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Chapter Citation
6.1 What can the results tell us?

This is the first truly global and comprehensive assessment of the world’s 286 transboundary river basins. It covers a range of topics (natural and social sciences) and scales (from large to very small basins and Basin Country Units to grid cells).

It is primarily a baseline study of current conditions, with the aim of comparing all transboundary basins within the same framework and using the same underlying data, thus adding credibility to the results. The findings are consistent with other global assessments (such as the Human Development Index, Joint Monitoring Programme on Water and Sanitation, WWF Living Planet Report, and IPCC reports), which often have a more specific focus and are usually presented at national rather than basin and BCU scales. This assessment provides opportunities for analysis at a number of scales and perspectives. For individual indicators and combinations of indicators (multiple stressors) it provides: 1) a global perspective of the magnitude of the risks; 2) a framework for comparative analysis of risks among basins; and 3) identification of the basins most and least at risk. Overall, this provides a context for response options at global/regional levels but also at the basin and country levels, and facilitates inter-basin learning opportunities. It also can be used in combination with detailed studies on individual basins.

Significant efforts have been made to reduce the large number of data points (results from 286 basins and 796 BCUs) into five relative risk categories. These are provided to improve communication of the results, and assist decision makers in identifying priority areas and issues for intervention, recognizing that minor differences in indicator scores are not likely to be particularly meaningful in this global-level assessment.

The state of water resources in any location depends on a complex array of natural circumstances, pressures, and management responses. This assessment has attempted to cover a broad spectrum of these factors, with each indicator representing an important aspect in its own right. The results identify basins and regions where there are high and low risks of water stress, pollution, and threats to ecosystems and impacts on them. It also assesses governance capacity at the national and transboundary level to deal with threats, and the likely level of vulnerability of societies trying to cope with these risks, including changes to the hydrological regime. The key findings for each of the five thematic groups of indicators are presented below (taken from the thematic group introductory sections in chapter 3).

Key findings for each thematic group

**Socioeconomics**

1. **Climate-related risk is linked to economic dependence and low wellbeing**: Basins with high economic dependence, low levels of societal wellbeing and high exposure to floods and droughts have the highest climate-related risks. These basins are found mostly in Africa and south and southeast Asia. They include, at the highest levels of vulnerability, the Limpopo, the Ganges and the Mekong.

2. **Wellbeing and governance capacity to address disasters are linked**: In basins where societal wellbeing is low, governance capacity to address vulnerability to floods and droughts is also likely to be low. Women, children and people with disabilities are groups particularly vulnerable to floods and droughts. Attention might be warranted to assess governance needs and increase capacity in these countries and basins.
3. **Larger basins have larger economic dependence:** Larger basins tend to have higher levels of economic dependence on basin water resources, due mainly to the fact that larger basins are likely to include greater portions of the populations and areas of the countries. The 14 basins with the highest levels of economic dependence collectively comprise a population that is almost 50% of all transboundary basins (almost 1.4 billion people). These larger basins may be harder to manage from a transboundary point of view because of the number of countries and diversity of priorities. Management becomes even more critical to safeguard socioeconomic wellbeing in these countries.

**Governance**

1. **More effort is needed on transboundary agreements:** The adoption of international principles associated with the shift of water paradigms toward more sustainable development has been faster in domestic water governance arrangements than in international treaties. Focus is needed on renegotiating and implementing transboundary agreements to incorporate more integrated approaches into basin-level management.

2. **Construction of water infrastructure needs a cooperative context:** The construction of new water infrastructure is in progress or planned in many transboundary basins, including in areas where international water cooperation instruments are still absent or limited in scope. In such areas, a formal institutional framework for transboundary dialogue could help to assuage potential disputes stemming from unilateral basin development.

3. **Capacity building is required within countries to meet transboundary objectives:** There have been advances in the development of transboundary institutional capacity to deal with transboundary tensions and the application of integrated approaches to national water management, but capacity building is still work-in-progress in most countries.

