Data partners will include the following institutions: FAO, who maintain the AquaStat and FishStat databases, UNICEF and World Health Organization (WHO), the Secretariats of the Rotterdam Convention for Prior Informed Consent (PIC) and of the Stockholm Convention on Persistent Organic Pollutants (POPs), the WB, UNEP/GRID, the Global Water Systems Project (GWSP) (Global reservoir and dam database), and the WorldFish Centre (GDP related fisheries).

Large marine ecosystems. The core group for the LME assessment will be coordinated by UNESCO-IOC. It will have a coordinator and secretariat based at the IOC, advised by an expert oversight panel balanced between natural science, social science, and economic and legal experts as well as a representative of the GEF and representatives of relevant UN agencies and NGOs. The expert oversight panel will be named by the partners of the TWAP LME assessment and GEF. In addition, the core group will be supported by assessment partners who will be collectively responsible for producing the final LME assessment report. The assessment partners must have an established network to access data, or hold the data themselves, as well as the experience and capacity to undertake the TWAP assessment. They are also collectively engaged in the cross-cutting assessment. The assessment partners would be supported by data partners which would include institutions as well as projects and programmes such as the GEF LME projects and RSPs.

Open ocean. The IOC and agencies including the European Commission GEOWOW project, GOOS and UNEP (DEWA and DEPI/Marine and Coastal Ecosystems Branch) would form the core group. Assessment partners include the Center for Marine Assessment and Planning (CMAP), UBC and Pew Sea Around Us project, UNEP/GRID-Arendal, UNEP-WCMC, the World Climate Research Programme (WCRP), Dalhousie University and CERMES, and GESAMP. Key data partners include: NOAA (Office of Science and Technology), Plymouth Marine Laboratory, the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), the IUCN Global Ocean Biodiversity Initiative (GOBI), the IOC Oceanographic Information and Data Exchange (IODE) and its Ocean Biogeographical Information System (OBIS), the SCOR-IOC International Ocean Carbon Coordination Project, FAO, and the International Seabed Authority.

3.5.3 Institutional arrangements proposed for the conduct of a transboundary waters assessment

The experiences gained and lessons learned in the development of the methodologies for the conduct of a transboundary waters assessment, the MSP, noted on page 6, have demonstrated the flexibility and robust nature of the basic approach, wherein UNEP would coordinate the work of identified core groups which would conduct the assessments of the water systems. These entities are proposed to constitute a steering committee under the guidance of the UNEP DEWA, and the GEF.

For project execution, the core groups would be supported by assessment partners, who would be responsible for obtaining necessary data from the data partners. To the extent possible and practicable, assessments will be based upon common data sets. For example, population data will be drawn from the same data source to avoid discrepancies in interpretation based on differing input data. To avoid multiple requests for these common data sets by the various WGs assessing the different water types, these requests will be coordinated by UNEP DEWA staff.

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3.6 Data and information management

A key element of TWAP is the acquisition, storage, processing, and evaluation of data and information on transboundary aquifers, lakes and reservoirs, rivers, LMEs, and open ocean.

For the purposes of this section, information is considered to be narrative or non-numerical, while data are considered to be numerical. An example of non-numerical information would be a description of a water body as being impaired, polluted, or pristine. These descriptors reflect a perception, and, while perceptions are not necessarily reflected in behaviours, they do convey an impression of the state of the resource. In contrast, numerical data quantify the degree of impairment in terms of contaminant loads or concentrations, possibly in relation to a legal standard or other numeric level. Data allow an absolute determination. For example, a lake may be perceived as polluted based on a green coloration when its total phosphorus concentration is 20 micrograms per litre (µg/l), but could be considered legally unimpaired if the regulatory standard is 40 µg/l.

3.6.1 Nature of available data and information

The WGs have proposed the application of a variety of indicators, based primarily on those globally accepted and available indices that can be related to water and/or to water bodies. GDP, a measure of economic activity, is an example of the types of indicators considered for use by the all of the WGs. While such indices may not be a direct reflection of water quality or quantity, they do indirectly suggest the level of demand for or pressures on aquatic systems. Increasing GDP, for example, is typically accompanied by increased demands for services, consumption of goods and production of waste. Relative affluence also appears to be related to increasing urbanization with its concomitant demands for, and impacts on, water resources, whether for food, water supply, process water, or transportation. Notwithstanding, these data are generally produced for country units rather than hydrographic units. Thus, there is a need to disaggregate the data from the national scale to level of the water system.

Each working group has identified data partners that are able to provide data and/or information on specific water resources. These partners are generally international or regional entities but may extend to national sources as necessary. While data and information will be drawn from a network of networks to the extent possible, it is likely that some data manipulation will be required by the assessment partners to ensure consistency of units and terminology.

3.6.2 The main sources of data for each water system

To the extent that the five working groups have identified common data and information needs, as in the case of data on current and projected populations, climate scenarios, and land use, for example, it is proposed that these needs be met through the use of a common source, and that requests for these types of data and information be coordinated by UNEP as the secretariat. Insofar as specific data and information needs are concerned, these too should be shared with the secretariat; however, each of the working groups has identified a process through which to obtain water body-specific information and data. These processes are summarized below.

Transboundary aquifers. It is anticipated that data and information on transboundary aquifers will be solicited through direct contacts with regional entities and entities within the SIDS that are in charge of groundwater resources. To avoid conflicts, SIDS, for purposes of the proposed implementation project, are assigned to the transboundary aquifers WG. The WG intends to acquire the necessary data and information directly from regional sources or through responses to a questionnaire. Map-based data and meta-data (information) are anticipated to form a significant part of the required information with some data currently being available in the UNESCO WHYMAP database. It is proposed that data processing be done using available models. A web-accessible information sheet on each aquifer will be populated and linked to a GIS-based map of each aquifer. To this end, IGRAC is noted as having specialized knowledge and expertise in working with transboundary aquifer data and information and will coordinate the data and information management of the TBA component. The Figure 9 shows the assessment as a flow of information from input to output and shows how an operational workflow of activities can be carried out to make the assessment robust.

Transboundary lakes. For Levels 1.1 and 1.2, ILEC will make significant use of the many global-scale data sets which have become available in recent years such as the digital elevation models (SRTM) for drainage basin delineation, LandScan for population, GlobCover for land use, and so on. Level 1.3 will also use a detailed questionnaire to address questions that are not possible to answer without detailed local knowledge such as the specific plans for lake basin management, institutional coordination, and so on. The LAKES searchable knowledge system will also be used to further access detailed information.

Transboundary rivers. The UNEP-DHI has identified a range of partners that maintain existing databases containing data and information necessary to the conduct of a transboundary rivers assessment. These include the Environmental Crossroads Initiative of the CUNY that assess water stress; the WaterGAP model of the Universities of Kassel and Frankfurt that focuses on environmental and agricultural water stress and biodiversity loss; the Program on Water Conflict Management and Transformation (PWCMT) of OSU; the Global NEWS model of IGBP and its partners that focuses on nutrient pollution; CIESIN at Columbia University that focuses on the demographics of water stress, pollution, and vulnerability; and a variety of existing databases maintained by FAO, UNICEF, WHO, the WB, International Commission on Large Dams (ICOLD), and others.

