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HANDBOOK ON WATER ALLOCATION IN A TRANSBOUNDARY CONTEXT

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Foreword

The world's water resources are facing unprecedented pressures from population growth and economic development. Estimates indicate that, with current practices, the world will face a 40 per cent shortfall between forecast demand and available supply of water by 2030. Climate change is worsening the situation, making water availability more unpredictable and increasing the frequency and intensity of floods and droughts.

With growing water scarcity, determining who can use water, for what purposes, in what quantity and of what quality, where and when—in short, determining water allocation—represents a major challenge. In transboundary basins—where (potentially conflicting) interests of different water users overlap with (potentially conflicting) interests of different countries—the challenge is even greater and the political sensitivity high. Yet, sustainable transboundary water allocation is increasingly important and urgent, as 60 per cent of freshwater resources globally cross national boundaries.

History shows that transboundary water allocation arrangements can work for the benefit of the States involved, but only if they are well designed, jointly agreed, adaptable and effectively implemented. It was therefore decided to develop this Handbook under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), which is serviced by the United Nations Economic Commission for Europe (UNECE). The Handbook aims to promote a better understanding of the benefits and challenges of transboundary water allocation and guide interested States through the process of assessing the potential usefulness of water allocation in their shared basins, and support the establishment of such arrangements.

A rich intergovernmental process under the Water Convention produced the Handbook, which benefited from the participation of more than 100 countries, 70 international organizations and 20 river basin organizations, and the knowledge and practice of more than 50 experts. It is the first time that existing experience on transboundary water allocation at the global level is gathered and systematically analysed to distil criteria, good practices and solutions. And through this highly participative and multidisciplinary process, the Handbook has already contributed to a better understanding of the benefits and challenges of utilizing water allocation in transboundary water cooperation.

The Handbook, and the experiences it builds upon, send a strong message on the importance of transboundary cooperation and of adaptability. Indeed, while allocating water in transboundary basins is not a new practice, the looming water crisis, accelerated social, economic and technological developments, and climate variability and change call for new, flexible approaches in allocation, in order to future-proof water management. Moreover, more controversy and disagreement can be expected, and only transboundary cooperation can ensure sustainable, equitable and resilient solutions that can prevent and address conflicts and promote development and peace.

It is my hope that the Handbook will help build the capacity needed to address this complex issue and contribute to the sustainable management of our transboundary waters. The way we manage our precious shared freshwater resources will determine not only the achievement of Sustainable Development Goal 6 on clean water and sanitation but also progress across other Sustainable Development Goals.

Olga Algayerova
United Nations Under-Secretary-General
Executive Secretary of the United Nations Economic Commission for Europe

Preface

The development of this Handbook on Water Allocation in a Transboundary Context has drawn significant interest, understandably. The basis for this Handbook originates from a global workshop on water allocation in transboundary basins, organized under the Water Convention in Geneva in 2017. Many delegates called for further activities to promote sustainable, equitable and resilient water allocation, including the development of a document for guiding related efforts. Recognizing this interest, the Water Convention's Programme of Work 2019–2021 included as an aim under Programme Area 3 to "support the development of equitable and sustainable transboundary arrangements on water allocation, and, to this end, increase understanding and knowledge of the criteria, mechanisms, tools and good practices for water allocation in transboundary basins and aquifers". The Handbook is a major step towards this aim.

An Expert Group supported the development of the Handbook and its main messages. Composed of experts from all continents, from governments, river basin organizations (RBOs), academia, civil society and international organizations, it provided guidance on the structure, substantive content and illustrative case studies. Specific expertise gaps were then filled based on identified needs, which further served to strengthen balanced representation and the diversity of perspectives. "Members" of the Expert Group were participants specifically invited to make a nomination for/join the Expert Group in seeking to achieving a balanced composition and diversity of representation and having met a minimum set of criteria. "Guests" themselves requested to participate in the Expert Group and met the same minimum criteria. There was no distinction in terms of functional participation in the Expert Group. I wish to thank all participants of the Group.

The Expert Group met three times (Geneva, 21 October 2019, and Geneva (online) 30 and 31 March and 20 and 21 October 2020) and was regularly consulted in the development process for technical inputs, reviewing content and providing feedback. The Handbook's review and feedback milestones were aligned with the Convention's regular meetings, including the annual Working Group on Integrated Water Resources Management (WGIWRM), the Working Group on Monitoring and Assessment (WGMA) and the Task Force on the Water-Food-Energy-Ecosystems Nexus. A full draft was shared with the joint WGIWRM and WGMA meeting in April 2021 and the Convention's National Focal Points in English, French and Russian languages.

A number of regional events and sessions in transboundary water cooperation workshops have been held to discuss the Handbook, including relevant case studies, and gain inputs and feedback. A dedicated session on water allocation was held in the "Regional workshop: Enhancing transboundary water cooperation in the MENA region: progress, challenges and opportunities" on 3–4 March 2020 in Beirut, Lebanon. A virtual "Regional workshop on equitable and sustainable water allocation – Sharing experiences on transboundary water allocation and water scarcity" hosted by Hungary and focused on countries in the European Union, the Balkans, the Caucasus and Eastern Europe was held on 5–6 October 2020. A virtual online "Regional meeting on water allocation and environmental flow assessment in a transboundary context" (22–23 September 2020) was also held as part of a regional process implemented by the International Water Assessment Centre (IWAC) in Kazakhstan, covering 10 countries in and around Central Asia, with case studies and outcomes provided for the Handbook.

I trust this Handbook addresses a significant and burgeoning interest in the topic and will serve as a valuable resource and modular guide for those working on water allocation. Further activities and events to disseminate the Handbook and build capacity on water allocation in a transboundary context are envisaged in collaboration with regions, basins and States where there is interest to learn more, including workshops where allocation is considered as part of a suite of tools and approaches under the Convention, such as the water-food-energy-ecosystem nexus approach. We look forward to receiving readers' feedback on the Handbook and to working together to strengthen the practice of water allocation in a transboundary context so that shared waters can be more effectively managed.

Mr. Péter Kovács
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Acronyms and abbreviations

DCP	drought contingency plan
DPSIR	Driving Forces–Pressures–State–Impact–Responses
DSS	decision support systems
EIA	environmental impact assessment
FAO	Food and Agriculture Organization of the United Nations
GWP	Global Water Partnership
IFTD	International Freshwater Treaties Database
IHP	Intergovernmental Hydrological Programme
IWRM	integrated water resources management
MCDA	multi-criteria decision analysis
MENA	Middle East and North Africa
OECD	Organisation for Economic Co-operation and Development
RBO	river basin organization
SDG	Sustainable Development Goal
SEA	strategic environmental assessment
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
Water Convention	Convention on the Protection and Use of Transboundary Watercourses and International Lakes
Watercourses Convention	Convention on the Law of Non-navigational Uses of International Watercourses

MAIN MESSAGES

1. **Transboundary water allocation determines one or more of the following: the quantity, quality and/or timing of water at the border between riparian States; and grants associated entitlements**. Simply put, water allocation determines who can use shared water resources, in what quantity and of what quality, for what purposes, where and when.

2. **Effective, equitable and sustainable transboundary water allocation is increasingly important in the present rapidly changing water security contexts, to prevent conflicts and underpin development.** With growing population, rising wealth, dietary change, urbanisation and rising industrial demand, most countries are placing unprecedent pressure on water resources. It is estimated that, with current practices, the world will face a 40 per cent shortfall between forecast demand and available supply of water by 2030. Climate change is worsening the situation by altering hydrological cycles, making water more unpredictable and increasing the frequency and intensity of floods and droughts. The 310 transboundary rivers and more than 500 transboundary aquifers in the world are vulnerable to these growing pressures. In an increasing number of them, in particular in water-scarce regions, available water resources are already fully utilized or overutilized.

3. **Transboundary water allocation is a joint, iterative planning, decision-making and implementation process and an outcome between two or more water-sharing States that is highly context specific**. Arrangements need to be tailored to the specific purposes and issues seeking to be addressed. Cooperation between riparian countries, the design of the process and the information supporting it are all crucial. Building and maintaining trust throughout the process is key.

4. **Transboundary water allocation should be based on international water law. The United Nations global water conventions, the Draft Articles on Transboundary Aquifers, regional agreements and other relevant international agreements provide overarching legal frameworks for allocating water in transboundary basins and aquifers.** These instruments contain the general principles of international water law (such as equitable and reasonable utilization, no significant harm, good neighbourliness and cooperation, protection of ecosystems, peaceful settlement of disputes, prior notification) that should underpin transboundary allocation arrangements. They also provide the governance tools (agreements, joint bodies) for developing, revising and implementing contextualized transboundary allocation agreements or other arrangements.

5. **To respond to changing conditions, including but not limited to climate variability and change, transboundary water allocation agreements and other arrangements should be adaptable.** New transboundary water allocation agreements and other arrangements need to be designed to be adaptable in the medium and long terms to changing hydrological, climatic and other related factors (socioeconomic, geographical, cultural, etc.). Existing water allocation agreements and other arrangements, or adopted subsidiary instruments, may need to be revised to be able to respond to changing conditions. Adaptive capacity can be integrated into transboundary allocation systems and institutions to respond to changing conditions, impacts and opportunities. Examples of this include applying allocations in percentages instead of absolute amounts, periodic reviews and using objective thresholds (e.g. persistent low precipitation) as a basis if exceptional deviations from agreed allocations are needed.

a. **Climate change must be approached as a cross-cutting challenge to effective allocation.** It is a potential risk multiplier that may necessitate adjustment of existing—and careful drafting of any new—transboundary water allocation agreements and arrangements. Impacts of climate change on future demands and flows should also be anticipated and used to inform the negotiation of allocation arrangements. Transboundary allocation arrangements need to factor in the increased uncertainty and inter- and intraannual variability of precipitation and run-off to cope with increasing frequency and extremity of drought and flood events. Making transboundary allocation arrangements climate resilient requires strong coordination mechanisms between and among different levels of governance, sector policies and stakeholder groups.

b. **The joint review of pre-existing usage patterns, and any transboundary allocation arrangements on which they are based, is an important step when adapting arrangements to evolving conditions and demands.** Such review should be based on equity and sustainability, especially as regards upstream and downstream water use allocations, including for the environment.

c. **It is also important to share and jointly develop or review plans for future water uses based on predicted foreseeable needs at the transboundary and State levels.** Water demands and flows evolve over time, due to many factors, including but not limited to changes in demography and land uses, and such evolutions need to be taken into account. Future plans with potential transboundary impacts should be shared as soon as reasonably possible in accordance with the principles of prior notification and consultation.

d. **Economic considerations (including impacts on prices, consumers and product surplus in the sectors concerned, fiscal impact and affordability constraints), along with social considerations (such as on employment), are important in managing demand and water infrastructure needs over time, as well as negotiating and implementing water allocation (rules and mechanisms, externalities, etc.).** Cost-benefit analyses can help to structure the options in water allocation and to assess the impact of those options. However, it must be acknowledged that not all costs and benefits can be quantified and monetized usefully, and, therefore, those aspects should be included in other terms in the analysis. The coordinated design and management of infrastructure and incentivizing efficiency and cost-effectiveness can help to increase efficiency of water infrastructure and reduce water demands.

6. **A main limitation of allocation can be its narrow focus on water quantity, quality and timing, within a bounded spatial area. Thus, transboundary allocation should always be considered in conjunction with complementary broader approaches**.

a. **Intersectoral approaches, such as the water-food-energy-ecosystem nexus approach**, help to inform the choice of sectoral and integrated policies and decisions that increase efficiency, reduce trade-offs and build synergies.

b. **Long-term basin planning incorporating the principles of integrated water resources management (IWRM)** can reduce the need to resort to specific water allocation arrangements, or provide a foundation for transboundary water allocation. For instance, IWRM requires the holistic consideration of different water sources and uses, together with the management of both supply and demand in the basin.

c. Considering all the **benefits that can be derived from water management** provides a comprehensive perspective to negotiating transboundary water allocation arrangements, which helps in moving beyond addressing purely water-related issues to their broader social, economic, environmental and political impacts.

7. **While designing and operationalizing water allocation arrangements is the product of a unique, context-driven pathway, the following three steps constitute an adaptable framework applicable to different settings:**
   i. **identification of incentives, reasons/motivations and development of a knowledge base;**
   ii. **negotiations of arrangements or agreements, including development of allocation mechanisms and plans, monitoring and ensuring compliance, and dispute prevention and resolution mechanisms;**
   iii. **implementation, including national implementation.**

8. **Developing transboundary water allocation arrangements is an iterative process that requires cooperation across all its steps. It is advisable to start by setting out the States' terms of reference, identify one or more simple shared objectives, develop trust and then expand.** It is recommended to incorporate feedback loops in order for States to jointly revisit and reassess important elements and steps in the process, as and when required.

9. **An adequate shared knowledge base and understanding of the issues at stake is a starting point for evaluating whether water allocation agreements and other arrangements provide the most appropriate means to address the issues.** This information can further assist with defining agreed allocations and system design, including related mechanisms and plans. Important elements of the knowledge base include water resource and availability assessments and analyses of environmental requirements, as well as use and impact assessments, preferably in different scenarios.

10. **The identification of the net benefits of cooperation regarding transboundary waters can help with creating enabling conditions, including the political willingness, for strengthening cooperation on water allocation in a transboundary context.** Tools are available to assist with this process. Allocation arrangements can thus contribute to broader peacebuilding and regional conflict prevention, mitigation or resolution.

11. **Historical records of negotiations over transboundary water allocation arrangements indicate that they have tended to follow a needs-based approach rather than approaches focused solely on legal rights** (whether absolute rights or other principles and entitlements)**.** Needs-based approaches that are based on basin characteristics, or the tangible benefits that water brings, are more easily quantifiable for the purposes of allocation. Such approaches have often provided a common starting point for negotiations by offering practical methods for determining water-sharing baselines in a transboundary context. Notwithstanding, legal rights are a crucial component of any negotiations regarding transboundary water allocation.

12. **Negotiations benefit from an assessment of present and future water needs in the riparian States, including a detailed diagnosis of potential water allocation scenarios.** Any future water needs assessment should consider feasible options for managing water demands, prioritizing vital human needs and improving water use efficiency in riparian States and by their main water users.

13. **A joint or coordinated assessment of vulnerability of water resources and of water-dependent sectors to climate change, and impacts scenarios are also useful tools.** They foster a shared understanding of the future water outlook and can provide scope for periodic review of the terms of allocation and their modalities for implementation

14. **Negotiating water allocation arrangements and agreements should not be seen as a one-off exercise.** Rather, it is part of a transboundary water cooperation process that advances step by step and may eventually need to be revised. In some cases, technical solutions, informal or temporary arrangements may be instrumental in reaching an acceptable short-term solution. However, formal legal and institutional arrangements are more suited to providing a long term and sustainable framework for transboundary allocation.

15. **To ensure the sustainability and implementation of the water allocation arrangements, it is crucial to identify key stakeholders beyond government entities concerned with water allocation and engage them in both the process of negotiation and its outcome.** These stakeholders may include international financial institutions, infrastructure operators, sectoral organizations, main water users or water user associations, civil society and citizens' organizations, local communities and Indigenous peoples. A stakeholder analysis can inform who should be involved, and an institutional analysis can inform the determining foundations for any arrangement. Special efforts are needed to involve traditionally marginalized and/or underrepresented members of society who rely on transboundary water resources, and to ensure gender equity. This broad participation brings benefits and contributes to an improved knowledge base, as well as enhanced equity and sustainability.

16. **Identification of different allocation options and alternatives and their careful consideration before taking decisions is beneficial, and diverse valuation tools and needs-based evaluations can be of assistance, while taking into account that not all benefits or factors can be quantified.** Multi-criteria decision analysis (MCDA), is one such means of providing transparent and systematic comparison. Various software tools and decision support systems (DSS) have been developed to support the application of MCDA and other methods in practice.

17. **Uncertainty related to water availability, variability and events is inevitable, making it essential to integrate flexibility mechanisms and adaptive capacity in allocation arrangements.** Better availability of data reduces uncertainty, but even a lack of data can be turned into an opportunity by sharing information and coproducing knowledge.

18. **Integrating clearly defined dispute settlement mechanisms (both diplomatic and adjudicatory mechanisms) can help support the implementation of transboundary allocation arrangements.** Given the often-contested nature of transboundary water use and allocation, it is beneficial to incorporate into any allocation agreement binding dispute settlement mechanisms that are agreed to by the riparian States.