**Ecosystems**

1. **Local-level, tailored solutions are needed to address species extinction risks:** Analysis at the BCU level gives a more detailed picture of extinction risks than analysis at the basin level, reflecting higher levels of endemic species or threats in some areas of a river basin such as the upper reaches or in large lake systems. This suggests that responses, too, should be at a more detailed level than basin-wide to address extinction risks. There is therefore an urgent need to continue to identify hotspots from transboundary impacts through basin-specific assessments (including, for example, GEF Transboundary Diagnostic Analyses (TDAs)). Conservation strategies should be focussed on ecological importance, not necessarily on scale.

2. **Decisions about dam sites and dam design are key to minimising negative ecosystem impacts:** Dam density is often a key driver of impacts on ecosystems, with impacts on flow and fragmentation of river systems. Recognizing the benefits of dams to human development, ongoing commitments are needed to improve guidelines for siting new dams, designing dams for multiple purposes and optimising the operation of dams to maximise human benefits and minimise negative ecosystem impacts. This is particularly important in a transboundary context, where dams are typically located in upstream countries.

**Water quantity**

1. **Action to address agricultural water stress must not increase environmental water stress:** Hotspots of environmental water stress are highly correlated with those of agricultural water stress. Addressing agricultural water stress (for example through increasing large-scale water storage) should be done with careful consideration of environmental water requirements.

2. **Human water stress needs to be addressed to mitigate projected environmental and agricultural stress:** Actions to counter human water stress should be expedited in river basins that are already prone to water stress to mitigate the increasing stress projected for most of these regions.
**Conclusions**

**Water quality**

1. **Water quality risks are high in many transboundary river basins:** Water quality is severely affected in more than 80% of the basins, either by nutrient over-enrichment (typically in developed regions e.g. North America and Europe) or by pathogens (generally in developing regions, e.g. South America, Africa, and in northern Asian basins with Russia), or in both (e.g. emerging economies in southern and eastern Asia).

2. **Water quality risks are projected to increase:** The projected scenario for nutrient pollution suggests that the relative risk will increase in around 30% of basins between 2000 and 2030, with the risk in two basins increasing by three categories. Between 2030 and 2050 nutrient pollution risk is projected to increase further in 21 basins, while in six basins the risk decreases by one category. The effects of nutrient pollution are also likely to exacerbate risks across other indicators and water systems (e.g. ecosystem health, coastal areas and aquifers).

3. **Mitigation measures are needed in all river basins to reduce risks:** In basins with a risk of nutrient and wastewater pollution, improvements to wastewater treatment may help to reduce both risks. Improved nutrient management in agriculture (e.g. crop and livestock) will likely be needed to reduce current risks of nutrient pollution in many basins. Even in basins with relatively low risk, both strategies are likely to become more important as the global population continues to rise, which is likely to increase risks of nutrient and wastewater pollution unless adequate mitigation measures are in place.

**Key findings for lakes and deltas**

While river basins interact with all other water systems assessed under TWAP (Aquifers, LMEs, Open Ocean and Lakes), either directly or indirectly, special attention under TWAP RB was given to Lakes (via the Lake Influence Indicator) and Deltas (via the Delta Vulnerability indicators).

**Lake influence on river basins**

1. **Low storage capacity can make basins more vulnerable to a changing climate:** Basins which suffer from water stress, droughts or floods may be even more vulnerable if they also have low lake storage capacity to act as a buffer (e.g., north-west Africa, parts of basins in southern Africa, and the Indian sub-continent). Water demand management in these areas is key.

2. **The proportion of reservoirs to lakes can guide responses:** Considering the proportion of reservoirs to natural lakes (i.e. the degree of controllable storage) provides further information for the design of response options to challenges such as water scarcity or exposure to floods. Response options are likely to be different in basins with high proportions of controllable storage compared to basins with high proportions of natural lakes.

**Delta vulnerability**

1. **The vulnerability of deltas differs across the world:** The results show a geographical spread of vulnerability depending on the indicator. The Ganges-Brahmaputra-Meghna delta appears to be the most vulnerable, followed by the Niger and Volta deltas. The Amazon, Orinoco and Yukon deltas appear to have low to moderate vulnerability.

