TWAP
TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

Transboundary Waters Systems – Status and Trends

Crosscutting Analysis

VOLUME 6: CROSSCUTTING ANALYSIS

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Preface

The Global Environment Facility (GEF) approved a Full Size Project (FSP), "A Transboundary Waters Assessment Programme: Aquifers, Lake/Reservoir Basins, River Basins, Large Marine Ecosystems, and Open Ocean to catalyze sound environmental management", in December 2012, following the completion of the Medium Size Project (MSP) "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme" in 2011. The TWAP FSP started in 2013, focusing on two major objectives: (1) to carry out the first global-scale assessment of transboundary water systems that will assist the GEF and other international organizations to improve the setting of priorities for funding; and (2) to formalise the partnership with key institutions to ensure that transboundary considerations are incorporated in regular assessment programmes to provide continuing insights on the status and trends of transboundary water systems.

The TWAP FSP was implemented by UNEP as Implementing Agency, UNEP's Division of Early Warning and Assessment (DEWA) as Executing Agency, and the following lead agencies for each of the water system categories: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including groundwater systems in small island developing states (SIDS); the International Lake Environment Committee Foundation (ILEC) for lake and reservoir basins; the UNEP-DHI Partnership – Centre on Water and Environment (UNEP-DHI) for river basins; and the Intergovernmental Oceanographic Commission (IOC) of UNESCO for large marine ecosystems (LMEs) and the open ocean.

The five water-category specific assessments cover 199 transboundary aquifers and groundwater systems in 43 small island developing states, 204 transboundary lakes and reservoirs, 286 transboundary river basins; 66 large marine ecosystems; and the open ocean, a total of 756 international water systems. The assessment results are organized into five technical reports and a sixth volume that provides a cross-category analysis of status and trends:

Volume 1 – ***Transboundary Aquifers and Groundwater Systems of Small Island Developing States: Status and Trends***
Volume 2 – ***Transboundary Lakes and Reservoirs: Status and Trends***
Volume 3 – ***Transboundary River Basins: Status and Trends***
Volume 4 – ***Large Marine Ecosystems: Status and Trends***
Volume 5 – ***The Open Ocean: Status and Trends***
Volume 6 – ***Transboundary Water Systems: Crosscutting Status and Trends***

A ***Summary for Policy Makers*** accompanies each volume.
Volume 6 presents a unique and first global overview of the contemporary risks that threaten international water systems in five transboundary water system categories, building on the detailed quantitative indicator-based assessment conducted for each water category. The report is a collaboration of the five independent water-category based TWAP Assessment Teams under the leadership of the Cross-cutting Analysis Working Group, with support from the TWAP Project Coordinating Unit.

Key messages

This novel assessment provides a first indicator-based look at the broad global patterns of risk to transboundary water systems and dependent human populations across the five water system categories – Aquifers, Lakes & Reservoirs, River Basins, Large Marine Ecosystems (LMEs) and the Open Ocean. Key directional indicators (indicating good to bad ecosystem states), addressing thematic (i.e. biophysical, socioeconomic and governance) conditions of transboundary waters, are chosen from each of the five water system category-based assessments, and are used to show broad patterns of relative risk. Risk is defined as the likelihood of failure to sustain the ecosystem services that transboundary waters provide for planetary and human wellbeing. It is assessed at five color-coded risk levels from highest risk (red) to lowest risk (blue) using individual indicators and their averages. The results are geographically organized to allow for comparisons of risk across water system categories and themes in 14 regions of the world. The 14 regions are based on the UN sub-continental regions, with the smaller areas like Northern, Southern and Western Europe being grouped together as a region, to optimize the regional aggregation and comparison of transboundary water systems. The Transboundary Waters Assessment Programme (TWAP) crosscutting analysis covers 89% of the global total of currently identified transboundary aquifer surface area and 87% of transboundary lake surface area for 204 lakes considered in the assessment. For transboundary river basins, LMEs and the Open Ocean, spatial coverage is 100%.

- Risk is generally lower in developed regions (Australia, North America and Europe) and higher in Sub-Saharan Africa and South and South East Asia. However, there are high and low risk systems in all regions, indicating the need for attention to transboundary water systems across the planet.
- Risk appears spread across the three thematic areas - biophysical, socioeconomic, governance - and signifies the need for policy and management interventions to address the integrated nature of risk in order to effectively sustain ecosystem health and human wellbeing.
- There is a tendency for risk to increase 'downstream' from aquifers and river basins to LMEs, with the exception of transboundary governance arrangements for aquifers, which are largely absent.
- The assessment of governance arrangements and architecture is a novel aspect of this assessment, but does not yet reflect how effective the governance responses are in sustaining ecosystem health and human wellbeing. Subsequent assessments should focus on measuring effectiveness.
- Spatial data coverage for transboundary aquifers and lakes should be improved. Across all five transboundary water categories, there is a serious need for long-term time-series data, including those that quantify and track rates and magnitudes of linkages between water systems, for transboundary management to become effective.