19. **Transboundary water allocation arrangements and agreements often need to be further specified to ensure effective implementation.** This can be supported by developing allocation mechanisms, coordination and monitoring plans—considering different scales—which may also provide flexibility for allocation.

20. **Implementation of transboundary water allocation arrangements relies on having effective legislation and institutions in place at the national and/or subnational levels, and may require revising and strengthening them.** Seeking alignment and coordination between transboundary allocation arrangements and relevant State legislation is beneficial and should be taken into consideration as early as possible in the planning process. Other national and subnational instruments, such as regional limits on water abstraction, water entitlement or licensing systems, and annual water allocation process and monitoring systems for compliance and enforcement can be useful. Moreover, the institutional and technical capacity of all concerned national and subnational agencies should be taken into consideration in transboundary water allocation implementation plans.

21. **While the implementation of agreed allocation measures rests with riparian States, transboundary joint bodies are key elements of well-functioning transboundary allocation systems.** They provide a platform for negotiation and regular exchange, stability and predictability in the long term. However, few joint bodies have a mandate with respect to water allocation. Moreover, even in the presence of a clear mandate, dealing with water allocation remains a challenging task for joint bodies that calls for strengthening their capacities.

22. **Collecting and sharing reliable data and information is a critical foundation for the planning and implementation of water allocation in transboundary basins.** Data and information should include both biophysical and socioeconomic aspects, as well as data and information needed to monitor future variability and change. Information-sharing can help to reconcile different understandings of the shared water resources between and among sectors and/or riparian States regarding water availability, status and significance for sustainable development. The following elements can strengthen the knowledge base for transboundary water allocation.

    a. **Joint and/or coordinated monitoring and assessment systems, which utilize sound and financially sustainable technology, are key for the design and implementation of water allocation arrangements.** Harmonized methodologies and parameters, inspired by best practices, can further support consistency of cross-border comparisons and interoperability of data. Such systems can be useful in verifying allocation implementation and effectiveness and provide the transparency necessary for compliance and enforcement.

    b. **Open, transparent and regular sharing of up-to-date information is important for allocation, but many States find this element challenging.** This should include the exchange between States of, and/or access to, any relevant data (including metadata) on the current status and variability of transboundary water resources within each State, including various stakeholders. It should also include any plans for future water uses and related developments, including infrastructure projects, as soon as they are reasonably known, as well as forecasts/outlooks on the availability of waters. Nevertheless, not all data is always required (or simply not available) and this should not prevent decision makers from taking decisions when relating to decision-making under uncertainty.

23. **Water allocation mechanisms can generally be divided into direct mechanisms, indirect mechanisms and/or mechanisms based on principles.** These mechanisms are not mutually exclusive and can be used in combination and change over time. For example, groundwater is a distinct type of resource compared with surface water, and, by consequence, specific mechanisms refer to pumping rates, water table impact and spring outflow or relate to storage capacity of the aquifer. It is up to the States involved in allocation arrangements to determine the mechanisms that are most relevant and suitable to use in their context and any associated benefits they wish to prioritize.

    a. **Direct mechanisms** typically specify: fixed quantities (for all or some States); percentage of flow; equal division; variable by water availability; variable according to time of the year; water loans; allocation of entire/partial aquifer/river (based on sole use); allocating time; and/or cap, limit or no allocation allowed.

    b. **Indirect mechanisms** include: dividing allocation based on the priority of use; consultation and/or prior approval; and/or the allocation mechanism determined by a river basin organization (RBO), commission and/or committee.

c. **Mechanisms based on principles** refer to one of the following: benefits-sharing; historical or existing uses; equitable use; sustainable use; or use of a market instrument.

24. **Growing practice in some transboundary basins reflects the prioritizing of human and ecological needs before allocating available water resources to other needs.** Water quality for human consumption is becoming an increasingly important aspect of transboundary allocation and the prevention and reduction of pollution loads a high priority. Preventing ecosystem degradation has also been a main driver for recent water allocation reforms.

    a. **Vital human needs for drinking water, sanitation and hygiene are increasingly prioritized, especially in regions facing frequent drought events or chronic water scarcity.** Water scarcity may compromise water supply and sanitation services and can have negative impacts on human health. Deteriorating water quality diminishes available potable resources, while the need for treatment increases costs for water use.

    b. **The state of freshwater ecosystems affects the quantity, quality and variability of allocable water.** Safeguarding or restoring key aspects of ecosystem functioning, such as downstream water supply, wetlands, freshwater fisheries or sediment transport to low-lying delta regions can thus be strategically important to transboundary allocation arrangements.

    c. **Increasing use of environmental/ecological flow assessment tools and approaches, while ensuring the environment is determined to be a water user, reflects an understanding that maintaining healthy freshwater ecosystems has broader, strategic social, cultural and economic benefits, both direct and indirect.** This trend also recognizes the intrinsic value of the integrity of ecosystems. Numerous methods for defining e-flows have been developed beyond the basic definition of minimum flows.

    d. **Ensuring obligations related to return flows and discharges are properly specified and enforced can further support the prioritization of human and ecological allocation needs**.

25. **In addition to international water law, other branches of international law and their principles can be useful for the definition of transboundary water allocation arrangements.**

    a. **Multilateral environmental agreements can be applicable where appropriate in developing transboundary water allocation arrangements**. These include but are not limited to the: Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention); Convention on Environmental Impact Assessment (EIA) in a Transboundary Context (Espoo Convention); Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention); Convention on Biological Diversity; and United Nations Framework Convention on Climate Change (UNFCCC).

26. **Several emerging principles and norms can be considered for inclusion in the development of allocation arrangements, depending on the context.** These include but are not limited to: Indigenous values and water allocation in conjunction with the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and cultural flows; the human rights to water and sanitation, and other rights; the community-of-interest approach; water stewardship; and the rights of rivers and ecosystems. Approaches to valuing water and supporting ecosystem services, for example, water pricing and payment for ecosystem services, have also gained increasing attention globally.

PART 1 - FOUNDATIONS

CHAPTER I: Introduction to Transboundary Water Allocation and the Global Handbook

SUMMARY:
This chapter describes the rationale of water allocation in a transboundary context. It sets up the Handbook by interrogating the central question: why and how is water allocation applied in transboundary basins, including surface and groundwater? The role, relevance, aims and limitations of allocation under changing circumstances and finite water resources are outlined. The Handbook's purpose, audience, process of development under the Water Convention, content and usability are then described.

1. Water Allocation in a Transboundary Context

a. Water allocation across borders in an era of changing circumstances

The question of how freshwater resources are allocated is becoming of increasing relevance to water managers today. Demand for water is growing globally. Factors including population growth, economic development and changing consumption patterns are driving this demand. At the same time, availability of water is increasingly limited by growing pressures such as water scarcity, deteriorating water quality, ecosystem degradation and climate change, which further exacerbates the situation in many already water-stressed basins.[1] Reserving water for environmental flow, Indigenous groups and ecosystem requirements is increasingly seen as a prerequisite for overall viability of water resources systems.[2]

The question of allocation is especially heightened in transboundary contexts. Over 60 per cent of freshwater resources globally cross national boundaries, including 310 transboundary rivers and 592 transboundary aquifers.[3] Many of these shared basins are vulnerable to the effects of climate change and other growing pressures. Water scarcity, contested infrastructure developments such as hydropower dams, and increasing demand for, and competition over, shared water resources are all separate, but often interlinked, factors that have been leading to growing tensions in transboundary basins around the world. Where adaptivity of the existing water management arrangements is low, this can exacerbate any issues. In turn, this can compound the difficulties of States reaching peaceful settlements on water sharing in the short-, medium- and long-term future.[4]

[1] UNESCO World Water Assessment Programme (WWAP), *The United Nations World Water Development Report 2020: Water and Climate Change* (Paris, 2020).
[2] Arthington, A. H. and others, "The Brisbane Declaration and global action agenda on environmental flows", *Frontiers in Environmental Science*, vol. 6 (July 2018).
[3] International Groundwater Resources Assessment Centre (IGRAC), "Transboundary aquifers of the world map", 2015.
[4] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water Cooperation: Identification, Assessment and Communication* (New York and Geneva, United Nations, 2015).

Many of the existing transboundary water allocation regimes are based on historical usage patterns. Some may require adjustment in light of changing circumstances, while taking into consideration that no use enjoys an inherent priority over other uses, except where there is an agreement or custom to the contrary.[5] In parallel, establishing allocation arrangements may be rising higher in policy agendas in settings where they were not previously considered a priority. While these topics have received detailed attention and guidance over recent years in national and subnational contexts,[6] there is a dearth of resources exploring transboundary allocation. Water allocation in a transboundary context thus demands more robust investigation to assess its conceptualization and application in practice.

BOX 1: Use of "transboundary" in the Handbook

The use of "transboundary" in this Handbook follows the definition expressed in the Water Convention: international rivers, lakes and aquifers. Most case studies and anecdotes in the Handbook are thus international in nature. Recognizing that valuable lessons can also be learned from cross-border water allocation examples at the subnational level, a few such intracountry case studies are also outlined in the Handbook.

b. The role of water allocation in transboundary water resources management

Water allocation can contribute to the effective management of transboundary waters when developed jointly by the riparian countries and in conformity with relevant international law. When water resources are shared between two or more States, some form of allocation may take place in order to obtain a level of certainty in availability for each of the sharing parties. The formality of allocation arrangements typically varies. They can range from temporary and technical arrangements for water sharing that may have no explicit references to "allocation", to specific water quantity, quality or timing quotas in agreements and treaties with detailed allocation mechanisms.

Transboundary water allocation is both a process and an outcome, which are not mutually exclusive. When formalized, water allocation can broadly be seen through two basic framings. On one hand, it is often a jointly agreed and clearly defined volumetric, qualitative or timing-related allocation quota. On the other, it generally involves an iterative process of joint planning and negotiation between two or more States (see Figure 1). Ideally, both the process and outcome should be sufficiently flexible and adaptable to cope with changing needs and variabilities. While variations on water allocation exist within and outside these two broad framings, ultimately, the framing applied depends on the allocation context and the particular interests of the parties. To be realizable and sustainable, water allocation objectives need to be aligned with the optimal and sustainable utilization of the shared waters, consistent with its adequate protection. These objectives need additional assessment in different climate and socioeconomic scenarios to ensure practicality. They must also be consistent with the 2030 Sustainable Development Goals (SDGs), especially SDG 6 on clean water and sanitation[7] and linked to related SDGs and other rules and principles of international law.

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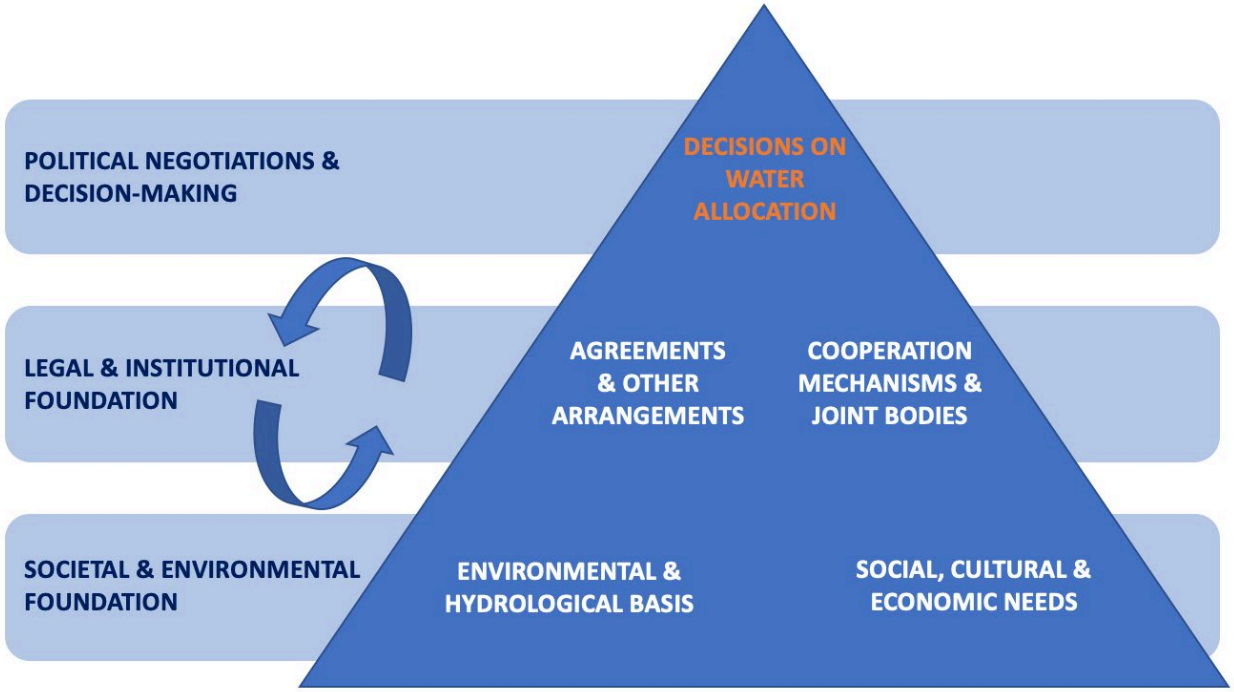
[5] 1997 Convention on the Law of the Non-navigational Uses of International Watercourses (Watercourses Convention), Art. 10.

[6] Organisation for Economic Co-operation and Development (OECD), *Water Resources Allocation: Sharing Risks and Opportunities*, OECD Studies on Water (Paris, 2015); Robert Speed and others, *Basin Water Allocation Planning. Principles, Procedures and Approaches for Basin Allocation Planning* (Paris, UNESCO, 2013); Dustin Evan Garrick, *Water Allocation in Rivers under Pressure: Water Trading, Transaction Costs and Transboundary Governance in the Western US and Australia* (Cheltenham, United Kingdom, Edward Elgar, 2015).

[7] See https://sdgs.un.org/goals/goal6.

Figure 1
Simplified decision-making hierarchy in transboundary water allocation



Source: M. Keskinen, 2020.

Water allocation is only one approach and is not an answer to all water-related challenges in transboundary settings. In many instances, broader approaches, such as assessing the benefits of transboundary cooperation,[8] benefit-sharing[9] and water-energy-food-ecosystem nexus approaches,[10] demand management strategies, and exploring alternative water resources or alternatives to planned uses of water are more appropriate (see Chapter IV). Such approaches help to establish a broader basis for win–win solutions in transboundary water management. Therefore, especially when utilized with basin-wide planning and integrated water resources management (IWRM) approaches, water allocation in a transboundary context can play a key role in contributing towards equitable and sustainable outcomes for all.

Certain foundational elements are important in forming the basis of any effective transboundary water allocation arrangement. Water allocation arrangements formalized in agreements should ideally be formed by a cooperative process, be planned jointly and incorporate inclusive stakeholder decision-making. Allocation between States must adhere to customary international law, general principles of international law and the law of treaties and any existing treaty obligations relevant to the transboundary waters concerned. The United Nations global water conventions, which codify the main principles of international law, provide guiding legal frameworks (and certain international customary law obligations) relevant for the establishment and maintenance of transboundary water allocation arrangements. The 2008 Draft Articles on the Law of Transboundary Aquifers provide further guidance for allocation of transboundary groundwater resources.

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[8] UNECE, “Benefits of transboundary water cooperation”, 14 January 2021.
[9] Claudia Sadoff and others, eds., *Share: Managing Water Across Boundaries* (Gland, Switzerland, International Union for Conservation of Nature (IUCN), 2008).
[10] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water* Cooperation (2015); UNECE, *Methodology for Assessing the Water-Food-Energy-Ecosystems Nexus in Transboundary Basins and Experiences from its Application: Synthesis* (New York and Geneva, United Nations, 2018).

Collecting and sharing relevant and reliable data and information is a vital foundation for the planning and implementation of water allocation in a transboundary context. Ideally, this is done through joint and/or coordinated monitoring and assessment systems. Overall, a strong knowledge base can help to reconcile different understandings of the shared water resources for transboundary water allocation between sectors and/or riparian States regarding water availability, status and significance for sustainable development.

Water allocation planning, frameworks and implementation should fit each unique transboundary context. Beyond common foundational elements, the specifics of any transboundary allocation arrangement should be based upon, and tailored to, the circumstances of the riparian States involved and the intended objectives. Climate change is a cross-cutting challenge impacting on regions, basins and States differently and contextualized allocation arrangements are therefore required.