2. **Deltas in Asia are most at risk:** In general the deltas in Asia seem to have the most serious challenges in terms of human vulnerability caused by a combination of relative sea level rise and population pressures (and sometimes poor delta governance).

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28 High confidence results only
Special attention should also be paid to the impact of upstream interventions on the most vulnerable deltas (e.g., reduction of sediment load by the construction of dams, changed hydrodynamics of rivers, pollution, and increased risk of salinity intrusion).

**Integrated analysis of all indicators across thematic groups**

While the baseline nature of this assessment has not made it possible to fully investigate causal chain effects, consideration of the full range of indicators is vital for the design of appropriate policy response options. Taken together, the results reveal complex links, which can be interpreted in a number of different ways (Chapter 4).

Although creating an overall risk index from all the indicators may be conceptually appealing, it would tend to mask levels of threat important for individual basins. Furthermore, the creation of such an index would be highly dependent on stakeholder priorities. Given that the intention of this assessment is to be relevant to a broad range of users at different scales, custom indices can be created from any combination of indicators in the data portal with user-defined weighting (http://twap-rivers.org/).

An integrated analysis of the indicators has been undertaken using a number of different techniques to examine the data from various perspectives, in an attempt to answer the questions below (Chapter 4).

**Can we classify basins with similar risk profiles?**

While each basin is unique, understanding similarities can facilitate inter-basin learning and the further development of broad management strategies which may be applicable to basins with certain types of risk profile. A cluster analysis was undertaken to identify such basin groups (Figure 6.1):

- **Cluster group 1: Undeveloped basins with low pressures on water resources**: 45 basins (with a population of roughly 89 million) that have generally low risk across most indicators. These tend to be either small basins in various parts of Africa, presumably with little water resource development so far, or isolated basins in temperate and polar regions, presumably with low pressures on their water resources. This group of basins represents those that are largely undeveloped and may therefore offer opportunities for sustainable development.

- **Cluster group 2: Inadequate governance, high ecosystem risk despite low development of water resources**: 39 basins (869 million people) appear to have inadequate governance which manifests in high risks to ecosystems, despite relatively low levels of development of water resources. These basins present a challenge for sustainable development and the management of risk, particularly given the moderate to high levels of exposure to droughts and floods respectively. Assessing governance needs in these basins should be a priority.

- **Cluster group 3: Poor governance, high risk, high water use**: 25 basins (84 million people) have generally poor governance and generally high risks across the socioeconomic indicators; they appear to be utilizing relatively high portions of their available water resources and have high economic dependence on water resources. Transboundary inter-sectoral allocation mechanisms may be useful management tools in these basins.

- **Cluster group 4: High human wellbeing, good governance, high risk to ecosystems and of human water stress**: 25 basins (282 million people) tend to have high levels of societal wellbeing, and good governance, but also high risk to ecosystems and of human water stress and moderate risk of environmental water stress. Low risks of agricultural water stress but high risks of ecosystem impacts from dams implies that storage capacity has been developed to mitigate agricultural water stress, but at the expense of the environment.
Conclusions

How are the individual indicators related?

Determining correlations between indicators across thematic groups can help to identify the strength of the statistical relationships between the links in the conceptual model that underpins this work. The results indicate how the human dimension of transboundary rivers, gauged by socioeconomic and governance indicators, is related to the physical dimension represented by water quality and quantity and ecosystem impacts. For example:

- Wastewater pollution, societal wellbeing and enabling environment (governance at the country level) are strongly related, suggesting that addressing wastewater pollution should occur in parallel with improvements in societal wellbeing and national governance;
- Environmental, human and agricultural water stress, and exposure to drought, which are usually worse in basins with high inter-annual variability of water flows, have high correlation levels. This confirms that in the past dams have been built to address water flow variability to meet high human and agricultural demands, with negative impacts on environmental water flows.

There is a negative correlation (although weak) between governance and societal wellbeing indicators, and between ecosystem impacts from dams and threats to fish. This would imply that basins which have been developed to support high levels of societal wellbeing may have done so at the expense of the environment.

