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: Crosscutt ng 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, along with the 12-volume annexes that make up the Global Compendium of Transboundary Waters, 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.

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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.

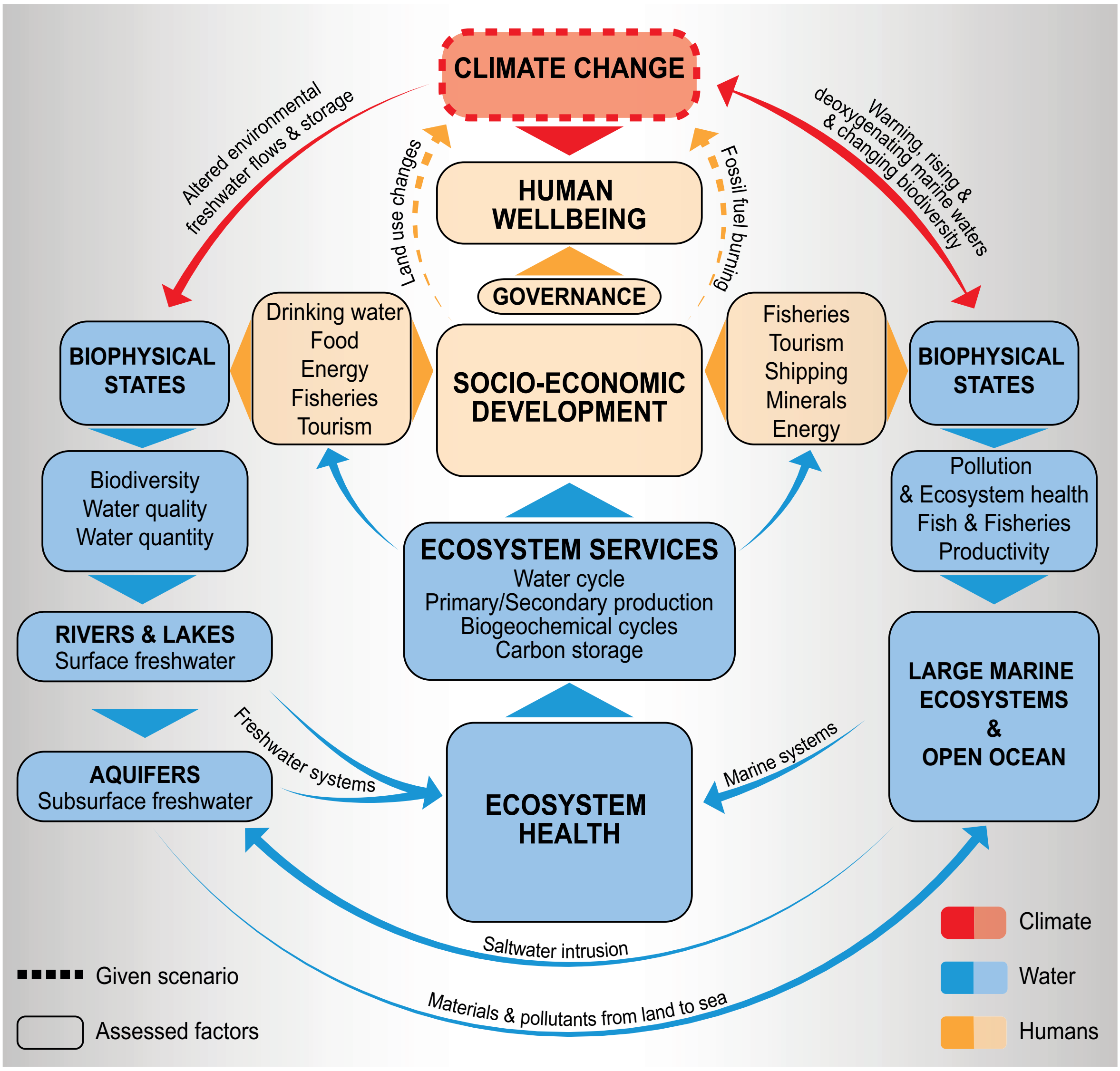
The TWAP assessment is the first global assessment that uses quantified and directional indicators of system states, pressures and impacts under three broad themes: biophysical, socioeconomic, and governance. Results are summarized into five colour-coded relative levels of system risk for each directional 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$_{\text{CATEGORY-THEME}}$ = Average (Theme Indicator$_1$, Theme Indicator$_2$,…Theme Indicator$_n$)

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

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

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

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.*

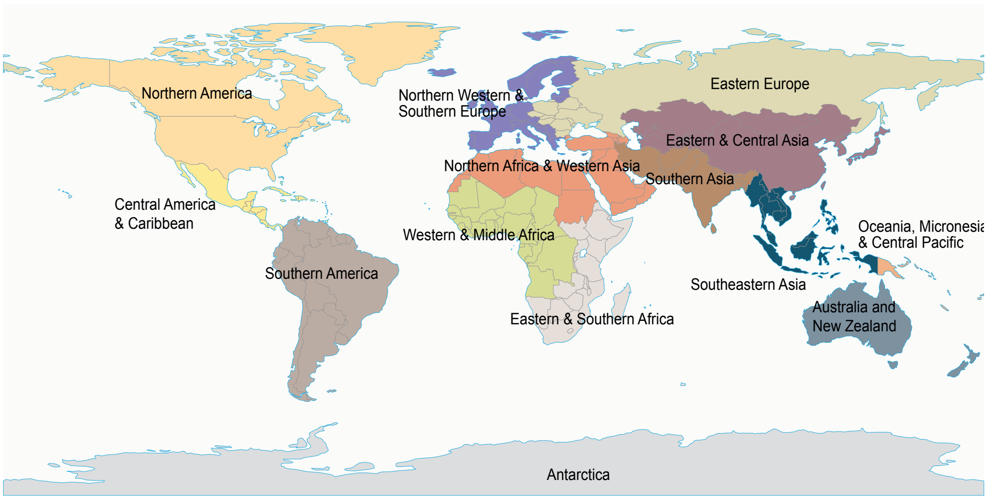


Table 1: Spatial coverage of crosscutting analysis and category specific TWAP assessment.

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.
River Basins: 286	**100%** of the global total transboundary river basin area of **62 000 000 km²**	The total global surface area of rivers and associated streams, transboundary or not, is estimated to be 662 000 km² using stream network analysis and awaits empirical validation. Thus the basin area is used to determine percent area covered by assessment. Both crosscutting analysis and River Basin assessment covered the same total basin area.
Large Marine Ecosystems: 66	**100%** of the global total LME surface area of **113 000 000 km²**	All LMEs were analyzed for the biophysical and socioeconomic indicators, while only transboundary LMEs were analyzed for governance risk. The Western Pacific Warm Pool, though not an LME, was included in the analysis of LMEs in Oceania, Micronesia and Central Pacific Region.
Open Ocean: 1	**100%** of the global total Open Ocean of **232 000 000 km²**	The Cumulative Human Impact Index for Open Ocean was used in this analysis. The Open Ocean Assessment examined many more important contextual indicators, although some of these could not yet be appropriately scaled down to their influence on local risks.

Table 2. Indicators used in this analysis (for details readers are referred to the water category-specific reports available at www.geftwap.org).

Water category	Biophysical	Governance	Socioeconomic
AQUIFERS	• Mean annual groundwater recharge depth including artificial recharge from irrigation • Mean annual groundwater recharge depth excluding artificial recharge from irrigation • Groundwater depletion • Groundwater development stress	• Presence of governance instrument addressing groundwater and/or freshwater system above it	• Annual amount of renewable groundwater resources per capita • Human dependency on groundwater • Population density
LAKES	• Incident Human water security • Incident Biodiversity security	• Presence of national or international governance instruments specifically addressing lake basins and reservoirs	• Human Development Index
RIVERS	• Environmental water stress • Human water stress • Agricultural water stress • Nutrient pollution • Waste water pollution • Ecosystem impacts from dams • Threat to fish • Extinction risk	• Legal framework • Hydropolitical tension • Enabling environment	• Economic dependency on water resources • Societal wellbeing • Exposure to floods and droughts
LMEs	• SST change • Ecological footprint • Change in Marine Trophic Index • % Catch bottom impacting gear • Fishing effort change • Change in catch potential 2050 under warming • Microplastic numbers/km2 • Macroplastic density gm/km2 • POPs-PCBs • POPs-DDTs • POPs-HCHs • DIN risk score • ICEP risk score • Merged nutrient risk indicator • Reefs at risk Index • Change MPA coverage	• Completeness • Integration • Engagement	• Size of coastal population • Number of coastal poor using national poverty lines and scaled to 100 km coast • HDI for the period 2009-2013 • Present day Climate Threat Index
Open Ocean	Cumulative Human Impact Index		

Risk in transboundary water systems

Risk in transboundary water systems is displayed globally in Figure 3 which shows average risk by water system category and by theme for the 14 TWAP regions of the world as well as by FAO Fishing Area for the Open Ocean. Risk was assessed thematically using biophysical, socioeconomic and governance indicators for each water system, and averaged by water system category, for aquifers, lake basins, river basins, and lmes; and by theme in each region. The open ocean risks assessed using cumulative human impacts and scaled to FAO fishing areas, provide another layer of risk.

Average thematic risk is generally lower among developed regions of Northern America and Europe, and higher in Sub-Saharan Africa, and in Southern and Southeastern Asia. The low to middle levels of human development based on the Human Development Index, account for the high average socioeconomic risks found in these areas. The absence of aquifer legal instruments to govern their use results in average governance risk of moderate level in 9 of 14 regions. Average biophysical risk tends to be moderate in 10 regions, and low in Southern America, Western and Middle Africa, Eastern and Southern Africa, and in the Oceania-Micronesia-Central Pacific region. ***Overall thematic trends show that Southeastern Asia is at high socioeconomic and high governance risk; the Oceania-Micronesia-Central Pacific region is at low socioeconomic and low biophysical risk.***

Among water categories, biophysical risks among transboundary aquifers are predominantly low in both developed and developing regions, indicating their status as a relatively untapped water resource and a critical buffered water storage in light of a warming climate. Transboundary lakes, assessed using 23 catchment drivers and not in-lake conditions, indicate lake catchments in Central America & Caribbean to be most at risk, both as a result of high socioeconomic and high biophysical risks. Transboundary lake catchments in Northern and Southern America, Northern Africa & Western Asia, Eastern Europe, Southern Asia and in Eastern & Central Asia, all are at low risk, averaged across themes. Transboundary rivers in Southern Asia are at high risk because of highest socioeconomic and high biophysical risks; those in Northern America and Northern-Western-Southern Europe region are at low risk because of low to moderate socioeconomic and low governance risk. LMEs are at high risk in Southern and Southeastern Asia because of highest socioeconomic and high biophysical risks; those in Eastern Europe are at low risk because of low socioeconomic and low governance risk. The Antarctic LME is at low risk on average although it is at moderate biophysical risk. ***Examining the regional patterns across water categories, Southern Asia is most at risk with its river basins and lmes showing high average risks across risk themes. Northern and Southern America, Northern Africa & Western Asia, and Eastern Europe, all have two water categories at low risk, and another two at moderate risk.***

In the case of the open ocean, all regions except for the Arctic show moderate to high levels of cumulative impacts, with climate change stressors dominating the patterns. While mitigating climate change requires global cooperation, the resulting impacts to ecosystem health and services at local and regional scales demand fine-scale monitoring, assessment and mitigation.

Regions that exhibit contemporary moderate and above risk levels thematically or by water category must address risk levels among transboundary water systems in their socioeoconomic, governance and biophysical dimensions; mitigating the root causes and effects of these risks. Areas that currently show low risks must seek to maintain these risk levels in the face of the challenges of a warming climate.

There is a tendency for biophysical risk to propagate downstream from aquifers to LMEs, so that a source-to-sea perspective must be embedded in water management if it is to be integrative across all aquatic systems, noting that marine living resource exploitation and pollution from coastal and marine sources provide additional in-situ stressors for marine waters. The assessment of governance arrangements and architecture is a novel aspect, but does not measure effectiveness of performance. Data for aquifers and lakes are scant and long-term time series data for all transboundary water categories must be significantly augmented to ensure their proper management and sustained system health.

The frequency distribution of risk by theme, pooled across aquifers, rivers, lakes and LMEs in a region is shown in Figure 4. With the total number of water systems across four water categories being equal to 100%, the percentage of water systems falling into each of the five risk levels is shown by theme. Risk is variable across the three themes – biophysical, socioeconomic, and governance, indicating a serious need for interventions at policy and management levels to address biophysical, socioeconomic and governance sources of risk in an integrated and thus strategic manner.

The profiles for each of the 14 regions provide greater at-a-glance detail on socioeconomic conditions as well as the distribution of risk across water categories and themes for each region (Figs 4-17). Reading the two-page spread from left to right, each profile provides a location map and some key demographic information at the top of the left page. Contemporary risks by water category and theme are shown at the top right. The bottom left shows contemporary risk for each of the three themes with the percentage of systems (pooled across aquifers, lakes, rivers and LMEs) indicated for each risk level. The segmented bars show the percentage of systems in each risk level. Finally, at bottom right, the average risks by water category and theme are summarized for the region.

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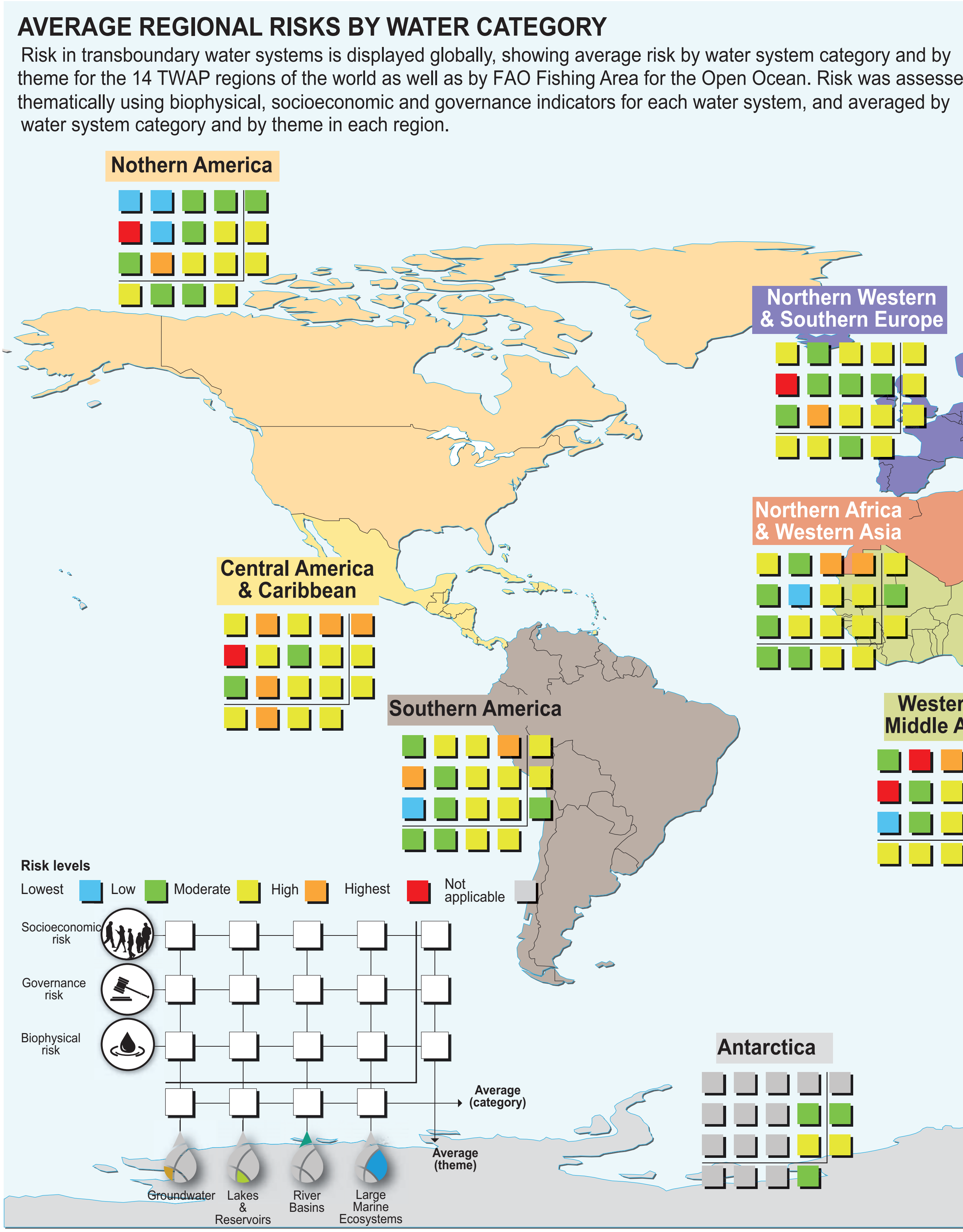
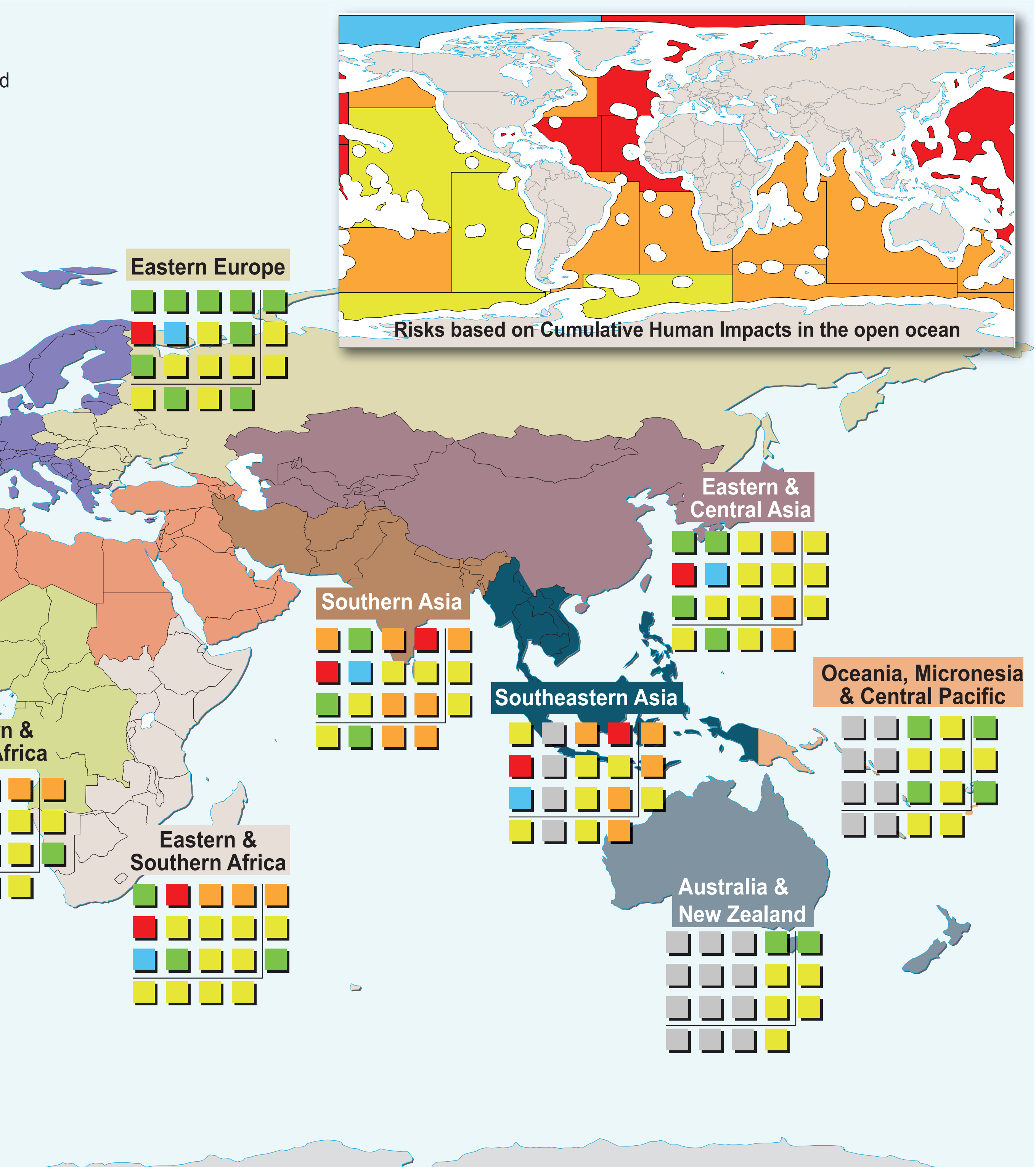
Figure 3: *Global Map of Risks*



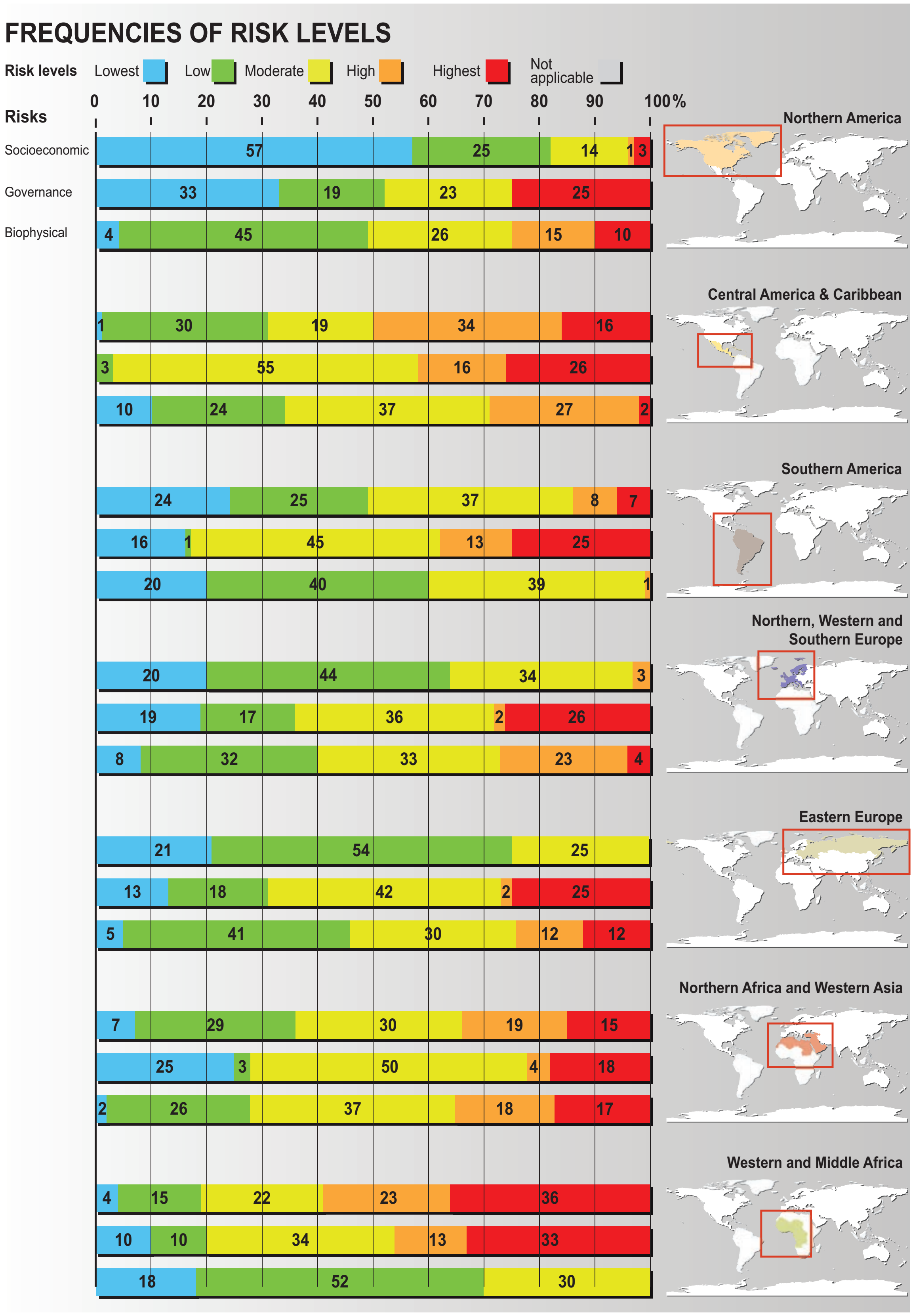


1. The Antarctic continent is not inhabited by resident citizens so that conventional country-based socioeconomic indicators are not applicable for assessing socioeconomic activities that take place on land and in surrounding waters including fisheries and tourism.