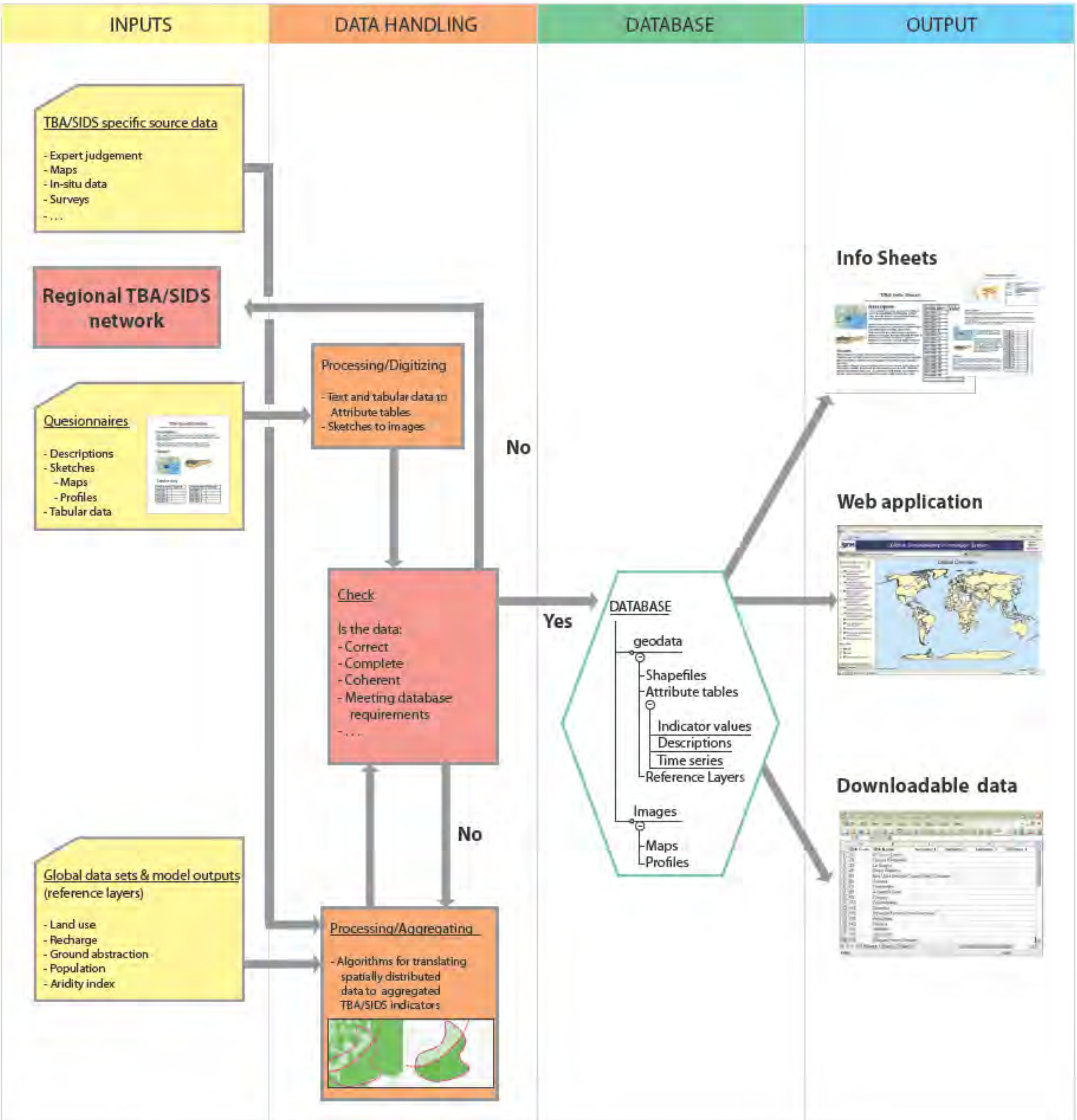

Figure 9. TWAP groundwater assessment information flowchart. (Source: Volume 2)

LMEs. UNESCO-IOC has proposed to acquire data on the LMEs through existing databases maintained by a range of institutions including: NOAA, remote sensing data on primary productivity; the University of Rhode Island, data on sea surface temperature; the University of California at Santa Barbara, mapping of cumulative human impacts in LMEs; CERMES (University of the West Indies in Barbados) and Dalhousie University, governance assessment; FAO and UBC fisheries data; UNEP/GRID-Arendal and UNEP-WCMC, marine habitat data; IGBP, modelling of nutrient inputs using the global NEWS model; IGBP, LOICZ and others, deltas at risk index; GESAMP, marine pollution; and the University of Miami, socioeconomics, among others. Data will be obtained by these partners from their own databases as well as from a large number of other sources.

Open ocean. UNESCO-IOC has proposed a similar data and information gathering process as has been derived for LMEs. The main source of data will be the sustained observations coordinated under GOOS, and a major source of information will rely on assessments of published peer-reviewed scientific literature for data streams that are not currently sustained. For the development of mapped products for the assessment, the European Union will be a major partner, as well as UNEP/GRID-Arendal. Further key partners include the University of California at Santa Barbara Center for Marine Assessment and Mapping in mapping and data display; FAO and UBC in fisheries; the Plymouth Marine Laboratory in ocean color analysis; the Sir Alister Hardy Foundation for Ocean Science in zooplankton collection and analysis; UNEP and UNESCO-IOC in data acquisition through their RSP and Global Ocean Observations System; GESAMP in pollution assessment; WMO, IUCN and the International Council for Science (ICSU) in climate forecasts and impacts; and NOAA in terms of data and information contained within their World Ocean Database.

3.6.3 Highlight overlaps in data sources between groups

Based upon the above, it is clear that data and information specific to each water system can be accessed from existing and easily accessible sources, primarily those maintained by regional and international bodies. To a large extent, these bodies are either the core group for each WG, or an entity well known to the core group through frequent contact and previous interactions. Each of the working groups has in place or is developing a framework within which to manipulate data and information so as to extract relevant data and information in a consistent form and format.

3.6.4 Data sharing and harmonization

There are obviously data such as those related to population and climate, noted above, that must be common between the working groups. The primary reason for this is to ensure comparability of the outputs and minimize the risk of assessments being influenced by the use of different data and information on a common topic of interest, such as population and climate, especially if such data are used to forecast impacts on specific water systems. Such data and information, and the assumptions underlying forecasts, must be common across all systems.

3.6.5 Harmonization of results

To enable the evaluation of forecasted futures using a common lens, it is desirable that the results of the assessment be presented in a manner that allows a global comparison. While each water system will be assessed using the standards and criteria applicable to that particular system, the results, in terms of impairments, risks, and threats, should be presented in a way that will allow the assessment across all five water systems. The data and information for the assessments for each transboundary water type are proposed to be stored and processed in decentralised data and information management systems per water system type. For the purposes of the final assessment, a centralized web-accessible interface is foreseen, supported by a uniform system of graphical and numerical rankings, intended to permit a degree of across-the-board synthesis. Uniformity in the cartographic presentations of the assessment results across the various water types also is recommended, although this remains an issue to be determined during the implementation of TWAP methodologies. One simple option for displaying results to enable comparison in a tabular form was proposed by the rivers WG and is shown in Figure 10.

	Indicator 1	Indicator 2	Indicator3	Indicator 4	Indicator 5	Indicator 6	Indicator 7	...	Indicator 14	Combined *Unweighted* Score (%) * if required
Basin 1	3	1	4	2	1	1	3		2	53
Basin 2	3	3	2	4	2	3	2		2	66
Basin 3	1	1	4	2	1	2	4		1	50
Basin 4	2	4	3	4	1	3	2		3	69
...										
Basin 260	1	3	2	4	1	3	3		2	59
Key overall indicator Issues	10	12	15	16	6	12	14		10	

Figure 10. Potential schematic representation of results summary.

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III. PROPOSAL FOR GEF TWAP FULL SIZE PROJECT

One of the major limitations to the effective management of transboundary waters is the lack of a systematic, periodic assessment of their changing conditions. For GEF to set priorities for its funding allocations and document the results of its investments in relation to the changing state of these transboundary systems globally, a periodic global transboundary waters assessment needs to be carried out. GEF's vision is for TWAP to establish a periodic, sustainable, global assessment process through partnerships that involve a wide range of stakeholders. It hopes to facilitate the integration of data collected by GEF IW projects, UN and other organisations, regional river basins and regional seas organisations into useful products; thus, enabling all partners, including the UNEP GEO, UN WWAP and the UNGA-led Regular Process in their global reporting and assessment of the state of the marine environment processes.

At present the data, modelling results, and sources of information are located in many different places, including regional organisations, academic networks funded by research programmes and sometimes by governments, private sector, and local and indigenous communities. Regional organizations might serve as platforms for the implementation of assessments and may use the assessment results as a baseline to track changes in the environmental and water resource situations. Such approach could increase the cost effectiveness of data management. National governments could use the results to set national programmatic priorities between transboundary and domestic water issues. The FSP will demonstrate results to donors and will present a common understanding of the issues and concerns in transboundary waters.

The GEF, UNEP and associated executive partners were developing methodologies for the global assessment of transboundary water systems with the view that such assessment will become a periodic activity to establish and forecast trends of the state of transboundary waters around the globe. The assessments should be appropriately spaced to allow for proper preparation; monitoring and collection of data and information; analysis and evaluation of results; preparation of conclusions and proposals; and above all communication of the main results and proposals to stakeholders and decision-makers.

The time frame for the FSP is proposed to be three years and it is hoped that the FSP will be a first cycle of the periodic assessment if a sustainable process for periodic assessment is established. Sustainability will depend on the establishment of an adequate funding mechanism and on the success of the FSP assessment. The duration of the second and successive cycles of the TWAP assessment should be decided at the end of the first cycle on the basis of analysis of the results of the first cycle and the formalised partnerships among all participants.

It is critical that the methodologies developed in the MSP be built on existing programmes so that a consortium of partners would be assembled that are committed to the success of the TWAP. The proposed partners all bring baseline programmes and associated investments to the TWAP, without which the TWAP would not be feasible. Incremental GEF funding will add value to the baseline programmes and ensure that outputs are suitable for the objectives of the TWAP. Attempts have been made to keep the required incremental GEF contributions to a minimum; for example, by using or building on existing data sets and tested methods from previous assessments. Significant investment and research has already gone into developing these tools and approaches. Co-financing the TWAP may not be immediately appealing to donors as it is a prioritisation exercise and the objective does not include immediate improvements to livelihoods or ecosystems. Nonetheless, the project could be of significant benefit to donors prioritising and coordinating funding, and it would be worthwhile explaining the benefits of the project to donors.