What can the assessment results tell us about the transboundary nature of risk?

The relationships between upstream and downstream areas within each basin are arguably one of the most important features of in-basin dynamics. Upstream actions can affect downstream BCUs. For this reason, it is key to observe how risks from the source of a river relate to risks further downstream and at the mouth of the river.

- The average risk for all indicators for BCUs located at the mouth of a transboundary basin is marginally higher than their respective BCUs at the source. Almost twice as many BCUs at the river mouth have higher risk than their respective BCUs at the source, although the differences are generally not large.
The disparity of level of risk among countries can act as a catalyst or as an obstacle for transboundary cooperation and have different effects on the overall status of the basin. However, there is no clear correlation between the level of general risk disparity and the overall level of risk in basins. Understanding and developing national and transboundary governance capacity is critical to address the transboundary nature of risk. Building national governance capacity often creates a strong basis for transboundary cooperation capacity, while a lack of national capacity can paralyze further transboundary governance.

**What can we say about how risks are likely to change in the future?**

Simulated projections for the 2030s and 2050s were generated on the basis of a ‘business-as-usual’ socio-economic scenario and an assumed continued high greenhouse gas (GHG) emissions pathway. The following indicators were considered: environmental stress induced by flow alteration, human water stress, nutrient pollution, hydropolitical tensions, and population density.

Four hotspots were identified; environmental and human (E&H) water stress is projected to increase in all four:

- **Orange and Limpopo basins, Southern Africa:** increased Environment and Human (E&H) water stress due mainly to increasing water withdrawals, and nutrient pollution due mainly to increased human sewage. Countries affected: Botswana, Lesotho, Mozambique, Namibia, South Africa, Zimbabwe.

- **Selected Central Asia basins:** range of factors differing between basins, including increased E&H water stress due to a combination of projected increases and decreases in water availability, increasing water withdrawal and population density; increased nutrient pollution and hydropolitical tensions. Basins: Tarim, Indus, Aral Sea, Helmand, Murgab, Hari, Talas, Shu and Ili. Countries affected: Afghanistan, China, India, Iran, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Tajikistan, Turkmenistan, Uzbekistan.

- **Ganges-Brahmaputra-Meghna basin:** increased E&H water stress due mainly to increased (>50%) water demand driven by population growth. Nutrient pollution remains high with agricultural sources (fertilizer and animal manure) being major contributors and sewage becoming increasingly important, and there is increased risk of hydropolitical tension associated with new water infrastructure. Countries affected: Bangladesh, Bhutan, China, India, Myanmar, Nepal.

- **Selected Middle East basins:** continued high to very high risk of E&H water stress due to decrease in renewable freshwater resources and higher water demand from increased population and irrigation. Nutrient pollution increases or remains in the highest risk category; increased risk of hydropolitical tension due to the political context. Basins: Orontes, Jordan River, Euphrates and Tigris. Countries affected: Egypt, Iraq, Iran, Israel, Jordan, Lebanon, Palestine, Saudi Arabia, Syria, Turkey.

In addition, many individual basins are at increasing risk, from a transboundary perspective, to changes in upstream-downstream pressures (e.g. the Nile).

**Can we identify any success stories?**

Part of the aim of this assessment has been to facilitate inter-basin learning. An attempt was therefore made to identify basins that may have relatively low risks or may be actively addressing pressures. This proved challenging due to the baseline nature of the assessment which made the analysis of causal relationships difficult. Repeat assessments with updated indicators and methodologies are needed to reveal clearer patterns over time.
Conclusions

6.2 What are the policy and management response options?

A number of issues related to the physical and socioeconomic environments of transboundary basins have been examined in this assessment. Some of these may be very closely linked to the natural levels of water availability and levels of population density and historic actions, which may be difficult to address through policy measures. For example, the analysis includes sub-indicator 2a Human Water Stress - water availability per capita, and indicator 7 Ecosystem Impacts from Dams, which accounts for dams constructed over the last 100 years or so. However, all the indicators provide information which can be incorporated into policy development and management planning. For example, understanding the relative level of ecosystem impacts from dams may provide impetus to further develop policies to protect the remaining ecosystems in the basin (e.g. through protected areas), or to improve dam operation to ensure environmental flow allocations.