2. Most of the Large Marine Ecosystems of Australia and all the coastal waters of New Zealand are not transboundary.

3. Included in the assessment of Oceania, Micronesia and Central Pacific are the countries within the Western Pacific Warm Pool.

Figure 4: *Frequencies*



The frequency distribution of risk by theme, pooled across transboundary aquifers, rivers, lakes and Large Marine Ecosystems (LMEs) in each of the 14 regions is shown here. For each theme, the total number of water systems across the four water categories in a region equals 100%, and the percentage of water systems falling into each of the five risk levels is indicated by the number in each risk segment. Risk in a region is variable across the three themes and signifies the need for governance to address the integrated nature of risk in order to effectively sustain ecosystem health and human wellbeing.

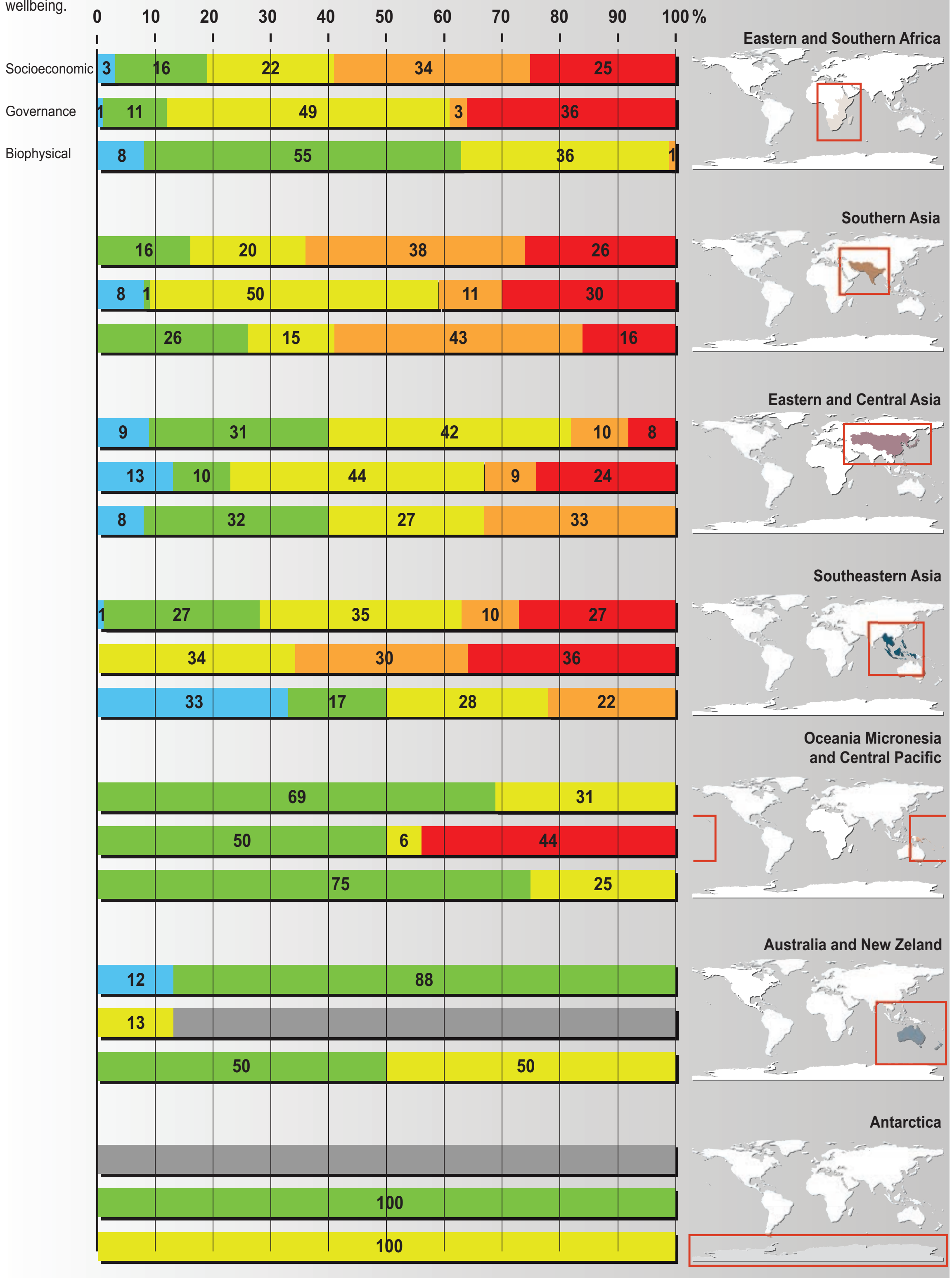
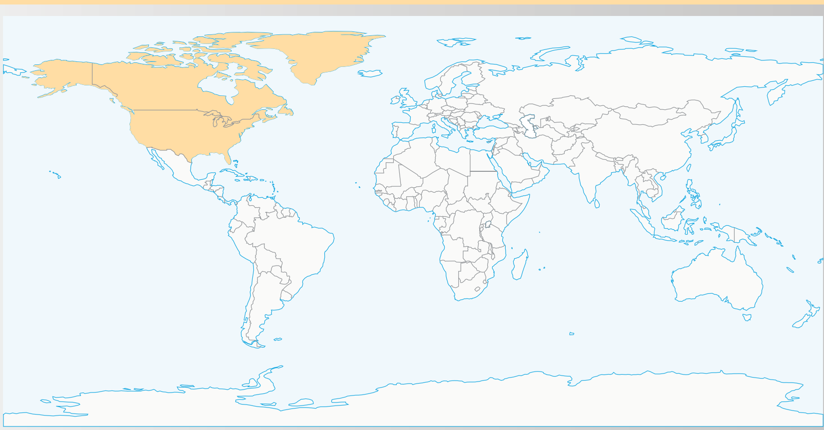


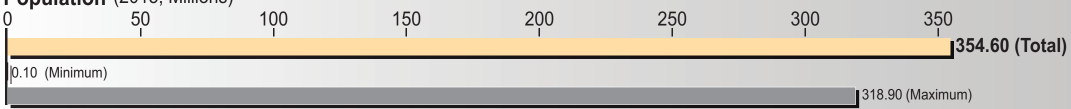
Figure 5: *Transboundary Waters*

TRANSBOUNDARY WATERS: NORTHERN AMERICA

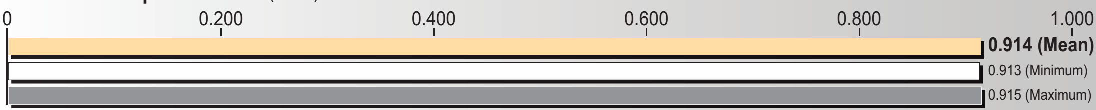


The region belongs to the very high HDI group with a regional average HDI of 0.914, and a population reaching 355 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Across 50 transboundary waters in the region (bottom left), about 82% experience low to lowest socioeconomic risks; 52% are subject to low to lowest governance although another 25% are at very high governance risk; and 52% are at moderate to highest biophysical risk. On average ((bottom right), the region's transboundary waters are at low socioeconomic risk, and at moderate governance and biophysical risks. Lake and river basins both are at low risks averaging all risk themes, and aquifers and LMEs are at moderate risk.

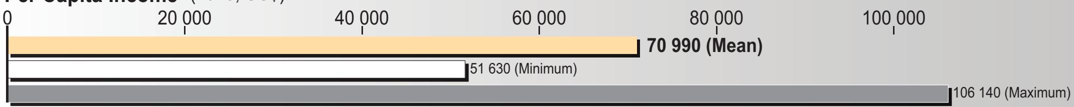
Population (2015, Millions)



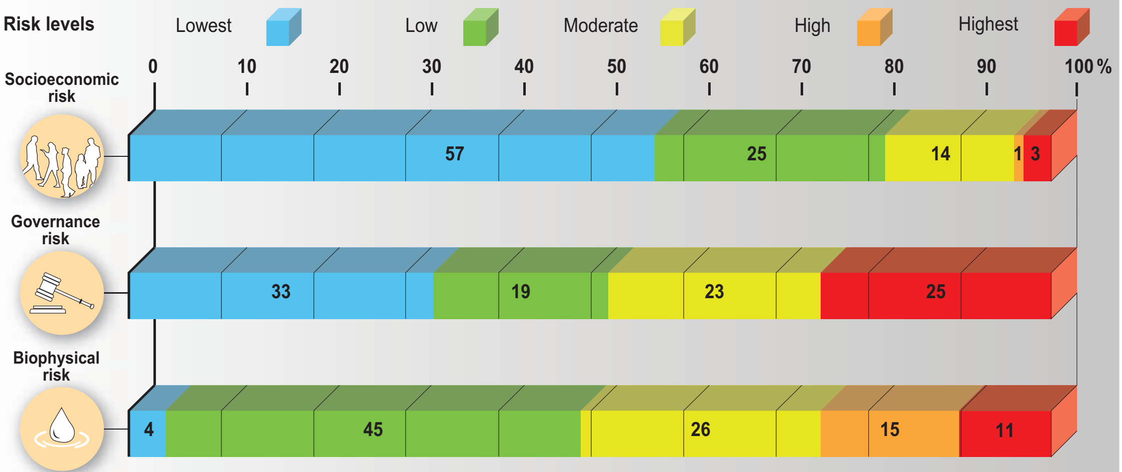
Human Development Index (2014)



Per Capita Income (2015, US$)



Contemporary Risks by Theme



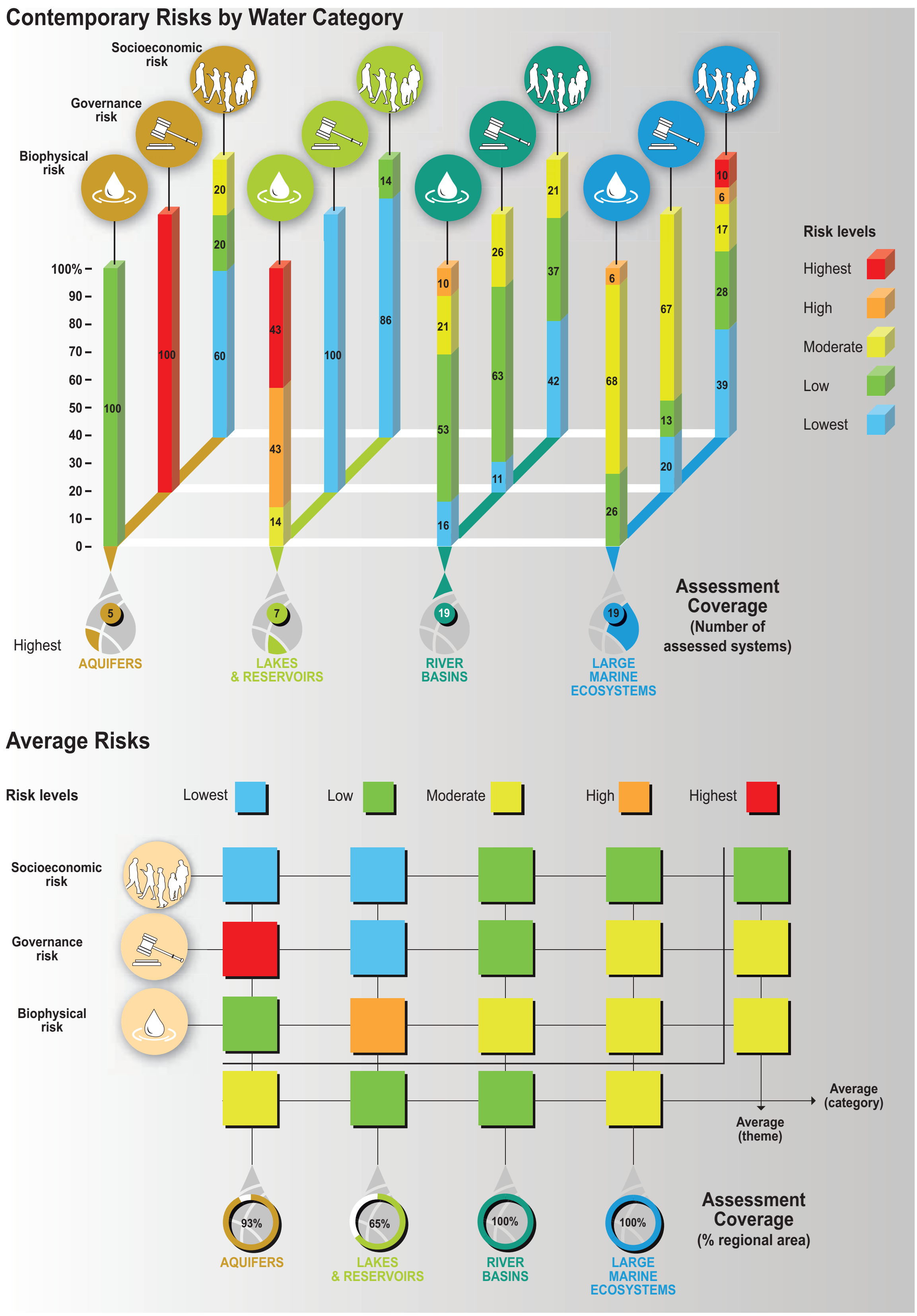
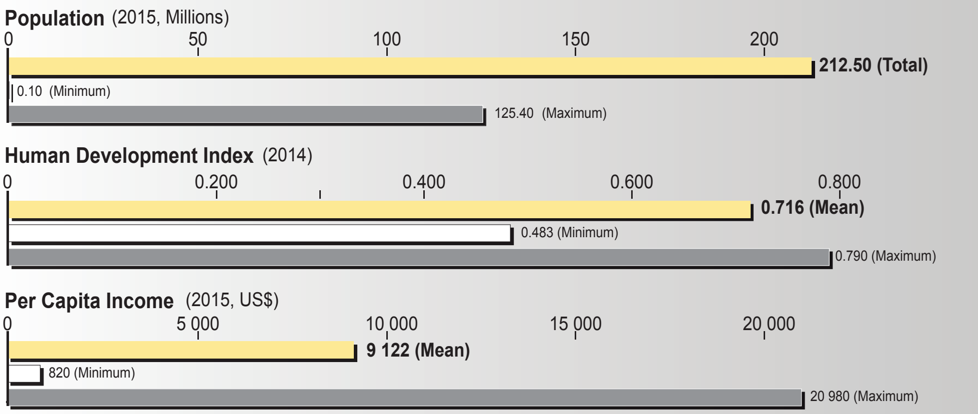

Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100%
90
80
70
60
50
40
30
20
10
0
100
100
60
20
20
43
43
14
100
86
14
10
21
53
16
26
63
11
21
37
42
6
68
26
67
13
20
10
6
17
28
39
Risk levels
Highest
High
Moderate
Low
Lowest
Highest
5
7
19
19
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(Number of assessed systems)
Average Risks
Risk levels
Lowest
Low
Moderate
High
Highest
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
93%
65%
100%
100%
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(% regional area)

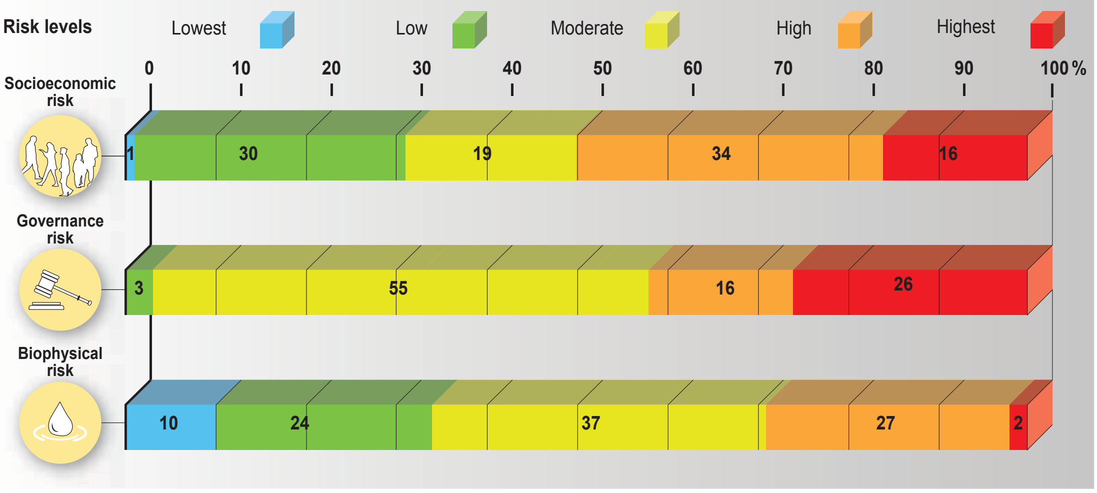
Figure 6: *Transboundary Waters*

TRANSBOUNDARY WATERS: CENTRAL AMERICA & CARIBBEAN

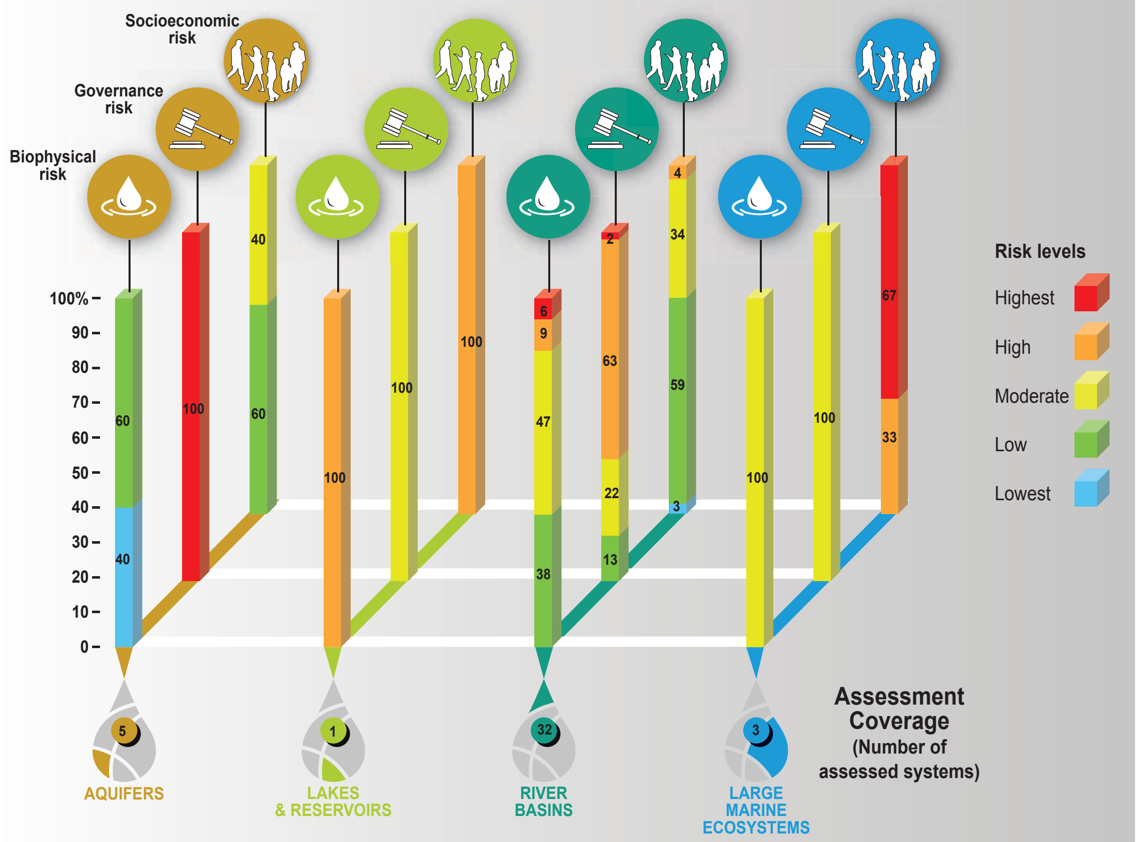
The region belongs to the High HDI group with a regional average HDI of 0.716, and a population reaching 212 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Across 41 transboundary waters in the region (bottom left), 50% experience high to highest socioeconomic risk; 97% are subject to moderate to highest governance risk; and 66% are threatened by moderate to highest biophysical risk. On average (bottom right), the region's transboundary waters are at high socioeconomic risk, and are at moderate governance and biophysical risks. Aquifers, river basins and LMEs are at moderate risk across risk themes, but lakes are at high risk.