As a follow-up to the TWAP MSP, a TWAP FSP proposal will be submitted to the GEF. This project will carry out a global assessment of the five types of transboundary waters including an assessment of the interlinkages among water systems. The concept of indicators and indices will be one of the main features of the FSP, among them transboundary status indicators, projected transboundary status and trends, socioeconomic indicators and governance indicators. Summary descriptor templates will be prepared for each of the transboundary water bodies together with a geo-referenced map and an associated GIS database of attributes. A targetted effort will be made to assess the status of hot spots areas; for example major deltas. Special attention will be given to SIDS which have been assigned to the TBA group and will ensure coordinated work among the relevant water systems. The FSP would complete the work of undertaking a comprehensive validation of the methodologies that were initiated in the MSP. Proposals for capacity needs, developed in the framework of the MSP, will be implemented in the FSP. The FSP will help GEF to set priorities for its allocation and to make more effective use of its resources for addressing higher priority water bodies. In the framework of the FSP, through a pilot effort for a small subset of each of the five transboundary water systems, a more in-depth assessment of actual information with a root-cause (causal chain) analysis will be carried out. The FSP will implement a process whereby data gaps identified during the MSP could possibly be filled.

The objective of the TWAP FSP is to identify and to improve the understanding of key environmental, legal and institutional transboundary concerns inherent to the management of transboundary waters through the conduct of systemic and indicator based system assessments for transboundary aquifers, lake/reservoir basins, river basins, LMEs, and open ocean areas around the globe as to allow the GEF to target its investments into priority transboundary water systems and to develop sustainable process for periodic global assessment of transboundary waters through formalization of partnerships and institutional arrangements.
The proposed FSP will be implemented at two levels:

Level 1 assessment. The Level 1 global baseline assessment of the five types of transboundary water systems will utilize networks and globally-available information and data sets. Newly-collected information (from observation networks and modelling) will complement the assessment where needed to address crucial data gaps. The Level 1 assessment will include evaluation of existing environmental and natural resource status of transboundary waters, human and natural drivers and related stress, human dependency and vulnerability to the extent possible, and the current status of governance arrangements. Predicted stresses for years 2030 and 2050 and resulting changes in state also will be assessed. In this way, the Level 1 component will establish a baseline environmental, governance, socioeconomic and natural resource overview of the five types of transboundary water systems. Without a proper baseline for monitoring of the stresses and environmental status, GEF and other international organisations cannot identify and track the impacts of their interventions on the status of transboundary water systems. Issues related to interlinkages between the five water systems will be addressed in the Level 1 assessment. Assessment of risk areas, such as transboundary deltas/estuaries also will be carried out, and hot spots identified in the Level 1 assessment.

Level 2 assessment. The Level 2 assessment will be a more in-depth assessment of a limited number of selected pilot water bodies within each transboundary water systems. The overall goal for transboundary aquifers, lakes, rivers, and LMEs will be to identify best indicator and assessment practices, and to validate the Level 1 assessments. It is noted that these different transboundary water systems comprise varying spatial scales, conditions and processes. Thus, although the overall assessment objectives for these transboundary systems are the same, specific differences in the approaches and analytical methodologies will be elaborated and sorted out during the PPG. Nevertheless, although the exact numbers will be defined by each transboundary water group depending on their specific characteristics, the Level 2 assessment will compare 2-4 water systems for each transboundary water system in industrialised countries and 2-4 water systems bodies in developing countries. Among the various data sources to be consulted, the Level 2 assessment will utilize information and data gathered in existing TDA studies and SAPs as appropriate, thereby providing valuable input for enhancing existing TDA and SAP methodologies. Comparative causal chain analyses also will be conducted. The Level 2 assessment for the open ocean will be a complementary examination, identifying impacts to human wellbeing for a specific location associated with global open ocean conditions, and linking local impacts with the global ocean. Based on the Level 1 assessments, elaborated indicators will be developed for assessing interlinkages (e.g. deltas/estuaries, islands) and these indicators subsequently used to identify hot spots. A best practice guide could also be developed for use by the GEF and other institutions for the development of monitoring activities to compile time series data for future assessments. All transboundary units also will include projections for 2030 and 2050 for a limited number of indicators.

While the proposed project is global in scope, it can support existing GEF IW projects, particularly SAPs, and all future GEF IW projects, most of which are country-driven, by assessing transboundary waters, developing sustainable partnerships for assessments and providing feasible assessment methodologies that can be adapted and implemented for all transboundary water systems. The proposed FSP will be linked to planned and ongoing observing and assessment activities, including GEF projects, by building on them and adding value to the data and information they produce, through analysis and synthesis. This project will also provide a basis for identifying regional priorities within the defined assessment units, but will also capture national priorities and will support the national and transboundary priorities in international waters of practically every GEF-eligible country. The project will be closely linked with the UNEP RSP, under which 18 Conventions and Action Plans are in existence around the world, as well as with GPA, WWAP and the UNGA Regular Process. The assessments will also support efforts towards achievement of the MDG and WSSD targets.

UNEP, UN organisations and other international agencies/organisations, whose activities and programmes are particularly relevant to the project will participate in the FSP. The partnerships and institutional arrangements, established among organizations during the MSP, will be formalized during the FSP. The implementation of the FSP is proposed to be coordinated by UNEP. For each of the five water systems a leading agency will be selected, with the task of carrying out the global assessment of respective transboundary water systems. Overall guidance will be provided by the Project Steering Committee, comprised of UNEP, the lead agency for each of the water systems as well as other main co-financing organisations and the GEF Secretariat.

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INDEX

ANNEX I

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ANNEX II

GLOSSARY OF TERMS

Assessment: the process of qualitatively or quantitatively evaluating differences between two conditions or between a given condition and some reference value or state.

Causal Chain Analysis: the process whereby a symptom manifested in the environment and determined to negatively affect the human use of an element of the natural environment is related back to human activities and the underlying socioeconomic policies that support such activities; also known as Root Cause analysis. [Example: if a water body is considered to be impaired by excessive quantities of nitrogen and phosphorus, the immediate cause may be the discharge of wastewater into the water body, while the ultimate cause may be a lack of water pollution control regulations or inappropriate siting of the waste-producing facility - the causal chain refers to this series of events.]

Common Issue: a concern that extends across two or more of the five TWAP water systems. [Example: Sedimentation is an issue to Lakes, Rivers, and LMEs, but not to Transboundary aquifers and Open Ocean.]

Commons: [in the ecological economics sense of the term] shared resources or elements of the environment e.g. forests, atmosphere, rivers, fisheries, grazing lands - that are shared, used and enjoyed by all..

Conceptual Framework: the agreed basis for and within which complex environmental, sociological and ecological processes are analysed, described, considered and addressed, and within which actions are evaluated and implemented to achieve a desired result or outcome; a theoretical framework that attempts to connect to all aspects of inquiry (e.g., problem definition, purpose, literature review, methodology, data collection and analysis) and give coherence to empirical inquiry; a conceptual framework may take different forms depending upon the research question or problem.

Cross-cutting Issue: a concern that is shared by all five water systems considered in the TWAP [Example: nutrient enrichment or contamination is an issue of concern in each of the water systems; however, the specific nutrient and the reason for the concern differ within each water system - with phosphorus typically being the algal growth limiting nutrient in freshwater systems, nitrogen typically being the algal growth limiting nutrient in marine systems, and nitrogen being a factor in human health in transboundary aquifers systems.]

Drainage Basin/Catchment/Watershed: a portion of the earth's surface that can be defined by topographic features as constraining water to drain in a specific direction; that area of the land surface across which waters travel to and focus on a common point in the landscape; more specifically, the watershed is the line created by linking the highest points on the landscape surrounding a particular water body.

Ecosystem Services: the benefit that humans obtain from an ecosystem. Ecosystem services include provisioning services such as food and water production, regulating services such as flood and disease control, cultural services such as spiritual and recreational benefits, and sustaining services such as nutrient cycling.

Emerging Issue: an issue, which is not yet generally recognized, but which is expected to emerge, or is foreseen to have significant impact on transboundary waters and the utilization of ecosystem services.

Environmental Status Indicator: a measure of the condition of a resource or ecosystem, generally based upon empirical or analytical data.

Eutrophication: the process whereby waters are progressively enriched with nutrients such as nitrogen and phosphorus, leading to increases in the growths of aquatic plants and algae and accompanied generally by undesirable changes in ecosystem structure and function.

Forecasting: the process by which a current condition is extrapolated to a future based upon knowledge of the system or processes involved. Within the TWAP specific projections are to be made for 2030 and 2050.