The use of water resources will inevitably involve trade-offs, especially in basins where water is scarce. This has been demonstrated in this assessment through the high positive correlation between environmental, agricultural and human water stress and exposure to drought. The inter-dependency between indicators is a reflection of the principles of Integrated Water Resources Management (IWRM), which stress the need for coordination between sectors, and have an important role to play in transboundary river basin management (GWP and INO 2009). How best to manage trade-offs will depend on the situation in the specific basin, but to achieve sustainability this has to be done in a way that safeguards the future capacity of the ecosystems to continue functioning. With awareness of the factors that predict trade-offs (private interest, provisioning versus other ecosystem services, local stakeholders) the chances of creating win-win situations increase (Howe et al. 2014).

The current governance situation at transboundary and national levels underpins basin and country capacity to respond to risks. Using the three governance indicators as a guide can help to identify basins and countries where more detailed assessments of governance/capacity needs are warranted, particularly where other risks are high. Assessment of capacity needs could for example be implemented through GEF Transboundary Diagnostic Analysis (TDA) and Strategic Action Plans (SAP) which could enhance the connectivity and relevance of such assessments to wider economic and infrastructure planning and decision-making processes.

The basins in cluster groups 2 (inadequate governance, high ecosystem risk despite low development of water resources), 3 (poor governance, high risk, high water use) and 7 (economic dependence, pollution, wetland loss but with water availability) (Figure 6.1 and section 4.2) may require the most urgent attention, although closer examination of the individual indicators would be required to identify specific basins and BCUs.

In addition to governance considerations, classes of response options to address the risks identified in this assessment, and to achieve human and natural system water security, include (but are not limited to):

a) **Infrastructure:** either constructed or natural, for addressing risks associated with water scarcity (water quantity thematic group), water pollution (water quality thematic group), societal wellbeing (water supply and sanitation), and exposure to floods and droughts. Many win-win options are available through environmental protection for direct human gain (e.g. ‘green infrastructure’ for improvements to water quality, and flood and drought).

b) **Improved technical and institutional capacity:** (particularly related to the enabling environment and other governance indicators) for addressing a wide range of risks through increasing levels of knowledge to better guide policy development, planning and management. This global assessment provides pointers to where more detailed studies may be warranted.

c) **Economic incentives / investments:** cost-recovery measures (e.g. progressive tariff structures for all water uses); subsidies for improving water efficiency and charges (e.g. pollution charges).

d) **Environmental protection / rehabilitation:** basins in cluster group 2 may be particularly relevant here, with generally high species extinction risk, moderate risks across all thematic groups, and high hydropolitical tension, suggesting imminent construction of water infrastructure with a lack of adequate governance. Cluster group 4 also has high risks in the Ecosystems thematic group, but generally good governance, implying that these risks may already be being addressed.
Focus should not only be given to high risk basins; attention should also be given to low and moderate risk basins (e.g. cluster group 1) where sustainable development and management may ensure that they remain at relatively low risk.

The implementation of any of the above classes of policy responses is dependent on governance and economic capacity. Thus, basins with weaker capacity may have a much larger set of issues to address in parallel with more specific responses such as infrastructure development for improvements to societal wellbeing.

The cluster groups identified in this assessment show that some basins face similar challenges. Appropriate partnerships should therefore be developed, working together on similar issues for joint outcomes. These are likely to include greater private-sector engagement, and ultimately investment for delivering joint objectives with government and international organizations and donors such as the GEF.

6.3 Need for transboundary cooperation

In a warming world with more variable rainfall and increasing socioeconomic drivers, upstream countries may intensify their use of water, while downstream countries will probably be increasingly dependent on their upstream neighbours for water resources. Without adequate benefit-sharing agreements and cooperative approaches to integrated water resource management, economically-dependent downstream countries may be negatively impacted (UN-Water 2008).