Contemporary Risks by Theme



Contemporary Risks by Water Category



Average Risks

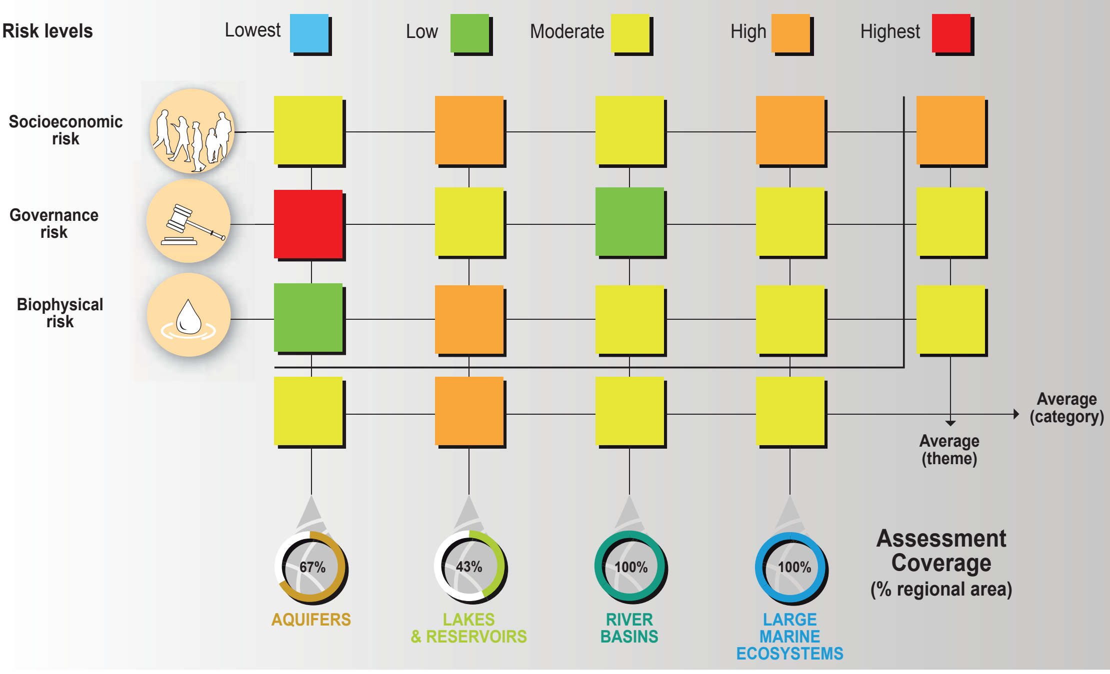
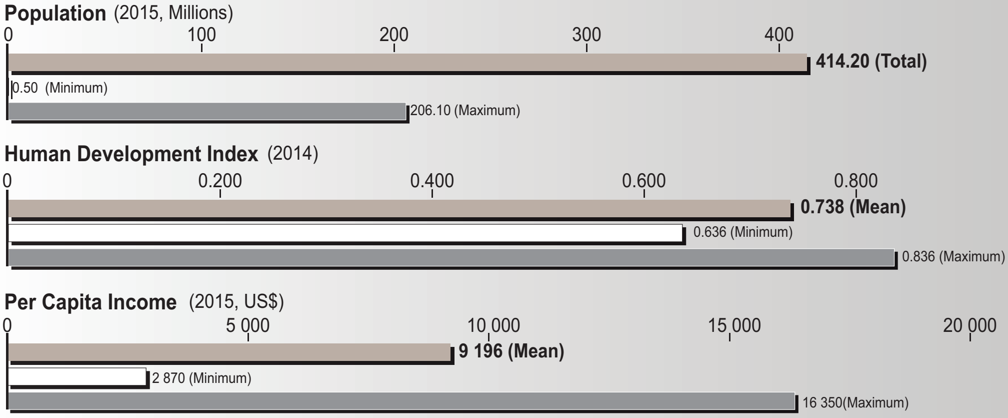


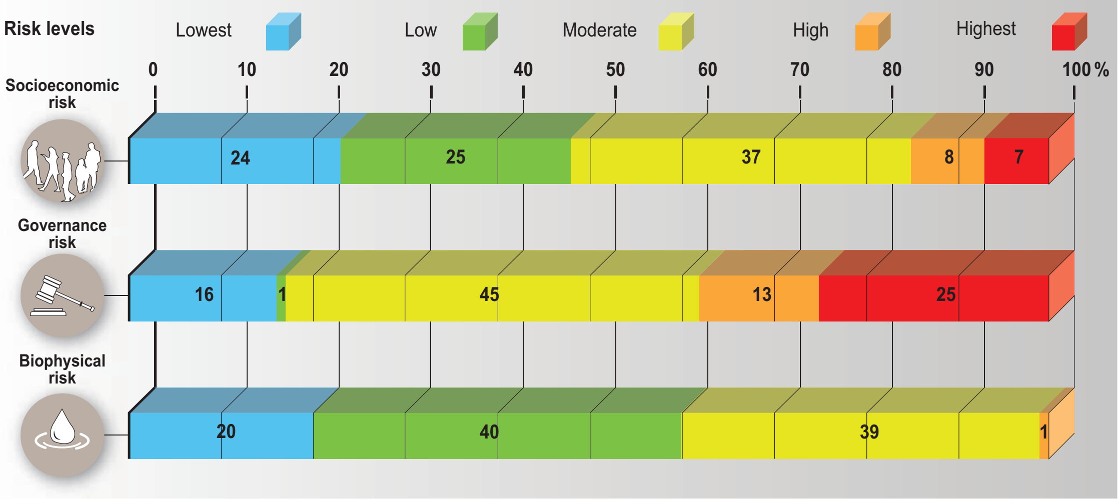
Figure 7: *Transboundary Waters*

TRANSBOUNDARY WATERS: SOUTHERN AMERICA

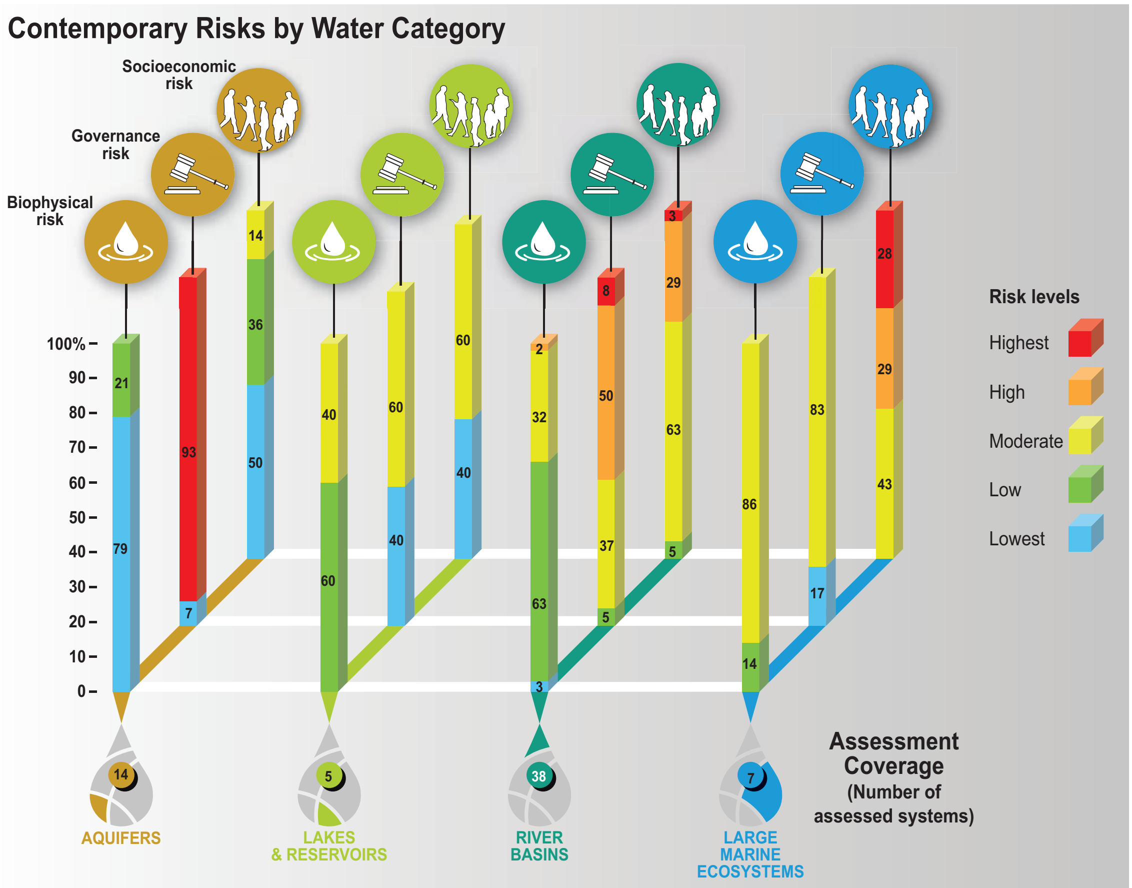
The region is classified as a High HDI with a regional average HDI of 0.738, and a population of 414 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Across 64 transboundary water systems (bottom left), 52% are threatened by moderate to highest socioeconomic risk, 83% by moderate to highest governance risk, and 79% by low to moderate biophysical risk. On average (bottom right), the region's transboundary waters are at moderate socioeconomic and governance risk, and at low biophysical risk. Transboundary aquifers and lakes are at low risk across risk themes, and river basins and LMEs are at moderate risk.



Contemporary Risks by Theme



Contemporary Risks by Water Category



Average Risks

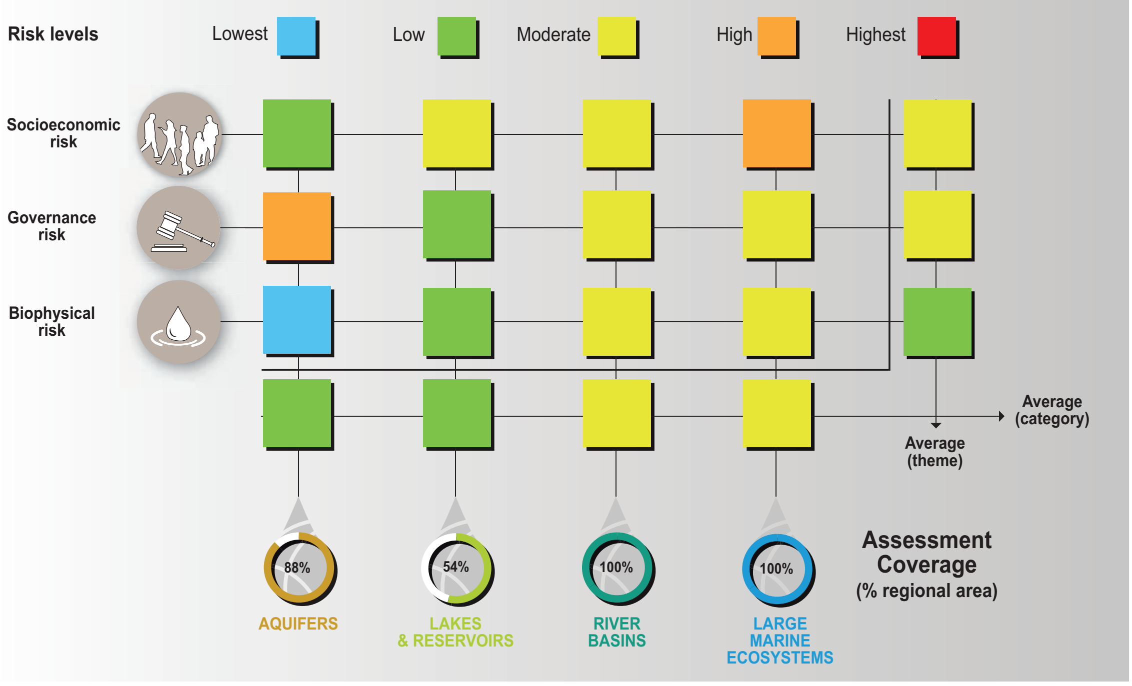
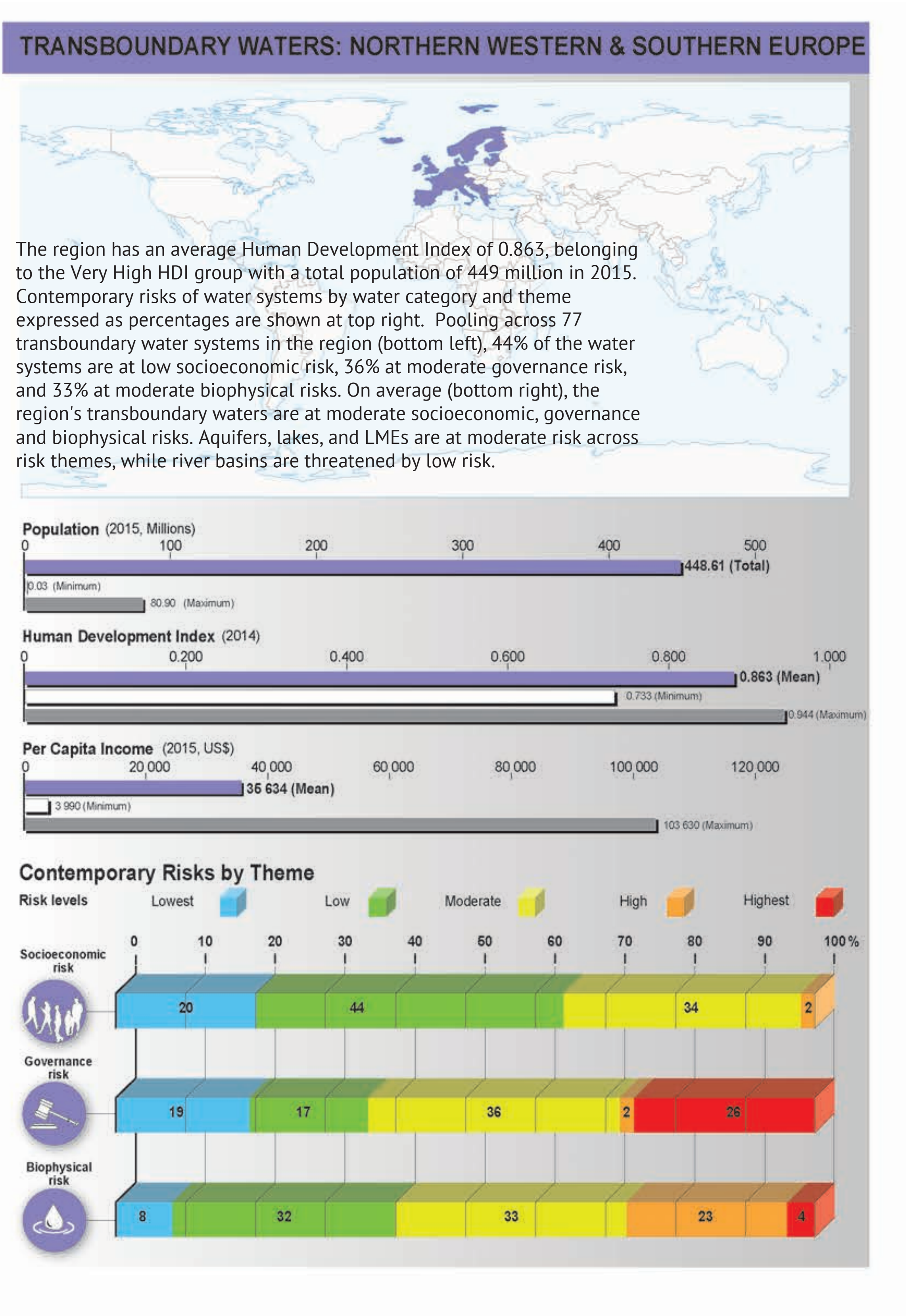
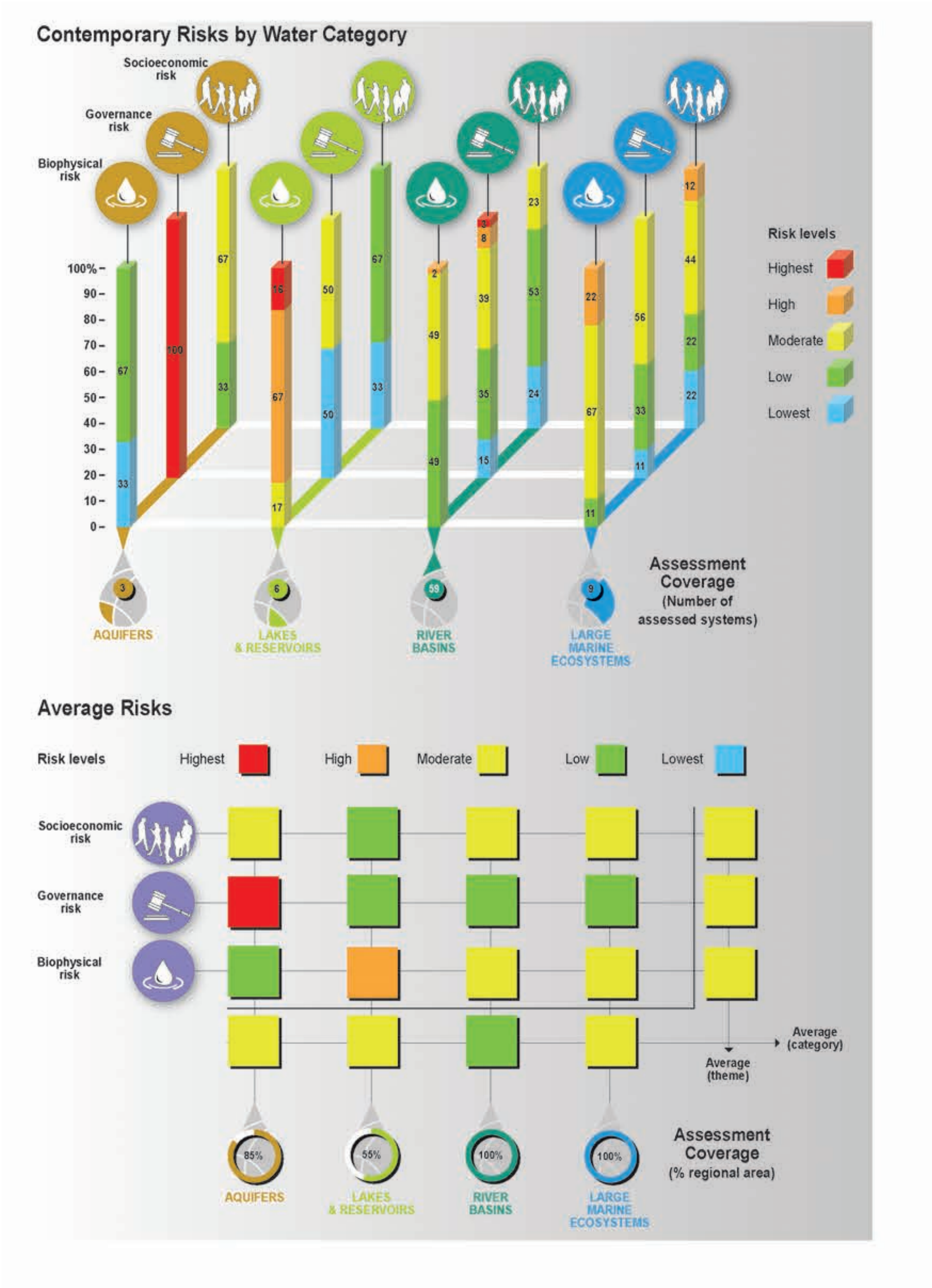


Figure 8: *Transboundary Waters*

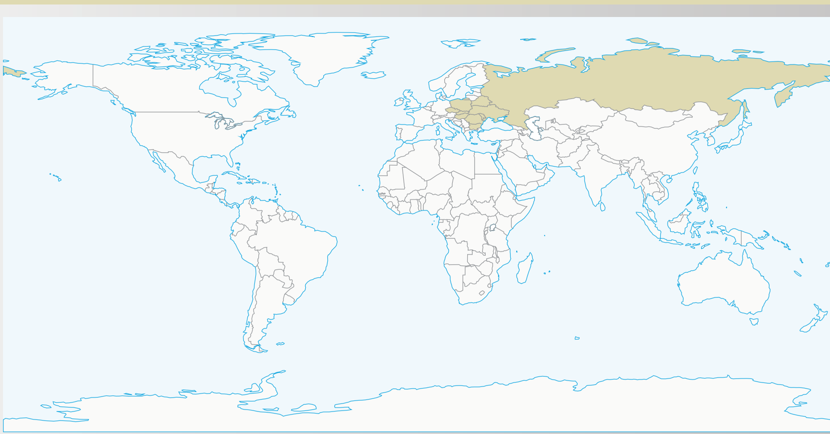




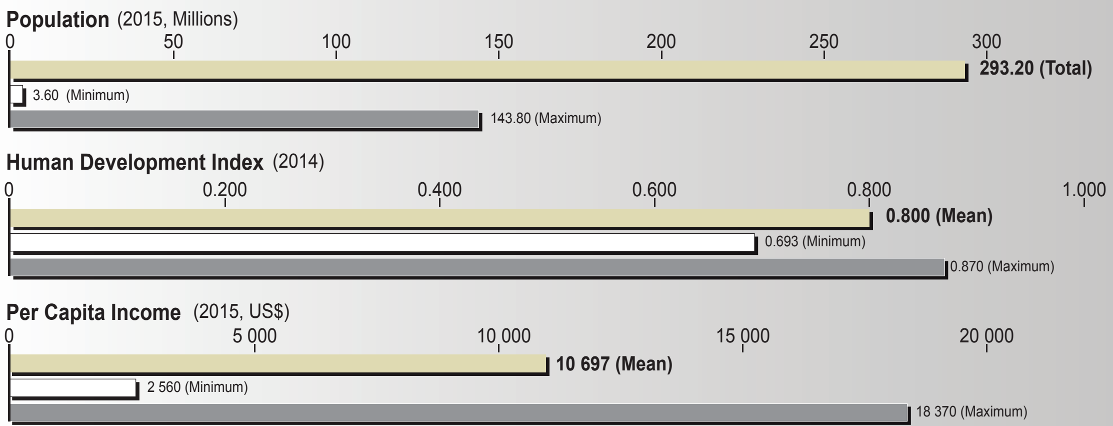
Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100% – 90 – 80 – 70 – 60 – 50 – 40 – 30 – 20 – 10 – 0 –
Risk levels
Highest
High
Moderate
Low
Lowest
Assessment Coverage (Number of assessed systems)
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Average Risks
Risk levels
Highest
High
Moderate
Low
Lowest
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
Assessment Coverage (% regional area)
85%
55%
100%
100%
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS

Figure 9: *Transboundary Waters*

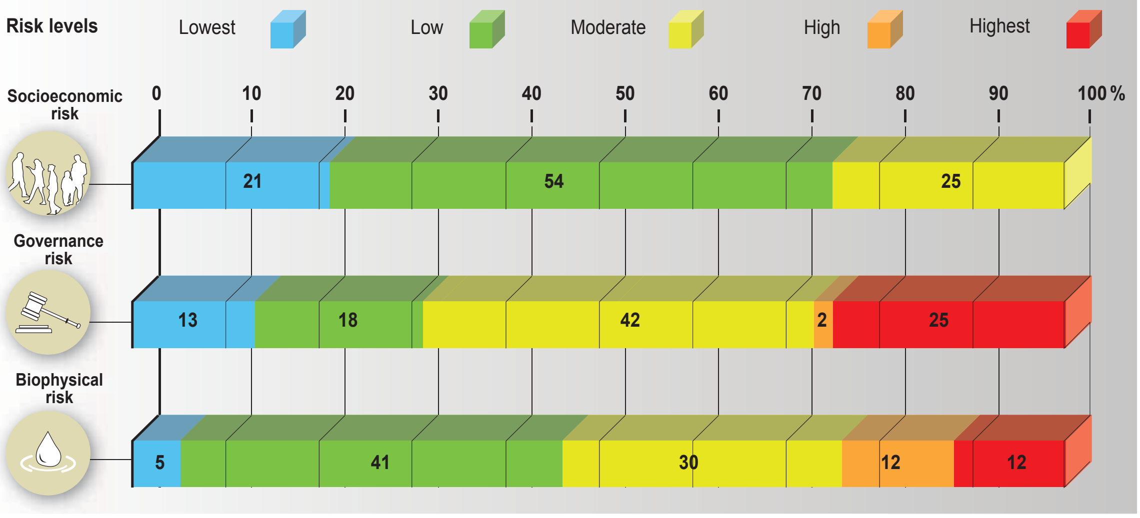
TRANSBOUNDARY WATERS: EASTERN EUROPE



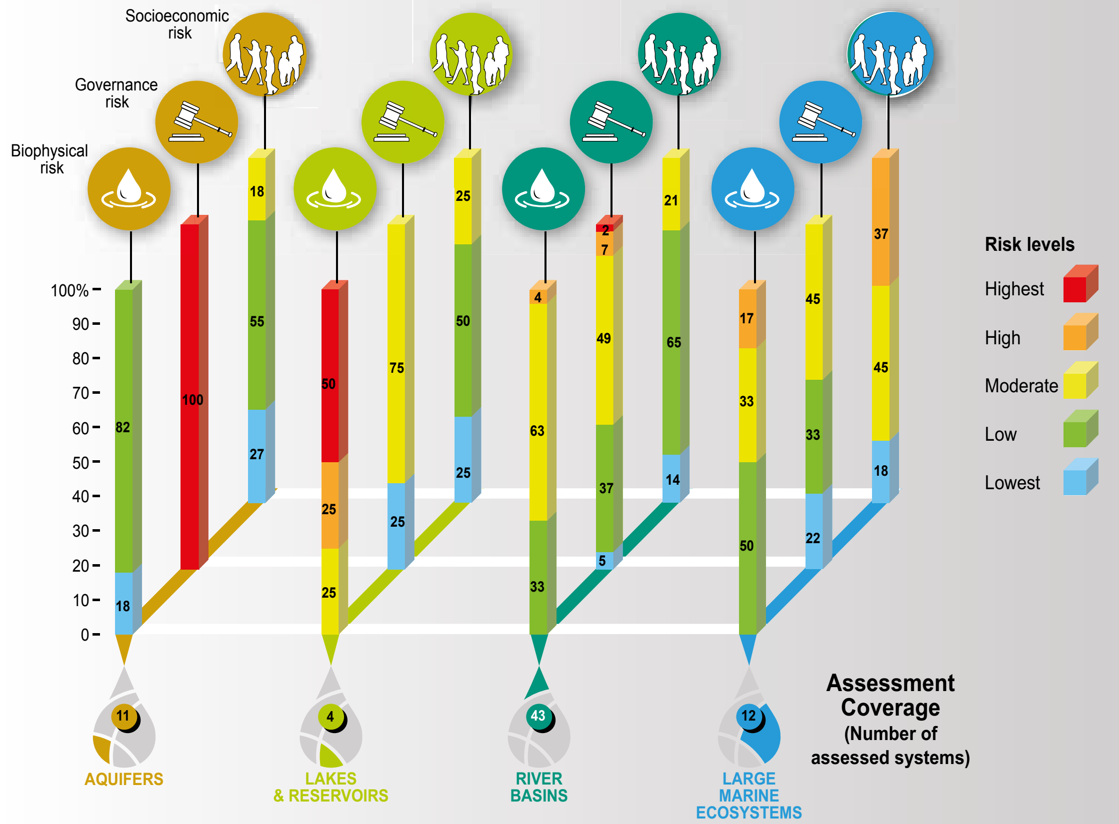
The region has an average Human Development Index of 0.863, belonging to the Very High HDI group with a total population of 449 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 77 transboundary water systems in the region (bottom left), 44% of the water systems are at low socioeconomic risk, 36% at moderate governance risk, and 33% at moderate biophysical risks. On average (bottom right), the region's transboundary waters are at moderate socioeconomic, governance and biophysical risks. Aquifers, lakes, and LMEs are at moderate risk across risk themes, while river basins are threatened by low risk.