Introduction

The Global Environment Facility (GEF) approved a Full Size Project (FSP), "A Transboundary Waters Assessment Programme (TWAP): Aquifers, Lake/Reservoir Basins, River Basins, Large Marine Ecosystems, and Open Ocean to catalyze sound environmental management", started in 2013, following the completion of the Medium Size Project (MSP) "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme" in 2011. The TWAP FSP focuses on two major objectives: (1) to carry out the first global-scale assessment of transboundary water systems that will assist the GEF and other international organizations to improve the setting of priorities for funding; and (2) to formalise the partnership with key institutions to ensure that transboundary considerations are incorporated in regular assessment programmes to provide continuing insights on the status and trends of transboundary water systems.

The five water-category specific assessments covered 756 international water systems consisting of 199 transboundary aquifers and 42 non-transboundary aquifers in small island developing states, 204 transboundary lakes and reservoirs, 286 transboundary river basins, 66 large marine ecosystems (and the Western Pacific Warm Pool), and the open ocean. The assessed waters cover over 70% of the planet's oceans and landmass, and about 16% of the planet's landmass that is also underlain by transboundary aquifers.

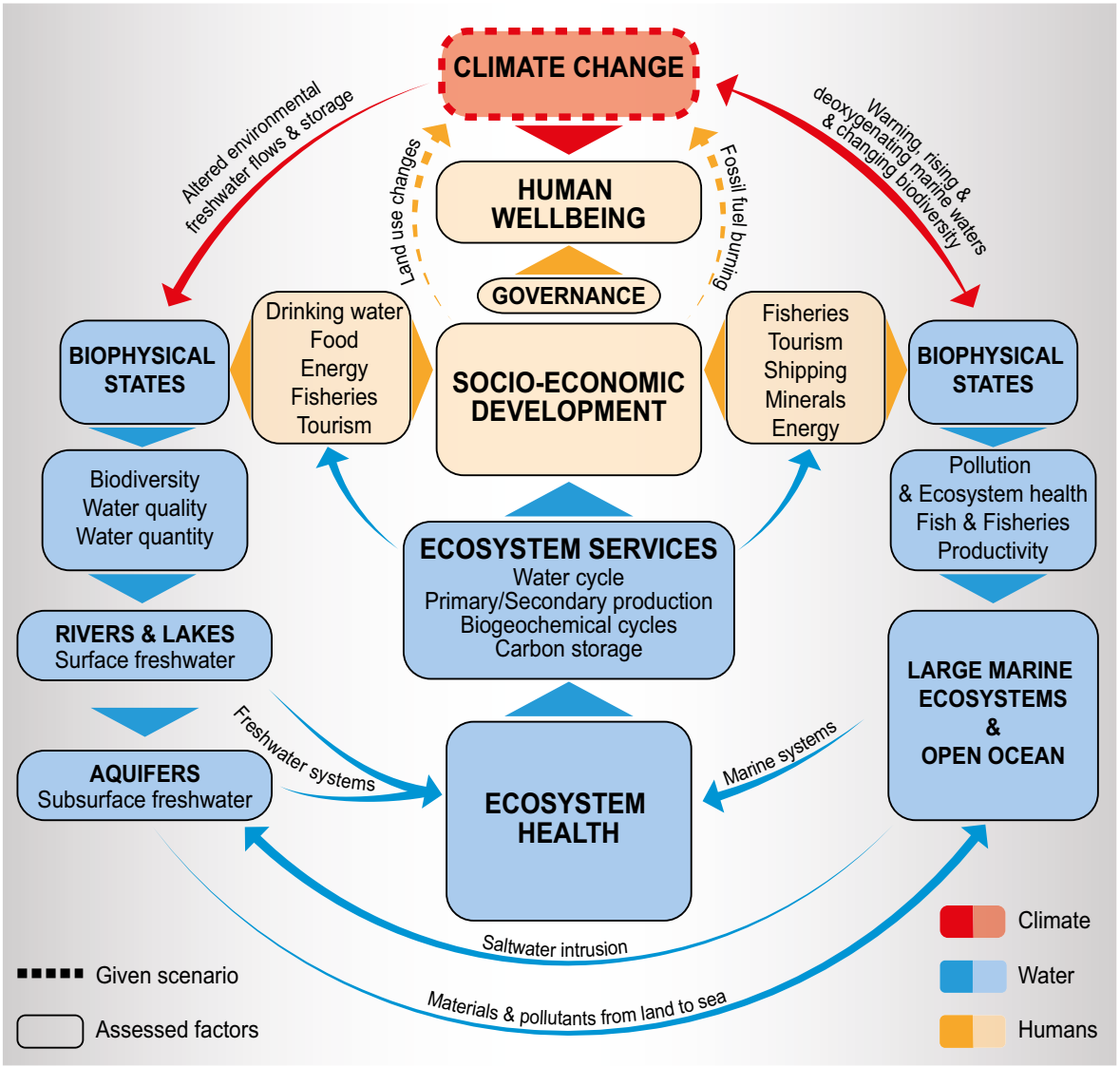
The TWAP assessment is the first global assessment that uses quantified and directional indicators of system states, pressures and impacts under three broad themes: biophysical, socioeconomic, and governance. Results are summarized into five colour-coded relative levels of system risk for each directional indicator - lowest, low, moderate, high, and highest - which are amenable to water system and regional scale comparisons. As a first global comparative assessment of transboundary waters (those shared by two or more countries), TWAP provides quantified assessment results that can inform the setting of priorities for intervention by GEF and others as well as the development of strategies on how nations and regions can meet their Sustainable Development Goals (SDGs) and targets for the period 2015- 2030. TWAP is also poised to help identify core indicators to support national monitoring and reporting of targets required to realize the Sustainable Development Goals (SDGs) for the period 2015 – 2030. TWAP freshwater indicators map to SDG 6 on Clean Water and Sanitation, notably Target 6.6 (protection and restoration of mountains, forests, wetlands, rivers, aquifers and lakes). TWAP marine indicators support SDG 14 on Oceans, Seas and Marine Resources, and all its targets.