Governance: the whole of public as well as private interactions taken to solve societal or environmental problems. It includes the formulation and application of principles guiding those interactions and care for institutions that enable them. Governance is broader than government and includes the full range of stakeholders and interactions.

Governance Indicator: a measure of the degree to which governance in achieved.

Hot spot: a geographical location, or localized environmental compartment, showing conditions that could have significant adverse transboundary effect on water systems.

Human System: portion of the biosphere involving people and anthropogenic activities.

Impact: a result, consequence or change resulting from a cause or action, generally used to describe negative effects.

Index: a number or formula expressing some property, ratio, etc., of something indicated. In the TWAP, an index is generally a combination of indicators [Example: a trophic state index.]

Indicator: an attribute or characteristics that is measured or evaluated in order to provide information about, or project the development of, a particular issue; the component elements used to develop an index.

Information and Data Management: the act of compiling, sorting and interrogating a compilation of knowledge and experience in order to meet the objectives of the TWAP.

Input-Output Analysis: a process for tracing resource flows through a system; flows may be conservative wherein the input equals the output, or dynamic wherein the input maybe modified in such a way as to decrease or modify the output. [Example: chloride is a conservative substance - the mass of chloride entering a water body must equal the mass of chloride leaving a water body less any chloride retained in the water body, while nitrogen is dynamic - the mass of nitrogen entering a water body may be subject to changes in form and state as a result of nitrification and de-nitrification or incorporated into organisms.]

Integrated Lake Basin Management (ILBM): a way of thinking that assists lake basin stakeholders to manage lakes and their drainage basins for sustainable use, and particularly to sustain ecosystem regulating services, taking into account the fact that lakes have a great variety of resource values whose sustainable development and use require special consideration of their lentic (static) properties and continuous improvement of lake basin governance that integrates institution, policy, participation, science, technology and funding.

Integrated Water Resources Management (IWRM): a process which promotes coordinated development and use of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems through the application of knowledge from various disciplines as well as the insights from diverse stakeholders to devise and implement efficient, equitable and sustainable solutions to water and development problems; a comprehensive, participatory planning and implementation tool for managing and developing water resources in a way that balances social and economic needs, and that ensures the protection of ecosystems for future generations.

Interlinkage: the relationship between ecosystem components, hydrological elements, or other natural systems created by the mutual interactions of systems or the influence of one system on another in either a positive or negative fashion.

International Waters: see Transboundary Waters

Lentic: pertaining to a standing surface water body: lake, pond, wetland; typically freshwater systems.

Level 1 Assessment: a baseline environmental, governance, socioeconomic and natural resource overview of the five types of transboundary water systems.

Level 2 Assessment: an in-depth assessment of a limited number of selected pilot water bodies to identify for aquifers, lake basins, river basins and LMEs best indicator and assessment practices and for open ocean to identify impacts to human wellbeing for a specific location.

Lotic: pertaining to any flowing surface water body: brook, creek, stream, and river.

Management: the process of human intervention in a natural system designed to achieve a specific outcome or set of outcomes.

Metric: means a measurable indicator; a measurable parameter used to form an indicator when combined with one or more other metrics.

Natural System: existing in nature or created by the forces of nature, in contrast to production by humans; not made, manufactured, or processed by humans.

Prioritization: the act of assigning relative importance to an issue, practice, or process.

Priority Issue: a concern which has been assigned a measure of relative importance.

Process Indicator: a measure of performance that assesses how a specific process affects stakeholder expectations, thus permitting modification of the process to enhance performance.

Productivity: the measure of output from a production process, per unit of input; primary productivity means the production of plant biomass; secondary productivity means the production of zooplankton biomass; tertiary productivity means production of fish biomass.

Projected Transboundary Stress Indicator: see Stress Indicator.

Provisioning Service: benefits accruing to humans as a result of the presence of a water body that both serves as a fishery and source of other natural products, such as reeds and papyrus, and as a water source to sustain agriculture through the irrigation of crops; also the service associated with the role of a water body in the production of ecosystems goods, such as fish.

Regulating Service: benefits accruing to humans as a result of the presence of a water body within a watershed, affecting both the rate of flow of water through a system and the effect of the system on climate through the role of water bodies in evaporation and condensation/precipitation.

Retention time: see Water Retention Time.

Socioeconomic impact: an action that has an effect on wealth creation and economic sustainability, quality of life, and human wellbeing; generally considered to refer to a negative effect.

Socioeconomic indicator: a measure of the value of a natural resource feature in contributing to improved wealth creation and economic sustainability, quality of life, and human wellbeing; a general measure of development and human wellbeing which may reflect the likely level of vulnerability or resilience of a community to adapt to changes to the natural resource on which it depends.

Strategic Action Programme (SAP): the process adopted by GEF to identify priority interventions necessary to address priority transboundary problems facing international water systems; a programme to address key root causes of transboundary concerns identified through the Transboundary Diagnostic Analysis process; see Transboundary Diagnostic Analysis.

Stress indicator: a measure of the change in the normal pattern of biotic distribution, or even the maintenance of an artificial pattern.

Sustainable: pattern of resource use that aims to meet current human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations.

Transboundary: crossing or existing beyond national boundaries.

Transboundary Diagnostic Analysis (TDA): the process adopted by GEF to undertake science-based analysis of transboundary water-related concerns and opportunities that exist in multi-country surface water, ground water, and coastal/marine water systems. They are used to identify priorities for joint action, root causes and scope for the concerns or opportunities, and serve as the basis for reforms and investments included in the action programmes.

Transboundary Status Indicator: see Environmental Status Indicator.

Transboundary water body: means any body of water or its drainage basin that transcends national and/or international boundaries, including oceans, LMEs, regional seas, rivers, lakes, transboundary aquifer systems, and wetlands.

Trophic State: the response of the entire biological structure of the water body to nutrients and other chemicals from a watershed, together with factors such as temperature and light, that affect the abundance of algae (production) in the water body.

Validation: the process of checking that a product, service, or system meets specifications and that it fulfils its intended purpose.

Vulnerability: the degree of exposure to risk experienced by human populations and/or infrastructure.

Water Quality: the physical, chemical and biological characteristics of water, most frequently used by reference to a set of standards against which compliance can be assessed; common standards relate to drinking water, safety of human contact, and the health of ecosystems.

Water Quantity: the volume or amount of water in a specific water body expressed in cubic meters; the quantitative basis for developing a water budget or water balance, which is the net result of the summation of all surface water inflows, groundwater inflows, and direct inflows of precipitation and the summation of all surface water outflows, groundwater outflows, and evaporation losses for a specific water body.

Water Retention Time: the average time that water (or some dissolved substance) spends in a particular water body (e.g. lake); the amount of time taken for a substance introduced into a lake to flow out of it again. The retention time is especially important where pollutants are concerned. At its simplest it can be calculated by dividing the lake volume by the flow into or out of the lake. Also known as 'residence time'.

Water System: one of five components of the global hydrological cycle considered in the development of a global transboundary waters assessment programme - namely, transboundary aquifers, rivers, lakes and reservoirs, coastal marine or LMEs, and open ocean; the global hydrological cycle.

ANNEX III

ASSESSING CROSS-CUTTING SOCIOECONOMIC INDICATORS FOR TRANSBOUNDARY WATER ECOSYSTEMS

Liana Talaue-McManus

1. INTRODUCTION

The Transboundary Waters Assessment Programme (TWAP) envisions promoting real investment in the conservation of transboundary water systems through meaningful engagement of stakeholders. It aims to develop transboundary waters assessment methodologies for use by the Global Environmental Facility (GEF) in defining priorities and facilitating partnerships necessary to implement a global assessment.

In the first phase of the TWAP, an 18-month long MSP shall develop an agreed methodology for five transboundary water systems (lakes, aquifers, rivers, LMEs, and open ocean) and their interlinkages. The methodology will be indicator-based and supported by existing data and information. The methodology will also identify partners and institutional arrangements among agencies and organizations that will enable the conduct of this global assessment. A full size project (FSP) will focus on implementing the methodology towards a systematized and broadly cohesive assessment of the five transboundary water systems.

This paper addresses the cross-cutting social and economic issues across the five categories of transboundary water systems, and the core indicators that provide measures of these. In identifying these core indicators, the authors acknowledge that these are insufficient to capture the breadth of human dimensions in each transboundary water system. As such each Working Group has the latitude to identify additional indicators to make its assessment methodology for its transboundary water system comprehensive to the extent that existing data and information can support. Furthermore, while cross-cutting indicators highlight the common issues across water systems, the weighting of such indicators along with water system category-specific indicators may vary among the five transboundary water system categories. This paper provides a draft-scoring scheme that allows comparison of systems within the same water system category, and for consistent scoring of social, economic and governance indices across water systems.