Contemporary Risks by Theme



Contemporary Risks by Water Category



Average Risks

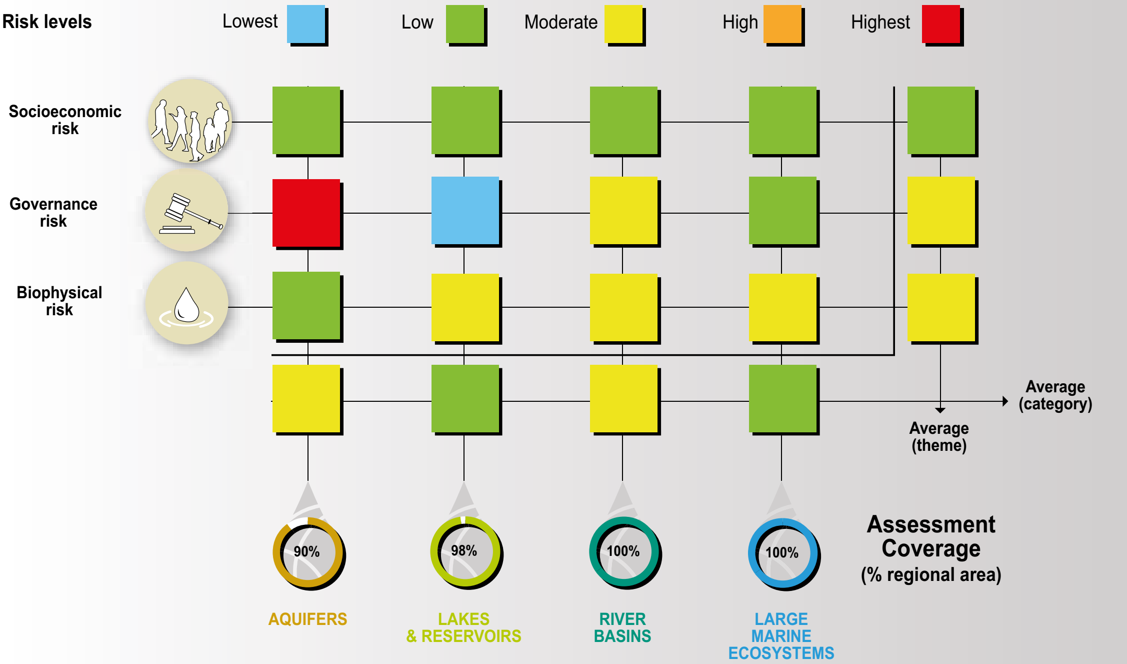
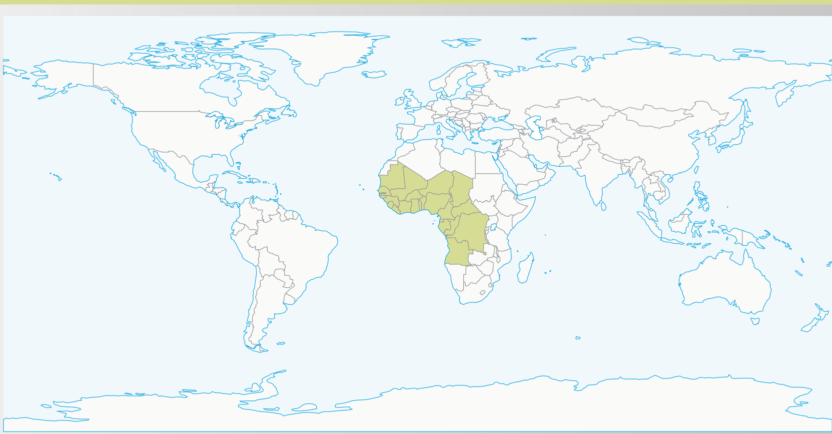


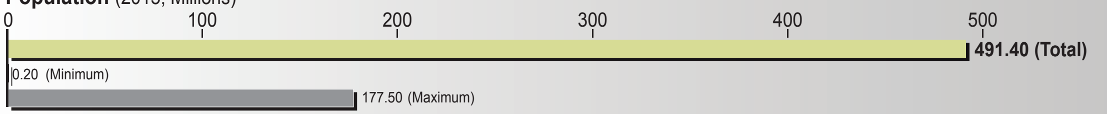
Figure 10: *Transboundary Waters*

TRANSBOUNDARY WATERS: WESTERN & MIDDLE AFRICA

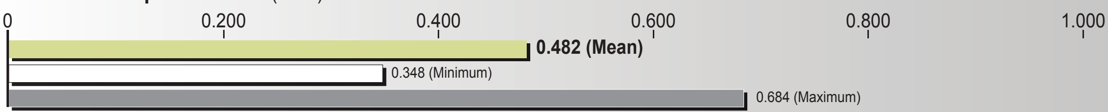


The region is classified as Low HDI Group with a regional HDI average of 0.482 and a population of 491 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Examining 68 transboundary water systems (bottom left), 59% are subject to high to highest socioeconomic risk; 46% are threatened by high to highest governance risk; and 82% are at low to moderate biophysical risk. On average, the region's transboundary waters (bottom right) are at high socioeconomic risk, moderate governance risk and low biophysical risk. All transboundary water categories- aquifers, lakes, rivers and LMEs -- are at moderate risk across risk themes.

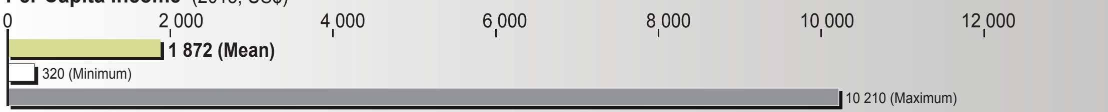
Population (2015, Millions)



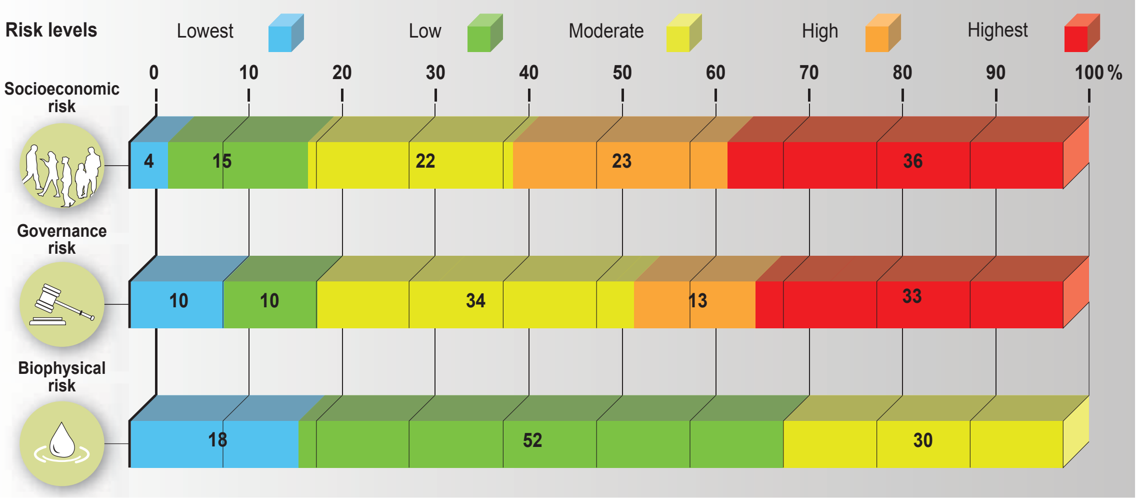
Human Development Index (2014)



Per Capita Income (2015, US$)



Contemporary Risks by Theme



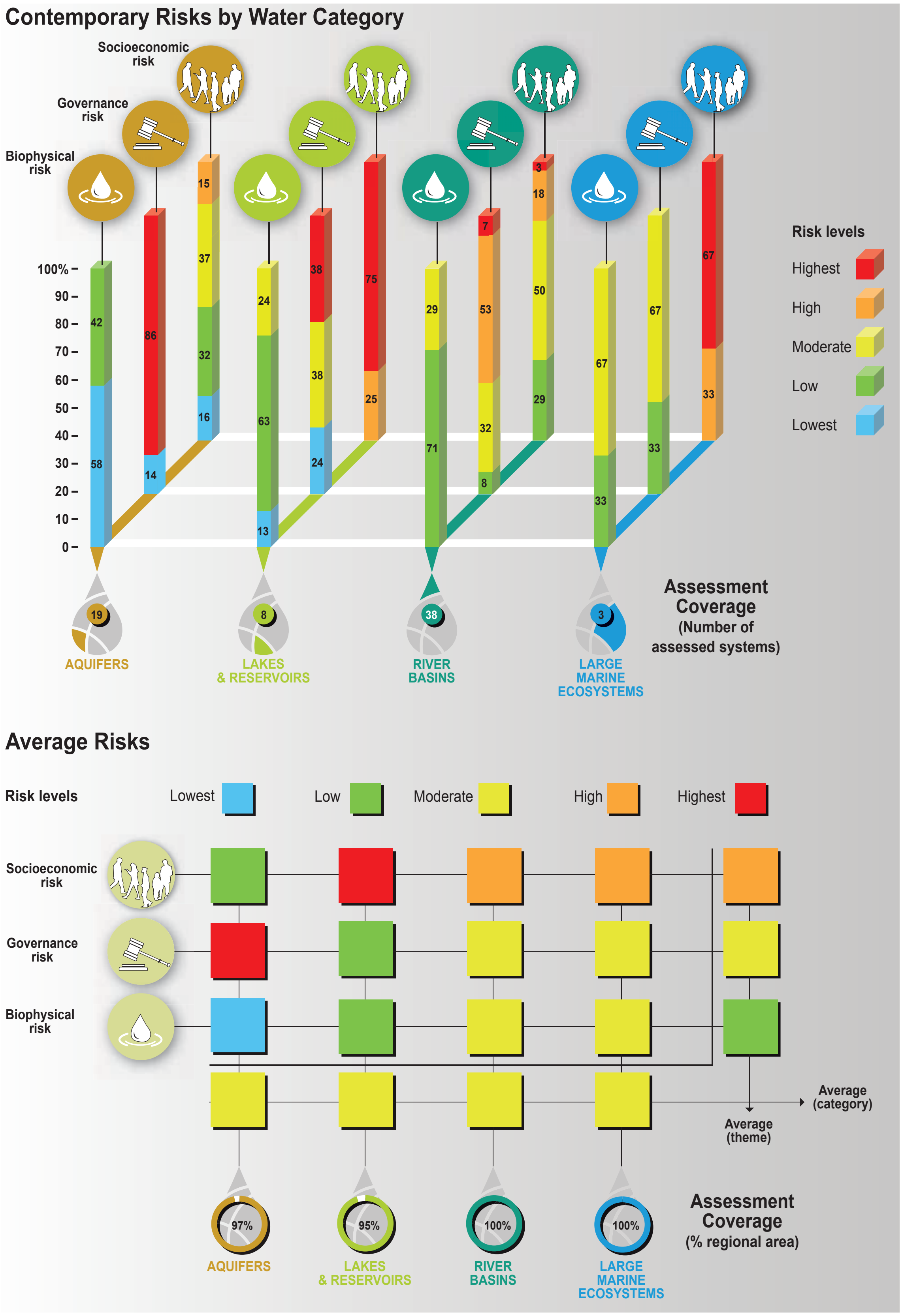
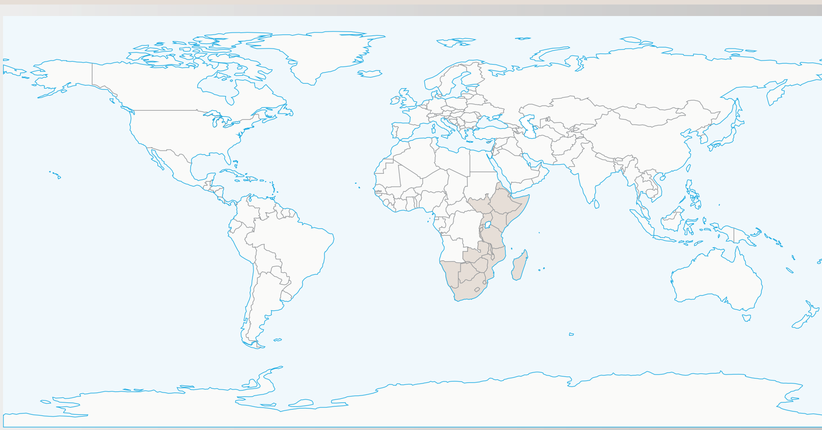
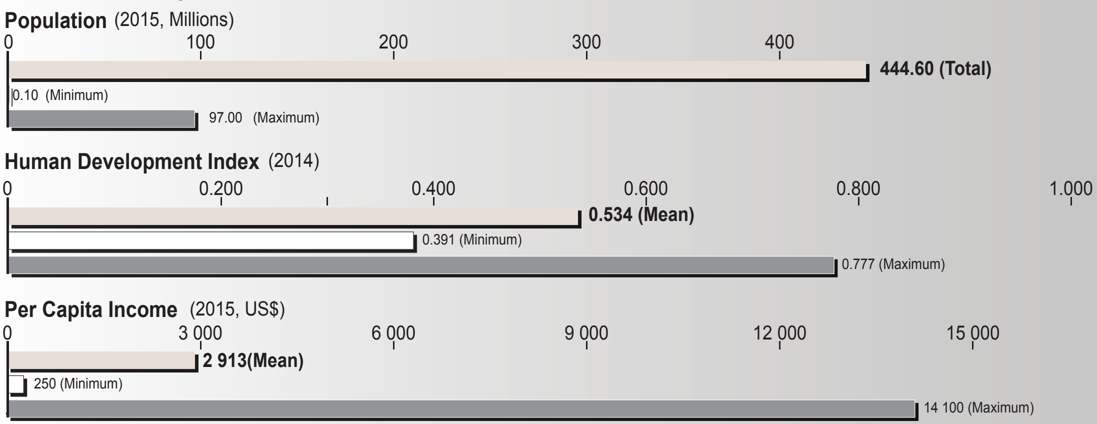

Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
Risk levels
Highest
High
Moderate
Low
Lowest
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage (Number of assessed systems)
19
8
38
3
Average Risks
Risk levels
Lowest
Low
Moderate
High
Highest
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
Assessment Coverage (% regional area)
97%
95%
100%
100%

Figure 11: *Transboundary Waters*

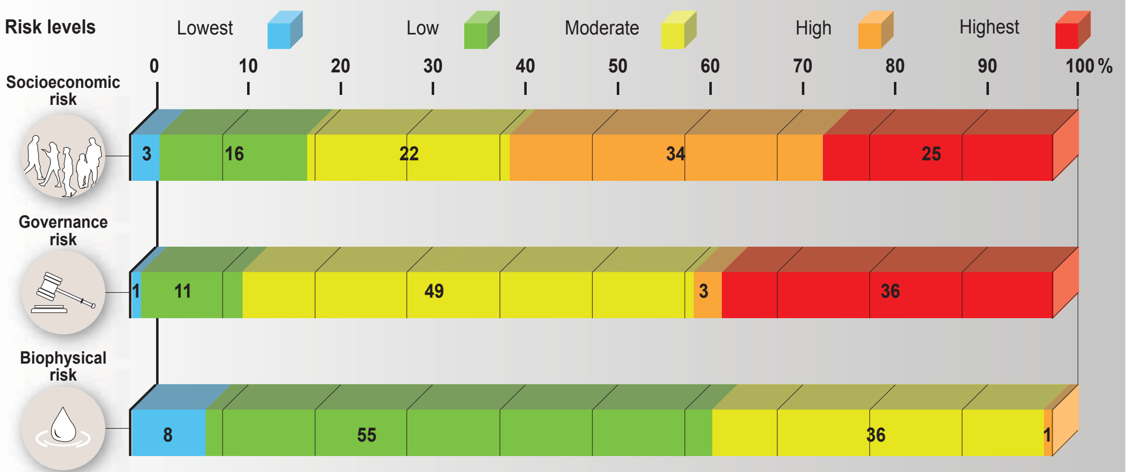
TRANSBOUNDARY WATERS: EASTERN & SOUTHERN AFRICA



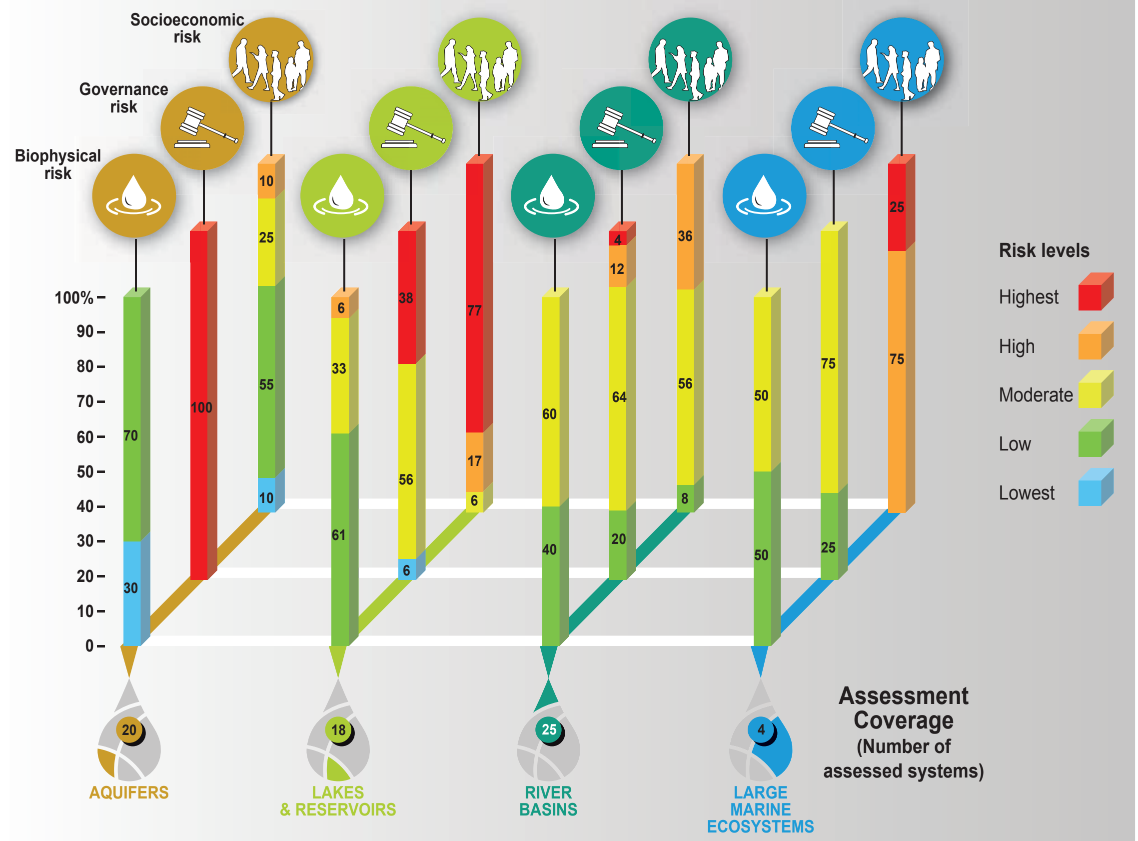
The region belongs to the Low HDI Group with a regional HDI average of 0.534, and a population of 445 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Examining how 67 transboundary waters are distributed by risk level and by risk theme (bottom left), 60% are threatened by high to highest socioeconomic risk, 88% by moderate to highest governance risk, and 92% by low to high biophysical risk with 55% experiencing low risk. On average, this region is similar to Western & Middle Africa region. Its transboundary waters (bottom right) are at high socioeconomic risk, moderate governance risk and low biophysical risk. All transboundary water categories – aquifers, lakes, rivers and LMEs- are at moderate risk for all risk themes, on average.