2. The Handbook on Water Allocation in a Transboundary Context

a. Mandate for developing the Handbook

Sustainable water management lies at the core of the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), the secretariat of which is provided by the United Nations Economic Commission for Europe (UNECE). The Water Convention is a unique, now global, intergovernmental legal and institutional framework with the objective to ensure the sustainable use of transboundary water resources by facilitating cooperation. Good practices in different aspects of water management are essential in reaching its objectives.

The Programme of Work 2019–2021 under the Water Convention[11] included area 3: Promoting an integrated and intersectoral approach to water management at all levels. One of the objectives of the Programme was to support the development of equitable and sustainable transboundary water allocation criteria through the development of a Handbook on Water Allocation in a Transboundary Context. The Handbook was to be based on existing practices and would cover the key aspects of equitable and sustainable allocation of water in the transboundary context, addressing both surface waters and groundwaters and also environmental flows.

BOX 2: Status of the Handbook

The Handbook has been produced under the Programme of Work 2019–2021 of the Water Convention and aims to provide a reference point and general guidance for transboundary water allocation. It is not binding on States, nor does it supersede any of the provisions or obligations contained in the Convention.

The Handbook deliberately builds upon the Water Convention's past work on water allocation. In 2017, the Water Convention secretariat organized a global workshop on water allocation in transboundary basins, in Geneva.[12] The topics, case studies and presenters involved in that event were reviewed and, where it was deemed appropriate, integrated into the development of the Handbook and the composition of the Expert Group. Moreover, several other guidance documents and approaches developed under the Convention that

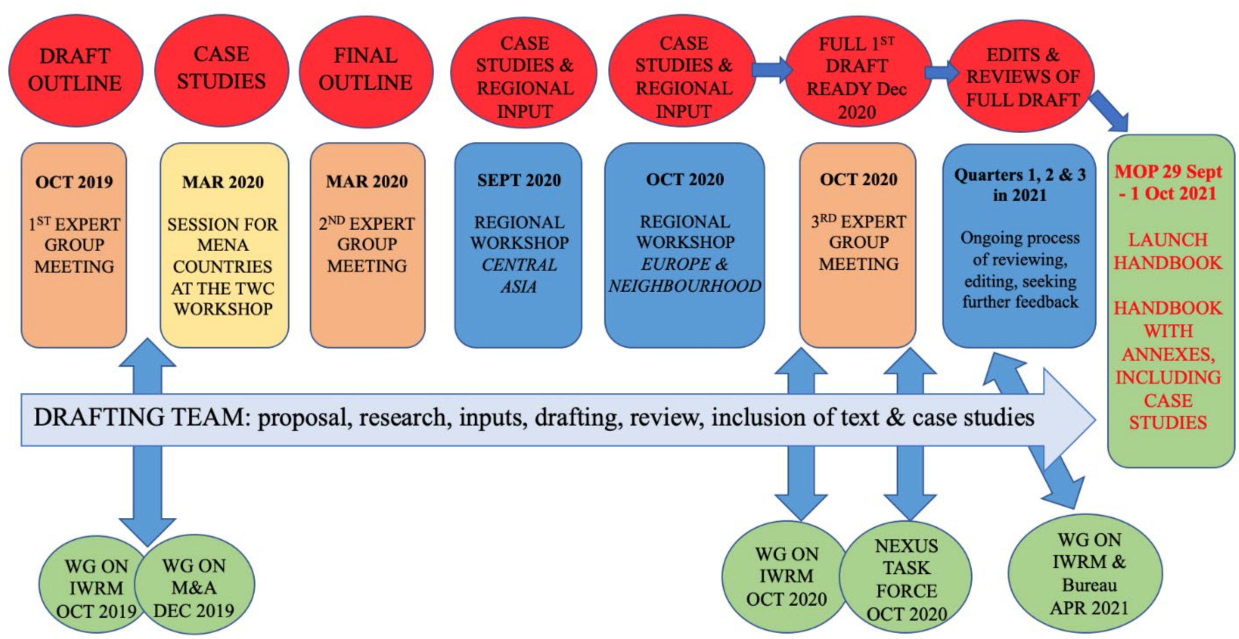
[11] United Nations Economic and Social Council, Economic Commission for Europe, *Report of the Meeting of the Parties on its eighth session: Addendum: Programme of Work for 2019–2021* (ECE/MP.WAT/54/Add.1).
[12] The presentations and other documents of the workshop are available at https://unece.org/environmental-policy/events/global-workshop-water-allocation.

are related to water allocation have been considered and integrated where appropriate, predominantly in Chapter IV.

b. Process for developing the Handbook

The development of the Handbook was carried out between 2019 and 2021 through an intergovernmental process under the auspices of the Water Convention (Figure 2). States were involved in the feedback and review process as key drafting milestones were linked to meetings of several of the Water Convention's bodies held between 2019 and 2021. Updates and draft documents were presented to two separate Working Groups—on Monitoring and Assessment and on Integrated Water Resources Management (the latter held annually)—as well as the Task Force on the Water-Food-Energy-Ecosystems Nexus. "Members" and "Guests" participating in the Expert Group in their individual capacities had several opportunities to review drafts and provide feedback.[13]

Figure 2
Overview of timeline for development of the Handbook



Source: UNECE Water Convention secretariat.

The Expert Group comprised approximately 40 experts specialized in water allocation from different continents, basins, States and organizations, acting in their individual capacity (see Acknowledgments for full list of Members and Guests). This Group guided and assisted the Drafting Team and the secretariat throughout the development of the Handbook. Three Expert Group meetings were held in which the structure

[13] "Members" of the Expert Group were classified as those participants who have been specifically invited to make a nomination for and/or join the Expert Group, as a result of our seeking to achieving a balanced composition and diversity of representation, and having met a minimum set of criteria. "Guests" were classified as those participants who have directly requested to participate in the Expert Group to support the development of the Handbook and have clearly demonstrated that they meet the set of minimum criteria for experts in area(s) specifically relevant to transboundary water allocation. There was no distinction, however, between Members and Guests in terms of functional participation in the Expert Group meetings, online communication and Handbook content review and feedback. Both could participate fully in the process.

and contents of the Handbook were discussed, relevant thematic topics and case studies presented and feedback and recommendations put forward for further content elaboration: Geneva, 21–22 October 2019 (in person)[14] and video conferences on 30–31 March 2020[15] and 20–21 October 2020.[16] The Expert Group also advised on and helped draft case studies on transboundary water allocation used to practically illustrate key features of chapter content.

A number of regional events and sessions as part of transboundary water cooperation workshops have been held to introduce the Handbook and gain region-specific feedback for its development. A virtual online "Regional workshop on equitable and sustainable water allocation – Sharing experiences on transboundary water allocation and water scarcity" focused on countries in the European Union, the Caucasus and Eastern Europe was held on 5–6 October 2020.[17] A "Regional workshop: Enhancing transboundary water cooperation in the MENA region: Progress, challenges and opportunities" held on 3–4 March 2020 in Beirut, Lebanon, sought to gain regional feedback for the Handbook through a session focused on lessons learned from allocation practices and experiences in the region.

In Central Asia, a parallel regional process on transboundary water allocation was implemented by the International Water Assessment Centre (IWAC) in Kazakhstan. Two regional workshops were convened—a "Technical meeting of experts on water allocation and environmental flow assessment in the transboundary context" held on 12–13 December 2019 in Nur-Sultan, Kazakhstan, and a virtual "Regional meeting on water allocation and environmental flow assessment in a transboundary context" held on 22–23 September 2020. A "Technical Meeting of Experts on Water Allocation and Environmental Flow Assessment in the Transboundary Context" was held online on 15 May 2020. The Central Asia regional process and events (in which the Water Convention secretariat and Drafting Team participated) aimed to identify good regional practices and approaches that can assist Central Asian and neighbouring countries in the development of equitable and sustainable transboundary water allocation mechanisms.[18] The key outcomes of the IWAC regional process for Central Asia, including a report detailing lessons learned and main recommendations, directly served to inform the development of this Handbook along with selected case studies from the region.

c. Target audience of the Handbook and its added value

The Handbook aims to cover global practice of transboundary water allocation. It seeks to be a practical guide providing an overview of the key elements, frameworks and modalities to consider in the application of transboundary water allocation, while recognizing that every allocation context is unique. A wide array of case studies from different continents and geographical regions has been selected, in consultation with the Expert Group, for the purposes of achieving diversity and balance of representation in the global examples.

The Handbook's primary audience is government officials, basin authorities and other water practitioners whose work directly concerns or relates to transboundary water resources, especially between States. Secondary audiences include all stakeholders with an interest in transboundary water allocation processes and outcomes. Such audiences would incorporate the general public, water user groups such as farmers and Indigenous peoples, specific interest groups such as non-governmental organizations (NGOs), and academics.

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[14] UNECE, "First meeting of the Expert Group on the Transboundary Water Allocation Handbook", 21 October 2019.
[15] UNECE, "Second meeting of the Expert Group on the Transboundary Water Allocation Handbook", 30–31 March 2020.
[16] UNECE, "Third meeting of the Expert Group on the Transboundary Water Allocation Handbook", 20–21 October 2020.
[17] ECE/MP.WAT/54/Add.1.
[18] United Nations Economic and Social Council, Economic Commission for Europe, *Rules of Procedure of the Meetings of the Parties, Strategy for the Implementation of the Convention at the Global Level, Programme of Work of the International Water Assessment Centre for 2019–2021 and Decisions* (ECE/MP.WAT/54/Add.2).

The novelty of the Handbook and its added value to the existing resources on water allocation is twofold. First, the Handbook was developed via an intergovernmental process (as outlined above). Second, its focus is transboundary water allocation between States. The Handbook draws on key themes, common elements and lessons learned from existing resources analysing national and subnational water allocation (see Chapter VIII, subsection 7a). Yet its specific framing is on water allocation in a *transboundary* context and so it addresses an identifiable niche in the available literature on water allocation and does so with a practical focus. The Handbook also innovates by integrating a diverse global selection of case studies that have never previously been compiled.

d. Table of Contents and how to read the Handbook

The Handbook is divided into Main Messages and two main parts (see Box 3):

- **Main Messages** discusses lessons learned and distils conclusions from the other parts of the Handbook;
- **Part 1 - Foundations (Chapters I–IV)** introduces the rationale of, foundations for, and limitations to, transboundary water allocation. It also discusses broader complementary approaches such as benefit-sharing related to water allocation;
- **Part 2 - Operationalizing (Chapters V–VIII)** provides the substantive and procedural basis for making water allocation happen, as well as practical steps for States to operationalize transboundary water allocation.

BOX 3: Summary of contents of the Handbook

MAIN MESSAGES

PART 1 – FOUNDATIONS

Chapter I:	Introduction to Transboundary Water Allocation and the Global Handbook
Chapter II:	Definitions, Objectives and Components of Transboundary Water Allocation
Chapter III:	Issues Water Allocation Can Address
Chapter IV:	Limitations to Water Allocation and its Linkages with Broader Approaches

PART 2 – OPERATIONALIZING

Chapter V:	Objectives of Water Management and Related Principles of International Law to Guide Transboundary Water Allocation
Chapter VI:	Cooperative Frameworks for Transboundary Water Allocation
Chapter VII:	Knowledge Base for Transboundary Water Allocation
Chapter VIII:	Operationalizing Transboundary Water Allocation: Processes, Mechanisms and Examples

ANNEX: Typology of Transboundary Water Allocation

The Handbook contains brief summaries of case studies from around the world that have been identified as being relevant to demonstrating transboundary water allocation. All the case studies include valuable lessons learned on transboundary water allocation, including illustrative features to the extent possible. Finally, an explanation of the Typology of Transboundary Water Allocation (TTWA) methodology comprises the Annex of the Handbook.

The Handbook should be read as a compendium of different dimensions of transboundary water allocation, highlighting the need to strike a balance between robustness and flexibility when developing allocation arrangements. Chapters can be read in order, but the Handbook is also intended to be modular depending on specific needs. In this regard, chapters, subsections and case studies can be referred to and applied as self-standing guidance. For this purpose and to improve accessibility, each chapter begins with a short summary explanation of its aim and contents so it can be read in isolation depending on the needs of the audience.

e. Dissemination and feedback

The parties to the Water Convention and international organizations can play an important role in the dissemination of the Handbook and putting it into practice and future use by governments. Feedback on the Handbook and its use in practice can be sent to the Water Convention secretariat: water.convention@un.org. In particular, feedback is encouraged on how the Handbook is applied in practice in different regions and basins globally, including, but not limited to, the steps for operationalizing transboundary water allocation and the main messages.

CHAPTER II: Definitions, Objectives and Components of Transboundary Water Allocation

SUMMARY:
This chapter details the definitions and objectives of water allocation in a transboundary context, and describes the key processes, approaches and mechanisms applicable in allocation arrangements and agreements. It also presents an overview of the core components of international water law, shared knowledge and data, and cooperation at different scales of governance for advancing sustainable and equitable water allocation.

1. Definitions and Objectives of Water Allocation in a Transboundary Context

Simply put, water allocation determines who can use shared water resources, for what purposes, in what quantity and of what quality, where and when. This Handbook takes as its starting point the following set of definitions for transboundary water allocation, building on previous practice and guidance.[19]

Transboundary water allocation is an iterative planning and decision-making process and/or an outcome that determines the quantity, quality and timing of water between two or more States and grants associated entitlements.

Water quantity is most commonly specified as an average volume of water (per year, month or other period) at a certain location. It may also be defined as an average, as a minimum volume, as a percentage of available supplies (a share of flow or of the volume in storage), or by a particular rule on access (e.g. legal right or entitlement to abstract a certain volume under particular circumstances).

Timing relates to daily, monthly, seasonal or inter-annual variabilities and exceptional circumstances, both natural and human induced, in water quantity or quality. In transboundary contexts, this occurs at the border. Velocity of water allocated is a combination of quantity and timing, which concerns the quantity of water passing through the border within a designated time period.

Water quality concerns certain water quality objectives and criteria with associated parameters, including standards and testing, that make water suitable for the intended use.

Transboundary waters means any surface or groundwaters that mark, cross or are located on boundaries between two or more States; wherever transboundary waters flow directly into the sea, these transboundary waters end at a straight line across their respective mouths between points on the low-water line of their banks. This definition comes from the Water Convention (Art. 1(1)) and the Convention incorporates a basin approach to the use and protection of transboundary waters. Another related definition under the Convention is “transboundary impact” (see Art. 1(2) of the Water Convention).

***Transboundary contexts**,* in this Handbook, covers a range of settings where surface waters and groundwaters (including rivers, lakes and aquifers) mark, cross or are located on boundaries between two or more States.

[19] See Water Convention text at https://unece.org/DAM/env/water/publications/WAT_Text/ECE_MP.WAT_41.pdf; Speed and others (2013); OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).

Allocable water is the share of water resources utilizable for abstraction for different uses in the given basin or aquifer area. Ideally, this occurs after flows needed to meet environmental objectives have been reserved.

Water entitlements give rights to different parties to abstract and use water for specific or general purposes. The entitlements may be further allocated to subbasins, regions and, ultimately, individual users who get water abstraction rights, permits, concessions or licences, depending on the jurisdiction.

Objectives of transboundary water allocation are context specific and often interconnected. They include, but are not limited to, those listed below (in no particular order):

- Equitable and reasonable use of shared water resources;
- Avoidance of significant harm to other States and parties;
- Environmental protection;
- Climate change adaptation;
- Management of exceptional circumstances, such as droughts and floods;
- Vital human needs;
- Benefit-sharing.

These different objectives are discussed in further detail in Chapter V.

2. Understanding Water Available for Allocation

Understanding water availability for different needs, uses and functions, in different seasons and climate and in development scenarios, is a key requirement for sustainable and equitable water allocation. In a transboundary context, estimation of allocable water consists of:

1. Delineating and agreeing on the basin and/or aquifer boundaries;
2. Assessing surface water and groundwater availability and quality, considering inter- and intraannual variability and overlap between the two water sources with hydrological and geohydrological analyses utilizing commensurate methods and data;[20]
3. Estimating allocable water in different seasons and in different scenarios.[21]

These different steps and associated methods are presented in more detail in Chapter VII.