2. FRAMEWORK

The framework shown in Figure 1 considers the central function of governance (government, markets, civil society) in defining ways that humans access goods and services from water ecosystems to build livelihoods and enhance human wellbeing while conserving the integrity and health of shared water ecosystems. Governance mediates within cultural contexts. Its strength and resilience derive from and result in a high level of human wellbeing, healthy ecosystems, and robust livelihoods. At the same time, it can be vulnerable to climate change, natural disasters, political instability, disease outbreaks and failed markets, depending on the overall health of its people, its economy and its natural resources. A dismal failure to internalize environmental costs in pricing monetized ecological goods and services including human consumption of water and natural habitats have led to their misappropriation. In addition, the evident policy disregard for conserving environmental water requirements to maintain the functioning of aquatic ecosystems has put a number in peril. An integrated human-environment assessment therefore needs to evaluate governance, human wellbeing, ecosystem health, and livelihood systems, and factors that may render these components vulnerable, alongside ecosystem health. Traditional assessments tended to make the latter the dominant focus, relegating human dimensions to one of lower priority.

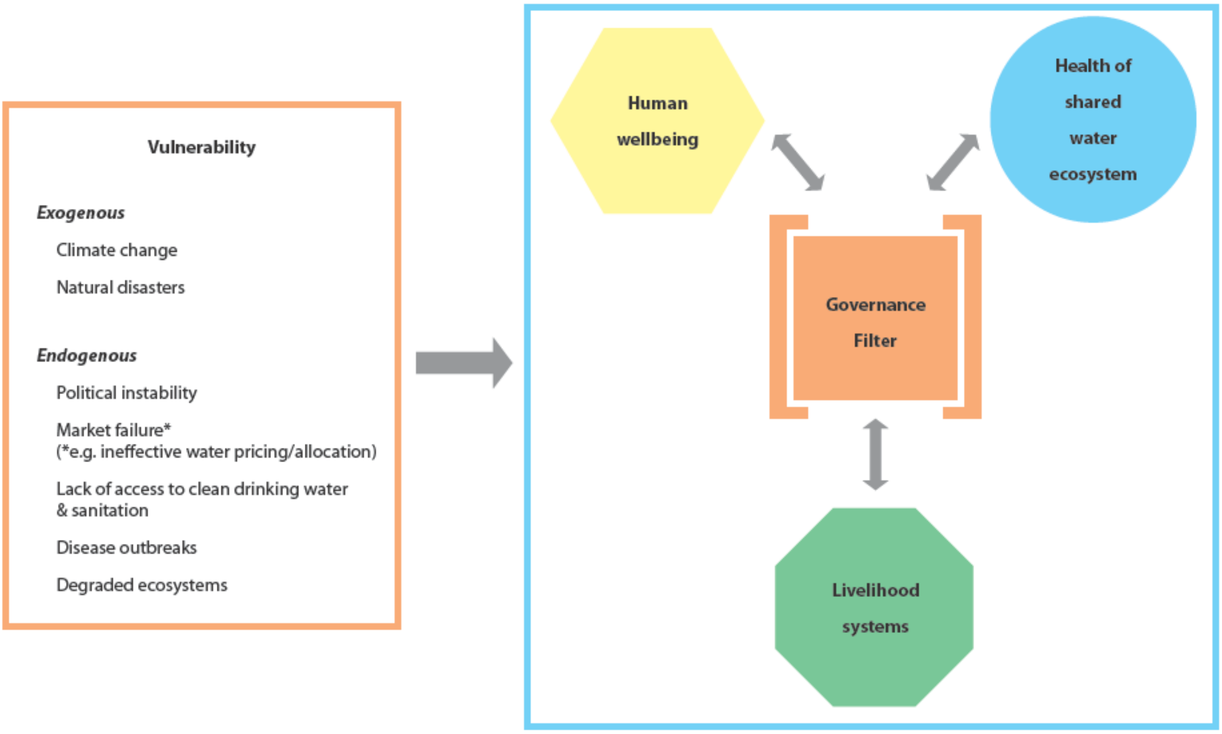

Figure 1. Framework for integrated human-environment assessment for shared water systems that may be used at multiple levels of governance from local to international scales. The vulnerability box includes major exogenous and endogenous stress factors but the list is by no means comprehensive. (Vulnerability box modified from Scoones, 1998).

In developing assessment methods, it is critical to acknowledge that human systems are organized differently compared to shared water systems (Müller, et al., 2005). Because of sovereignty, human organization at the level of the state provides the major and fundamental starting point for any form of integrated assessment. Negotiations for conservation and use of shared water systems almost always proceed only with full consent by border states. It is logical and feasible to begin preliminary evaluation using national indicators, for which data is commonly available in global databases. Basic or Level 1 assessments using national indicators can provide coarse but useful baseline assessments. However, because of the mismatch between the spatial boundaries of the shared water ecosystem and the geopolitical boundaries of the border states, such preliminary evaluation may mask important features and interactions that may emerge at finer scales of analyses. This behooves disaggregating national indicators into sub-national unit-based metrics, the spatial boundaries for which are spatially or functionally related to the boundaries of the shared water ecosystem. These metrics may then be aggregated to derive basin-relevant indicators in more in depth or Level 2 assessments.

The framework in Figure 1 can be used at multiple scales of governance from local to international levels. Like natural systems, human systems have features that nest into higher levels, such as geopolitical boundaries. However, in human systems, not all interactions can be nested. These include direct individual-group interactions, which cannot be thoroughly represented at higher hierarchies even in the most democratic of systems (Müller, et al., 2005). Thus, it is critical that integrated assessments as envisioned in TWAP take into account subnational as well as national indicators to capture to the extent possible, emergent properties at multiple levels, especially those that indicate non-nested interactions between local and national stakeholder interests. While analyses of transboundary waters may focus heavily on interactions between nations that share such water systems, the actions by and impacts on local communities should be taken into account as national indicators and national policies do not necessarily represent those of the latter. The mismatch between local interests and those articulated at national scale make environmental issues such as damming and diversion of transboundary rivers, for example, hotly contested debates (Hirsch, 2006; Hirsch, et al., 2006). Moreover, assessments take place with assessors' value systems influencing the preparation and conduct of assessments (Lélé and Norgaard, 1996). The choice and weighting of indicators need to be done with as broad a base of experts and stakeholders to pave the way for more representative and robust results.

3. INDICATORS

Definition of terms:

a. ***Socioeconomic measure*** – a quantity that measures a socioeconomic variable which has limited value in and of itself in determining progress in attaining societal goals. Examples include population, number of households, number of people employed.
b. ***Socioeconomic metric*** – a calculated or composite indicator based upon two or more measures. Examples include population density, and per capita measures (measures divided by population).
c. ***Socioeconomic indicator*** – a metric that can be set to a prescribed state based on the results of a process or the occurrence of a specified condition. Specifically, a socioeconomic indicator points to the extent to which a particular societal goal is attained. Thus, the impacts of policy interventions on user groups are best evaluated using socioeconomic indicators.
d. ***Socioeconomic index*** – made up of two or more indicators. A classic example is HDI that is a composite of three indicators – life expectancy at birth, adult literacy rate, and per capita GDP.

This paper focuses on the quantifiable features of livelihood systems (economics) and human well being (social) components of the framework including those that measure their vulnerability. Table 1 shows the cross-cutting issues across water system categories and the list of indicators that may be used to assess these.

The economic component includes GDP metrics as measures of dependence or reliance on water system derived goods and services as well measures of vulnerability that can undermine such dependence. Those for fisheries and agriculture are supported by existing data at the national scale. The rest are aggregated as industrial GDP, although disaggregated data may be available for most developed countries. Disaggregating GDP to compute water industry based GDP may be targetted in a Level 2 assessment. Note that the ratio of sector GDP to total GDP is the indicator rather than the GDP value itself. As such the ratio automatically weights the sectoral GDP in comparison to the total GDP at the country level or at the sub-basin level as data permits. Water pricing components of GDP per freshwater withdrawal may need deeper thought for implementation in Level 2 assessments in the form of case studies. Indicators that negatively impact livelihoods are likewise included. Specifically, these include 2 metrics from the Global Climate Risk Index (Harmeling, 2009).

The social cluster addresses cross-cutting issues of human wellbeing and its vulnerability (number of deaths per 100,000 inhabitants from Harmeling, 2009) . Data support for social indicators at the national scale have good coverage. National databases will provide fine-grain resolution for deriving basin-wide social indices and which may be best implemented as a Level 2 assessment. The population metrics may be integrated if data for human wellbeing and vulnerability are disaggregated to urban and rural subcomponents. Population metrics are critical for developing projection scenarios for 2030 and 2050 as requested by the GEF Secretariat.

Table 1. Economic and social indicators for shared water system assessment.