Contemporary Risks by Theme



Contemporary Risks by Water Category



Average Risks

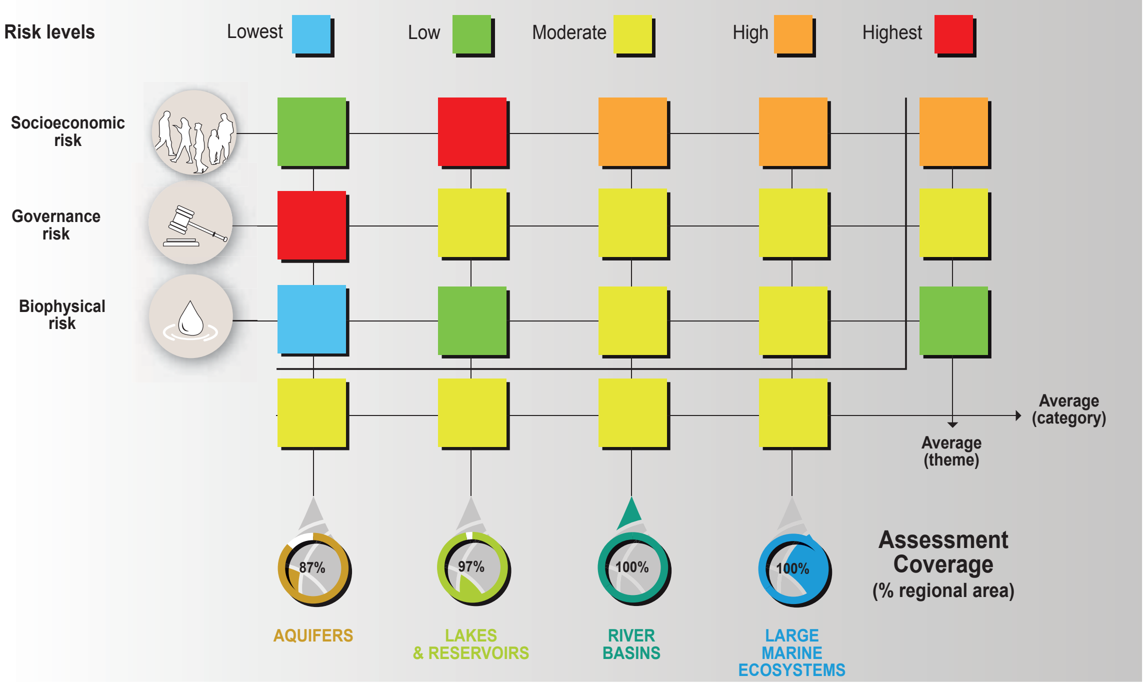
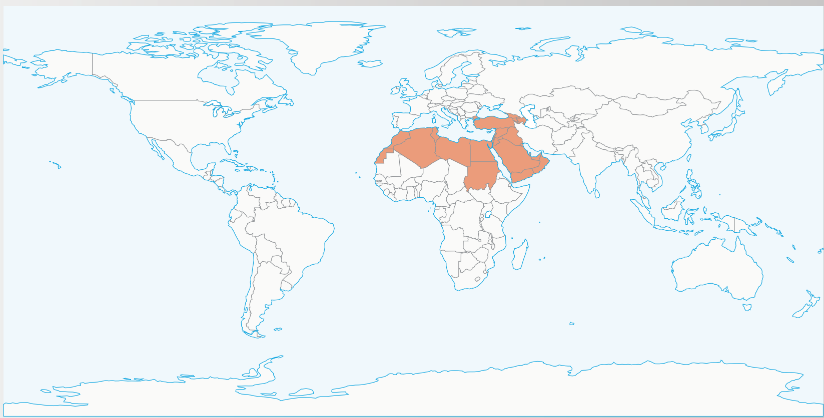
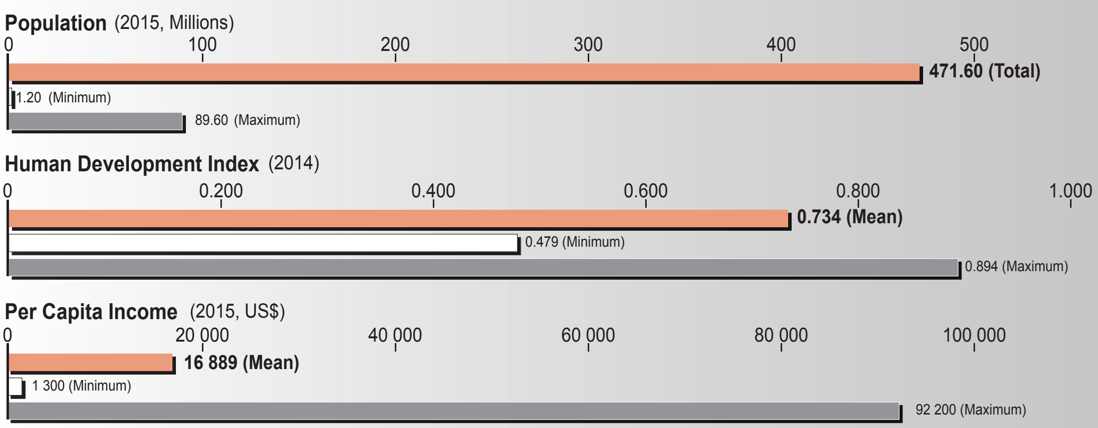


Figure 12: *Transboundary Waters*

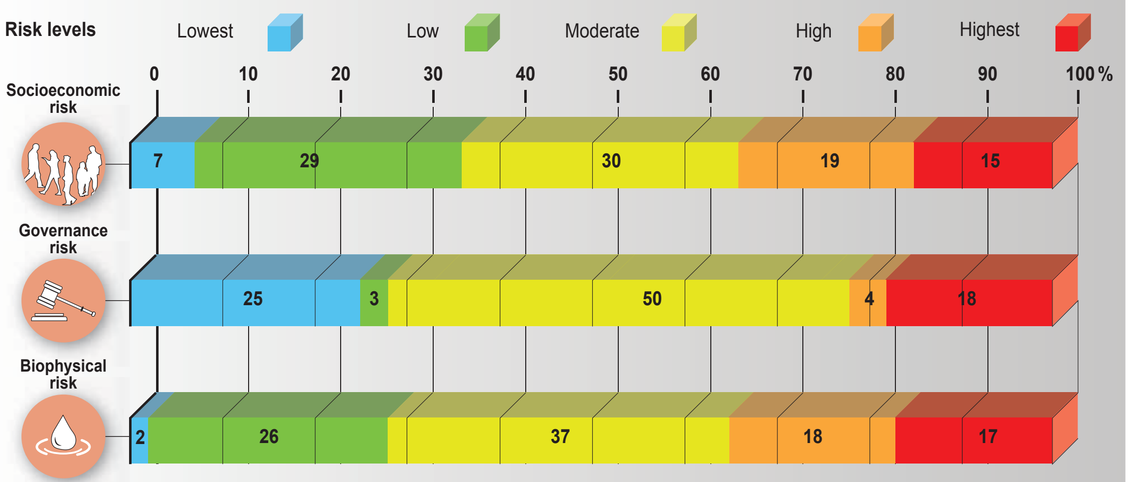
TRANSBOUNDARY WATERS: NORTHERN AFRICA & WESTERN ASIA



The region belongs to the High HDI Group with a regional HDI average of 0.734 and a population reaching 472 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 51 transboundary water systems (bottom left), 63% suffer from moderate to highest socioeconomic risk; 73% from moderate to highest governance risk; and 72% from moderate to highest biophysical risk. On average, the region's transboundary waters (bottom right) are subject to moderate socioeconomic risk, low governance risk and moderate biophysical risk. Aquifers and Lakes are at low risk across risk themes, while river basins and LMEs are at moderate risk.



Contemporary Risks by Theme



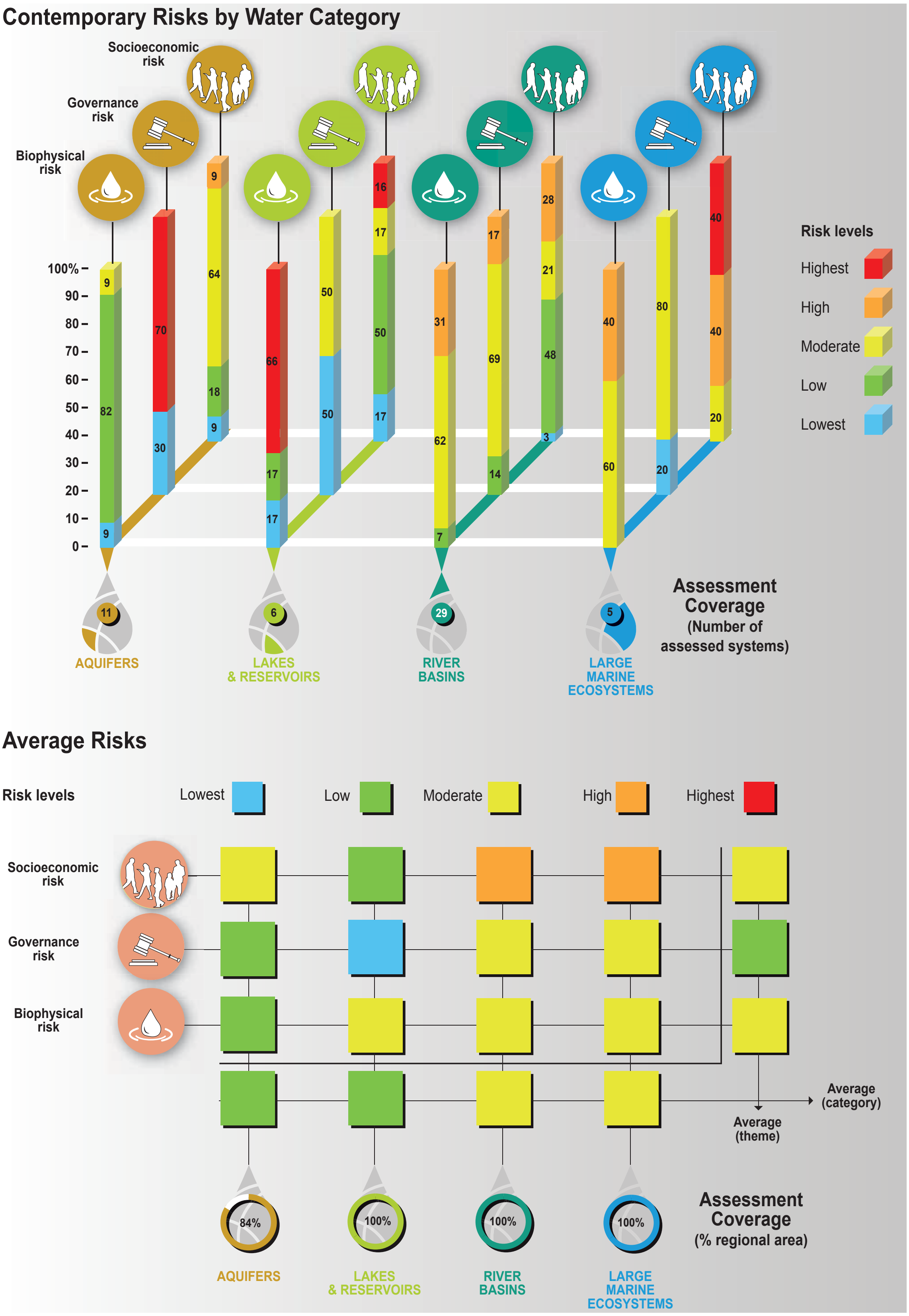
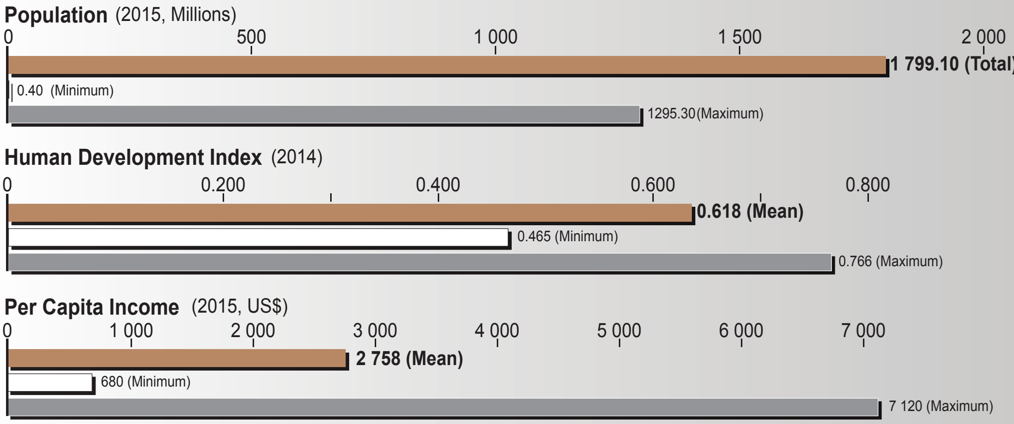
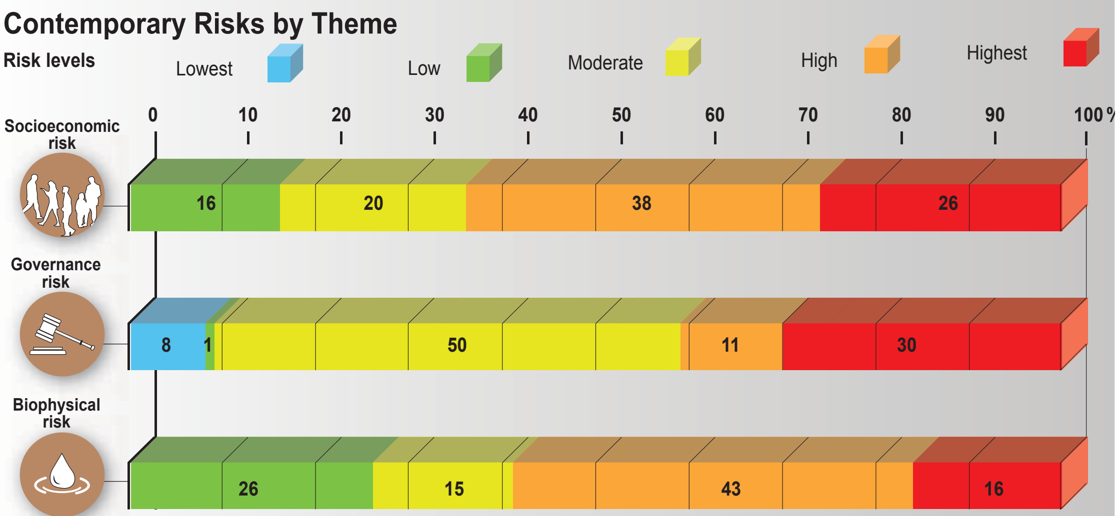

Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100%
90
80
70
60
50
40
30
20
10
0
9
82
9
70
30
9
64
18
9
66
17
17
50
50
16
17
50
17
31
62
7
17
69
14
28
21
48
3
40
60
80
20
40
40
20
Risk levels
Highest
High
Moderate
Low
Lowest
11
6
29
5
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(Number of assessed systems)
Average Risks
Risk levels
Lowest
Low
Moderate
High
Highest
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
84%
100%
100%
100%
Assessment Coverage
(% regional area)
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS

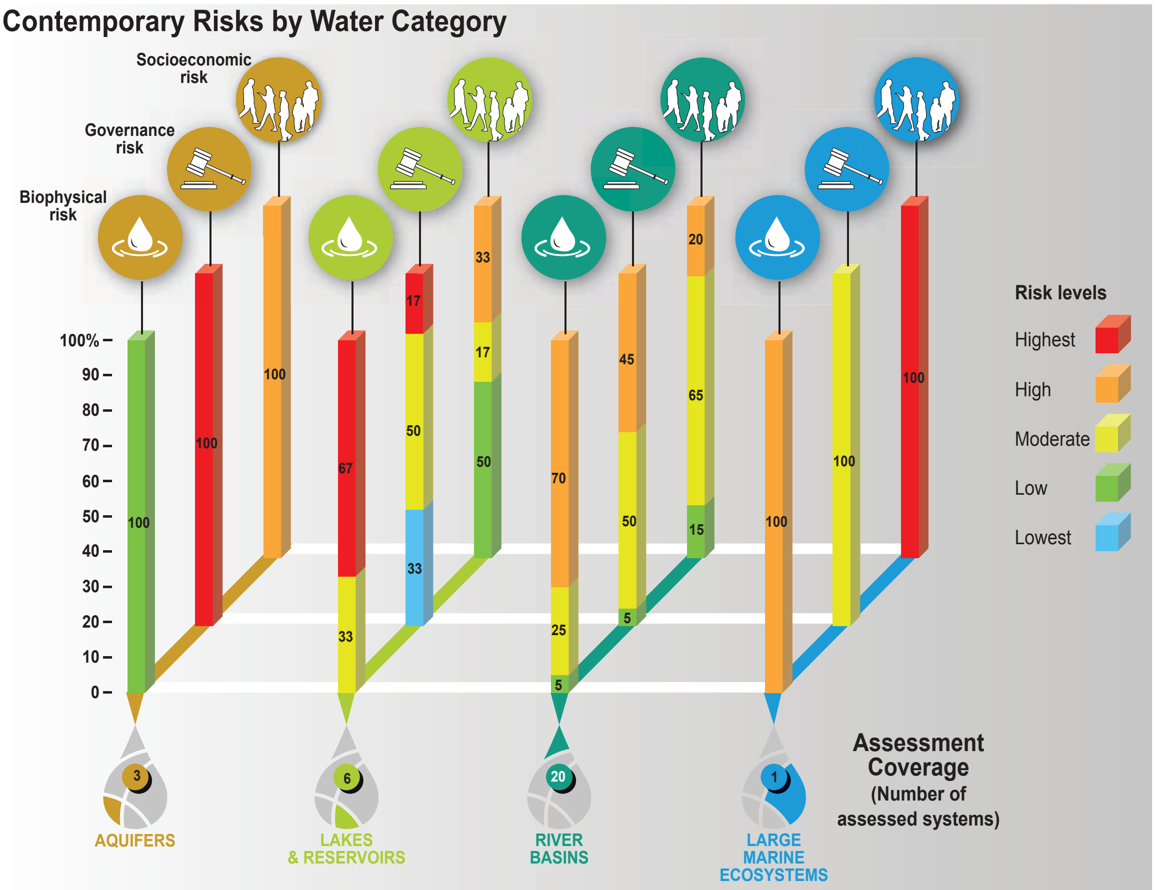
Figure 13: *Transboundary Waters*

TRANSBOUNDARY WATERS: SOUTHERN ASIA

The region has an average Human Development Index of 0.618, belonging to the Medium HDI group with a total population of 1800 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 30 transboundary water systems in the region (bottom left), 38% of the water systems are at high socioeconomic risk, 60% are subject to moderate governance risk, and 43% are at high biophysical risk. On average, the region's transboundary waters (bottom right) are subject to high socioeconomic, moderate governance and moderate biophysical risks. Transboundary river basins and LMEs are at high risk; aquifers are at moderate risk and lakes are at low risk, across all risk themes.






Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100%
90
80
70
60
50
40
30
20
10
0
100
100
100
67
33
17
50
33
33
17
50
70
25
5
45
50
5
20
65
15
100
100
100
Risk levels
Highest
High
Moderate
Low
Lowest
3
AQUIFERS
6
LAKES & RESERVOIRS
20
RIVER BASINS
1
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(Number of assessed systems)

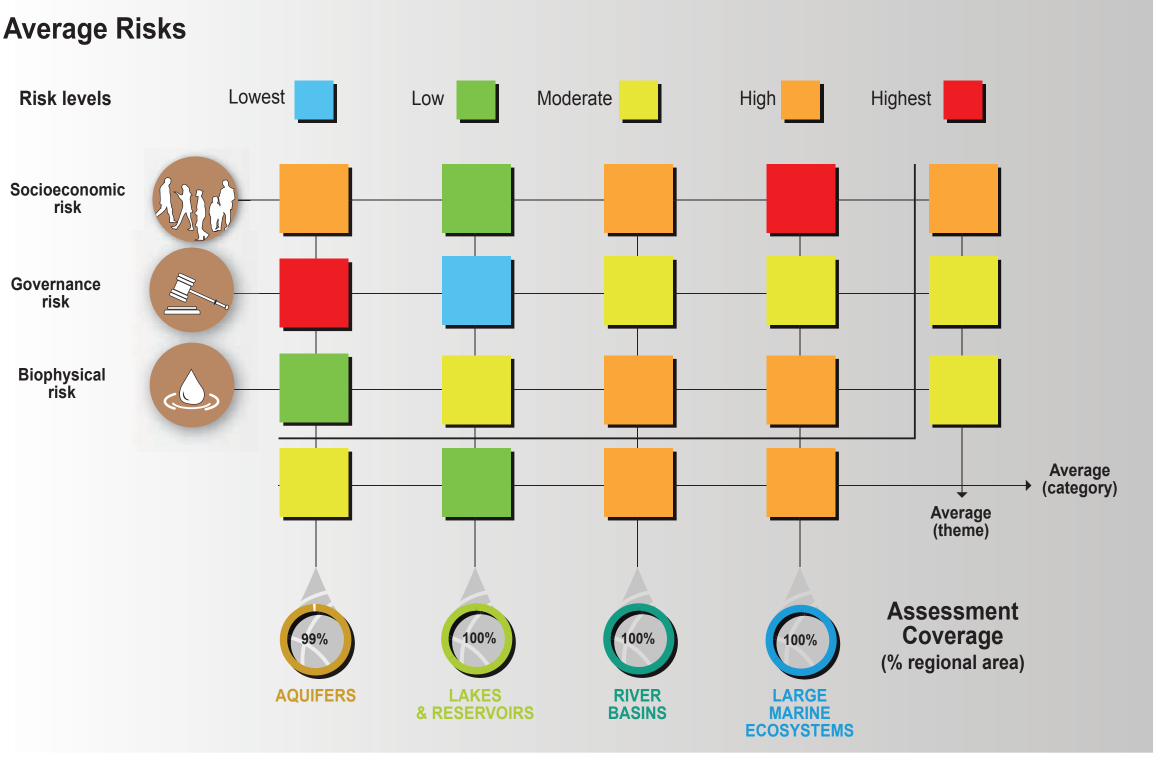
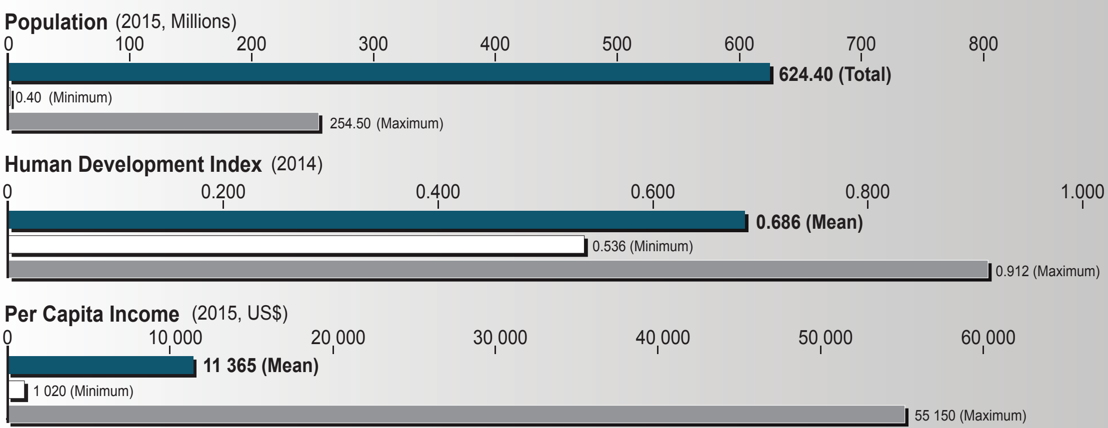
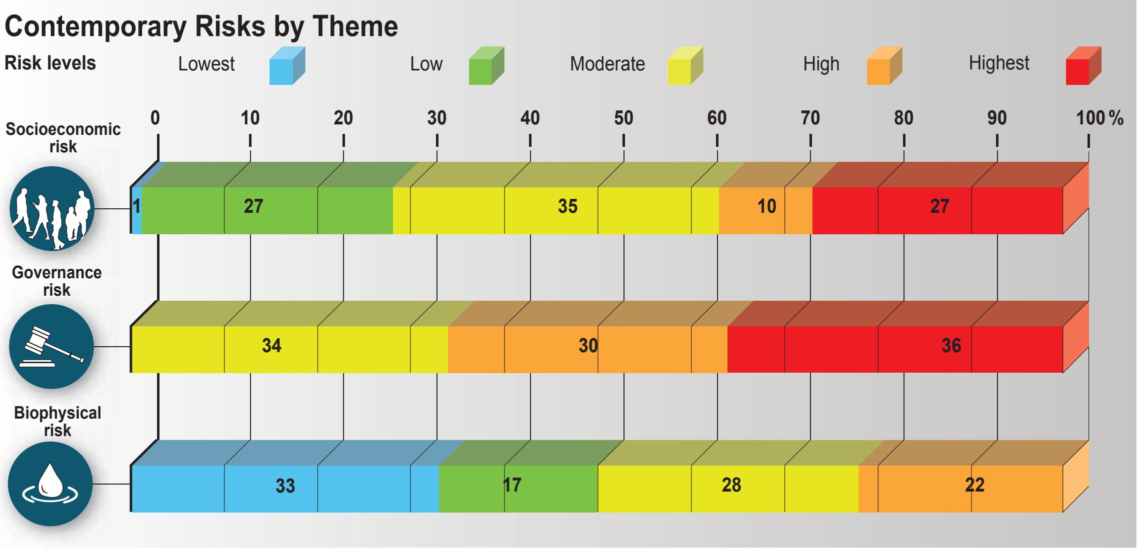

Average Risks
Risk levels
Lowest
Low
Moderate
High
Highest
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
99%
AQUIFERS
100%
LAKES & RESERVOIRS
100%
RIVER BASINS
100%
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(% regional area)