This assessment shows that in the current situation, almost twice the number of outlet countries (downstream) have higher risks than the respective headwater countries (upstream) (section 4.3). It will be in the self-interest of downstream countries, particularly relatively affluent ones, to support improved land management, water-saving technologies, infrastructure, and technical capacity in upstream neighbours.

In this assessment, the transboundary nature of basins has been addressed mainly through the use of basin-country-units (BCUs). Using BCUs helps to show how each country contributes to the overall picture of risk in a given basin, and that the problems and solutions in transboundary basins are often directly linked to individual countries. Thus, this BCU approach contributes to identifying which countries may need to be proactive or may need more assistance to solve problems that have transboundary implications.

Vulnerability is the part of risk that can be managed and reduced through a variety of policy actions. Drivers such as population and economic growth are external to the water resource system, but there are policy and technical mechanisms to reduce the pressures they exert on water. River basins facing high risk therefore can and should work intensively on initiatives that act on the ‘controllable’ part of risks e.g. reducing or assuaging pollution. In this context, transboundary cooperation, particularly in the form of treaties, should not been considered to be a ‘panacea’ to all problems that affect international rivers, since not all forms of cooperation necessarily lead to better outcomes on the ground. Nevertheless, there is little doubt that unilateral policy actions often do not achieve their intended goals and may produce undesirable impacts that can create tensions between countries.

One example of this is water pollution control, which is unlikely to be effective if not designed and discussed across borders. Similarly, actions conceived to benefit the economy of one country (e.g. through the development of hydropower potential) could be profoundly detrimental in other parts of the basin. The associated potential international tensions could be mitigated through transboundary agreements where part of the benefits can be shared among the countries.

Results show a slight correlation between high economic dependence on water, relatively high water stress and a strong legal framework (e.g. the Orange in southern Africa and Jordan in the Middle East), possibly indicating a higher incentive for the countries in such basins to define the legal rights and obligations between States. However, even with the best intentions, it may become increasingly challenging to develop policies, laws and management
arrangements for transboundary benefit during times of prolonged water scarcity or when there are tensions between national priorities and transboundary considerations. This is illustrated by the complicated transboundary cooperation surrounding dam building in upland areas such as the upper reaches of the Mekong, the Blue Nile, and the Indus rivers. UNECE has developed policy guidelines for identifying, assessing and communicating the benefits of transboundary cooperation.

6.4 Looking to future transboundary river basin assessments

There are several initiatives worldwide that could benefit from the complex methods and indicators that have been developed over the course of the TWAP River Basins component. Other mechanisms adopting the TWAP methodology, in part or in full, could also assist in realizing the potential value of the TWAP results by keeping the datasets alive and contributing to periodic assessments.

For example, there is considerable opportunity to make use of TWAP methods and indicators to support the two global international watercourses conventions (UNECE and UN) considering the current lack of monitoring mechanisms that make indicator-based comparisons between basins over time possible.

The timing of the TWAP assessment coincides with the entry into force of the UN International Watercourses (WC) Convention (17 August 2014), providing a solid baseline for this Convention. The setting in place of a mechanism to track implementation of this Convention, and the possible nature of any resulting assessments, might however be dependent on a decision being taken by the Parties to the Convention.

Regional assessments carried out so far under the UNECE Water Convention have been limited geographically to pan-Europe. The scope of UNECE’s next assessment of transboundary waters — expected to be carried out from 2019 to 2021 — is open and expected to be influenced by the Convention’s global launch. UNECE has developed policy guidelines for identifying, assessing and communicating the benefits of transboundary cooperation, which were published in 2015.29

The TWAP assessment can also support monitoring of the proposed Sustainable Development Goals (SDGs). All targets under the proposed water goal (and some under other goals) are relevant to transboundary basins. The indicators and results of this report can support a number of these targets, including those related to water quantity, water quality, sustainable use of water resources, and protection of ecosystems. The assessment framework and indicators themselves could be modified to facilitate monitoring of the SDGs. Target 6.5 explicitly mentions transboundary cooperation: “by 2030 implement integrated water resources management at all levels, including through transboundary cooperation as appropriate”. All three governance indicators will be able to support this target, particularly the legal framework and enabling environment indicators.