The TWAP FSP was implemented by UNEP as Implementing Agency, with UNEP's Division of Early Warning and Assessment (DEWA) as Executing Agency. The following agencies were the lead partner institutions which led the water category-specific assessments: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including groundwater systems in Small Island Developing States (SIDS); the International Lake Environment Committee Foundation (ILEC) for lake and reservoir basins; the UNEP-DHI Partnership – Centre on Water and Environment (UNEP-DHI) for river basins; and the Intergovernmental Oceanographic Commission (IOC) of UNESCO for Large Marine Ecosystems (LMEs) and the Open Ocean.

The crosscutting analysis

The analysis integrates the results of the five independent water category-specific assessments where system risk is underpinned by the interactions among water system health, human wellbeing and governance, within the constraints of a changing climate (Figure 1). System health is evaluated using selected directional biophysical indicators, which include metrics that quantify water quantity, water quality, and biodiversity for freshwater systems; and productivity, fish and fisheries, pollution and ecosystem health for large marine ecosystems. For the Open Ocean, measures of Cumulative Human Impacts are used to assess waters beyond national jurisdictions, as these indicate relative risk. Socioeconomic indicators cover dependent human populations including population sizes, incidence of poverty, human development levels, and threats imposed by climate-related natural disasters. Governance risks are evaluated using governance architecture, with a view to subsequently analysing governance performance using more detailed analytical approaches. All indicators are assessed with 2000-2010 as the reference period, and several include projection scenarios to 2030, 2050 and 2100. For this crosscutting analysis, only contemporary indicators are used.

Figure 1: *The conceptual framework used in this analysis builds on the principle that ecosystem health sustains planetary and human well-being. Risks that weaken a system state, including those that exacerbate global warming, erode natural capital that is needed for long-term human development.*



The results are geographically organized to allow for comparisons of risk by water system category and by theme in 14 regions of the world (Figure 2 and Table 1). The regional breakdown is a variant of the UN sub-continental regional subdivisions to enable optimal distribution of international waters and regional comparisons. To do so, the average risk was calculated in each region at two spatial scales (***Boxed Text – Computing regional averages***). At system scale, the average thematic values were obtained for all indicators that were assessed and grouped under each of the three themes – socioeconomics, governance and biophysical. The indicators that were used can be found in Table 2. The individual water systems are listed by water category for each region in Table 3. At regional scale, for each water category, the regional averages by theme are derived by weighting the water system averages by the ratio of a system's area (surface or basin area) to the regional total area. The final averages for each region by water category are likewise area-weighted. Regional thematic averages across water categories are simple numeric averages that weight water categories equally regardless of size. This report displays the average risk at the regional level to enable a global comparison across the five water categories and three themes. Risk is assessed at five levels, from highest to lowest and color coded throughout from red to blue. In TWAP, risk can be interpreted as follows: the higher the risk, the greater is the likelihood of failure to sustain the ecosystem services from transboundary systems that are essential for human well-being.