Indicator Cluster	Cross-cutting Issue	Indicator or Metric	Units	Data Source/Remarks
Economic cluster	Reliance on water-based system	Ratio Per capita GDP (Fisheries: total)	unitless	FAO FishStat (National)
		Ratio Per capita GDP (Agriculture: total)	unitless	FAO (National)
		Ratio Per capita GDP (Hydropower/Fossil fuels: total)	unitless	?
		Ratio Per capita GDP (Water transportation: total)	unitless	?
		Ratio Per capita GDP (Water tourism: total)	unitless	?
		GDP per freshwater withdrawal	$ per km^3	?
	Vulnerability	Per capita damages in purchasing power parity from all natural disasters	$	Climate Risk Index 1990-2008 (National) (Other climate change indices may be considered, e.g. GAR 2009 report)
		Average losses per unit total GDP	%	Climate Risk Index 1990-2008 (National)
		Income inequality using WEALTH GINI Coefficient	Unitless	Davies, *et al.* (2008)
Social cluster	These metrics can by subsumed if the indicators below can be disaggregated for rural and urban sectors	Population	N	Will be used for projection scenarios; World Bank (national); National census databases (subnational units)
		Rural:Urban ratio	Unitless	
		Rural population growth rate	% per year	
		Urban population growth rate	% per year	
	Human wellbeing	Access to improved drinking water	%	JMP WSS (National)
		Access to sanitation	%	JMP WSS (National)
		Contribution of fish to metabolic protein requirements	%	FAO FishStat (National)
		Adult literacy	%	World Development Indicators (National)
		Life expectancy at birth	years	World Development Indicators (National)
	Vulnerability	Deaths per 100,000 inhabitants caused by climate related natural disasters	N per year	Climate Risk Index 1990-2008 (National)

4. DRAFT SCORING SYSTEM

This paper includes a draft scoring system that Working Groups can vet. This was not discussed in detail by groups during the MSP but is provided here as a suggestion for presenting results of the assessment. The motivation for this is to present a visual so that TWAP participants can determine a meaningful way to allocate weights across indicator clusters and which may become the basis for deriving rolled-up ecosystem based indices as requested by the GEF Secretariat (Fig. 2).

4.1 Weight allocation and number of indicators per issue

It would be interesting if the cross-cutting elements of the human system (Governance, Wellbeing, and Economics) may be weighted similarly across all five shared water systems. The number of indicators may vary for each cluster should there be a need to include indicators that are particular to a water system; but the weight allocations for these clusters are constrained to agree upon percentages (%s in Fig. 2 are mock); thus maintaining a constant weighting of these components on the computed ecosystem-level indices for ecosystems within a water system, and across all five shared water system categories.

In addition to maintaining constant weights for cross-cutting indicators, optimizing the allocation of weights per cluster also encourages participants to think of an optimal number of indicators to include per cluster.

More indicators per cluster minimizes the numerical influence of each indicator on the derived index. Using the mock allocations for human well being at 15%, 5 indicators may be more meaningful than 10 indicators for this cluster.

In short, weight allocation and optimizing the number of indicators per cluster are complementary exercises. They should be done with the entire scoring system in mind, noting that high sensitivity to cross-cutting human dimension components is a desirable feature to target.

4.2 Interpretation of ecosystem indices and issue sub-indices

Focusing on the rolled up ecosystem index as sole basis for comparing ecosystems within a shared water ecosystem category is simplistic. It may even be dangerous if this is done without explicit regard for the underlying indicators and contextual information from which it was derived. Thus, it is important that the analyses of ecosystem indices proceed by providing appropriate narratives of subindices, indicators and comprehensive yet succinct qualitative contextual information.

Each cluster or indicator can be subjected to a evaluation scheme which can take the form of a 3-part traffic-light like approach, or fine-grained quartile, pentile or similar classification. An evaluation scheme at indicator or cluster level provides a more nuanced basis for establishing priorities rather than just by ecosystem index. Furthermore, it also opens avenues for GEF to provide interventions that focus on weaknesses, and to derive best practices from strengths of ecosystem evaluations. Tables 2 and 3 elaborate on a traffic-light like approach evaluation at the indicator cluster level, as an example.

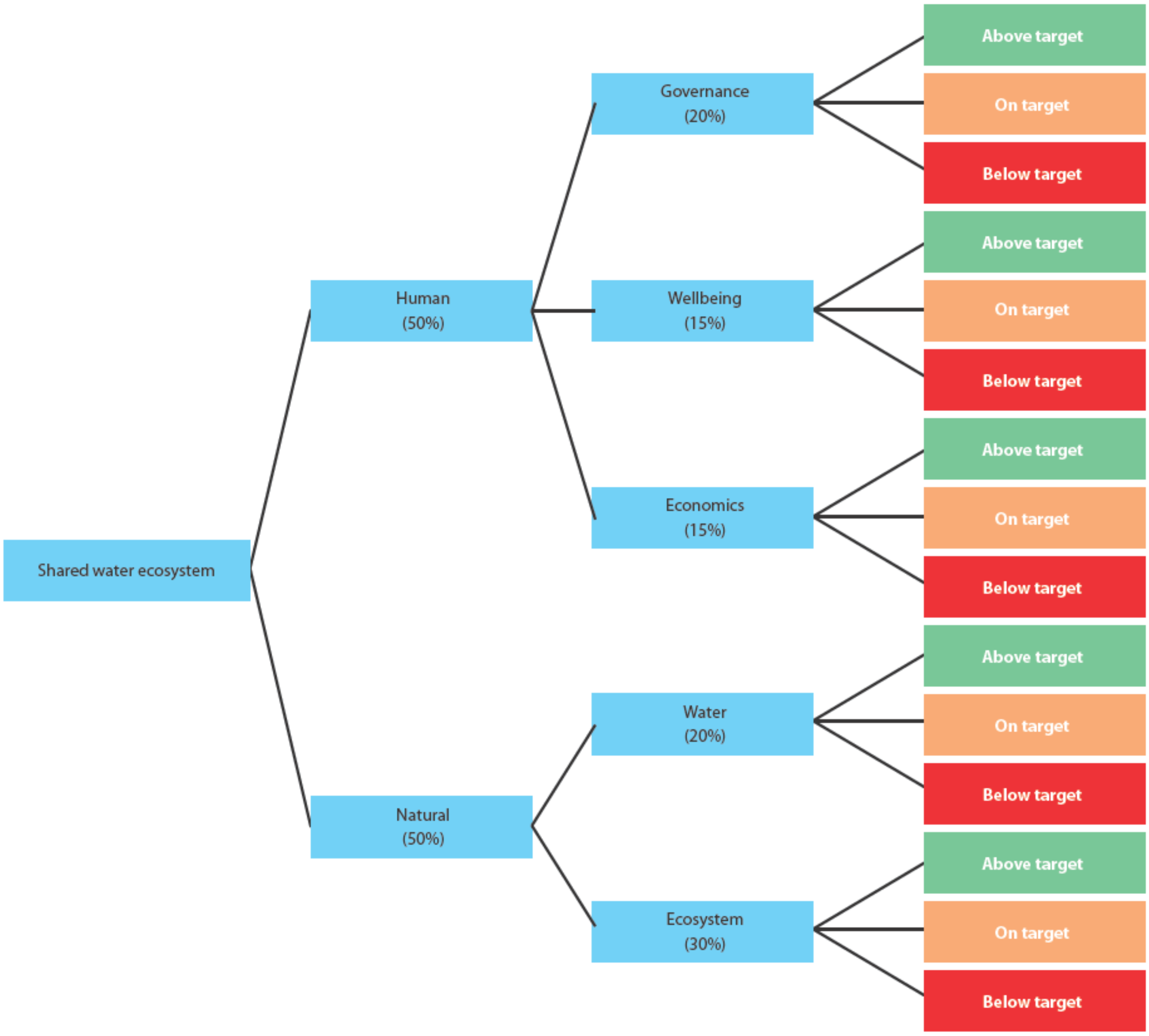

Figure 2. Draft scoring system with traffic-light evaluation scheme.

Table 2. Evaluated Ecosystem Type Nomenclature to classify outcome types.

INDICATOR CLUSTER	ABOVE TARGET (3)	ON TARGET (2)	BELOW TARGET (1)
Governance (G)	3G	2G	1G
Human wellbeing (H)	3H	2H	1H
Economic wellbeing (EW)	3EW	2EW	1EW
Freshwater conservation (F)	3F	2F	1F
Ecosystem health (EH)	3EH	2EH	1EH

Table 3. Possible evaluated ecosystem types.

Table 3a. Evaluated ecosystem type 1.

INDICATOR CLUSTER	ABOVE TARGET	ON TARGET	BELOW TARGET
Governance			
Human wellbeing			
Economic wellbeing			
Freshwater conservation			
Ecosystem health			
Ecosystem index range, median, mean			
EVALUATED ECOSYSTEM TYPE	1G-1H-1EW-1F-1EH		

Table 3b. Evaluated ecosystem type 2 combination.