The water available for allocation does not equate with the total water amount present in a basin or aquifer, primarily for three reasons. First, water availability may be constrained by hydrological variability, geology or infrastructure. Second, part of the flow is required for maintaining ecosystem and environmental functions. Third, the natural quality of water does not necessarily meet the requirements of different needs, uses and functions, and degraded water quality resulting from human impact such as pollution further limits the use of water for human and environmental needs. On the other hand, alternative water resources may increase the overall water availability within a given area, also for transboundary purposes. Common alternatives,

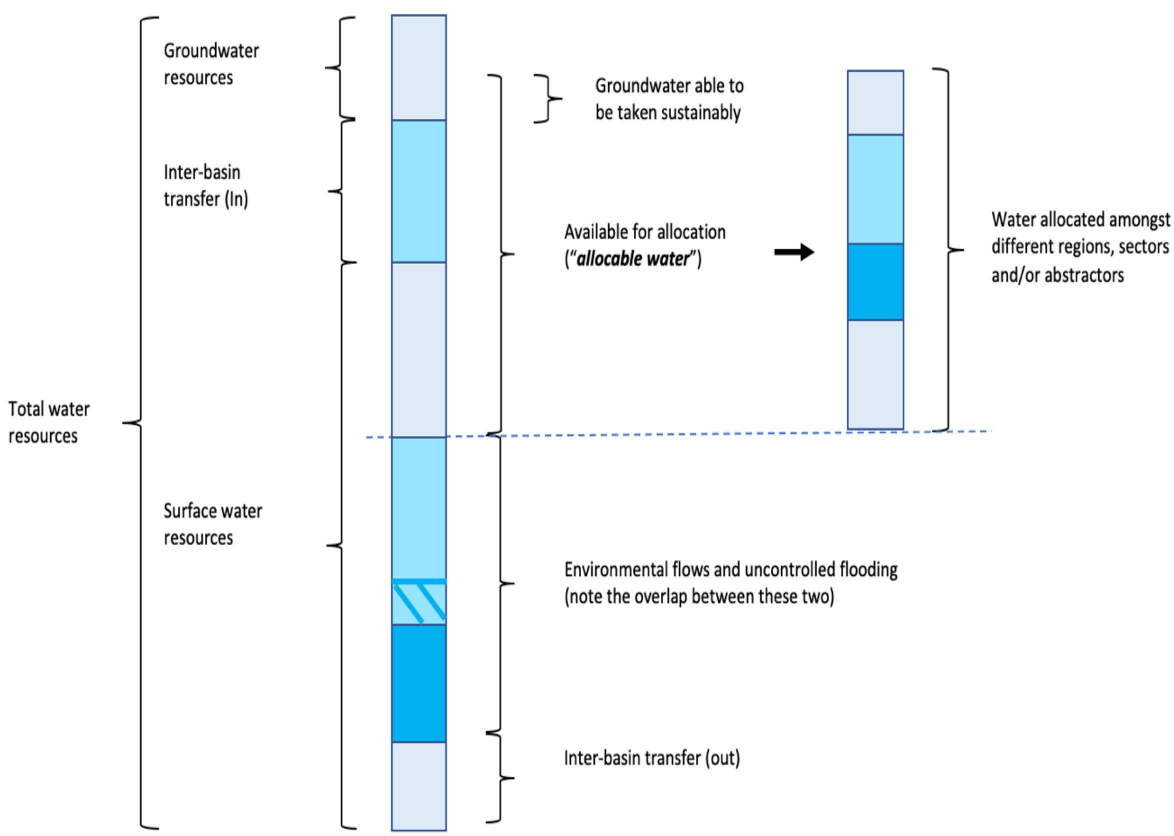
[20] The overlap between river flow and groundwater recharge is largest where groundwater contributes significantly to river flow (i.e. a significant fraction of groundwater recharge is converted into river flow via base flow), which happens in humid areas. The other extreme is in arid areas, where river flow may contribute to groundwater recharge. Not accounting for this overlap may overestimate total renewable, and allocable, freshwater resources.

[21] For general guidelines on assessment of transboundary water resources, see UNECE, *Second Assessment of Transboundary Rivers, Lakes and Groundwaters* (New York and Geneva, United Nations, 2011). For a detailed approach for estimating allocable water, see Speed and others (2013).

which have both advantages and disadvantages, include desalinated water, interbasin transfers[22] and rainwater harvesting. Resource augmentation by, for example, managed aquifer recharge, may also improve availability.

The total water available for allocation is thus the share of water utilizable for abstraction for different uses in the given basin or aquifer area, after the flows needed to meet environmental objectives have been reserved (Figure 3). It should be approached as a dynamic concept and number, however, as both the availability of water resources and water requirements change depending on the season, development trajectory and climate. The issues impacting on allocable water, and the issues water allocation may address, are discussed in more detail in Chapter III.

Figure 3
Total water resources and water available for allocation



Source: Robert Speed and others, *Basin Water Allocation Planning. Principles, Procedures and Approaches for Basin Allocation Planning* (Paris, UNESCO, 2013), p. 102.

[22] It should be noted here that interbasin transfers are "associated with both positive and negative impacts to water-exporting, water-transmitting, and water-importing regions", see Logan Purvis and Ariel Dinar, "Are intra- and inter-basin water transfers a sustainable policy intervention for addressing water scarcity?", *Water Security*, vol. 9 (April 2020), 100077. For further information, see, generally, J. Gupta and P. van der Zaag, "Interbasin water transfers and integrated water resources management: where engineering, science and politics interlock", *Physics and Chemistry of the Earth, Part A: Solid Earth and Geodesy*, vol. 33, No. 1–2 (2008), p. 28–40.

3. Key Processes, Approaches and Mechanisms of Transboundary Water Allocation

Transboundary water allocation processes, as defined**,** are a part of broader cooperation and management systems of shared water resources across, or at, a border. They typically consist of:

1. *Identification* of water issues at stake, water resources availability and distribution and resource use and demand assessments, and identification of current legal status and institutional frameworks in place;
2. *Negotiating* and *establishing* transboundary agreements or arrangements, defining the water allocation approach and mechanism applied;
3. *Implementation*, consisting of legal and policy instruments and mechanisms at different scales, including water laws, monitoring and compliance mechanisms, and entitlements, permits and licences granted to individual or collective water users.[23]

These different elements of allocation processes are elaborated in detail in the following chapters of this Handbook, notably in Chapter III and Chapters V–VIII. This section will look more closely at approaches and mechanisms that can be applied in transboundary water allocation.

BOX 4: Typology for Transboundary Water Allocation methodology

Specific research results presented in this Handbook are part of an analysis done via the International Freshwater Treaties Database (IFTD) regarding global trends in transboundary water allocation mechanisms over time and status at present. This analysis is conducted using the Typology for Transboundary Water Allocation (TTWA) methodology to code agreements contained in the Transboundary Freshwater Dispute Database (TFDD).

Information about the TTWA methodology for analysing each agreement, the coding for all three steps and a summary of the allocation mechanisms using TTWA are contained in the Annex to this Handbook. Additional information can be found on the TFDD website: https://transboundarywaters.science.oregonstate.edu/content/transboundary-freshwater-dispute-database.

It is important to note that both the TTWA methodology and the data set used in conducting this discrete piece of research for the Handbook are one approach to conducting a broad analysis of the global practice of allocation in international freshwater agreements. Other approaches may be used and this research and the Handbook do not advocate for one approach over another. Please also note that the specific categories of allocation determined under the methodology in the text are signified via inverted commas, for example, "agriculture/irrigation".

Allocation mechanisms in international water agreements generally balance theoretical approaches with practical considerations. Approaches to transboundary water allocation shape how States negotiate, establish and develop methods and mechanisms to allocate water. According to research by McCracken and others,[24]

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[23] See also Speed and others (2013); OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).

[24] M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming). The TTWA methodology builds on previous work tracking transboundary water allocation mechanisms, see Jesse H. Hamner and Aaron T. Wolf, "Patterns in international water resource treaties: the Transboundary Freshwater Dispute Database", *Colorado Journal of International Environmental Law and Policy, 1997*

these can be separated into six general categories, as outlined in Table 1 below. These categories are not strictly defined and can overlap, and multiple approaches might influence States during transboundary water allocation processes. Different types of considerations—such as the physical characteristics of the basin (e.g. population, hydrology and climate), goals of intended water use (e.g. navigation, environmental flows, agriculture and other water-intensive industries), economic criteria (e.g. benefit-sharing and balancing of supply and demand) and considerations for future use—may factor into which approaches influence the allocation process. For example, a country's hydrography can have an impact on the amount of water allocated and influence its approach to developing and shaping the allocation mechanism. Basins with high intraannual variability in rainfall might develop an allocation mechanism based on water availability during the wet and dry seasons. Together, theoretical approaches and associated practical considerations guide and shape transboundary water allocation processes and help States determine the specific allocation mechanism that outlines how water is physically allocated.

A number of studies list considerations or criteria that are taken into account in water allocation. One such categorization is provided by McCracken and others (Table 1):

Table 1
Approaches to transboundary water allocation and associated examples of considerations

Approaches to International Water Allocation	Examples of Considerations
Rights-based Approaches: Emphasizes the right to water based on hydrography or historical use; includes the concepts of absolute sovereignty and integrity.	Hydrography, historical use
Needs-based Approaches: Establishes allocation based on a riparian's needs rather than what they perceive to be their right. Needs can be based on various criteria, such as population or irrigable land area.	Population, irrigable land, future development, energy demand and consumption
Hierarchy-based Approaches: Allocates water based on priority. Most commonly, different sectors or uses are given priority (e.g. drinking water, agriculture), but this could also give hierarchy to historical, existing, or future uses.	Multiple types of hierarchies, for example: - Sectoral hierarchies: municipal, agricultural, industrial requirements - Temporally established hierarchies: previous, existing or future requirements
Proportionate Division Approaches: Allocation based on the physical division of water, either implicitly or explicitly.	Equal amounts of water per capita, absolute equality, or other proportion between riparians, based on temporal patterns, volume or percentage of water resources
Strategic Development Approaches: Allocates water by balancing competing needs. For example, this could include balancing economic development and environmental needs through the use of alternative scenarios, risk assessments and addressing uncertainty.	Future needs, considering multiple goals or needs, including but not limited to population growth, environmental, economic, development and risk-mitigation interests in a broader context; this can include plans for water use in an explicitly future-

Yearbook, No. 157 (1997); Mark Giordano and others, "A review of the evolution and state of transboundary freshwater treaties", *International Environmental Agreements: Politics, Law and Economics*, vol. 14, No. 3 (2014), p. 245–264.). The typology is based on overarching theoretical approaches that have shaped the allocation of transboundary waters, as well as examples of considerations that can be used to interpret and apply these approaches when developing an allocation mechanism. Moreover, the allocation mechanisms in the TTWA also take into account theoretical approaches to allocation and their respective considerations, as described below. Furthermore, the methodology also enables the comparison of the type of mechanism, such as direct, indirect, principle based and groundwater specific. The results of this analysis of past and present international freshwater agreements—spanning from the mid-1800s to the present—using the TTWA methodology has been highlighted in the text of the Handbook. This analysis accompanies a broader update, spanning the period 1820 to 2020 of the IFTD, which is in process and will be published in McCracken and others, "Typology for transboundary water allocation" (forthcoming).

	focused context and can include benefit-sharing outside of water resources to balance multiple needs and goals for a region
Market-based Approaches: Allocates water by market, based on the economic value it generates in different economic activities.	Supply vs. demand balance, efficiency, equity

Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

Specific allocation mechanisms in negotiated transboundary agreements can take various forms. This determines how water is physically allocated, divided or distributed between States. Allocation mechanisms take into consideration several criteria and the same research by McCracken and others (forthcoming) highlights examples of explanatory components, including fixed quantity, prior utilization and water loans. Examples of context components include agriculture/irrigation, hydropower and environmental flows. It must be noted that these are not exclusive categories and an allocation mechanism can satisfy multiple explanatory and context components.

Table 2
General approaches, associated explanatory mechanisms and example allocation agreements

Approaches	Explanatory Mechanism	Example
Rights-based Approach	Fixed quantity; allocation of entire/partial rivers; historical or existing use	Agreement between Iran and Iraq concerning the use of frontier watercourses, and protocol
Needs-based Approach	Fixed quantity; percentage of flow; prioritization of use	Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Swaziland for co-operation on the protection and sustainable utilisation of the water resources of the Incomati and Maputo watercourses
Hierarchy Approach	Prioritization of use; historical or existing use	Treaty between Great Britain and the United States relating to Boundary Waters and Boundary Questions, signed at Washington
Proportionate Division	Fixed quantity; percentage of flow; equal division	An agreement between the Syrian Arab Republic and the Lebanese Republic for the sharing of the Great Southern River Basin water and building of joint dam on the main course of the river
Strategic Development	Variable by water availability; water loans; prioritization of use; benefits-sharing; sustainable use	Treaty between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on cooperation in the field of protection and sustainable development of the Dniester River Basin
Market-based	Market-based mechanism	Issue of new water entitlements through an auction/tender process in Queensland, Australia.

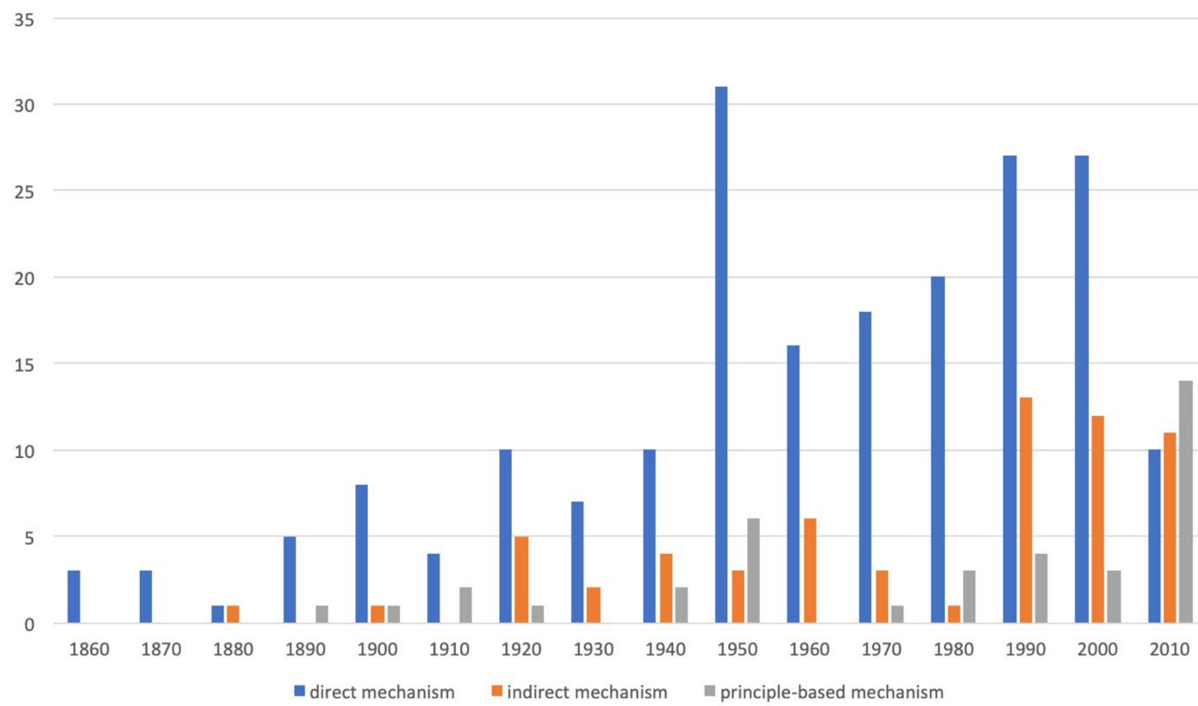
Source: McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

Note: An example agreement is provided for each theoretical approach that contains an explanatory mechanism that could be associated with that approach.

Table 2 lists the theoretical approaches to transboundary water allocation processes, examples of how water might be allocated, and an example treaty that could have been informed by that approach based on the type of allocation mechanism included in the agreement. Explanatory components can be used within more than one approach, such as fixed quantity. For example, a State can identify a specific volume of water it requires based on its rights, needs or hierarchy of uses. The theoretical approach, therefore, influences how the volume of water allocated is arrived at, as well as how the State might present an argument for requiring this volume in a negotiation.

While a detailed discussion of the global trends in the types of allocation mechanisms—how and why water is allocated, as categorized by the method applied—is included in Chapter VI, section 1, there are some general trends worth noting here. Within the method, the explanatory mechanism can be separated into three broad groups: direct mechanisms, indirect mechanisms and principle-based mechanisms.[25]

Figure 4
Global trends in the type of allocation mechanism over time



Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).
Note: The number of agreements with a direct, indirect or principle-based allocation mechanism is separated by decade spanning the 1860s to the 2010s. Also note that the 2010 decade is partial and only summarizes the period from 2010–2017, not the entire 2010–2019 decade, due to data availability and update timing.