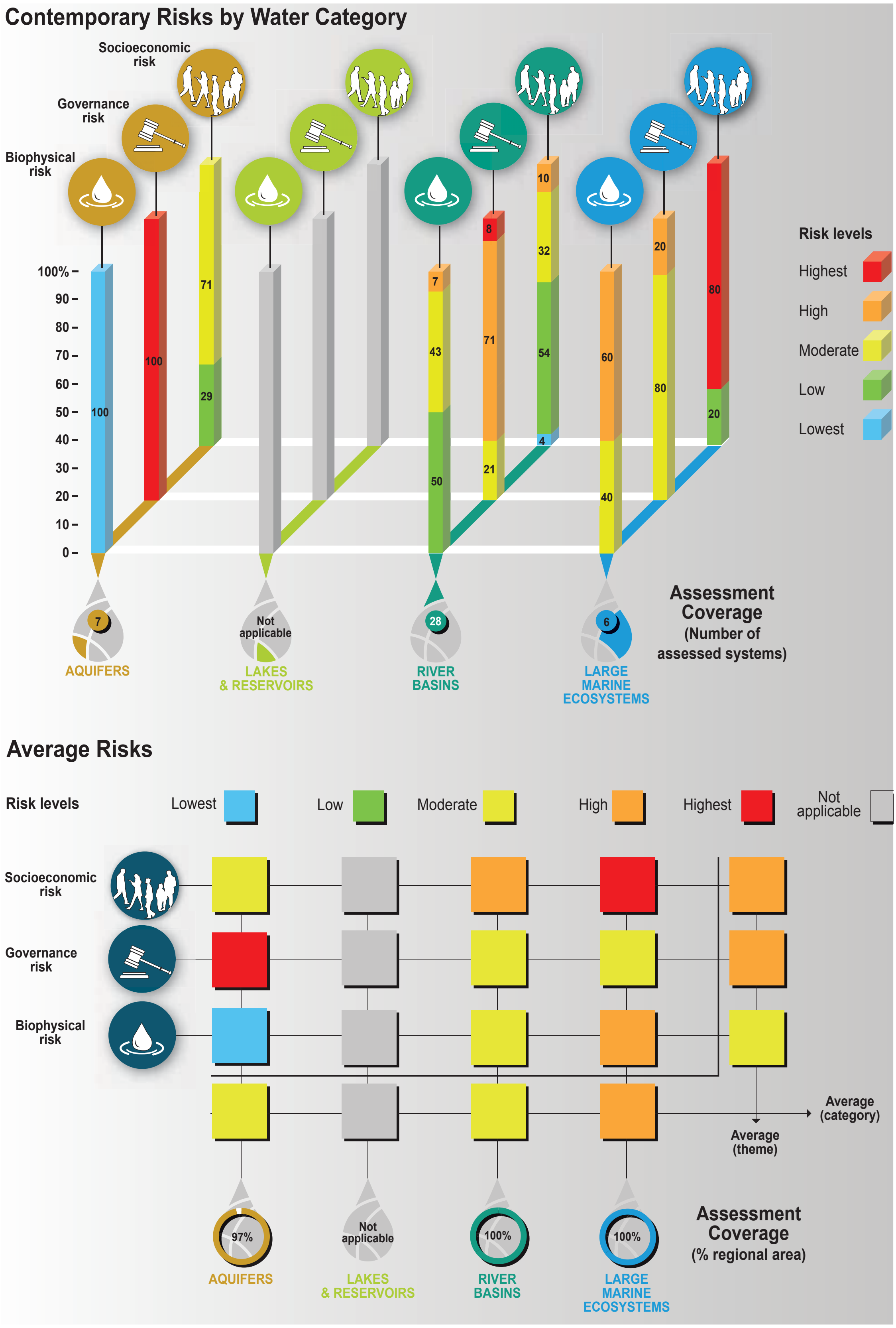
Figure 14: *Transboundary Waters*

TRANSBOUNDARY WATERS: SOUTHEASTERN ASIA

The region has an average Human Development Index of 0.686, belonging to the Medium HDI group with a total population of 624 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 40 transboundary water systems in the region (bottom left), 37% (10% + 27%) of the water systems are at high to highest socioeconomic risk, 36% are subject to the highest governance risk, and 50% (28% + 22%) are at moderate to high biophysical risk. On average, the region's transboundary waters (bottom right) are subject to high socioeconomic and governance risks and to moderate biophysical risks. LMEs are at high risk and aquifers and river basins are at moderate risks across all risk themes.





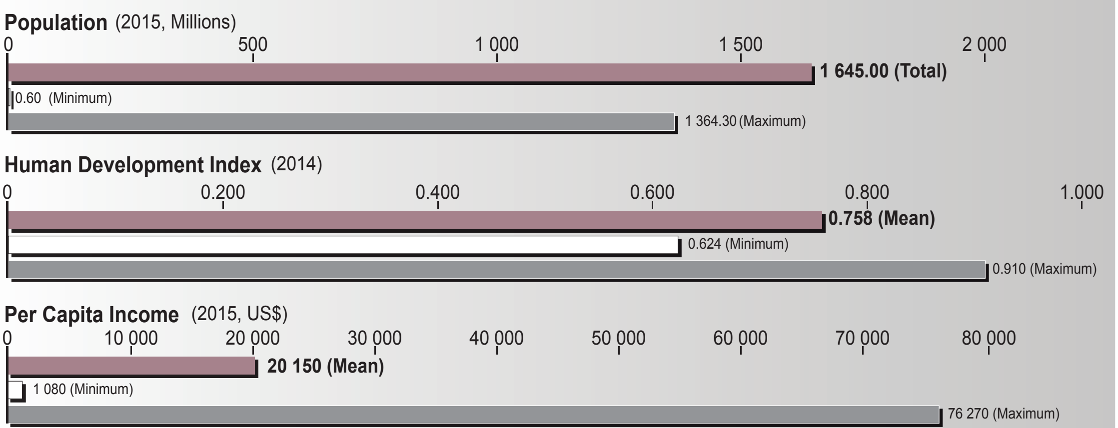


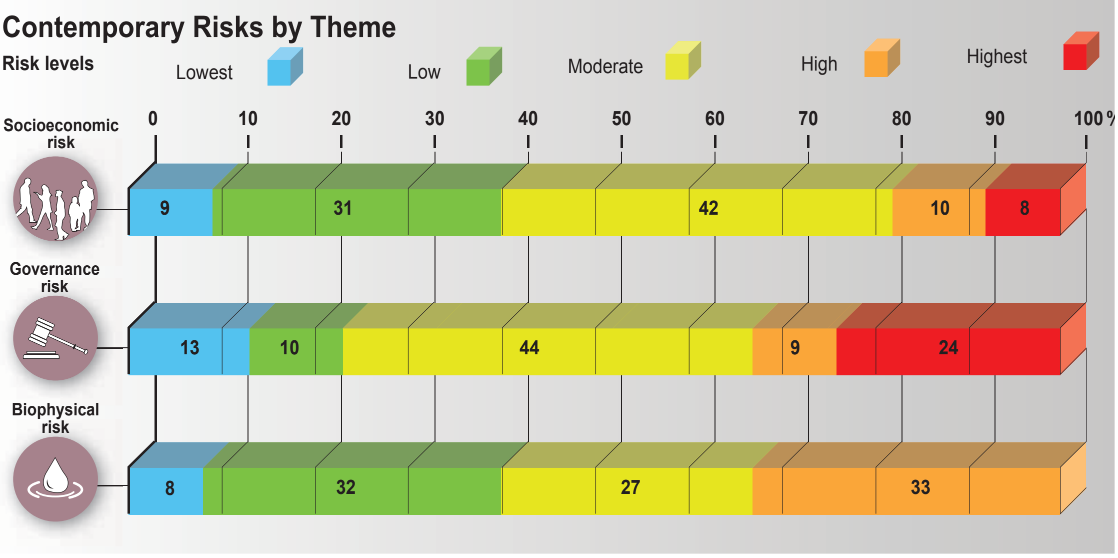
Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100%
90
80
70
60
50
40
30
20
10
0
100
100
71
29
7
43
50
8
71
21
10
32
54
4
60
40
20
80
80
20
Risk levels
Highest
High
Moderate
Low
Lowest
7
Not applicable
28
6
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(Number of assessed systems)
Average Risks
Risk levels
Lowest
Low
Moderate
High
Highest
Not applicable
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
97%
Not applicable
100%
100%
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(% regional area)

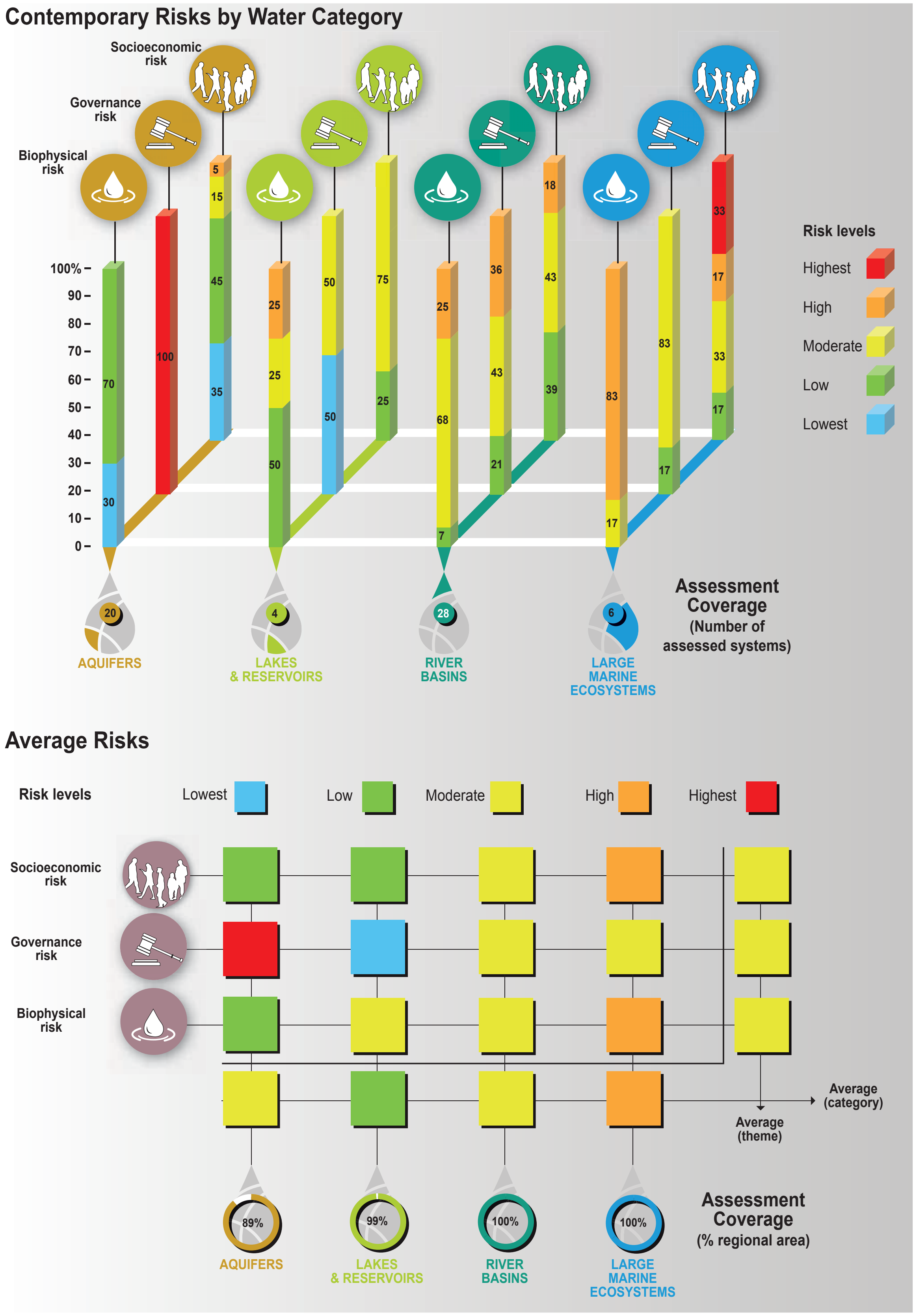
Figure 15: *Transboundary Waters*

TRANSBOUNDARY WATERS: EASTERN & CENTRAL ASIA

The region has an average Human Development Index of 0.758, belonging to the High HDI group with a total population of 1645 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 58 transboundary water systems (bottom left), 60% suffer from moderate to highest socioeconomic risk; 77% from moderate to highest governance risk; and 60% from moderate to high biophysical risk. On average, the region's transboundary waters (bottom right) are at moderate socioeconomic, governance and biophysical risks. LMEs are at high risk across risk themes; both aquifers and river basins are at moderate risk, and lakes are at low risk.



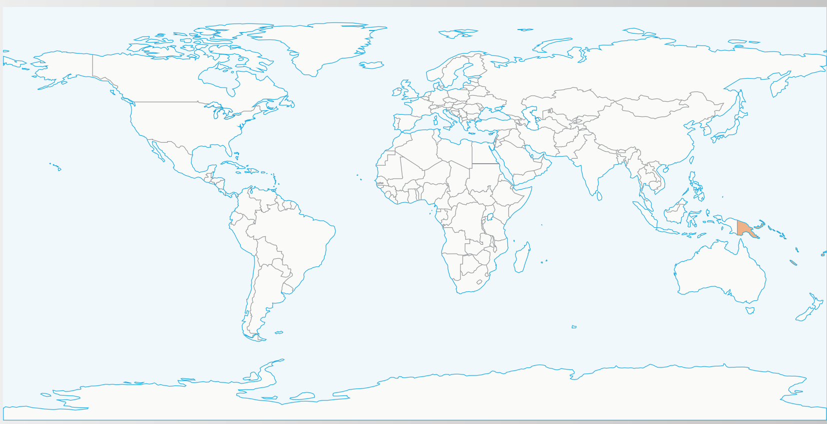




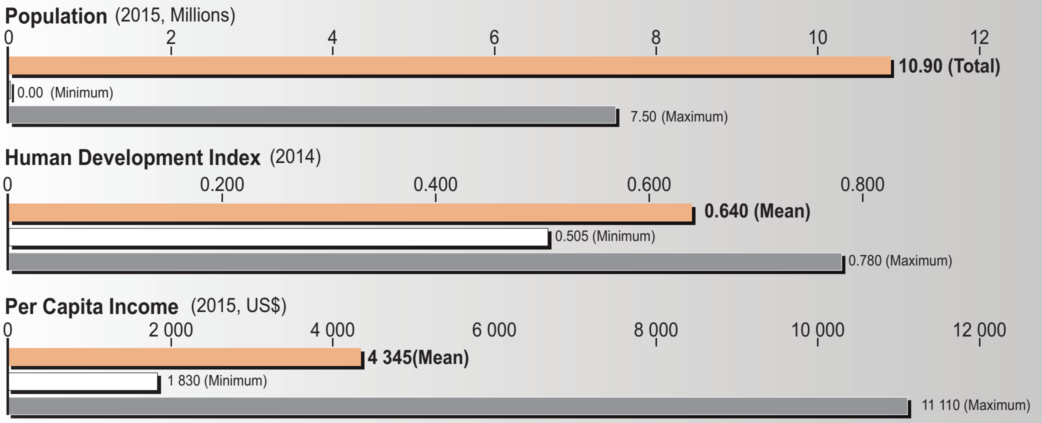
Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100%
90
80
70
60
50
40
30
20
10
0
Risk levels
Highest
High
Moderate
Low
Lowest
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage (Number of assessed systems)
20
4
28
6
Average Risks
Risk levels
Lowest
Low
Moderate
High
Highest
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
89%
99%
100%
100%
AQUIFERS
LAKES & RESERVOIRS
RIVER BASINS
LARGE MARINE ECOSYSTEMS
Assessment Coverage (% regional area)

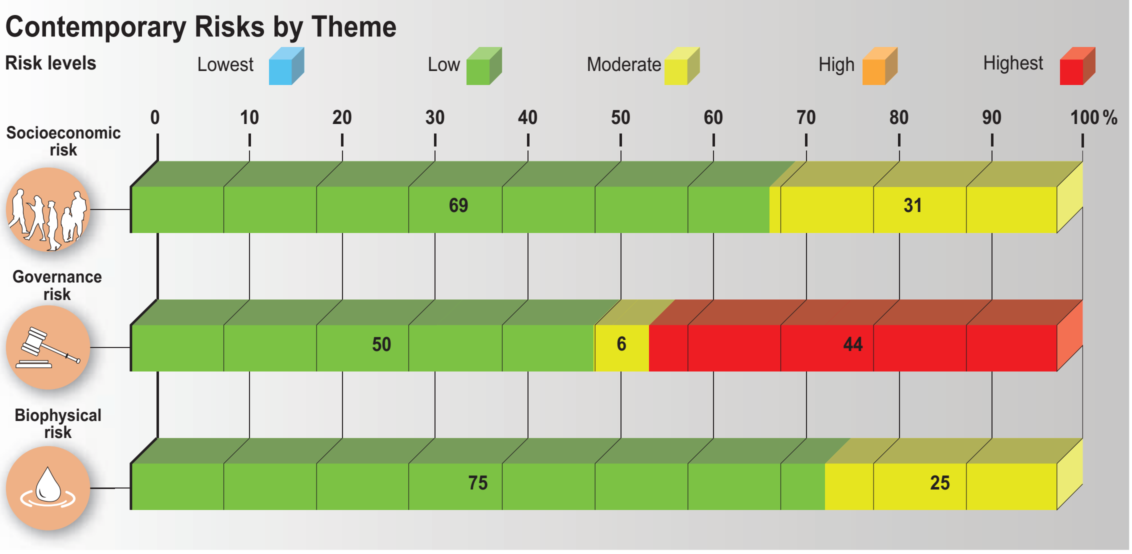
Figure 16: *Transboundary Waters*

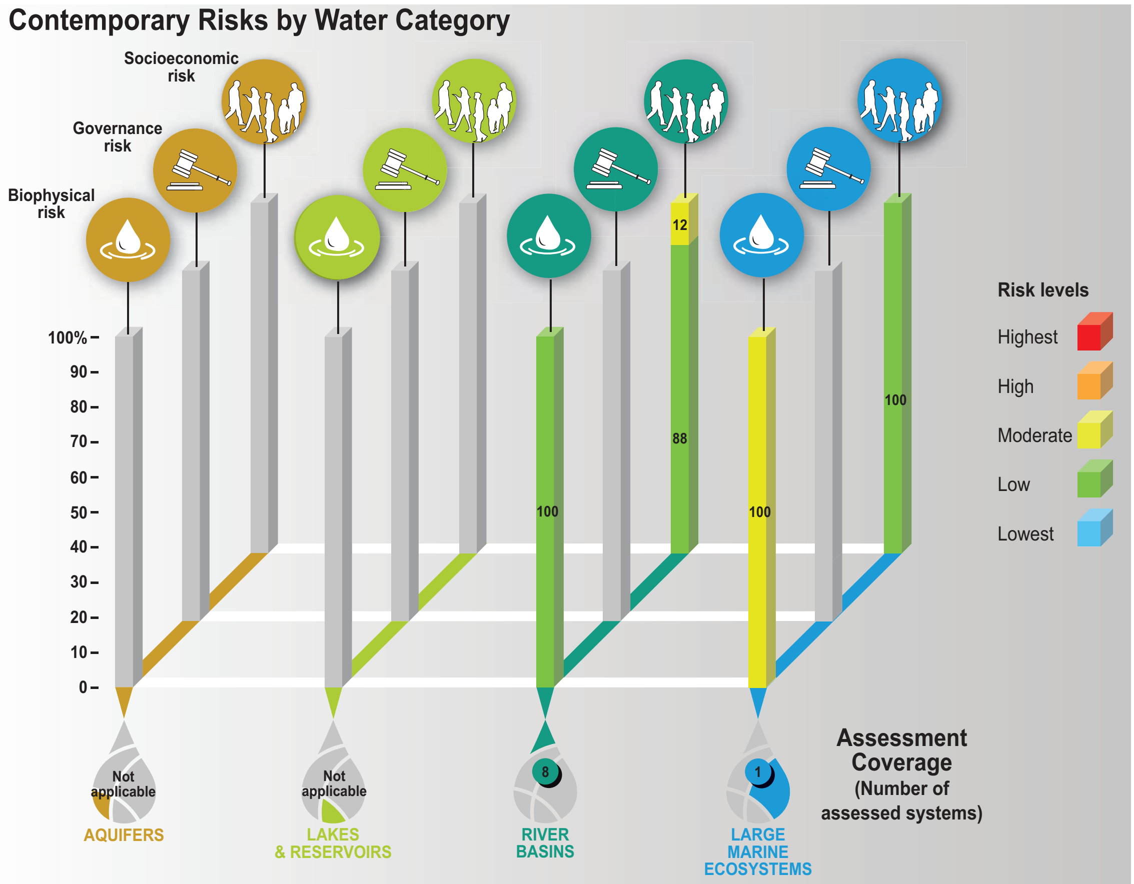
TRANSBOUNDARY WATERS: OCEANIA, MICRONESIA & CENTRAL PACIFIC



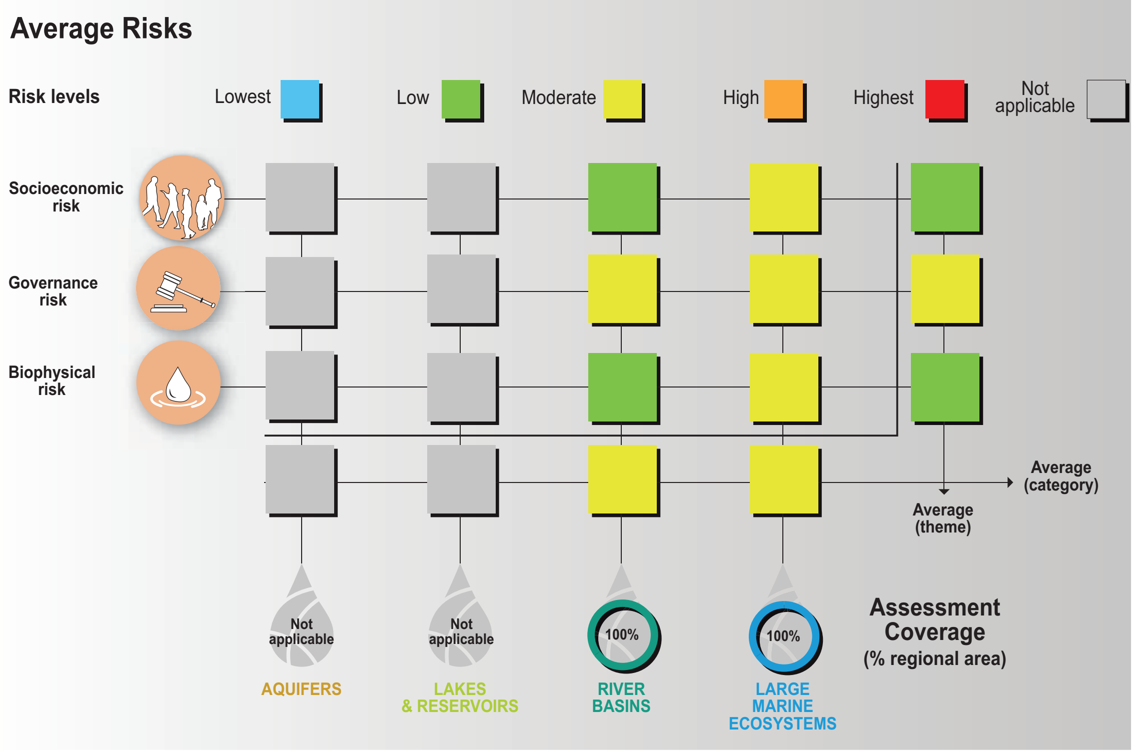
The region is classified as Medium HDI with a regional average HDI of 0.640 and a population of 11 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Across nine transboundary waters and the Western Pacific Warm Pool (WPWP) area (bottom left), 69% experience low socioeconomic risk, 50% moderate to highest governance risk, and 75% are subject to low biophysical risk and another 25% moderate biophysical risk. On average (bottom right), transboundary waters are at low socioeconomic and biophysical risk, but are at moderate governance risks. Both river basins and LME and the WPWP are at moderate risk averaging across all risk themes.