It must be noted that, in relation to the SDGs and other global assessments, the TWAP methodology is not confined to transboundary basins. The majority of datasets are global, gridded data that can be aggregated to the desirable unit (e.g. region, country, and local area).

The assessment framework and indicators developed in this assessment may also be useful as a platform for river-basin organisations seeking to establish monitoring and evaluation systems. This basin-level information could feed back into future global analyses. It can also be used to develop the GEF Transboundary Diagnostic Analyses (TDAs) into a more science-driven, robust and comparable process.

29 http://www.unece.org/env/water/publication/ece_mp.wat_47.html
Other organizations that could benefit from the *TWAP River Basins Report* methodology and results as a complement to qualitative country/basin reports including Regional Economic Commissions, transboundary institutions and bi/tri lateral commissions, intergovernmental organizations and roundtables, development agencies, investment framework agencies, the International Network of Basin Organizations (INBO) and regional basin umbrella organisations, the World Water Assessment Programme (WWAP), Global Water Partnership (GWP), Delta Alliance and other regional institutions with a mandate for monitoring and assessment of transboundary waters. Ways in which the results and conclusions from this and future assessments can benefit such institutions include: priority setting, work programming and investment targeting, informing negotiations and collaborative economic and environmental ventures.

Importantly, the TWAP has fostered a willing partnership of institutions with the capacity to work with other interested parties to either reproduce the assessment in full or to adapt and improve aspects of the assessment to be fit for a number of purposes at many different levels. The future potential for the TWAP River Basins assessment is described in more detail in the *TWAP RB Sustaining Mechanisms* document (see http://twap-rivers.org/).

Throughout the *TWAP River Basins Report*, particularly in the indicator descriptions in Chapter 3 and the integrated analysis in Chapter 4, authors have made suggestions for potential future improvements to the methodology. The more broadly applicable suggestions include:

- A deeper understanding of drivers and impacts, in order to identify cause-effect relationships. This will probably require more in-depth analysis of (selected) basins.

- More analysis into within-basin relationships to gain better understanding of the transboundary aspects of risk. In some cases this may require more detailed datasets (some of which are currently being developed).
• Investigation of the interactions between and implications behind the water-food-energy nexus in basins, including identification of important trade-offs and opportunities presented by integrated water resource management at the transboundary level.

• A closer look at the performance and implementation of governance arrangements at national and transboundary levels and understanding of outcomes at both levels. This may include consideration of private and private-public actors, possibly illustrated by case studies.

• More ‘ground-truthing’ to compare the global assessment results with realities in the basins. This may involve more detailed studies of smaller, representative sub-sets of basins, and increased engagement with stakeholders in these basins.

• Further consideration (particularly for the integrated assessment) of which basins may be more relevant to consider as transboundary basins, and which may be considered as predominantly ‘national’.

• Consideration of the significance of gender and gender disaggregated information in global transboundary assessments.

• Separate analyses of larger and smaller basins, which may lead to different patterns of risk being identified, and consequently improve information for developing policy and management responses.

6.5 Decision-making in the context of uncertainty

Throughout the report, the authors have sought to identify needs for further research and methods to complement those applied to this study of transboundary river basins. However, gaps in data should not be an excuse for inaction. The world has entered a phase of risk management, where risks from environmental degradation, water scarcity, and climate change are increasingly real. Here, the precautionary principle must be invoked. Failure to manage transboundary water resources may result in significant human suffering and economic losses.

Mabey et al. (2011) call for an increased resilience of international resource-management frameworks, concluding that “The time to strengthen regimes is now, when the impacts of climate change are still at relatively low levels. This is also the time to actively identify gaps and critical areas where management and or governance regimes are absent, and intensify multilateral and bilateral engagements to address these gaps.” Basins with insufficient governance regimes will need to be strengthened, and basins in which there are already tensions between upstream and downstream countries will require special attention from the international community, including the GEF.
References