Direct mechanisms explicitly define a means for physically dividing water, such as a fixed volume or percentage of flow. Indirect mechanisms establish a procedure for determining the allocations, for example, prioritization of uses or through a joint body. Treaties can also establish mechanisms based on principles that guide States in developing allocation mechanisms, for example, historical use or equitable use. Historically, States tend to establish agreements that directly allocate water through a measurable means (direct

[25] Alena Drieschova, Mark Giordano and Itay Fischhendler, "Governance mechanisms to address flow variability in water treaties", *Global Environmental Change*, vol. 18, No. 2 (May 2018), p. 285–295; Giordano and others (2014).

mechanisms), as shown in Figure 4. While still evident in older agreements, indirect mechanisms and principle-based mechanisms have become more common in recent decades, with both indirect and principle-based mechanisms exceeding direct mechanisms in the 2010s. This trend illustrates a shift towards approaches that manage water allocation rather than directly allocating water itself. Furthermore, it shows how treaties have shifted from defining specific regulations towards establishing management procedures and principles.

4. Basis of Water Allocation in International Water Law

International law concerning transboundary rivers, lakes and aquifers (international water law) constitutes the overall framework and foundation for transboundary water management and cooperation. Transboundary water allocation arrangements therefore fall within, and are shaped by, international water law, including general international law (treaty and custom) relevant to transboundary waters, and more specific treaty practice between and among States sharing transboundary rivers, lakes and aquifers. In general, several key principles of international water law are today regarded as having developed into customary law rules, including the principle of cooperation that is the foundation for effective water allocation in a transboundary context.[26]

The key international legal principles and rules governing transboundary rivers, lakes and aquifers can be found in customary international law, treaties (bilateral, subbasin, basin) and regional agreements—such as the Revised Protocol on Shared Watercourses in the Southern African Development Community (SADC Revised Protocol) of 2000—applicable to transboundary waters, and in the two global international water law frameworks: the Water Convention and the 1997 Convention on the Law of the Non-navigational Uses of International Watercourses (Watercourses Convention), collectively referred to as "the United Nations (or UN) global water conventions". The 2008 Draft Articles on the Law of Transboundary Aquifers provides further guidance on transboundary groundwater resources.[27]

The United Nations global water conventions reflect the main principles of international customary law on transboundary freshwater resources. As with the Watercourses Convention, the Water Convention's three-pillar normative structure includes: i) the obligation to prevent, control and reduce significant transboundary impact (the so-called "no-harm rule"); ii) the equitable and reasonable utilization principle; and iii) the principle of cooperation—all of which are part of customary international law. While transboundary water allocation is not directly and explicitly addressed in the United Nations global water conventions, both provide guiding legal frameworks (and certain obligations as per international customary law) relevant for the establishment and maintenance of transboundary water allocation arrangements, as discussed and illustrated in Chapters V, VI and VIII of this Handbook.

5. Cooperative Frameworks and Scales of Governance for Water Allocation

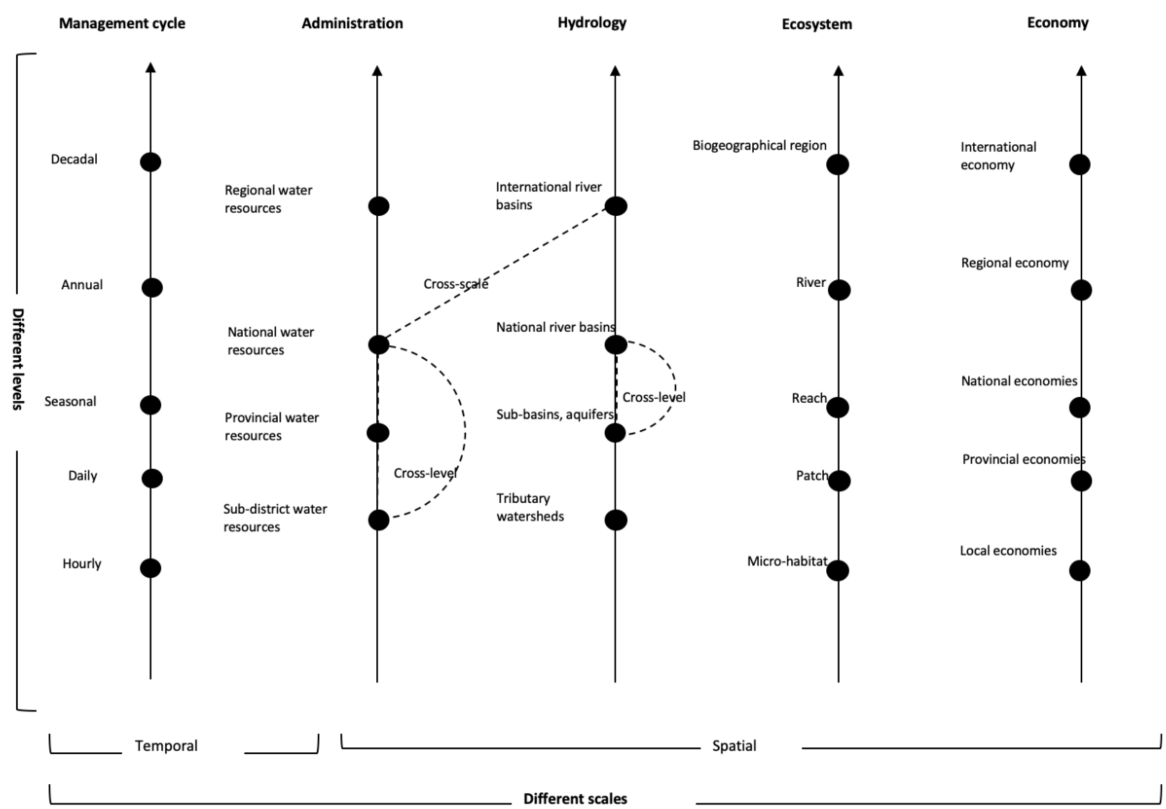
Usually, transboundary water allocations are first made based on area, for example, States, subcatchments or administrative areas, and thereafter further divided based on purpose of water use, for example, of sectoral user groups, or for irrigation or other water supply schemes. In international water bodies, the management scales are often nested: while transboundary allocation is agreed between the countries, each country then

[26] See, for example, Owen McIntyre, "Substantive rules of international water law", in *Routledge Handbook of Water Law and Policy*, Alistair Rieu-Clarke, Andrew Allan and Sarah Hendry, eds. (London, United Kingdom, Routledge, 2017), p. 234–246.
[27] See, for example, Francesco Sindico, *International Law and Transboundary Aquifers* (Cheltenham, United Kingdom, Edward Elgar, 2020).

implements the arrangement and agreements by applying its own allocation schemes based on its own national policies and legislation. As has been described, "[w]ater-related decision-making is often complex and necessarily should take into account many different scale and level perspectives; deliberation is a way of coping with this complexity and contributing to ensuring that negotiations and policy making is better informed than might otherwise be the case. Rarely does a single scale or level have the sole claim to legitimacy. A key strength of deliberation is that it can ensure that different scale and level perspectives are heard and competing logics are examined."[28] (See Figure 5 for a visual representation of interaction between levels and scales in transboundary water allocation).

Bilateral, subbasin and basin treaties relevant to transboundary waters are a primary means to establish specific inter-State provisions for water allocation in a transboundary context. Such treaties and agreements may include, for example, provisions on water allocation methods and data and information exchange, which may incorporate criteria, procedures and exceptions, for example. While it is also possible that a particular transboundary water agreement does not specifically and/or explicitly address the issue of allocation, it may provide the foundations to develop allocation mechanisms, by more generally providing a basis for cooperation and facilitating joint water management between/among the States sharing a particular river, lake or aquifer.

Figure 5
Example of interaction between levels and scales in transboundary water allocation



Source: John Dore and Louis Lebel, "Deliberation and scale in Mekong water governance", *Environmental Management*, vol. 46, No. 1 (July 2010), p. 62.

[28] John Dore and Louis Lebel, "Deliberation and scale in Mekong water governance", *Environmental Management*, vol. 46, No. 1 (July 2010), p. 62.

The actual operationalization and implementation of water allocation takes place within defined jurisdictions, such as at the national and subnational levels. National-level water allocation or State-level water allocation typically sets the context for, and informs the needs for, transboundary water allocation. Depending on the State system, national-level water allocation is further divided into basin-level and regional water allocation. It usually allocates the transboundary shares to subnational jurisdictions, administrative regions and management entities that decide and grant water entitlements, permits and licences to individual water users and abstractors. While each national context is different, having some general guidelines and principles on water allocation at both national and subnational levels facilitates fluent cooperation on water allocation. Many of the international water law principles are transferable also at the national and subnational levels in federal States with transboundary waters and applicable via incorporation into domestic legislation.[29] The general steps/elements for operationalizing transboundary water allocation are presented in Chapter VIII.

CASE STUDY 1: United States of America and Mexico transboundary water allocation on the Colorado River and Rio Grande: the 1944 Water Distribution Treaty[30]

The United States and Mexico established the International Boundary Commission (IBC) on 1 March 1889 as another temporary body to apply the rules that were adopted by the Convention between the United States of America and the United States of Mexico Touching the International Boundary Line Where it Follows the Bed of the Rio Colorado, 1884. The IBC was extended indefinitely in 1900 and is considered the direct predecessor to the modern-day International Boundary and Water Commission.

The United States and Mexico used studies developed by the IBC as the basis for the first water distribution treaty between the two countries, the Convention between the United States and Mexico: Equitable Distribution of the Waters of the Rio Grande, 1906, which allocated the waters of the Rio Grande from El Paso to Fort Quitman, an 89-mile (143 km) international boundary reach of the Rio Grande through the El Paso-Juárez Valley. This Convention allotted to Mexico 60,000 acre-feet annually of the waters of the Rio Grande to be delivered in accordance with a monthly schedule at the headgate to Mexico's Acequia Madre just above Juárez, Chihuahua. To facilitate such deliveries, the United States constructed, at its expense, the Elephant Butte Dam in its territory. The Convention includes the provision that in the event of extraordinary drought or serious accident to the irrigation system in the United States, the amount of water delivered to the Mexican Canal shall be diminished in the same proportion as the water delivered to lands under the irrigation system in the United States downstream of Elephant Butte Dam.

The IBC was also instrumental in developing the second water distribution treaty between the United States and Mexico in 1944, which addressed utilization of the waters of the Colorado River and Rio Grande from Fort Quitman, Texas to the Gulf of Mexico. The Water Treaty of 3 February 1944 expanded the duties and responsibilities of the IBC and renamed it the International Boundary and Water Commission (IBWC). The 1944 Treaty charged the IBWC with the application of the Treaty and the exercise of the rights and obligations which the United States and Mexican Governments assumed thereunder and with the settlement of all disputes that were to arise under the Treaty.

Of the waters of the Rio Grande, the Treaty allocates to Mexico:

a) The totality of the waters that reach the main current of the Rio Grande (Rio Grande), the rivers San Juan and Álamo; including the returns from the lands that irrigate these last two rivers.
b) Half of the runoff from the main channel of the Rio Grande (Rio Grande) below the main lower international storage dam, provided that such runoff is not expressly assigned in this Agreement to either of the two countries.
c) Two-thirds of the flow that reaches the main current of the Rio Bravo (Grande) from the Conchos, San Diego, San Rodrigo, Escondido and Salado and Arroyo de Las Vacas rivers, in accordance with the provisions of subsection c) of what is allocated to the United States.

[29] See, generally, for example, Dante A. Caponera and Marcella Nanni, *Principles of Water Law and Administration: National and International*, 3rd ed. (London, United Kingdom, Routledge, 2019).
[30] Source: International Boundary and Water Commission (www.ibwc.gov/About_Us/history.html). United States and Mexican Government officials were given the opportunity to update the text.

d) Half of any other runoff in the main channel of the Rio Grande (Rio Grande), not specifically assigned in this article, and half of the contributions of all non-gauged tributaries - which are those not named in this article- between Fort Quitman and the International Main Lower Dam.

The Treaty allots to the United States:

a) All the waters that reach the main current of the Rio Grande (Rio Grande) from the Pecos, Devils, Goodenough spring and Alamito, Terlingua, San Felipe and Pinto streams.
b) Half of the runoff from the main channel of the Rio Grande (Rio Grande) below the main lower international storage dam, provided that such runoff is not expressly assigned in this Agreement to either of the two countries.
c) One third of the water that reaches the main current of the Rio Bravo (Grande) from the Conchos, San Diego, San Rodrigo, Escondido, Salado and Arroyo de Las Vacas rivers; third part that will not be less altogether, on average and in cycles of five consecutive years, of 431,721,000 cubic meters (350,000 acre feet) per year. The United States shall not acquire any rights for the use of the waters of the tributaries mentioned in this subsection in excess of the aforementioned 431,721,000 cubic meters (350,000 acre feet), except the right to use the third part of the runoff that arrives to the Rio Grande (Grande) of said tributaries, although it exceeds the aforementioned volume.
d) Half of any other runoff in the main channel of the Rio Grande (Rio Grande), not specifically assigned in this article, and half of the contributions of all non-gauged tributaries - which are those not named in this article - between Fort Quitman and the International Main Lower Dam.

In cases of extraordinary drought or serious accident in the hydraulic systems of the gauged Mexican tributaries that make it difficult for Mexico to deliver the 431,721,000 m^3 (350,000 acre-feet) per year that are allocated to the United States as the minimum contribution of the aforementioned Mexican tributaries, in subsection c) of paragraph B of this article, the shortages that exist at the end of the aforementioned five-year cycle will be replenished in the following cycle with water from the same tributaries.

As long as the useful capacity allocated to the United States of at least two of the major international dams, including the one located further upstream, is filled with waters belonging to the United States, it will be considered ending a five-year cycle and all debts fully paid, beginning, from that moment, a new cycle.

The 1944 Treaty further provided for the two Governments to jointly construct, operate and maintain on the main channel of the Rio Grande the dams required for the conservation, storage and regulation of the greatest quantity of the annual flow of the river to enable each country to make optimum use of its allotted waters.

The 1944 Treaty provides that of the waters of the Colorado River there are allotted to Mexico:

a) A guaranteed volume of 1,850,234,000 cubic meters (1,500,000 acre feet) each year, to be delivered in accordance with the provisions of Article 15 of this Agreement;
b) Any other volumes that reach the Mexican derivation points; on the understanding that, in the opinion of the United States Section, in any year there is water in the Colorado River in excess of that necessary to supply consumption in the United States and the volume guaranteed annually to Mexico of 1,850,234,000 cubic meters (1,500,000 acre feet), the United States undertakes to deliver to Mexico, as established in Article 15 of this Agreement, additional quantities of water from the Colorado River system up to a total volume not exceeding 2,096,931,000 cubic meters (1,700,000 acre feet) annually.

Mexico will not acquire any right, other than that conferred by this subsection, for the use of the waters of the Colorado River system for any purpose, in excess of 1,850,234,000 cubic meters (1,500,000 acre feet) per year.

In cases of extraordinary drought or serious accident to the irrigation system of the United States, which makes it difficult for it to deliver the guaranteed amount of 1,850,234,000 cubic meters (1,500,000 acre feet), per year, the water assigned to Mexico, according to Subparagraph a) of this article, will be reduced in the same proportion in which consumption is reduced in the United States.

To enable diversion of Mexico's allotted waters, the Treaty provided for the construction by Mexico of a main diversion structure in the Colorado River, below the point where the California–Baja California land boundary line intersects the river. It also provided for the construction at Mexico's expense of such works as may be needed in the United States to protect its lands from such floods and seepage as might result from the construction and operation of the diversion structure.

6. Shared Knowledge and Data for Water Allocation

Sustainable and equitable transboundary water allocation planning and agreements are best supported by a shared knowledge base, commensurate data and well-functioning monitoring and information-sharing systems. Ideally, harmonized and comparable assessment and monitoring methods, data management systems and uniform reporting procedures can provide a common ground for deliberation, planning, negotiating, decision-making and operational water management.[31] They are built on the regular and systematic collection of sufficient quality-controlled data and represent a necessary basis for reliably assessing and monitoring shared water resources and understanding different needs, uses and functions, which can in turn inform water allocation arrangements.

More specifically, shared knowledge and data may relate to: assessment of available surface water and groundwater resources; potential for augmentation of resources (water reuse, desalinization, rainwater harvesting, managed aquifer recharge, etc.); determining needs of the environment, sectors and States in different development scenarios, and supply and demand management options, and the development of technical and management tools for water allocation, monitoring and compliance. This component is dealt with in greater detail in Chapter VII.