INDICATOR CLUSTER	ABOVE TARGET	ON TARGET	BELOW TARGET
Governance			
Human wellbeing			
Economic wellbeing			
Freshwater conservation			
Ecosystem health			
Ecosystem index range, median, mean			
EVALUATED ECOSYSTEM TYPE	2G-1H-2EW-1F-1EH		

Table 3c. Evaluated ecosystem type 3 combination.

INDICATOR CLUSTER	ABOVE TARGET	ON TARGET	BELOW TARGET
Governance			
Human wellbeing			
Economic wellbeing			
Freshwater conservation			
Ecosystem health			
Ecosystem index range, median, mean			
EVALUATED ECOSYSTEM TYPE	2G-2H-2EW-3F-3EH		

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ANNEX IV

TWAP COMMON GOVERNANCE ASSESSMENT

Robin Mahon[1], *Lucia Fanning*[2] *and Patrick McConney*[1]

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INTRODUCTION

The Transboundary Waters Assessment methodology will address governance assessment as a common issue for all five IW focal area categories (transboundary aquifers, rivers, lakes, LMEs and open ocean). It will do so by undertaking the governance assessment in two phases which will be referred to as the Level 1 and Level 2 governance assessments. The purpose of this assessment is twofold: (1) To provide a holistic picture of governance arrangements for individual water systems as a basis for discussion about how to improve governance at the system level; and (2) To provide a common approach to evaluating governance arrangements across systems to facilitate a global picture and also to facilitate allocation of resources to systems within IW categories.

The Transboundary Waters Assessment methodology for governance is part of an overall methodology that is being developed by the TWAP. The objective of TWAP is to develop scientifically credible methodologies for conducting a global assessment of the five transboundary water systems and to catalyse a partnership and arrangements for conducting such a global assessment. In addressing governance, a broad definition has been adopted; "Governance is the whole of public as well as private interactions taken to solve societal problems and create societal opportunities. It includes the formulation and application of principles guiding those interactions and care for institutions that enable them." (Kooiman, 2003). It emphasizes that governance is broader than government and includes the full range of stakeholders and interactions.

For the Level 1 assessment all five IW categories will include in their global assessments a preliminary assessment of governance arrangements for each transboundary water system. This will assess the extent to which transboundary governance architecture is in place for the system, but will not assess the performance or functionality of the arrangements. This Level 1 assessment will be about whether or not the critical transboundary issues are covered by governance arrangements that have full policy cycles. It is expected to reveal the extent to which the issues are covered, whether there are gaps or overlaps in coverage and the nature of the arrangements that are in place.

The Level 2 assessment will assess the functionality and performance of governance arrangements in terms of a fuller range of criteria such as effectiveness, inclusiveness, efficiency and equitability. This methodology remains to be developed. This can be pursued by further integrating the governance models reviewed and presented in the Transboundary Waters Assessment Medium-Sized Project (TWAP) LME governance working paper (Mahon, et al., 2010) and others such as ILBM guidelines for lake brief preparation (RCSE, Shiga University and ILEC, 2010) into a comprehensive assessment process. It is proposed that this be undertaken by a small working group of governance experts and IW water category experts and then applied to about 20-40 selected IW situations drawn from the five IW categories.

One of the objectives of the TWAP governance assessment methodology is to develop the approach in a way that it can be applied by key stakeholders with the water system as a self-assessment. Attention will also be paid to how the assessment can be integrated into the GEF IW TDA/Causal Chain Analysis (CCA)/SAP methodology.

LEVEL 1 ASSESSMENT – SYSTEM GOVERNANCE ARCHITECTURE

Several steps are required to determine the governance architecture in place for a particular water system to be governed (Table 1). The whole architecture is greater than the sum of its parts, especially for integration of governance at the transboundary level. This process as summarised in Table 1 will provide a picture of: The extent to which governance issues are covered (and allow identification of gaps); the match between governance arrangements and issues; the extent to which arrangements extend outside the system; the extent to which issues are covered by multiple arrangements that could result in conflict; and, how well arrangements are clustered to make best use of existing institutions and organisations.

Table 1. Steps required to assess governance architecture in a system to be governed.

STEP	KEY POINTS
Identify system to be governed	Begin with a clear definition of the system to be governed. In the case of the GEF IW program the system is considered to be the entire LME or other IW area. Geographical boundaries of the system and the countries involved in the transboundary system must be clearly identified. In the case of the GEF IW program the system to be governed is considered to be the entire river basin, aquifer, lake or reservoir, LME or other IW area, or portion of the open ocean.
Identify issues to be governed	In some IW systems the issues will already have been identified through a TDA and may have been further explored through CCA. Issues may have both a topical and a geographical component
Identify arrangements for each issue	Determine the extent to which each issue is covered by an identifiable arrangement, whether formal or informal. Must be specific to the issue and have a complete policy cycle. Each arrangement should have functionality in three modes: (1) The meta-mode (articulation of principles, visions and goals, equating to policies in ILBM parlance); (2) the institutional mode (agreed ways of doing things reflected in plans and organizations; and, (3) the operational mode if it is to be adaptive and effective. These modes may operate at different scale levels within the same arrangement hence the need for links within arrangements.
Identify clustering of arrangements within institutions	Examine the way that arrangements are clustered for operational purposes and/or share common institutions/organisations at different levels. Similar issues may be covered by similar arrangements. There may be efficiency in clustering these arrangements. Alternatively, clustering may occur at higher levels for policy setting or institutional efficiency, but be separated at lower levels.
Identify links	Identify actual and desirable links within and among arrangements and clusters.

IW systems are likely to involve a variety of governance issues. For the purpose of this assessment, five major categories of issues have been identified, several of which cut across IW categories (Table 2). It is expected that all arrangement level issues will fit into these categories to facilitate comparison within and among water categories.

Table 2. The major categories of issues for IW water categories.

ISSUE CATEGORY*	IW WATER CATEGORY				
	Groundwater	Lakes	Rivers	LMEs	Open Ocean
Water quantity	✓	✓	✓		
Water distribution	✓	✓	✓		
Water quality	✓	✓	✓	✓	✓
Fisheries		✓	✓	✓	✓
Biodiversity	✓	✓	✓	✓	✓
Habitat destruction		✓	✓	✓	✓
Climate change mitigation					✓

* Impacts of, and adaptation to, climate variability and change may be integrated in each issue category.

The above process will be used to reduce the governance architecture for each system to a set of scores (Table 3). These will be derived from separate assessments of the issue specific arrangements as shown in Table 4. The approaches to evaluating the arrangements may vary among systems and arrangements ranging from highly expert judgment based to being based on extensive analysis of multilateral agreements, protocols, institutional constitutions and other instruments, supported by sound science and knowledge of stakeholder opinion. This allows for considerable flexibility in approach within each system, but will also mean that the final summaries for the systems will be based on widely ranging degrees of analysis. For this reason it is important that there be provision in the system for extensive annotation in foot or endnotes, so that the user can understand what went into each analysis. The arrangements for clustering and links will be reflected in a matrix showing interactions among arrangements. Further development of this aspect of the assessment is to be the subject of a workshop to be held at Dalhousie University in March 2011.Climate change vulnerability is recognized as being a component of all the above issues. It is expected that as these issues are unpacked and the arrangements are examined, the vulnerabilities to climate change will be made explicit in each issue. Similarly, it is assumed that governance responses will include adaptation.

It should be noted that while the conceptual basis for this methodology is well accepted, the methodology itself is being developed for this purpose and has not been previously used or tested. Therefore, its application will be exploratory and its further development with respect to both purposes above should be an integral part of its application.

LEVEL 2 ASSESSMENT – PERFORMANCE OF GOVERNANCE ARRANGEMENTS

The Level 2 assessment will evaluate the functionality and performance of governance arrangements according to agreed criteria. Within a single IW system, the arrangements needed may differ considerably among issues and have to be tailored to the specific context or need. The Level 2 assessment should be carried out in collaboration with the organizations involved in governance so as to be sensitive to the specific context of the system to be governed. Mahon, et al. (2010) provides the conceptual background to what might be involved in examining the component parts or governance arrangements within selected transboundary water systems.

The governance arrangement provides an appropriate assessment unit for governance performance. The Level 2 assessment will focus on systems that are sufficiently complete that there is some level of planning and review, and thus the setting of goals and objectives against which to assess governance performance. It will assess the presence, appropriateness, completeness and functioning of policy cycles according to agreed criteria and against agreed objectives. Which of these will be most useful will depend on the nature of the cycle, e.g. whether it is formalized at the organisational level with documentation, or informal and established mainly through practice. Each of the desired criteria can be give scores in a scale depending on stakeholder responses, expert judgment or measured outputs.

Table 3. GEF IW transboundary system governance architecture - System summary[1].