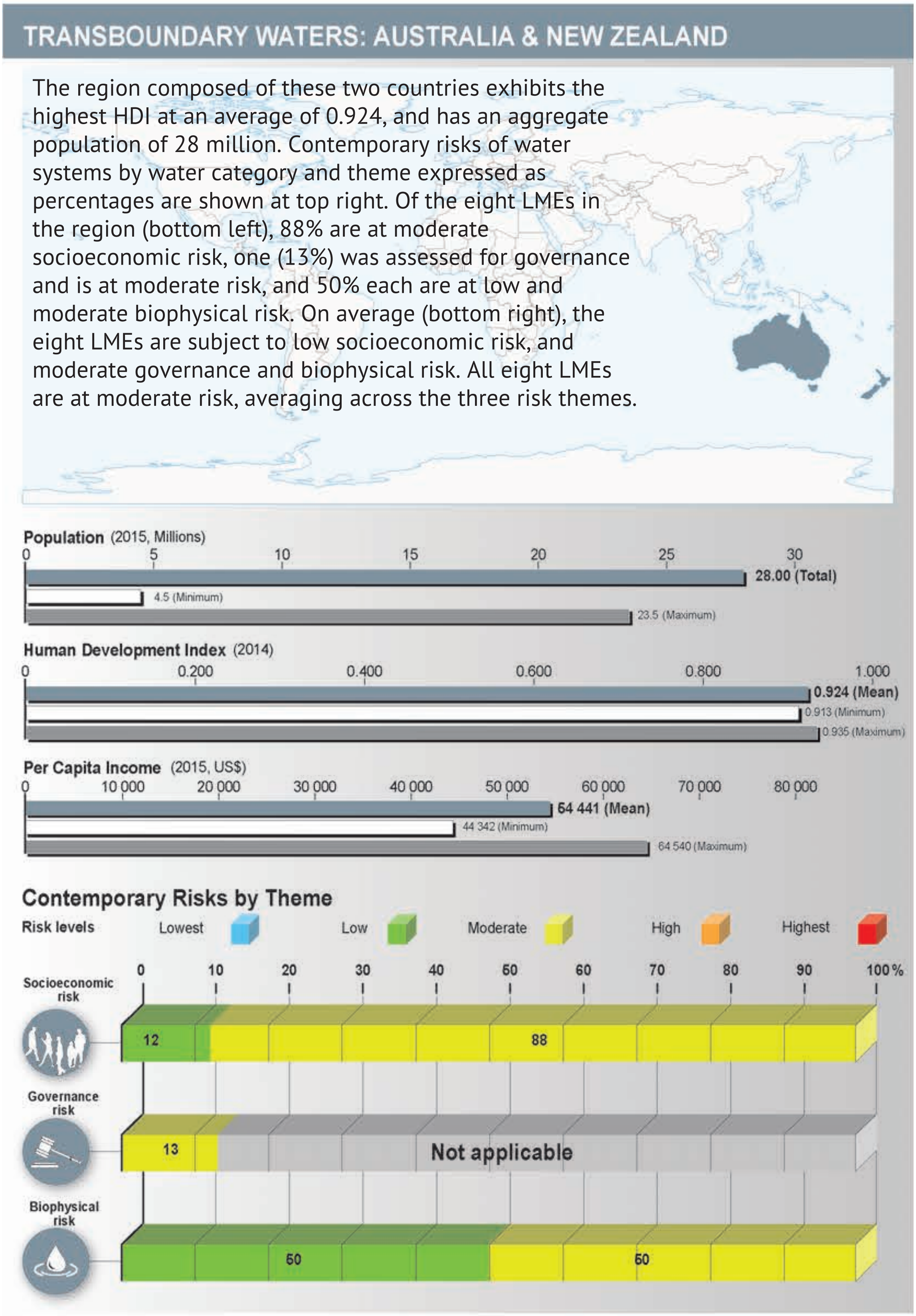


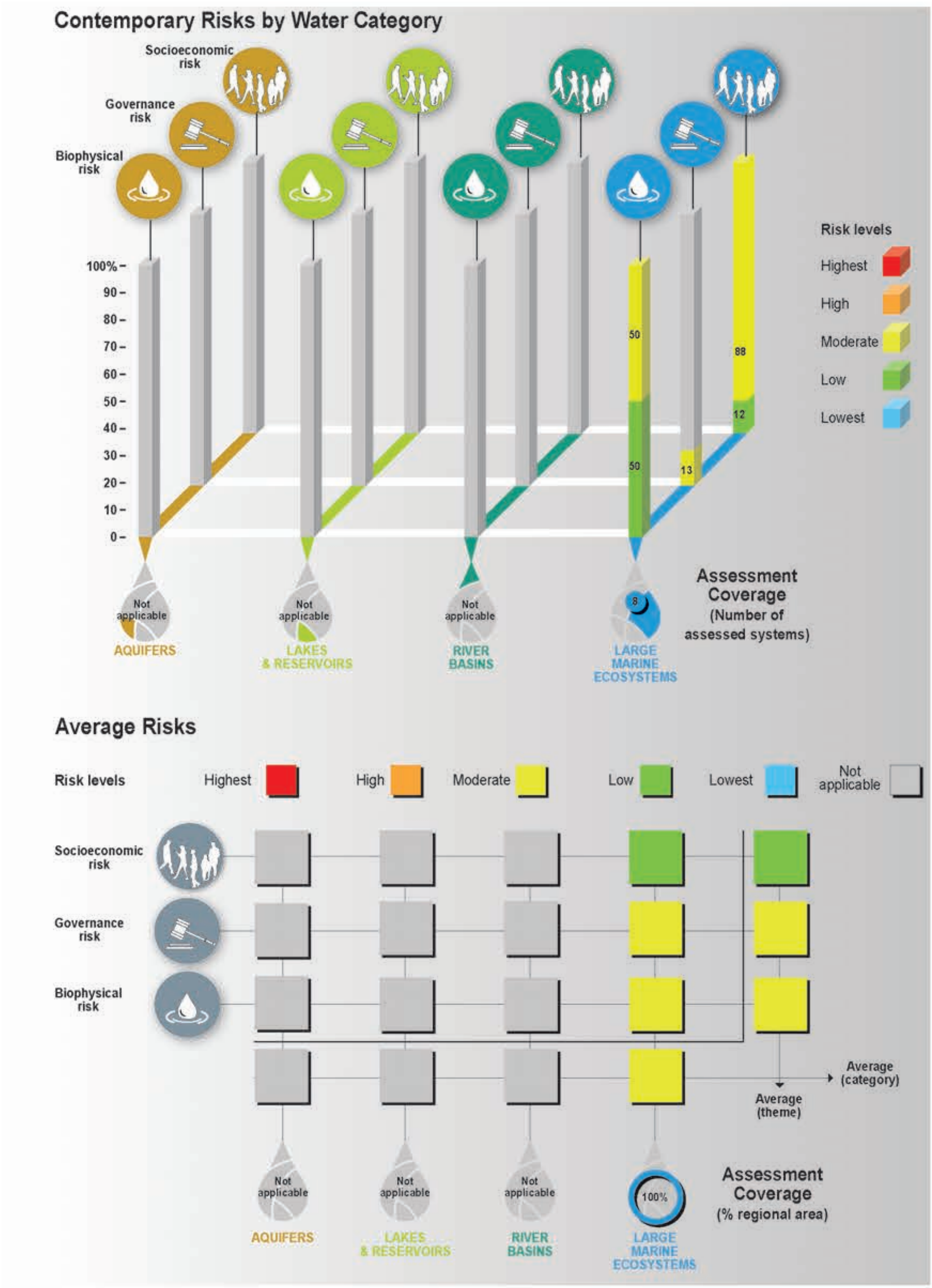
Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100%
90
80
70
60
50
40
30
20
10
0
12
88
100
100
100
Risk levels
Highest
High
Moderate
Low
Lowest
Not applicable
AQUIFERS
Not applicable
LAKES & RESERVOIRS
8
RIVER BASINS
1
LARGE MARINE ECOSYSTEMS
Assessment Coverage (Number of assessed systems)



Average Risks
Risk levels
Lowest
Low
Moderate
High
Highest
Not applicable
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
Not applicable
AQUIFERS
Not applicable
LAKES & RESERVOIRS
100%
RIVER BASINS
100%
LARGE MARINE ECOSYSTEMS
Assessment Coverage (% regional area)

Figure 17: *Transboundary Waters*

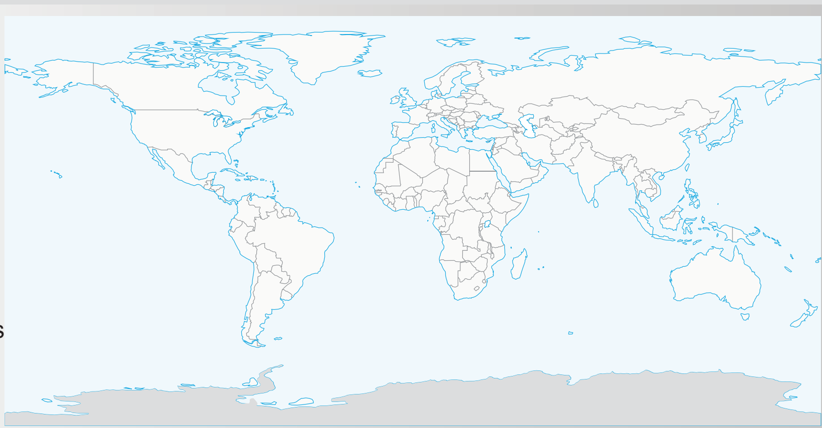




Contemporary Risks by Water Category
Socioeconomic risk
Governance risk
Biophysical risk
100%
90
80
70
60
50
40
30
20
10
0
50
50
13
88
12
Risk levels
Highest
High
Moderate
Low
Lowest
Not applicable
AQUIFERS
Not applicable
LAKES & RESERVOIRS
Not applicable
RIVER BASINS
8
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(Number of assessed systems)
Average Risks
Risk levels
Highest
High
Moderate
Low
Lowest
Not applicable
Socioeconomic risk
Governance risk
Biophysical risk
Average (category)
Average (theme)
Not applicable
AQUIFERS
Not applicable
LAKES & RESERVOIRS
Not applicable
RIVER BASINS
100%
LARGE MARINE ECOSYSTEMS
Assessment Coverage
(% regional area)

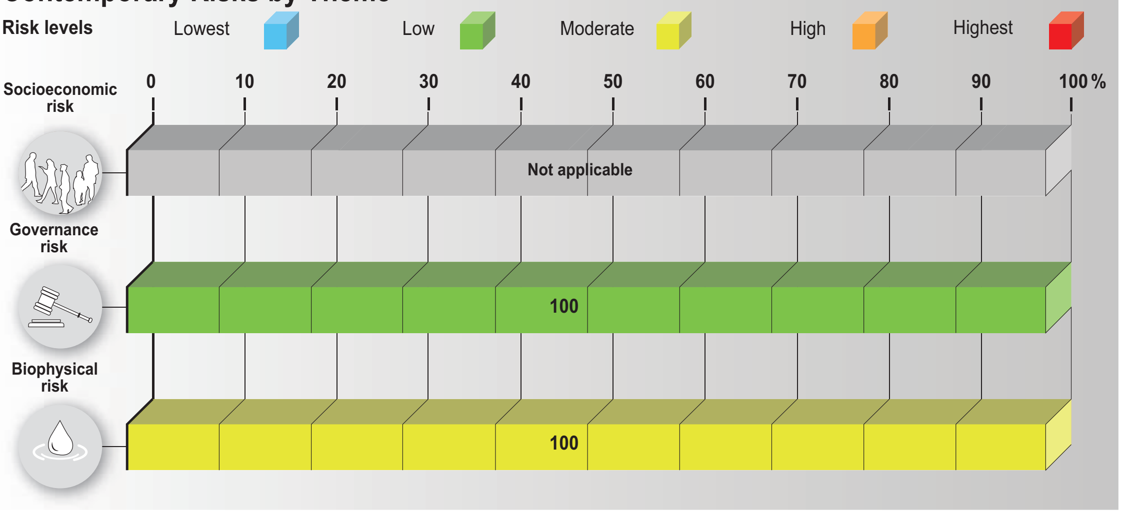
Figure 18: *Transboundary Waters*

TRANSBOUNDARY WATERS: ANTARCTICA

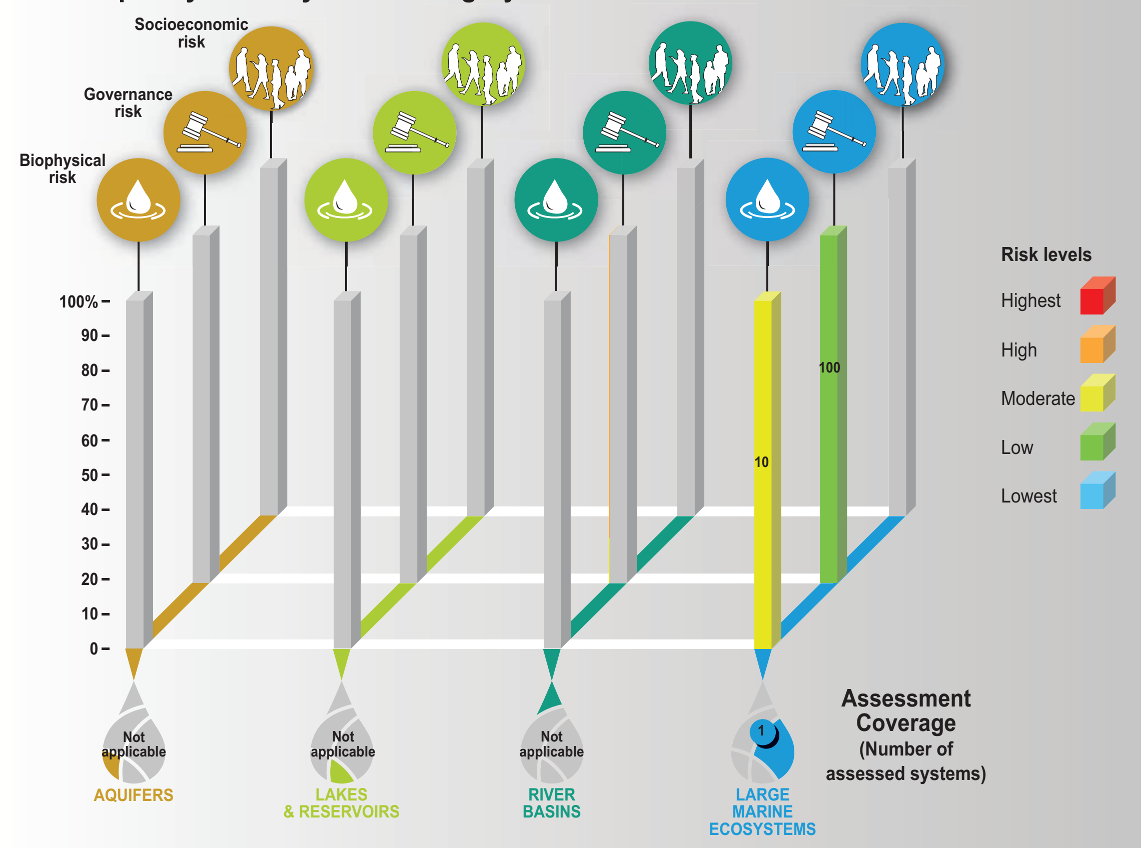


The Antarctic continent is not inhabited by resident citizens so that conventional country-based socioeconomic indicators are not applicable for assessing socioeconomic activities that take place on land and in surrounding waters. For the period 2001-2010, Antarctic LME average annual fish catch is estimated at 12 000 tons, worth 2013 US$ 2.4 million per year. Average annual tourism revenues for the period 2004-2013 are estimated to reach 2013 US$ 1229 million. The Antarctic LME is subject to low governance risk and moderate biophysical risk.

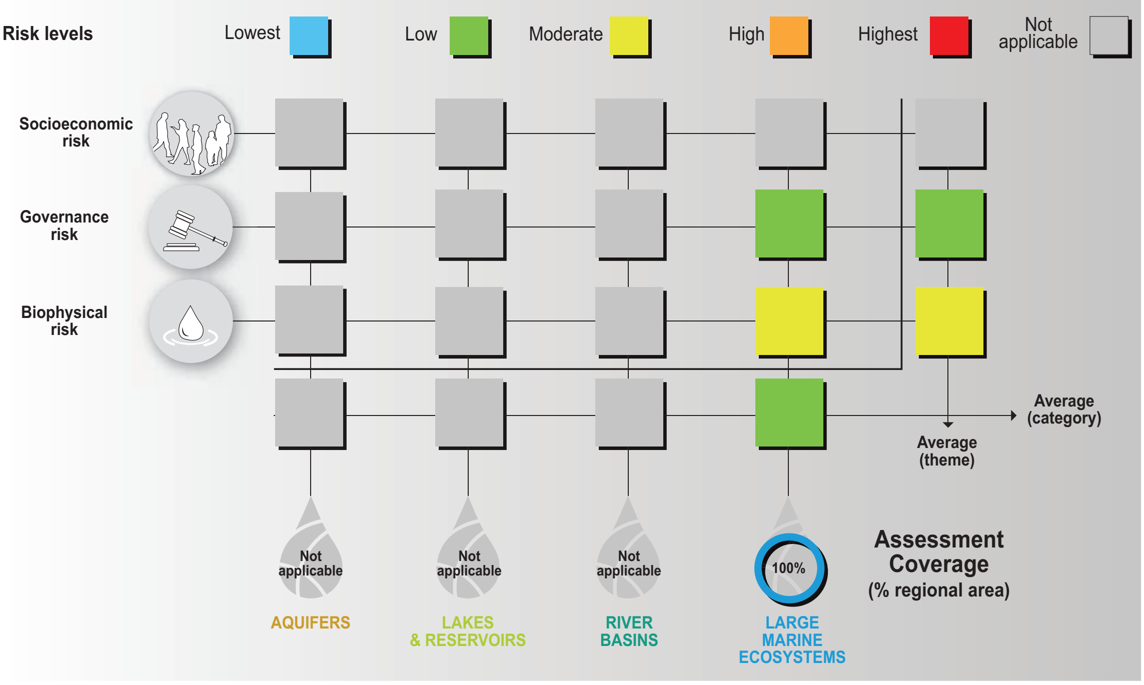
Contemporary Risks by Theme



Contemporary Risks by Water Category



Average Risks



A Way Ahead

TWAP has demonstrated the widespread incidence of the risk of unsustainability in transboundary aquifers, lakes, rivers, Large Marine Ecosystems and the open ocean across the planet. To reduce and reverse the causes of risk in order to meet Sustainable Development Goal (SDG) targets by or before 2030, countries will need to continue developing and monitoring key indicators in order to identify and mitigate the sources of risk. The continued development and monitoring of key indicators, such as those used by TWAP, will be an essential aspect of this process. Full details of the indicators used and the findings can be found in the five technical reports for the water system categories and their technical summaries for policy makers (www.geftwap.org).

In addition to indicators that are specific to the transboundary water categories, it will be important to address the impacts of linkages among systems as well as the associated sources of risk in order to reduce risk. The approach of five separate assessments precluded a proper evaluation of the implications of the linkages between water systems in different water categories. Yet, it is well known that there are many biophysical linkages such as the flow of water itself, pollution, movement of plants and animals and influences on climate (Fig 19). Seeking to understand and quantify these linkages must be a focus of the next global assessment.

Much has been learned in TWAP that can be applied to ensure an expanded suite of indicators that is focused on critical issues. As an example, the conjunctive use of surface and subsurface freshwater for food and energy production may require a nexus approach in which sustainable food and energy systems may need to be premised on the sustainability of surface aquatic systems (rivers and lakes) and subsurface aquifers, which is challenged by a warming climate. Among marine systems, the downstream and lateral flows of water, materials and pollutants together with direct point sources of pollution and exploitation of marine living resources are undermining the health of coastal ecosystems. In the open ocean as well as near the coast, climate impacts from intensifying processes of ocean warming, accelerating sea level rise, acidification, and deoxygenation are exerting profound influences on changes in primary and secondary production, biodiversity and carbon storage. Sea level rise will be an intensifying source of risk where cause and consequence span millennia. When anthropogenic influence alters the ability of the ocean to modulate climate and planetary survival is at risk, human behavior towards land-ocean-climate interactions will require more than risk minimization. It behooves a fundamental shift in policy time frame and targets where human actions today have immediate as well as millennial consequences.

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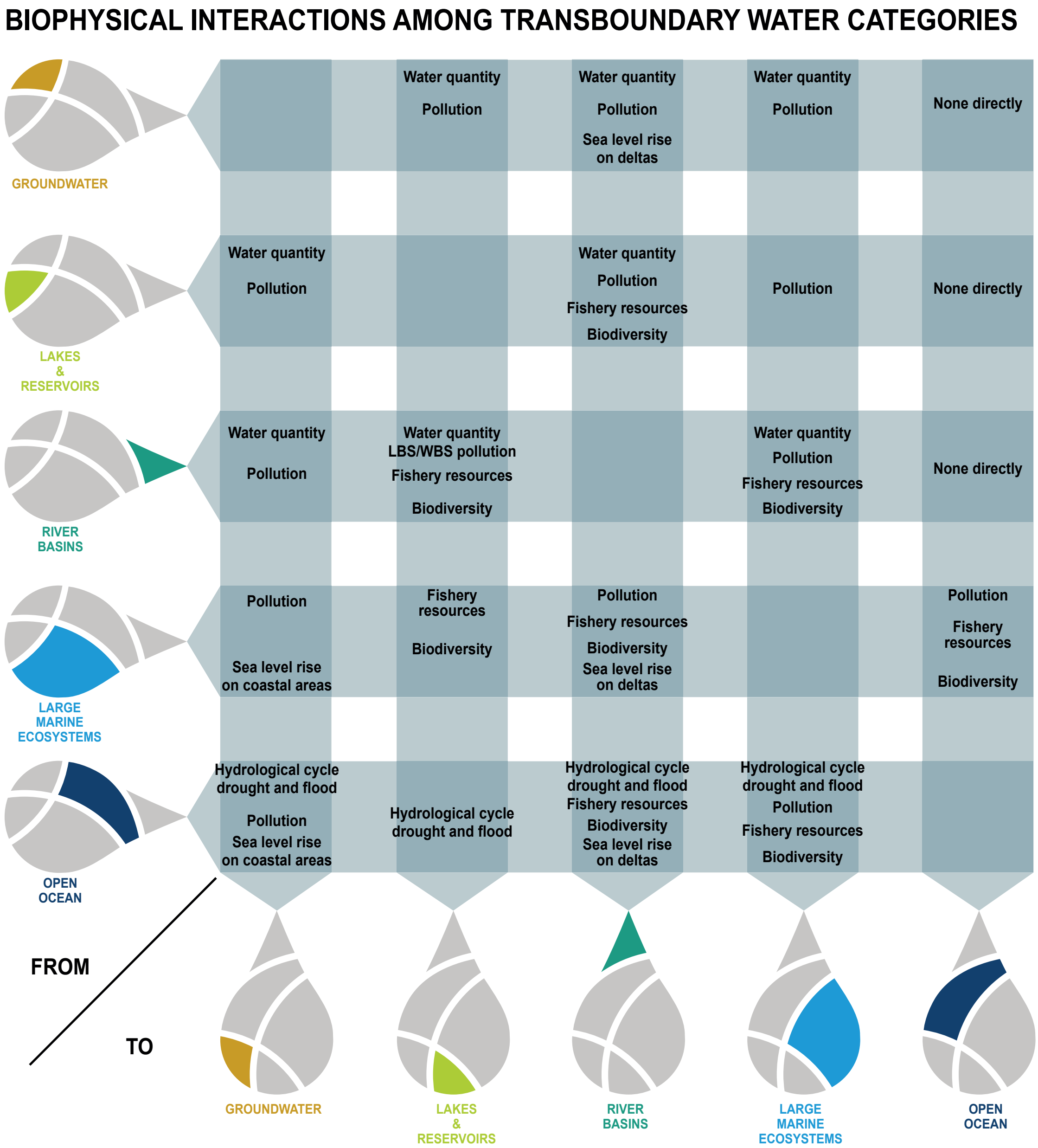
Figure 19: *Water flows and exchanges of materials including transported sediments, pollutants and species occur between source and destination transboundary water systems across water categories. These system-system interactions contribute to altering system states in terms of biogeochemistry, productivity and biodiversity. They also influence carbon storage and fluxes that impact climate change. Subsequent assessments should address these interactions.*



Water quantity: Water itself moves between aquatic systems. Overextraction in a source system or blockage of flow to another system can lead to shortages that impact users in the recipient system.