[31] UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (New York and Geneva, United Nations, 2006).

CHAPTER III: Issues Water Allocation Can Address

SUMMARY:
This chapter first discusses the main drivers of water management challenges today and in the future—particularly the need to respond to increased and competing demands for water and water-related services—and the resulting pressures on available water resources. It then examines how allocation approaches and frameworks can seek to address these challenges of water availability, variability and uncertainty, focusing particularly on interventions in transboundary contexts. Methods for balancing various water uses and needs when planning and implementing transboundary water allocation and potential reallocation are then proposed, including balancing historical, current and future uses.

1. Understanding the Drivers and Roles of Water Allocation in a Transboundary Context

Increased and competing demands for water and water-related services and the resulting pressures on the available water resources have resulted in growing attention towards water allocation during the past decades. The key driver behind the interest in water allocation globally has been the overall and ongoing growth in water abstractions, primarily due to population growth, economic development and changing consumption patterns. Basin "closure", i.e. complete allocation of all available water resources, is an increasingly common problem in many parts of the world. Due to higher water demand, there is also greater interaction between depletion and pollution of both surface and groundwater sources.[32] Water allocation can thus play an important role in addressing these major water issues of today and the future, many of which cross State and national borders. Moreover, it can be stated that "[a]ppropriate water allocation results in more socially and economically beneficial use of the resource while protecting the environment. Unsuitable or ineffective approaches drive water stress. Understanding water rights and water allocation is therefore key to understanding the solutions to global water stress".[33]

From the outset, water allocation must not be viewed as a race to delineate and claim access to the world's increasingly scarce and degraded freshwater resources. Rather, water allocation is one method of addressing water challenges in seeking to achieve more effective, sustainable and equitable integrated water resources management (IWRM). As emphasized in Chapter II, water allocation approaches, mechanisms and arrangements are best applied as a part of broader basin-level planning, management and transboundary cooperation. In many instances, demand management measures, efficiency improvements or finding alternatives from benefit-sharing can complement supply-focused allocation solutions towards achieving effective IWRM (see also Chapter IV). Moreover, environmental protection is increasingly central to allocation frameworks. In a survey of 27 Organisation for Economic Co-operation and Development (OECD) and key partner countries in 2015, environmental protection, or meeting ecosystem requirements, was the most frequently cited driver for both recent and ongoing national allocation reforms. It was followed by economic development, while equity in access to water, water quality concerns, climate change mitigation and adaptation, and the need to address water scarcity all featured in more than half of the cases as well.[34] Transboundary water allocation is not and should not be considered a zero-sum game for available resources.

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[32] Speed and others (2013).
[33] Tom Le Quesne, Guy Pegram and Constantin Von Der Heyden, "Allocating scarce water: a primer on water allocation, water rights and water markets", WWF Water Security Series, No. 1 (Godalming, United Kingdom, WWF-UK, 2007), p. 10.
[34] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).

As a necessary basis for allocation decision-making, this chapter first discusses availability and variability of water resources now and in the future, including the outlook on climate change and exceptional circumstances such as droughts and floods. It will then present the different water use needs and functions with their associated characteristics that need to be taken into account when allocating water. The chapter also highlights the importance of understanding and addressing different factors impacting on allocable water, including water infrastructure, water scarcity, and water quality and environmental degradation. To conclude, the chapter discusses the importance of considering historical, current and future uses and balancing different water uses and needs.

2. Availability, Variability and Associated Uncertainty: Now and in the Future

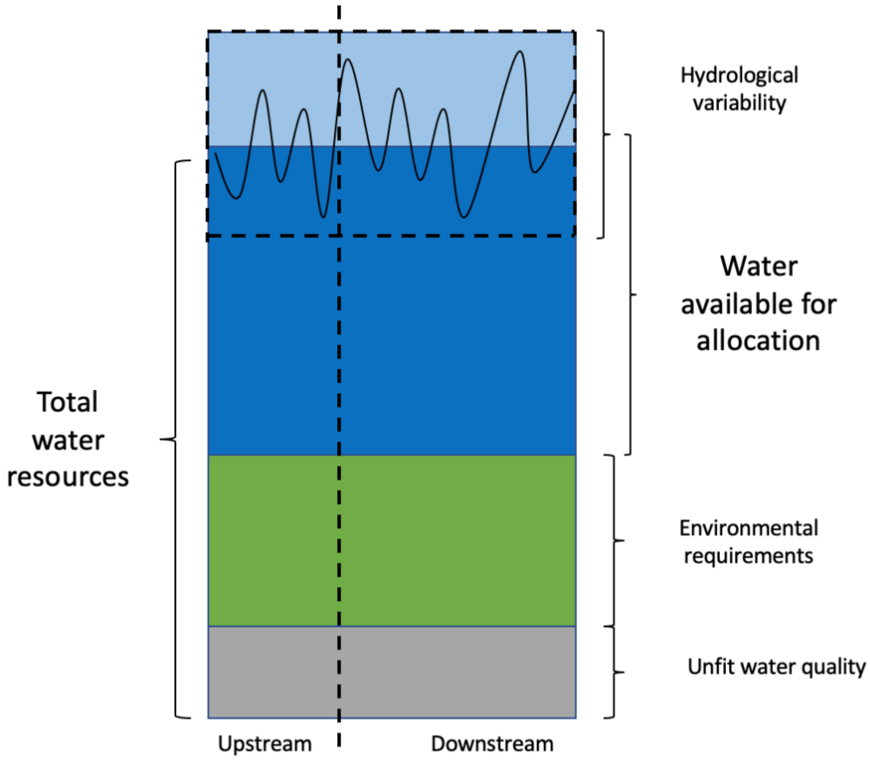
a. Availability of surface and groundwater resources

Availability of freshwater resources for allocation in a transboundary context generally depends on the availability of renewable surface and groundwater sources (see Figure 6). Many different factors impact on water availability. Human activities directly affecting the availability of surface water resources for allocation consist of abstraction and water use, which may further be divided into non-consumptive and consumptive uses. Non-consumptive uses are generally described as releasing water back to the source after use or not abstracting water for use at all (e.g. recreation at water bodies, navigation) while consumptive uses remove the water from local sources (e.g. via irrigation and evapotranspiration in agriculture). However, change in the quality of the water released back to the source also effectively limits its reuse, too (for a detailed description on consumptive and non-consumptive uses, see subsection 3b below). In addition, water infrastructure, depending on its coverage and efficiency or leakage ratio, may further increase or decrease surface water availability. Climate change, water quality and ecosystem health also impact on availability, as detailed later in this chapter.

Aquifers are usually connected to surface water systems, which has implications for overall water availability. In areas with significant connectivity between surface and groundwater, high levels of groundwater abstraction can affect the availability of surface water as groundwater provides significant contributions to streamflow. The implications of this are twofold: first, assuring minimum water flows in a stream, e.g. for environmental flows (see subsection 3a of this chapter) requires control of groundwater allocations and abstractions; second, water allocation may be contingent on the level of depletion of groundwater resources in a transboundary setting, and may favour a shift from groundwater to surface water reliance or to one of enhanced/managed aquifer recharge.[35] Due to their non-renewable nature, fossil transboundary aquifers require careful consideration and assessment in their use and management in the specific context, including whether alternative water sources are available or not.[36]

[35] Aditya Sood and others, "Global environmental flow information for the Sustainable Development Goals", IWMI Research Report, No. 168 (Colombo, Sri Lanka, International Water Management Institute, 2017).
[36] UNESCO, "Non-renewable groundwater resources: a guidebook on socially-sustainable management for water-policy makers", Stephen Foster and Daniel P. Loucks, eds., IHP-VI Series on Groundwater, No. 10 (Paris, 2006).

Figure 6
Simplified diagram of available water and water for allocation in a transboundary context



Source: Organisation for Economic Co-operation and Development (OECD), *Water Resources Allocation: Sharing Risks and Opportunities*, OECD Studies on Water (Paris, 2015) (modified).

CASE STUDY 2: Spatial limitations to abstracting non-renewable groundwater from the Saq–Disi aquifer

The Saq–Disi sandstone aquifer (estimated area 308,000 km^2), shared by Jordan and Saudi Arabia, supplies water through the Disi water transport project (350 km) to Amman and other governorates in Jordan. Saudi Arabia uses the same basin to supply Tabuk and other cities, in addition to agricultural uses. Already significant in the 1980s, abstraction in more recent decades has increased. In the past decade, migration of large numbers of Syrian refugees into Jordan exacerbated the need for water. With the objective of achieving long-term sustainable management of this transboundary groundwater source with a low rate of contemporary renewal, the aquifer-sharing countries signed an agreement in 2015. More specifically, the agreement determines, first, protected areas in both countries—some 50 km long and 10 km (in Jordan) or 20 km wide (in Saudi Arabia)—where no groundwater investment projects are allowed, and second, managed areas where restricted, mutually agreed drilling standards are applied to reduce the effects on declining water level and on water quality. Moreover, in the managed areas, injection of any contaminant is prohibited in order to protect groundwater.

A technical committee that emanated from the Saudi Arabia–Jordan Joint Water Committee is to supervise the implementation of the provisions, monitor groundwater (withdrawal, water levels and quality) as well as collect and analyse data, information and studies. Among future challenges in this mainly arid zone is the severe drawdown in the water level that gradually reduces the aquifer's capacity to provide water while demands have increased. The depletion has led to restricting groundwater use from Saq–Disi aquifer for household and drinking water purposes only. Other water sources are being developed in the countries, including desalinization and water reuse, although these are not part of the agreement's scope.

Groundwater availability is predominantly affected by human activities and access to the aquifer systems, including availability of appropriate infrastructure and technology. Due to climate change, groundwater demand is expected to grow further in certain regions around the world, due to the higher demand for, and temporal variability of, surface water flows.[37] In various regions, groundwater is a more important source of water supply than surface water. With 592 transboundary aquifers identified globally, groundwater provides drinking water to at least 50 per cent of the global population and constitutes 43 per cent of the global irrigation water use.[38] At the same time, 20 per cent of the world's aquifers are estimated to be overexploited and many of them are contaminated.[39] Groundwater rights may also be less well defined, or not enforced, compared with surface water rights, implying that groundwater may be exploited at the expense of surface water in the vicinity of shared transboundary water courses, with indirect implications for surface water availability.[40] Increases in groundwater abstraction coupled with shifts of increasing variability in aquifer recharge have further highlighted the need for the conjunctive management and regulation of surface and groundwater systems.[41]

Alternative water resources may increase the volume of surface and groundwater available in a given State, in another area or for a specific user, and thus indirectly contribute to the overall volume allocable with other parties. Examples of alternative water resources include interbasin water transfers,[42] managed aquifer recharge (groundwater recharge enhancement), desalinated water, harvested rainwater, non-renewable groundwater, return water in irrigation, reclaimed and recycled wastewater, and utilizing soil water or precipitation in areas previously irrigated. It should be noted, however, that given the externality of many of these alternatives, their use can potentially increase the stress or scarcity of water availability in other basins.

b. Managing temporal and spatial variability in transboundary water allocation

Natural hydroclimatic conditions form the basis of available water resources of a region (e.g. dry or humid). Water resources availability varies *intraannually* (between seasons) and *inter-annually* (between years), over decades and longer periods of time, due to climate oscillations. Hydrological flow regimes, and thus availability of water for allocation, are influenced by the main water sources. Snowmelt sources commonly have a pronounced spring flooding period, whereas in glacier-fed rivers from high mountains a higher flow is better sustained over time. Rivers with an important base flow from groundwater, or with big lakes in their basin, are more stable providers of water.[43] Hydroclimatic shifts to these flow regimes may be the result of natural variation or driven by human activities. Human-induced shifts are exemplified globally by climate change and regionally, for example, by changes in land cover due to deforestation, afforestation, agriculture or urbanization resulting in changes in run-off, infiltration and evapotranspiration.

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[37] Richard G. Taylor and others, "Groundwater and climate change", *Nature Climate Change*, vol. 3 (2013), p. 322–329.
[38] IGRAC, "Transboundary aquifers of the world map", 2015.
[39] Tom Gleeson and others, "Water balance of global aquifers revealed by groundwater footprint", *Nature*, vol. 488 (2012), p. 197–200.
[40] Richard Owen, *Groundwater Needs Assessment: Limpopo Basin Commission LIMCOM* (n.p., Southern African Development Community; BGR; Africa Groundwater Network; Waternet, 2011).
[41] Jonathan Lautze and others, "Conjunctive management of surface and groundwater in transboundary watercourses: a first assessment", *Water Policy*, vol. 20, No. 1 (2018), p. 1–20.
[42] It should be noted here that interbasin transfers are "associated with both positive and negative impacts to water-exporting, water-transmitting, and water-importing regions", see Purvis and Dinar (2020). For further information, see, generally, Gupta and van der Zaag (2008); C. D. Snaddon, B. R. Davies and M. J. Wishart, "A global overview of inter-basin water transfer schemes, with an appraisal of their ecological, socio-economic and socio-political implications, and recommendations for their management", TT 120/00 (Pretoria, Water Research Commission, 1999).
[43] UNECE, *Second Assessment of Transboundary Rivers, Lakes and Groundwaters* (2011).

Managing temporal variability and trends in water resources availability for transboundary water allocation requires long historical series, as well as: availability, access and sharing of data; solid understanding of different water resources and their uses and changing demands; allocation mechanisms that are flexible and adaptable to adjust to and cope with shifts in hydroclimatic patterns, including exceptional circumstances such as droughts and floods; integration of appropriate conflict resolution mechanisms or dispute resolution processes; and fit-for-purpose infrastructure for both surface and groundwater (e.g. dams and reservoirs, and managed aquifer recharge), as detailed below.

Besides temporal variations, upstream–downstream basin positions are spatial factors resulting in differences in the surface water available for allocation in transboundary contexts. Impacts of climate change and exceptional circumstances, such as droughts and flooding, also typically vary in different parts of large river basins. Addressing the resulting issues in a way that respects the principles of equitable and reasonable utilization and no harm is at the very heart of transboundary water allocation and broader cooperation, as discussed in other sections of this Handbook. In some aquifers, most of the groundwater recharge may occur in one country, whereas the groundwater may be extensively abstracted in the other areas. It is thus also necessary to consider groundwater recharge and its effects on surface water availability in allocation arrangements.[44]

c. Climate change as a cross-cutting challenge

Impacts of climate change on water resources

Climate change is unequivocally a major challenge for water resource use and allocation throughout the world.[45] The impacts of climate change are primarily felt via changes in the hydrological cycle.[46] Climate change causes shifts in timing, location, amount and forms of precipitation (both in mean precipitation and between seasons and years), affects mean annual stream flows and increases the frequency and intensity of extreme events such as droughts and floods. Climate change impacts on water resources are thus both episodic, such as extreme weather events like droughts and floods, long term and permanent, as evident in changes in flow regimes and absolute water balances (Figure 7).[47]

Rising temperatures increase surface water evaporation, evapotranspiration from vegetation affecting agricultural water use and glacial ice melt, for example. Glacial melting in the world's major mountain ranges, the sources of rivers supplying 1.5 billion people worldwide, may temporarily provide more water downstream but deplete those water towers over time.[48] Some areas in the world may experience wetter conditions due to climate change, but those often come with their own challenges and trickle-down effects such as increases in flooding and nutrient leaching from land. Climate change further affects the availability and condition of freshwater resources by aggravating other growing pressures on water resources such as water scarcity, deteriorating water quality and ecosystem degradation.[49] It thus also complicates achieving the target of SDG 6 of ensuring safe and sustainable access to water for all.[50]