Computing regional averages (RA)

Sample region: Northern America	Socioeconomic (SE)	Governance (GO)	Biophyiscal (BP)	$Average_{CATEGORY}$
Aquifers	$RA_{AQUIFERS-SE}$	$RA_{AQUIFERS-GO}$	$RA_{AQUIFERS-BP}$	$A_{AQUIFERS}$
Lakes	$RA_{LAKES-SE}$	$RA_{LAKES-GO}$	$RA_{LAKES-BP}$	A_{LAKES}
Rivers	$RA_{RIVERS-SE}$	$RA_{RIVERS-GO}$	$RA_{RIVERS-BP}$	A_{RIVERS}
LMEs	$RA_{LMEs-SE}$	$RA_{LMEs-GO}$	$RA_{LMEs-BP}$	A_{LMEs}
$Average_{THEME}$	A_{SE}	A_{GO}	A_{BP}	

Where:

System Average$_{CATEGORY\text{-}THEME}$ = Average (Theme Indicator$_1$, Theme Indicator$_2$,…Theme Indicator$_n$)

$Regional\ Average_{CATEGORY\text{-}THEME}$ = [(System Average$_{CATEGORY\text{-}THEME1}$ X System Area$_1$) +
(System Average$_{CATEGORY\text{-}THEME2}$ X System Area$_2$) +…
(System Average$_{CATEGORY\text{-}THEMEn}$ X System Area$_n$)] / Regional Area

$Average_{CATEGORY}$ = Area – weighted Average (RA_{SE}, RA_{GO}, RA_{BP})

$Average_{THEME}$ = Simple Average ($RA_{AQUIFERS-THEME}$, $RA_{LAKES-THEME}$, $RA_{RIVERS-THEME,}$ $RA_{LMES-THEME}$)

Only water categories with data in a region are included in the calculation of averages. Thus, the individual system surface or basin areas weight the regional averages by water category. Regional thematic averages, in contrast, weight the water categories equally.

Figure 2: *This analysis grouped countries into 14 regions to allow for thematic and water category risk averaging and regional comparisons.*

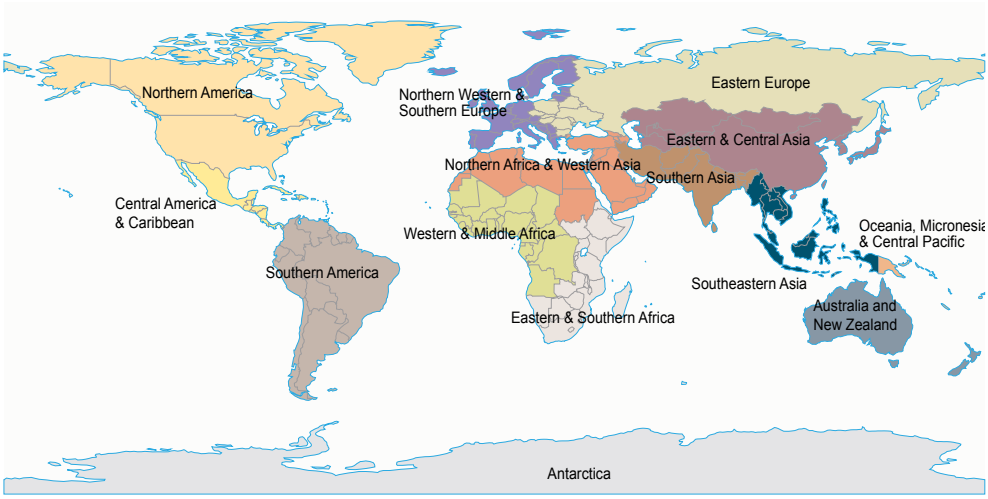


Table 1: Spatial coverage of crosscutting analysis and category specific TWAP assessment.

Number of Transboundary Water Systems assessed in this study	Percentage Assessed of Known Transboundary Waters	Geographic coverage of this study and the water category-specific assessments
Aquifers: 108	**89%** of the global total transboundary aquifer surface area of **26 561 572 km²**	This analysis used the data set for aquifers that was derived from the WaterGap model. Groundwater systems in 42 Small Island States and which are not transboundary were also assessed and reported in the Aquifers Report but were excluded in this analysis along with smaller transboundary aquifers. Thus, the Aquifers Report has a wider spatial coverage at 96%.
Lake Basins & Reservoirs: 53	**87%** of the global total transboundary lake surface area of **874 171 km²**	Twenty-three catchment scale drivers, grouped into thematic areas of catchment disturbance, pollution, water resource management, and biotic factors, not in-lake conditions, were used to quantify threats to Incident Human Water Security and Incident Biodiversity Security. The average of these risk levels were used in calculating the Regional Score Cards with a focus on 53 large lakes and reservoirs. The Lake Report includes ancillary data for an additional 151 smaller lakes, mainly for comparison purposes.
		The total global surface area of rivers and associated streams, transboundary or not, is estimated to be 662 000 km² using stream