Pollution: As water flows it carries with it contaminants, nutrients, sediment and solid waste.

Fishery resources: Many types of exploited resources move between lakes, rivers, coastal waters and Open Ocean either seasonally or during different life history stages and depend on the health of these systems for their productivity.

Biodiversity: Many species move between lakes, rivers, coastal waters and Open Ocean either seasonally or during different life history stages and depend on the health of these systems for their productivity.

Hydrological cycle (drought/flood): Circulation, temperature and evaporation in the Open Ocean are major drivers of the global hydrological system which determines when, where and how much water is returned to terrestrial freshwater systems.

Sea level rise on deltas: Sea level rise can inundate low lying coastal freshwater systems, especially deltas and render them unsuitable for many human

Table 3. The assessed transboundary water systems by category and by region (number). Adding the number of systems for a category across regions will yield global total numbers that include multi-regional systems. Systems marked (*) were not included in the statistical analysis.

NORTHERN AMERICA (53)			
AQUIFERS (7)	**LAKES (8)**	**RIVERS (19)**	**LMES (19)**
• Cuenca Baja del Rio Bravo-Grande • Cuenca Baja del Rio Colorado* • Edwards-Trinity-El Burro • Poplar • Judith River • Milk River • Northern Great Plains	• Amistad • Champlain • Erie • Falcon • Huron • Michigan • Ontario • Superior*	• Alsek • Colorado • Chilkat • Columbia • Fraser • Firth • Mississippi • Nelson-Saskatchewan • Rio Grande (North America) • Skagit • St. Croix • St. John (North America) • St. Lawrence • Stikine • Taku • Tijuana • Whiting • Yaqui • Yukon	• East Bering Sea • Gulf of Alaska • California Current • Gulf of California • Gulf of Mexico • Southeast U.S. Continental Shelf • Northeast U.S. Continental Shelf • Scotian Shelf • Labrador - Newfoundland • Pacific Central-American Coastal • Caribbean Sea • Canadian Eastern Arctic - West Greenland • Greenland Sea • Northern Bering - Chukchi Seas • Beaufort Sea • Hudson Bay Complex • Central Arctic • Aleutian Islands • Canadian High Arctic - North Greenland
CENTRAL AMERICA & CARIBBEAN (44)			
AQUIFERS (8)	**LAKES (1)**	**RIVERS (32)**	**LMES (3)**
• Cuenca Baja del Rio Bravo-Grande • Cuenca Baja del Rio Colorado* • Edwards-Trinity-El Burro • Boca del Cerro-San Pedro • Ocosingo-Usumacinta-Pocóm-Ixcán • Soconusco-Suchiate/Coatán* • Esquipulas-Ocotepeque-Citalá* • Peninsula de Yucatán-Candelaria-Hondo	Azuei	• Artibonite • Belize • Candelaria • Chamelecon • Changuinola • Chiriqui • Choluteca • Coatan Achute • Coco/Segovia • Colorado • Conventillos • Corredores/Colorado • El Naranjo • Goascoran • Grijalva • Hondo • Jurado • Lempa • Massacre • Moho • Motaqua • Negro • Paz • Pedernales • Rio Grande (North America) • San Juan • Sarstun • Sixaola • Suchiate • Temash • Tijuana • Yaqui	• Gulf of Mexico • Pacific Central-American Coastal • Caribbean Sea

SOUTHERN AMERICA (64)			
AQUIFERS (14)	**LAKES (5)**	**RIVERS (38)**	**LMES (7)**
• Agua Dulce • Amazonas • Aquidauana-Aquidabán • Boa Vista-Serra do Tucano-North Savanna • Costeiro • Grupo Roraima • Litoráneo-Chuy • Merged: - Litoral-Cretácico - Serra Geral - Sistema Acuífero Guaraní - Bauru-Caiua-Acaray Aquifer - Salto-Salto Chico • Merged: - Coesewijne - A-Sand/B-Sand • Pantanal • Permo-Carbonifero • Titicaca • Yrendá-Toba-Tarijeño • Zanderij	• Chungarkkota • Itaipu • Salto Grande • Titicaca • Lago de Yacyreta	• Amacuro • Amazon • Aviles • Aysen • Baker • Barima • Cancoso/Lauca • Carmen Silva/Chico • Catatumbo • Chira • Chuy • Comau • Corantijn/Courantyne • Cullen • Essequibo • Gallegos/Chico • Jurado • La Plata • Lagoon Mirim • Lake Fagnano • Lake Titicaca-Poopo System • Maroni • Mataje • Mira • Oiapoque/Oyupock • Orinoco • Palena • Pascua • Patia • Puelo • Rio Grande (South America) • San Martin • Seno Union/Serrano • Tumbes • Valdivia • Yelcho • Zapaleri • Zarumilla	• Pacific Central-American Coastal • Caribbean Sea • Humboldt Current • Patagonian Shelf • South Brazil Shelf • East Brazil Shelf • North Brazil Shelf

<table>
<tr><th colspan="4">NORTHERN, WESTERN & SOUTHERN EUROPE (77)</th></tr>
<tr><th>AQUIFERS (4)</th><th>LAKES (6)</th><th>RIVERS (58)</th><th>LMES (9)</th></tr>
<tr><td>• Belgian - Dutch - German Lowland Aquifer System
• Ordivician - Cambrian Groundwater Body
• Cambrian -Vendian - Voronka Groundwater Body / Lomonosovsky Aquifer
• Upper Pannonian Thermal Aquifer</td><td>• Macro Prespa (Large Prespa)
• Lake Maggiore
• Neusiedler/ Ferto
• Ohrid
• Scutari/Skadar
• Szczecin Lagoon</td><td>• Bann
• Barta
• Bidasoa
• Castletown
• Danube
• Daugava
• Douro/Duero
• Drin
• Ebro
• Elbe
• Erne
• Fane
• Flurry
• Foyle
• Garonne
• Gauja
• Glama
• Guadiana
• Isonzo
• Jacobs
• Kemi
• Klaralven
• Krka
• Lake Prespa
• Lava/Pregel
• Lielupe
• Lima
• Lough Melvin
• Maritsa
• Mino
• Naatamo
• Narva
• Neman
• Neretva
• Nestos
• Oder/Odra
• Olanga
• Oulu
• Parnu
• Pasvik
• Po
• Rhine
• Rhone
• Roia
• Salaca
• Seine
• Schelde
• Struma
• Tagus/Tejo
• Tana
• Torne/Tornealven
• Tuloma
• Vardar
• Venta
• Vijose
• Vuoksa
• Wiedau
• Yser</td><td>• Barents Sea
• Norwegian Sea
• North Sea
• Baltic Sea
• Celtic-Biscay Shelf
• Iberian Coastal
• Mediterranean Sea
• Iceland Shelf and Sea
• Faroe Plateau</td></tr>
</table>

EASTERN EUROPE (70)			
AQUIFERS (11)	**LAKES (4)**	**RIVERS (43)**	**LMES (12)**
• Delger River • Irtysh-Obsky • Merged: - Ordivician - Cambrian Groundwater Body - Cambrian -Vendian - Voronka groundwater body / Lomonosovsky aquifer • Middle Heilongjiang - Amur River Basin • Pre-Caspien • Shishhid River Aquifer • South-Pred-Ural Aquifer • Syrt • Upper Pannonian Thermal Aquifer • Yenisei Upstream • Zeya River Basin	• Cahul • Caspian Sea • Neusiedler/ Ferto • Szczecin Lagoon	• Amur • Danube • Daugava • Dnieper • Dniester • Don • Elancik • Elbe • Har Us Nur • Jacobs • Jenisej/Yenisey • Kemi • Kogilnik • Kura-Araks • Lake Ubsa-Nur • Lava/Pregel • Maritsa • Mius • Narva • Neman • Nestos • Ob • Oder/Odra • Olanga • Oral/Ural • Oulu • Pasvik • Prohladnaja • Psou • Rezvaya • Samur • Sarata • Struma • Sujfun • Sulak • Terek • Tuloma • Tumen • Vardar • Velaka • Vistula/Wista • Volga • Vuoksa	• East Bering Sea • Barents Sea • Sea of Japan • Sea of Okhotsk • West Bering Sea • Northern Bering - Chukchi Seas • Beaufort Sea • East Siberian Sea • Laptev Sea • Kara Sea • Black Sea • Central Arctic

WESTERN & MIDDLE AFRICA (74)			
AQUIFERS (25)	**LAKES (8)**	**RIVERS (38)**	**LMES (3)**
• Aquifer extension Sud-Est de Taoudeni • Aquifer Vallee de la Benoue • Aquifere Cotier • Aquifere du Rift • Baggara Basin • Cestos-Danané* • Coango • Cuvelai and Ethosa Basin / Ohangwena Aquifer System • Cuvette • Irhazer-Illuemeden Basin • Karoo-Carbonate • Keta / Dahomey / Cotier basin aquifer • Lake Chad Basin • Nata Karoo Sub-basin / Caprivi deep-seated Aquifer • Nubian Sandstone Aquifer System (NSAS) • Rio del Rey* • Senegalo-Mauretanian Basin • Tanganyika Aquifer • Tano Basin* • Taoudéni Basin • Volta Basin • AF33 • AF34* • AF40* • AF82*	• Aby • Albert • Chad • Lake Congo River • Kivu • Mweru • Selingue • Tanganyika	• Akpa • Atui • Benito/Ntem • Bia • Cavally • Cestos • Chiloango • Congo/Zaire • Corubal • Cross • Cuvelai/Etosha • Gambia • Geba • Great Scarcies • Komoe • Kunene • Lake Chad • Little Scarcies • Loffa • Mana-Morro • Mbe • Moa • Mono • Niger • Nile • Nyanga • Ogooue • Okavango • Oueme • Sanaga • Sassandra • Senegal • St. John (Africa) • St. Paul • Tano • Utamboni • Volta • Zambezi	• Canary Current • Guinea Current • Benguela Current

EASTERN & SOUTHERN AFRICA (72)			
AQUIFERS (25)	**LAKES (18)**	**RIVERS (25)**	**LMES (4)**
• Afar Rift valley / Afar Triangle Aquifer • Aquifere du Rift • Baggara Basin • Coastal Sedimentary Basin I* • Coastal Sedimentary Basin III • Cuvelai and Ethosa Basin / Ohangwena Aquifer System • Dawa • Eastern Kalahari Karoo Basin • Gedaref • Jubba • Kagera* • Karoo Sandstone Aquifer • Karoo Sedimentary Aquifer • Karoo-Carbonate • Khakhea/Bray Dolomite • Kilimanjaro* • Mereb • Merged: - Sand and Gravel Aquifer - Weathered Basement • Nata Karoo Sub-basin / Caprivi Aquifer • Rhyolite-Breccia* • SE Kalahari Karoo Basin / Stampriet Artesian Aquifer System • Shabelle • Sudd Basin • Tanganyika • Zeerust/ Lobatse/ Ramotswa Dolomite Basin*	• Abbe/Abhe • Albert • Cahora Bassa • Chilwa • Chiuta • Cohoha • Edward • Ihema • Josini/ Pongolapoort Dam • Kariba • Kivu • Malawi/Nyasa • Mweru • Natron/Magad • Rweru/Moero • Tanganyika • Turkana • Victoria	• Awash • Baraka • Buzi • Congo/Zaire • Cuvelai/Etosha • Gash • Incomati • Juba-Shibeli • Kunene • Lake Natron • Lake Turkana • Limpopo • Lotagipi Swamp • Maputo • Nile • Okavango • Orange • Pangani • Pungwe • Ruvuma • Sabi • Thukela • Umba • Umbeluzi • Zambezi	• Benguela Current • Agulhas Current • Somali Coastal Current • Red Sea

NORTHERN AFRICA & WESTERN ASIA (53)			
AQUIFERS (13)	**LAKES (6)**	**RIVERS (29)**	**LMES (5)**
• Baggara Basin • Basalt Aquifer System (West): Yarmouk* • Gedaref • Irhazer-Illuemeden Basin • Merged: -Tawil Quaternary Aquifer System: Wadi Sirhan Basin - Saq-Ram Aquifer System (West) • Merged: - Umm er Radhuma-Dammam Aquifer System (South): Rub' al Khali - Wajid Aquifer System - Wasia-Biyadh-Aruma Aquifer System (South): Tawila-Mahra/ Cretaceous Sands - Neogene Aquifer System (South-East): Dibdibba-Kuwait Group • Merged: - Wasia-Biyadh-Aruma Aquifer System (North): Sakaka-Rutba - Umm er Radhuma-Dammam Aquifer System (North): Widyan-Salman - Neogene Aquifer System (South-East): Dibdibba-Kuwait Group • Neogene Aquifer System (North-West): Upper and Lower Fars • Northwest Sahara Aquifer System (NWSAS) • Nubian Sandstone Aquifer System (NSAS) • Senegalo-Mauretanian Basin • Sudd* • Taoudeni Basin	• Aras Su Qovsaginin Su Anbari • Caspian Sea • Dead Sea • Lake Darbandikhan • Lake Nasser/ Aswan • Sea of Galilee	• An Nahr Al Kabir • Asi/Orontes • Astara Chay • Atui • Baraka • Congo/Zaire • Coruh • Daoura • Dra • Gash • Guir • Jordan • Kura-Araks • Lake Chad • Maritsa • Medjerda • Nahr El Kebir • Niger • Nile • Oued Bon Naima • Psou • Rezvaya • Samur • Sulak • Tafna • Terek • Tigris-Euphrates/Shatt al Arab • Velaka • Wadi Al Izziyah	• Mediterranean Sea • Canary Current • Arabian Sea • Red Sea • Black Sea

SOUTHERN ASIA (29)			
AQUIFERS (3)	**LAKES (5)**	**RIVERS (20)**	**LMES (1)**
• East Ganges River Plain Aquifer • Indus River Plain Aquifer • South of Outer Himalayas Aquifer	• Aras Su Qovsaginin Su Anbari • Caspian Sea • Lake Darbandikhan • Mangla • Sistan	• Aral Sea • Astara Chay • Atrak • BahuKalat/ Rudkhanehye • Dasht • Fenney • Ganges-Brahmaputra-Meghna • Hamun-i-Mashkel/ Rakshan • Hari/Harirud • Helmand • Indus • Irrawaddy • Kaladan • Karnaphuli • Kowl E Namaksar • Kura-Araks • Muhuri (aka Little Feni) • Murgab • Tarim • Tigris-Euphrates/Shatt al Arab	• Arabian Sea • Bay of Bengal

SOUTHEASTERN ASIA (42)			
AQUIFERS (10)	**LAKES (NA)**	**RIVERS (27)**	**LMES (5)**
• Cambodia Mekong River Delta Aquifer • Downstream of Lancang River • Hong River Basin • Karst Aquifer of Upper Zuojiang Valley* • Khorat Plateau Aquifer • Limbang Aquifer* • Lower Mekong River 1 Aquifer • Lower Mekong River 2 Aquifer • Nu River Valley Aquifer* • Salween River Aquifer		• Bangau • Bei Jiang/Hsi • Beilun • Ca/Song-Koi • Digul • Fly • Ganges-Brahmaputra-Meghna • Golok • Irrawaddy • Jayapura • Kaladan • Karnaphuli • Loes • Ma • Maro • Mekong • Pakchan • Red/Song Hong • Saigon • Salween • Sebuku • Sembakung • Sepik • Song Vam Co Dong • Tami • Tjeroaka-Wanggoe • Vanimo-Green	• Bay of Bengal • Gulf of Thailand • South China Sea • Sulu-Celebes Sea • Indonesian Sea

EASTERN & CENTRAL ASIA (61)			
AQUIFERS (23)	**LAKES (4)**	**RIVERS (28)**	**LMES (6)**
• Amu-Darya • Birata-Urgench • Buir Nuur-Khalkh river Aquifer • Dankhan Khudgiin Sair aquifer • Delger River • Downstream of Lancang River • Ertix River • Hong River Basin • Ili River • Irtysh-Obsky • Karst Aquifer of Upper Zuojiang Valley* • Middle Heilongjiang - Amur River Basin • Nu River Valley* • Pre-Caspien • Shishhid River Aquifer • South-Pred-Ural Aquifer • Syr Daria • Syrt • Tacheng Basin / Alakol • Yalu River Basin • Yalu River Valley* • Yenisei Upstream • Zeya River Basin	• Aral • Caspian Sea • Sarygamysh • Shardara/Kara-Kul	• Amu-Darya • Aral Sea • Atrak • Bei Jiang/Hsi • Beilun • Ganges-Brahmaputra-Meghna • Han • Har Us Nur • Hari/Harirud • Ili/Kunes He • Indus • Irrawaddy • Jenisej/Yenisey • Lake Ubsa-Nur • Mekong • Murgab • Ob • Oral/Ural • Pu Lun T'o • Red/Song Hong • Salween • Shu/Chu • Sujfun • Talas • Tarim • Tumen • Volga • Yalu	• South China Sea • East China Sea • Yellow Sea • Kuroshio Current • Sea of Japan • Oyashio Current

OCEANIA, MICRONESIA & CENTRAL PACIFIC (9 + WPWP)			
AQUIFERS (NA)	**LAKES (NA)**	**RIVERS (8)**	**LMES (1 + WPWP)**
		• Digul • Fly • Jayapura • Maro • Sepik • Tami • Tjeroaka-Wanggoe • Vanimo-Green	• Insular Pacific-Hawaiian • Western Pacific Warm Pool (WPWP) (not an LME)

AUSTRALIA & NEW ZEALAND (8)			
AQUIFERS (0)	**LAKES (0)**	**RIVERS (0)**	**LMES (8)**
			• North Australian Shelf • Northeast Australian Shelf • East Central Australian Shelf • Southeast Australian Shelf • Southwest Australian Shelf • West Central Australian Shelf • Northwest Australian Shelf • New Zealand Shelf

ANTARCTICA (1)			
AQUIFERS(0)	**LAKES (0)**	**RIVERS (0)**	**LMES (1)**
			• Antarctic LME

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Acknowledgements

Lead Authors:

Liana Talaue McManus (Consultant, UNEP/DEWA), **Robin Mahon** (Centre for Resource Management and Environmental Studies, University of the West Indies, Barbados) (Co-Chairs, TWAP Crosscutting Analysis Working Group).

Members, TWAP Crosscutting Analysis Working Group:

Name, TWAP Component	Primary affiliation
Alice Aureli, *Aquifers Component Principal*	UNESCO International Hydrologic Programme (IHP), Paris, France
Leszek Bialy, *Aquifers (Former) Component Coordinator*	UNESCO International Hydrologic Programme (IHP), Paris, France
Julian Barbiére, *Large Marine Ecosystems (LMEs) Component Principal*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Maija Bertule, *Rivers Component*	UNEP-DHI Partnership Centre on Water and Environment, Denmark
Emanuele Bigagli, *Open Ocean Component*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Peter Bjørnsen, *Rivers Principal*	UNEP-DHI Partnership Centre on Water and Environment, Denmark
Bruno Combal, *LMEs and Open Ocean Components*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Aurélien Dumont, *Aquifers Component*	UNESCO International Hydrologic Programme (IHP), Paris, France
Lucia Fanning, *Co-Chair Governance Crosscutting Working Group*	Marine Affairs Program, Dalhousie University, Canada
Albert Fischer, *Principal* and *(Current) Open Ocean Component Coordinator*	UNESCO Intergovernmental Oceanographic Commission
Paul Glennie, *Rivers Component Coordinator*	UNEP-DHI Partnership Centre on Water and Environment, Denmark
Sarah Grimes, *(Former) Open Ocean Component Coordinator*	University of Geneva
Sherry Heileman, *LMEs Component Coordinator*	UNESCO Intergovernmental Oceanographic Commission, Paris, France
Pierre Lacroix, *Data and Information and Crosscutting Working Group*	University of Geneva
Matthew Lagod, *(Current) Aquifers Component Coordinator*	UNESCO International Hydrologic Programme (IHP), Paris, France
Masahisa Nakamura, *Lakes Component*	Research Center for Sustainability and Environment, Shiga University, Japan
Geert-Jan Nijsten, *Aquifers Component*	International Groundwater Centre (IGRAC)
Walter Rast, *Lakes Principal and Component Coordinator*	The Meadows Center for Water and the Environment, Texas State University, USA
Alex de Sherbinin, *Rivers Component*	Center for International Earth Science Information Network, Columbia University, New York, USA

Science communication: Nieves Izquierdo Lopes and Janet Skaalvik (GRID-ARENDAL)

UNEP Secretariat: Liana Talaue McManus (Project Manager), Joana Akrofi, Kaisa Uusimaa (UNEP/DEWA) and Isabelle van der Beck (Task Manager)

Design and layout: Audrey Ringler (UNEP) and Jennifer Odallo (UNON)

GIS: Jane Muriithi (UNEP/DEWA)

Central Data Portal: Pierre Lacroix and Andrea de Bono (GRID-Geneva)

Administrative Boundaries: Source of administrative boundaries used throughout the assessment: The Global Administrative Unit Layers (GAUL) dataset, implemented by FAO within the CountrySTAT and Agricultural Market Information System (AMIS) projects.

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The water systems of the world – aquifers, lakes, rivers, large marine ecosystems, and open ocean- sustain the biosphere and underpin the socioeconomic wellbeing of the world's population. Many of these systems are shared by two or more nations. These transboundary waters, stretching over 71% of the planet's surface, in addition to the subsurface aquifers, comprise humanity's water heritage.

Recognizing the value of transboundary water systems and the reality that many of them continue to be degraded and managed in fragmented ways, the Global Environment Facility Transboundary Waters Assessment Programme (GEF TWAP) was developed. The Programme aims to provide a baseline assessment to identify and evaluate changes in these water systems caused by human activities and natural processes, and the consequences these may have on dependent human populations. The institutional partnerships forged in this assessment are envisioned to seed future transboundary assessments as well.

The final results of the GEF TWAP are presented in the following six volumes:
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.

This document – Volume 6 Transboundary Water Systems: Crosscutting Status and Trends (A Summary for Policy Makers) – highlights a first global analysis to examine the present-day thematic dimensions of risk among 756 international water systems across five water categories in 14 regions of the world. It hopes to encourage subsequent assessments to quantify and monitor interactions between systems, and make these system-system linkages as salient bases for effective transboundary water management in a warming climate.

www.unep.org

United Nations Environment Programme
P.O. Box 30552 - 00100 Nairobi, Kenya
Tel.: +254 20 762 1234
Fax: +254 20 762 3927
e-mail: publications@unep.org
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