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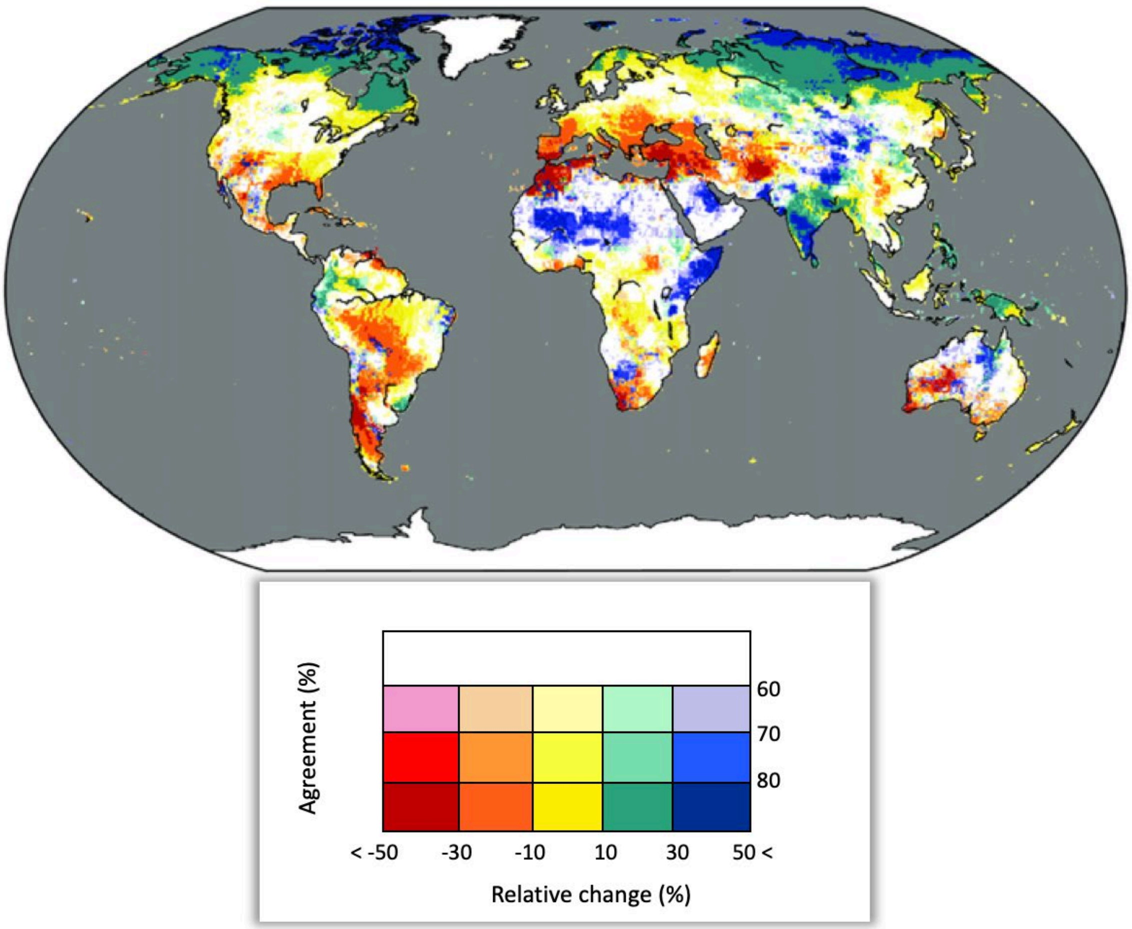
[44] Speed and others (2013).
[45] UNESCO WWAP, *The United Nations World Water Development Report 2020*.
[46] OECD, *Water and Climate Change Adaptation: Policies to Navigate Uncharted Water* (Paris, 2013), p. 23.
[47] Jacob Schewe and others, "Multimodel assessment of water scarcity under climate change", *Proceedings of the National Academy of Sciences*, vol. 111, No. 9 (2014), p. 3245–3250; UNECE and International Network of Basin Organisations (INBO), *Water and Climate Change Adaptation in Transboundary Basins: Lessons Learned and Good Practices* (Geneva, United Nations, 2015).
[48] Daniel Viviroli and others, "Increasing dependence of lowland populations on mountain water resources", *Nature Sustainability*, vol. 3 (2020), p. 917–928.
[49] UNESCO WWAP, *The United Nations World Water Development Report 2020*.
[50] See https://sdgs.un.org/goals/goal6.

Figure 7

Percentage change of mean annual streamflow for a global mean temperature rise of 2°C above 1980–2010 levels (2.7°C above pre-industrial levels)



Source: Blanca E. Jiménez Cisneros, Taikan Oki and others, "Chapter 3: Freshwater resources" in C. Field and others, eds., *Climate Change Impacts, Adaptation and Vulnerability Part A* (Cambridge, Cambridge University Press, 2014), p. 229–269.

Note: Colour hues show the multi-model mean change across five general circulation models (GCMs) and 11 global hydrological models (GHMs), and saturation shows the agreement on the sign of change across all 55 GHM–GCM combinations (percentage of model runs agreeing on the sign of change).

Transboundary water resources management and cooperation in a changing climate

The 2015 Paris Agreement to the United Nations Framework Convention on Climate Change and SDG 13[51] both urge countries to collaborate on taking urgent action in combating climate change and its impacts, including both mitigation and adaptation measures. As climate change is expected to alter the desired and actual uses of water, it calls for adaptation measures in water resources management at the national, transboundary and regional scales. Types of adaptation measures include legislative and regulatory instruments (e.g. laws, regulations and agreements based on international conventions), financial and market instruments (e.g. licences, permits and taxes), education and informational instruments (e.g. public awareness campaigns), policy instruments (e.g. intersectoral mechanisms for cooperation and agreement of different sectoral policies, etc.), as well as structural (e.g. flood protection infrastructure) and non-structural (e.g.

[51] See https://sdgs.un.org/goals/goal13.

information exchange and nature-based solutions such as wetland restoration) measures.[52] In practice, examples of adaptation measures can range from demand management strategies, including structural changes in economy (e.g. shift to crops, sectors or technologies using less water), new technical standards (e.g. best available techniques (BAT)), metering and pricing, and introducing other incentives for water-saving and improving water-use efficiency, to trading of water rights[53] and ecosystem conservation and restoration.

Climate change poses the following specific challenges for transboundary IWRM, among others:

- increased uncertainty regarding availability and variability of shared water resources;
- potentially unequal regional distribution in climate-change-induced effects and resulting impacts;
- changing water demands (e.g. agricultural water demands are sensitive to increase in evapotranspiration);
- resulting growing tensions, even in areas where transboundary interaction in the past has been characterized by cooperation;
- worsening of water quality and dissemination of water-related diseases;
- increasing costs for water management, especially if there is a lack of transboundary and cross-sectoral cooperation in prioritizing the adaptation measures.

At the same time, enhanced transboundary cooperation provides many benefits for climate change adaptation. Benefits primarily come in the form of potential for joint climate and socioeconomic scenarios, vulnerability and impact assessments, disaster risk reduction strategies and response measures, reducing uncertainties through exchange of data, sharing costs and benefits, better prioritization of measures and improving/developing broader regional cooperation and dispute settlement mechanisms.[54] Joint bodies are central forums for developing and implementing adaptation strategies, but their operationalization lies with the member countries. Conversely, some national adaptation measures may have transboundary impacts and thus require transboundary cooperation.[55]

Transboundary water allocation in a changing climate

Climate change must be approached as a cross-cutting challenge for effective transboundary allocation. It is a potential risk multiplier that may necessitate adjustment of existing—and careful drafting of any new—transboundary water allocation agreements and arrangements. Ideally, transboundary allocation arrangements should factor in the increased uncertainty, inter- and intraannual variability of precipitation, run-off and, in some cases, step reductions to cope with increasing frequency and extremity of drought and flood events. Measures such as adaptative capacity and flexibility can assist in addressing these issues, as outlined in Chapter V, section 6. Making transboundary allocation arrangements climate resilient also requires strong coordination mechanisms between different levels of governance, sectoral policies and stakeholder groups.[56] They need to be aligned with climate change adaptation and mitigation efforts, taking into account the different water requirements of different energy options, such as hydropower, solar and wind

[52] UNECE, *Guidance on Water and Adaptation to Climate Change* (Geneva, United Nations, 2009).
[53] UNESCO WWAP, *The United Nations World Water Development Report 2020*.
[54] UNECE and INBO (2015).
[55] UNECE, *Guidance on Water and Adaptation to Climate Change* (2009).
[56] See, generally, Garrick, *Water Allocation in Rivers under Pressure* (2015); John Matthews, "The test of time: finding resilience across climate boundaries", in *Green Growth and Water Allocation: Papers presented at a workshop held on 22–23 November 2012 in Wageningen, the Netherlands*, Sophie Primot and others, eds. (n.p., Netherlands National Committee IHP-HWRP; Netherlands National Commission for UNESCO, 2013), p. 119–129.

power and biofuels.[57] Renewable energy can drive sustainable water use and allocation and vice versa when the synergies and trade-offs in the water-food-energy-ecosystem nexus are appropriately addressed.[58]

d. Drought

Impacts of drought in transboundary settings

Drought, along with flooding, is an example of exceptional, though ever more frequent, circumstances that transboundary water allocation needs to address. Drought can refer to prolonged absence or marked deficiency of precipitation over an extended time (meteorological drought), or a deficiency of groundwater, stream water or lake storage (hydrological or blue-water drought), or a deficiency in water stored in the soil or vegetation (agricultural or green-water drought), as consequences of abnormally dry weather periods.[59] Beginning as hydrological events that cause water shortages, how droughts evolve and what their impacts are and who/what they impact on depend on the State and management of human systems.[60] Drought can result in loss of harvest and livestock, food insecurity and decreased domestic water supply that lead to famine, malnutrition, poor hygiene and stunting, with children and women being the most vulnerable. Prolonged drought conditions may cause collapse of social structures and lead to forced migration and be a significant contributing factor to conflict (eg. In Syria).

CASE STUDY 3: Allocation lessons from the United States' governance of intracountry cross-border rivers: drought contingency plan on the Colorado River[61]

Approximately 1,400 miles long and flowing through seven States of the United States and into Mexico, the Colorado River drains roughly one-twelfth of the land area of the contiguous United States. The Colorado River Basin is divided into the Upper and Lower Basins at the Lee Ferry Colorado River Compact Point (Compact Point) located in northern Arizona. The Upper Basin spans portions of Wyoming, Colorado, New Mexico, Utah and northern Arizona. The Lower Basin covers parts of Nevada, Arizona, California, south-western Utah and western New Mexico. The Colorado River also supplies water to parts of the states of Baja California and Sonora in north-western Mexico.

The Colorado River provides water to almost 40 million people and 4 million to 5.5 million acres of farmland. The Upper Colorado River Basin supplies approximately 90 per cent of the water for the entire Basin, primarily from snowmelt run-off. The Lower Basin is arid, with little tributary run-off reaching the mainstream of the Colorado River except during occasional rain events. The Lower Basin depends upon managed use of the Colorado River System to make its surrounding land habitable and productive. Colorado River water is also delivered to areas that lie outside the Basin's hydrologic boundary, including parts of southern California, the east side of the Front Range in Colorado, the west side of the Wasatch Range in Utah, and parts of northern and central New Mexico. In addition, federally recognized tribes hold a substantial amount of quantified and unquantified federal reserved water rights to the Colorado River and its tributaries.

The dams, reservoirs, and canals in the Colorado River System provide storage for regional water supply, facilitate water deliveries, provide flood control benefits, improve navigation and generate hydroelectric power. These facilities are operated in coordination with adjacent or nearby water delivery systems that also provide a variety of other

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[57] UNECE and INBO (2015).

[58] UNECE, *Towards Sustainable Renewable Energy Investment and Deployment: Trade-offs and Opportunities with Water Resources and the Environment*, ECE Energy Series, No. 63 (Geneva, United Nations, 2020).

[59] Paul Sayers and others, *Drought Risk Management: A Strategic Approach* (Paris, UNESCO, 2016).

[60] Dustin E. Garrick and others, "Managing the cascading risks of droughts: institutional adaptation in transboundary river basins", *Earth's Future*, vol. 6 (2018), p. 809–827.

[61] All text constitutes direct quotation from the following United States Government webpages, updated slightly by Government officials: (www.doi.gov/water/owdi.cr.drought/en/index.html; www.drought.gov/news/colorado-river-drought-contingency-planning; www.drought.gov/news/colorado-river-drought-contingency-planning; https://www.usbr.gov/dcp/; www.usbr.gov/newsroom/newsroomold/newsrelease/detail.cfm?RecordID=66103).

economic, cultural and ecological benefits. The Basin's two largest reservoirs, Lake Powell and Lake Mead, hold about 50 million acre-feet of combined storage, which is approximately 83 per cent of the total system storage capacity. This large storage capacity creates a buffer against year-to-year hydrologic variability and longer term drought periods by allowing excess water to be stored during wet years and used during dry years.

Due to year-to-year differences in precipitation and snowmelt, the natural water supply of the Basin is highly variable. Long-term drought such as the Basin has experienced since 2000 reflects natural climate variability coupled with the likely impacts from changing climate. Since most of the Basin's water supply comes from the Upper Basin, drought conditions in the Upper Basin impact on water supply and resources in both the Upper and Lower Basins of the Colorado River.

Since 2000, the Colorado River Basin has experienced the driest 22-year period in more than 100 years of historical natural flows. As a result, the risk of reaching critically low elevations at Lakes Powell and Mead has increased significantly since the drought began. Critically low reservoir levels could affect compliance with the 1922 Colorado River Compact; Lake Powell could drop below the level required to generate hydropower and water shortages in both basins could have a negative impact on the economies, livelihoods and natural resources in both the United States and Mexico.

In the Colorado River Basin, the federal governments, Basin States, Indigenous tribes, local water districts and non-governmental organizations (NGOs) in the United States and Mexico cooperate to develop creative strategies to reduce the impacts of drought and increase reservoir storage at Lake Powell and Lake Mead. Activities related to drought response include a basin-wide system conservation programme and drought contingency planning efforts in both the Upper and Lower Basins through 2020. Water conservation strategies have added approximately 50 feet to Lake Mead's elevation. The implementation of Minutes 319 and 323 to the 1944 United States–Mexico Water Treaty and related binational discussions also underscore the importance of the partnership and continued collaboration between the two countries. Additional planning studies conducted with stakeholders include the 2012 Basin Study and Moving Forward efforts and the Colorado River Basin Ten Tribes Partnership Tribal Water Study. To reduce the risk of Lake Powell and Lake Mead declining to critically low levels, in December 2017, the United States Department of the Interior called on the seven Colorado River Basin States of Wyoming, Colorado, Utah, New Mexico, Arizona, California and Nevada to put drought contingency plans (DCPs) in place before the end of 2018. The Colorado River DCP was submitted to Congress on 19 March 2019. On 16 April 2019, the Colorado River Drought Contingency Plan Authorization Act was signed into law. It requires the Department of the Interior to execute the Colorado River DCP without delay and operate applicable Colorado River System reservoirs accordingly.

The agreements include an Upper Colorado River Basin DCP and a Lower Colorado River Basin DCP. The Upper Basin DCP is designed to: i) protect critical elevations at Lake Powell and help assure continued compliance with the 1922 Colorado River Compact; and ii) authorize storage of conserved water in the Upper Basin that could help establish the foundation for a Demand Management Programme that may be developed in the future. The Lower Basin DCP is designed to: i) require Arizona, California and Nevada to contribute additional water to Lake Mead storage at predetermined elevations; ii) create additional flexibility to incentivize additional voluntary conservation of water to be stored in Lake Mead; and iii) require the Secretary of the Interior to design programmes to create or conserve 100,000 acre-feet or more of system water annually, to benefit Lower Basin system reservoirs, subject to applicable law and availability of appropriations.

In addition to the reductions and other measures to which the Basin States agreed under the DCP, Mexico has also agreed to take additional measures to protect the Colorado River Basin. Under a 2017 agreement, Minute 323 to the 1944 United States–Mexico Water Treaty, Mexico agreed to implement a Binational Water Scarcity Contingency Plan but only after the United States adopted the DCP. Reclamation Commissioner Brenda Burman stated, "This is an historic accomplishment for the Colorado River Basin. Adopting consensus-based DCPs represents the best path toward safeguarding the single most important water resource in the western United States. These agreements represent tremendous collaboration, coordination and compromise from each Basin State, American Indian tribes, and even the nation of Mexico."

As droughts and floods are increasing in certain regions globally, the number of people affected by these phenomena is growing and will further increase in the future. This is due to population growth, but also a result of changing land and water use patterns, such as people moving to marginal lands that are more exposed to the hazards.[62] Drought risks and impacts usually vary within transboundary basins and aquifer areas. Differences exist not only in the timing of rainfall deficits, but also in how run-off is generated and regulated across the basin. Drought affects groundwater resources depending on hydrogeological conditions, and through increased demand and consumption as availability of surface waters diminishes and via lowered seepage and renewal.[63]

Drought and flood risk in transboundary settings may be further understood as the interaction between: i) the *hazard* (i.e. drought or flood); ii) *exposure* to those hazards, i.e. the population, and environmental and socioeconomic assets potentially affected; and iii) *vulnerability*, i.e. local and transboundary water governance capacity to manage impact of the hazard. The exposure to drought will further vary according to the type of water use, distribution of population in rural and urban areas, and environmental assets. Vulnerability to droughts and capacity to manage their impact may also vary significantly across the basin, influenced by water resource development and the distribution of water and shortage risks under transboundary water agreements.[64] Accordingly, transboundary water allocation must look at the distributed risk of drought across a basin, so that the most at-risk parts/areas receive higher or more assured allocations.