IW CATEGORY:				**TOTAL NUMBER OF COUNTRIES:**	**SYSTEM NAME:**		**REGION:**
Transboundary issue[2]		Number of countries[3]	Priority for countries[4]	Descriptive or commonly used name for the governance arrangement[5]	Completeness of governance arrangement[6]	Priority for intervention to improve governance[7]	Observations[8]
1							
2							
3							
4							
..n							
Governance index[9]							

[1] This page provides an overview of all the arrangements in the system and their status.

[2] There is the question of how far down in detail these should go. This can be a matter of choice, and part of the flexibility of the system, but it should ideally be to the level where the transboundary issue requires a separate arrangement for management? To use a fishery example individual species or groups of species may each require their own assessment and measures, but may all be handled in one institutional arrangement. However, for geopolitical reasons some species or groups of species may require separate processes and should be treated as separate issues needing separate arrangements. Ideally, these issues should be identified and quantified in a TDA. If not, experts knowledgeable about the system may have to ID them.

[3] Indicates how many of the total number of countries are involved in the particular issue.

[4] This should be based on the TDA but may have to be based on expert judgement. To be scored from 0-3.

[5] Ideally this would be the name used by the participants in the arrangement.

[6] The score given in this column will be derived from the scores allocated on the arrangement specific page. This would preferably be a mathematical derivation weighted by importance of the functions there, but could be an overall expert assessment based on what is there.

[7] This would be a combination of the national priority for the issue and its status (possibly weighted by some country statistic).

[8] This provides the opportunity for brief comments that may help the user interpret the information provided on the summary page, but is not intended to be a substitute for annotation.

[9] Weighted average based on priority

Table 4. GEF IW transboundary system governance architecture - Arrangement summary.

ARRANGEMENT:		ISSUE:			
Governance function[10]	Responsible organisation or body[11]	Scale level or levels[12]	Completeness[13]	Priority for attention[14]	Observations[15]
Meta level - preparation of policy advice					
Meta level - Policy setting or decision-making					
Policy cycle - preparation of management advice					
Policy cycle - Management decision-making					
Policy cycle - Implementation					
Policy cycle - Review of implementation at strategic and operational levels					
Policy cycle - Provision of data and information					
Total[16]					

Links within governance arrangements as well as between them are a critical component of the governance system. These can be examined from various perspectives to see what role they play in the functionality of the arrangement. One may investigate whether the links are bidirectional and therefore facilitate feedback for adaptation. The nature of the interactions is also relevant. Are they for information exchange only, or do they include aspects of stronger interaction such as cooperation or control? A discussion of the criteria that can be used in assessing functionality of governance arrangements is provided by Mahon, et al. (2010). Ehler (2003) provides a comprehensive list of governance performance indicators that can be applied as appropriate in assessing policy cycles, while RCSE, Shiga University, and ILEC (2010) present a series of diagnostic questions that can be considered in evaluating water resources governance.

The Governance Working Group to be formed to develop and oversee the Level 2 assessment should be drawn from a diversity of individuals and organizations that are actively working on concepts and applications of governance in natural resource systems. Some examples would be the Earth System Governance Project, The Resilience Alliance, the Fisheries Governance Network and PWCMT of OSU. This WG should include members from all five IW water categories.

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10 This column list the governance function that are considered to be necessary at two levels (a) the policy setting level and (2) the policy cycle level.
11 Organisation or organisations responsible for the function should be listed here.
12 These are the institutional scale level or levels at which the function is performed.
13 Rate on a scale of 0 = absent, 1 = low (ad hoc, irregular, unsupported by formal documentation or little known by stakeholders), 2 = medium, and 3 = high (clearly identifiable, regular, documented or supported by policy and legislation and widely known among stakeholders).
14 This is aimed at within system assessment of where to intervene rather than at contributing to the global comparative assessment.
15 This provides the opportunity for brief comments that may help the user interpret the information provided, but is not intended to be a substitute for annotation.
16 Assume each step is equally important and receives equal weighting?

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The inputs of the TWAP Cross-cutting Working Group on Socioeconomics and Governance contributed greatly to the refinement of the approach presented in this document.

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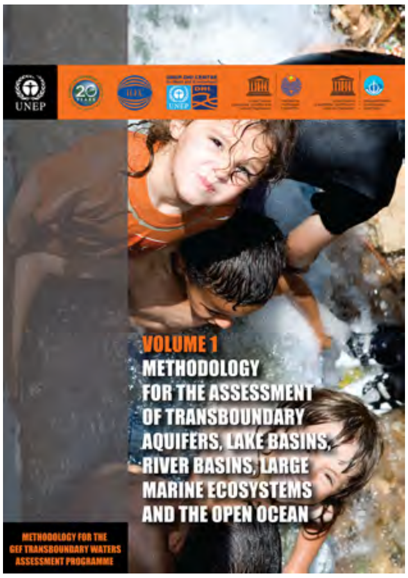
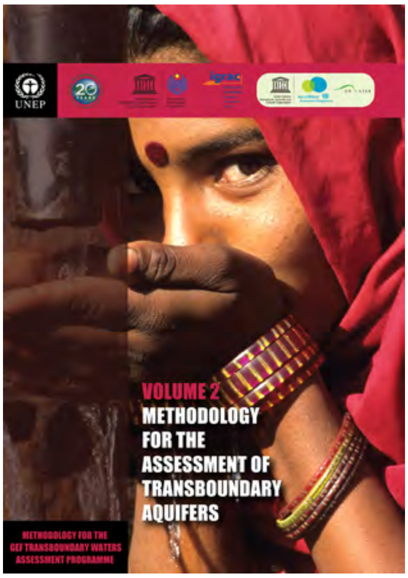
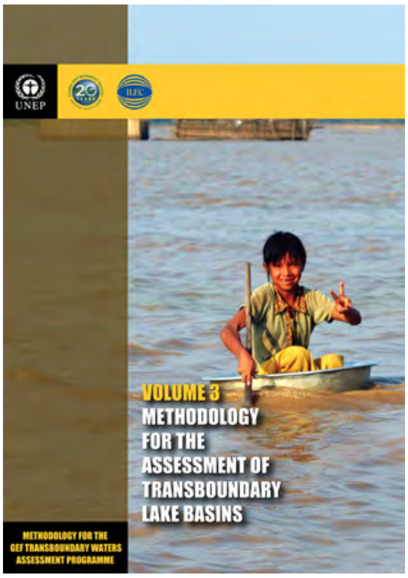
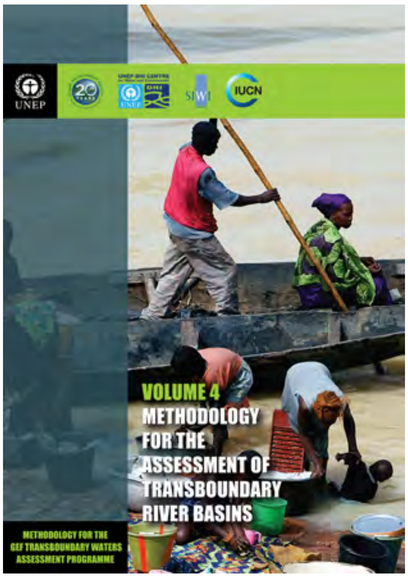
METHODOLOGY FOR THE GEF TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

Volumes 1-6









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The water systems of the world - aquifers, lakes, rivers, large marine ecosystems, and open ocean - support the socioeconomic development and wellbeing of the world's population. Many of these systems are shared by two or more nations and these transboundary resources are interlinked by a complex web of environmental, political, economic and security interdependencies. In order to address this challenge UNEP, under the auspices of the GEF, coordinated over a 2 years period from 2009 to 2011 the implementation of the Medium Size Project (MSP) entitled "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme (TWAP)".

This Project produced methodologies for transboundary water systems. The final results of this Project are presented in the following six volumes:

Volume 1 - Methodology for the Assessment of Transboundary Aquifers, Lake Basins, River Basins, Large Marine Ecosystems and the Open Ocean;
Volume 2 - Methodology for the Assessment of Transboundary Aquifers;
Volume 3 - Methodology for the Assessment of Transboundary Lake Basins;
Volume 4 - Methodology for the Assessment of Transboundary River Basins;
Volume 5 - Methodology for the Assessment of Large Marine Ecosystems; and
Volume 6 - Methodology for the Assessment of the Open Ocean.

This document – Volume 1 – is a summary of the detailed methodologies described in volumes 2 - 6.

This Project has been implemented by UNEP in partnership with the following lead agencies for each of the water systems: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including aquifers in small island developing states (SIDS); the International Lake Environment Committee (ILEC) for lake basins; UNEP-DHI Centre for Water and Environment (UNEP-DHI) for river basins; and Intergovernmental Oceanographic Commission (IOC) of UNESCO for large marine ecosystems and the open ocean.

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