Transboundary drought management and water allocation
The multiscale nature of drought requires coordination. In a transboundary context, this means coordinating between riparian States: measures for monitoring and timely data exchange (early warning systems); drought risk mitigation and adaptation strategies; and integrated surface and groundwater management.[65] Water allocation and entitlements are critical in determining what water resources will be available for abstraction and use during drought periods and how those resources will be shared.[66] Groundwater tends to be increasingly relied upon in drought situations, indicating the need to have a good understanding of the availability, renewability and trade-offs associated with groundwater resources. One example of this is heavy groundwater development in proximity to streams, which may reduce base flows in streams (derived from groundwater) during dry and drought periods. Proper water accounting is critical for operational water allocation.[67]

Drought often acts as a trigger to, and is easier to identify than, water scarcity as a long-term trend. Drought management thus provides important reflection points for longer term development of management processes and mechanisms,[68] including those related to achieving the SDG targets 6.4 on water-use efficiency, 6.5 on IWRM, 11.5 on disaster risk reduction and 15 on protecting terrestrial ecosystems and combating desertification and land degradation.[69] For legal principles and mechanisms regarding transboundary drought management, see Chapter IV, subsection 6c.

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[62] UNECE and United Nations Office for Disaster Risk Reduction, *Words into Action Guidelines: Implementation Guide for Addressing Water-related Disasters and Transboundary Cooperation: Integrating Disaster Risk Management with Water Management and Climate Change Adaptation* (New York and Geneva, United Nations, 2018).
[63] Karen Villholth and others, "Integrated mapping of groundwater drought risk in the Southern African Development Community (SADC) region", *Hydrogeology Journal*, vol. 21, No. 4 (June 2013), p. 863–885.
[64] Garrick and others, "Managing the cascading risks of droughts" (2018).
[65] See also, for general information, European Commission, Water Scarcity and Droughts Expert Network, "Drought management plan report: including agricultural, drought indicators and climate change aspects", Technical Report, No. 2008 023 (Luxembourg, Office for Official Publications of the European Communities, 2007).
[66] Paul Sayers and others (2016).
[67] Sood and others (2017).
[68] Anne F. Van Loon, "Hydrological drought explained", *WIREs Water*, vol. 2. No. 4 (July/August 2015), p. 359–392.
[69] See https://sdgs.un.org/goals.

e. Flooding

Impacts of floods in transboundary settings

Flooding can be defined as: overflowing by water of the normal confines of a watercourse or other body of water; and accumulation of drainage water over areas that are not normally submerged.[70] The definition of flood is: (1) Rise, usually brief, in the water level of a stream or water body to a peak from which the water level recedes at a slower rate; (2) Relatively high flow as measured by stage height or discharge.[71] Floods are natural climate-driven phenomena that are necessary for the survival and health of many ecosystems. Moreover, some livelihoods, such as floodplain and flood pulse agriculture and fishing, are dependent on floods and there are also related cultural traditions, practices and heritage in some parts of the world.[72] Flood waters are a vital water resource, especially in many arid and semi-arid areas, where they also function as important sources of groundwater recharge.[73] Both regular and exceptional flood events can frequently present a serious hazard to infrastructure and economic assets, health, human lives and the environment.[74]

Risks and impacts of flooding can vary within transboundary basins. It generally depends on the exposure of communities to flooding and the vulnerability of people, their property and infrastructure to flood damage. Probability of damage grows when development activities in river channels and the adjacent floodplains have not accommodated the associated flood risks. The heavier the river channels and floodplains are altered, the lower their resilience to flooding usually is, or, alternatively, the more their impacts are shifted downstream.[75] Both the magnitude and frequency of floods and their associated risks are expected to increase with climate change.[76] Land use changes, i.e. drainage or deforestation, also affect the flood peak height and duration downstream (see Case Study 4 on the Pripyat River Basin and the operation rules for the Vyzhevsky spillway).

The hydromorphology (i.e. shape and cross-sections) of rivers and deltas is constantly changing due to erosion and sedimentation. The changes can also affect a river's flood predictability over time. Heavy floods associated with extreme meteorological events may rapidly change a river's shape and size. Flood protection or erosion control measures might also affect river morphology.[77] Erosion and sedimentation also impact on the performance of flow regulation infrastructure, which has an important role in both flood protection and implementing water allocation arrangements. In a transboundary context this might have implications on basin agreements and, in turn, on water allocation mechanisms.

Transboundary flood risk management and water allocation

Transboundary flood risk management requires basin-wide monitoring and warning systems. Such systems should focus their measures on parts of the basin where they are most needed and effective and thus enable redistribution of risks and resources. Integrated flood management approaches build on the IWRM approach, risk management principles covering the cycle of preparedness, response, recovery and reconditioning the

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[70] World Meteorological Organization (WMO) and UNESCO, "International glossary of hydrology", 3rd ed., WMO No. 385 (Geneva, WMO, 2012).

[71] Ibid.

[72] See, generally, Fei Yan, "Floods and culture", in *Urban Planning and Water-related Disaster Management: Strategies for Sustainability*, Guangwei Huang and Zhengian Shen, eds. (Cham, Switzerland, Springer International, 2019).

[73] Mark O. Cuthbert and others, "Observed controls on resilience of groundwater to climate variability in sub-Saharan Africa", *Nature*, vol. 572 (2019), p. 230–234.

[74] United Nations, *Transboundary Flood Risk Management: Experiences from the UNECE Region* (New York and Geneva, 2009).

[75] Ibid.

[76] UNESCO WWAP, *The United Nations World Water Development Report 2020*.

[77] L. J. Slater, A. Khouakhi and R. L. Wilby, "River channel conveyance capacity adjusts to modes of climate variability", *Scientific Reports*, vol. 9 (2019), 12619.

management system, and also accommodate the beneficial aspects of floods to humans and ecosystems.[78] Similarly to droughts, flood risk management is integral for achieving the aims of SDG 11.5 to significantly reduce the number of people affected by natural disasters.

For transboundary water allocation, floods should generally be approached as exceptional events, the frequency and severity of which are likely to grow in the future. Allocation quotas need to accommodate variability in water availability, but they may also act as flood management measures (see Case Study 8 on the Vuoksi River). It is equally necessary to build monitoring, data exchange, early warning systems and prior notifications of flow releases into allocation agreements between co-riparian States. For legal principles and mechanisms regarding transboundary flood management, see Chapter IV, subsection 6c.

CASE STUDY 4: Developing climate-adaptable arrangements to manage floods and dry periods in the Pripyat River Basin

In its upper reach, the Pripyat River flows from Ukraine to southern Belarus. Before reaching Belarus in its natural bed, the Vyzhevsky spillway in Ukraine diverts part of the water from the Pripyat to south-western Belarus to provide water for the Dnieper–Bug Canal. Proper functioning of the longest navigable channel in Belarus depends on water intake via Vyzhevsky spillway, along with other sources. There are important wetlands along the natural riverbed and the diversion channel, making proper balancing of the flow between the two a challenging task.

In 2010, operation rules for the Vyzhevsky spillway were agreed upon between Belarus and Ukraine. The principles of water allocation are based on a bilaterally accepted approach and methodology. Their implementation is monitored on both sides by regional water authorities. Both annually inform the Belarus–Ukraine working group meetings, ensuring the institutional and political stability of the arrangement.

On top of establishing a regime for allocating water to the Dnieper–Bug Canal, the rules regulate activities during floods. Among other issues, the operation rules clarified that Belarus is to deal with maintenance of the headlock of the spillway in the territory of neighbouring Ukraine, resolving longstanding property issues. The rules proved to work well, including during dry periods in 2015 and 2016 when no water was taken from the Pripyat to the Dnieper–Bug Canal. Such cooperative management will become ever more important as climate change intensifies in the Basin.

3. Water Uses and Needs

a. Environmental needs

Ecosystem well-being as a foundation for sustainable water allocation

The health of freshwater ecosystems is the foundation for the sustainability of water resources and the services and benefits derived from water. In modern water allocation arrangements environmental needs are assessed and an environmental reserve is recommended to be set aside before allocating water to other uses.[79] While deciding on environmental requirements in water resources management is ultimately a political process and decision, such decisions should be based on verifiable scientific data. The latest science,[80] as well as the SDGs (notably 6.6, 14, 15),[81] emphasizes that the environment should not be seen as a water-using sector among others, the needs of which may be negotiated, but, rather, that ecosystem well-being must be given high value as it affects all other water uses. The 1992 Convention on Biological Diversity can be used as a general guide for water allocation in this regard insofar as it defines an ecosystem approach relevant

[78] United Nations, *Transboundary Flood Risk Management: Experiences from the UNECE Region* (2009).
[79] Speed and others (2013).
[80] Secretariat of the Convention on Biological Diversity, *Global Biodiversity Outlook 5* (Montreal, 2020).
[81] See https://sdgs.un.org/goals.

to IWRM and distinctly promotes "the restoration and maintenance of biologically diverse ecosystems as a way of improving access to clean drinking water and as a means to eradicate poverty".[82]

Environmental and ecological flows

Environmental needs within water allocation are best described with the concept of environmental flows, often used interchangeably with ecological flows, with both commonly abbreviated to *"e-flows"*. While multiple definitions of the term exist, the most comprehensive recent definition, from The Brisbane Declaration and Global Action Agenda on Environmental Flows (2018), describes environmental flows as "the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being".[83] The concept of ecological flows focuses on ecosystem needs as a part of the overall environmental flow.[84] When properly implemented, environmental flows can achieve multiple benefits, including: helping sustain and generate ecosystem services and livelihoods dependent on them; creating economic and recreational value; preserving rivers; sharing benefits of basin development more equitably; and in general contributing to the sustainable management of rivers.[85]

Environmental flows in transboundary water allocation

Environmental flows have emerged as one of the key frameworks for informed, participatory decision-making in water resources planning to arrive at a balance among extraction, use and conservation of watersheds and their waters.[86] One of the key challenges of environmental flow management is to maintain a sufficient minimum flow of water in rivers and prevent overabstraction during low-flow periods. Periodic high flows are required for maintaining water quality, triggering fish spawning and migration, sediment transport, groundwater recharge and wetland inundation (see Case Study 6 on spring flows from the Dniester River Basin). River ecosystems may also be negatively affected if too much water is released from storage during periods when rivers would naturally experience low flows.[87] As all aspects of the environmental flow regime are potentially important to the environment, ideally, water allocation arrangements should account for natural variability, predictability, seasonal timing and flood magnitude of the given aquatic system and its connections to other systems (e.g. surface and groundwater).

CASE STUDY 5: Ecological flow and water allocation in the Samur River

For rational use and protection of the Samur River, a border river between the Russian Federation and Azerbaijan, a bilateral agreement was signed in 2010. Importantly, 30.5 per cent of the water shall be reserved for the ecological flow while the rest is allocated equally between the countries as per Article 3 of the agreement. It is also stated that satisfying the need for water of either country is not allowed at the expense of ecological flow. As some of the groundwaters are hydraulically connected with surface waters of the Samur, the countries have also agreed to ensure the regime of groundwater abstraction, which excludes a decrease in the groundwater level in the Samur River delta.

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[82] Secretariat of the Convention on Biological Diversity, *Drinking Water, Biodiversity and Development: A Good Practice Guide* (Montreal, 2010), p. 1. See also, generally, Alistair Rieu-Clarke and Christopher Spray, "Ecosystem services and international water law: towards a more effective determination and implementation of equity?", *Potchefstroom Electronic Law Journal*, vol. 16, No. 2 (2013), p. 12–65.
[83] Arthington and others (2018).
[84] Rafael Sanchez Navarro, "Environmental flows and flow regulation in the Drina River Basin", desk study prepared for UNECE, Geneva, 2019.
[85] Shripad Dharmadhikary, *Environmental Flows in the Context of Transboundary Rivers 2017: Exploring Existing International Best Practices and How They Could be Applied in South Asia* (Berkeley, California, International Rivers, 2017). See also Cate Brown and others, *Good Practice Handbook: Environmental Flows for Hydropower Projects: Guidance for the Private Sector in Emerging Markets* (Washington, D.C., World Bank, 2018).
[86] Sood and others (2017).
[87] Speed and others (2013).

In transboundary settings, environmental flow assessments provide optimal results when undertaken as a joint exercise considering the river basin in a holistic manner. Assessments should account for interlinkages and interdependencies across political boundaries. Besides national- or State-level stakeholders, local stakeholders directly dependent on and affected by the flow regulations should be consulted.[88] A functional transboundary environmental flow programme requires harmonization of environmental flow methods in the basin, integration of environmental flows in the water planning and allocation and their effective implementation, operational rules (i.e. for reservoirs) and exchange of information.[89] For the necessary knowledge base for the assessment of environmental requirements and assessment methods, see Chapter VII, section 10.

CASE STUDY 6: Springtime artificial ecological water releases in the Dniester River Basin

Since the 1980s, springtime artificial ecological water releases have taken place at the Dniester Hydropower Hub to provide water for flora and fauna in the middle and lower stretches of the Dniester River. The Hydropower Hub was constructed in the 1980s to improve flood protection and water availability during low-water periods for Moldova and for Odessa City and oblast in Ukraine, among other reasons. Analysis is still needed to study and address ecological flow needs throughout the year rather than only during the spring season. At the request of the Governments of Moldova and Ukraine, the GEF Dniester Project undertook a study[90] that included development of a simple "calculator" tool that can be used to support operational decision-making when comparing and selecting specific release scenarios depending on the hydrological situation, requirements, limitations and expectations.

b. Water use sectors and functions

Sectors, functions and in-stream uses

Water allocation has a key role in balancing water availability for different sectors and functions, ideally after the environmental flow requirements have been accounted for. While major differences in sectoral shares exist between countries depending on their socioeconomic structures, agriculture, including inland aquaculture, continues to be the biggest water user globally, constituting 69 per cent of water withdrawals.[91] Industries contribute 19 per cent, including water use in the energy sector, while municipal and domestic uses amount to 12 per cent.[92]

The other main functions or in-stream water uses that depend on known or sustained water levels but do not contribute to water withdrawals per se include navigation, pollution dilution, tourism and recreational uses, cultural uses, freshwater capture fisheries and ecosystem maintenance.[93] For example, Niagara Falls, shared between the United States and Canada, is governed by treaties that allocate fixed quantities of water that are variable depending on the time of year. This is done to ensure that the Falls' aesthetic is preserved during months of heavy tourism, while simultaneously satisfying hydropower requirements of the nearby power generation stations.[94]

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[88] Dharmadhikary (2017).
[89] Navarro (2019).
[90] Oksana Huliaieva and Nickolai Denisov, *Analysis of the Goals, Limitations and Opportunities for Optimizing the Regime of Spring Ecological Reproductive Releases from the Dniester Reservoir* (Kyiv, Organization for Security and Cooperation in Europe, 2020).
[91] Food and Agriculture Organization of the United Nations (FAO), "Aquastat: FAO's global information system on water and agriculture".
[92] Ibid.
[93] Amit Kohli, Karen Frenken and Cecilia Spottorno, "Disambiguation of water use statistics", 23 September 2010 (FAO).
[94] See Treaty Between Canada and the United States of America Concerning the Diversion of the Niagara River, 1950 ("the Niagara Treaty").

Consumptive and non-consumptive uses

An important distinction to be made when assessing water use of different sectors and functions is whether their use is consumptive or not. For consumptive uses, the water withdrawn is effectively removed from the local water body, such as via evapotranspiration in agriculture and evaporation in thermoelectric power generation, or its quality is changed. In non-consumptive uses, water is not withdrawn from (e.g. in-stream water use), or it is returned to, the same water body (sometime after treatment) and may be reused or recycled. Some industrial and domestic water uses, as well as different functions, are non-consumptive by their nature, but with most of them direct reuse of the released or otherwise affected water is typically limited by a change in its quality.[95] A key parameter defining both surface and groundwater availability is the ratio between water consumption and renewable freshwater resources. A consumption rate higher than renewal results in water stress and depletion of the water source over time.

While improving water use efficiency is generally encouraged, it may also reduce return flows, the amount of water seeping into groundwater or available for downstream uses. Disregard for diminished return flows or other interceptions of run-off as a result of afforestation, for example, may result in overestimation of available water resources, their overallocation and overuse. Furthermore, improvements in water use efficiency may not change or may even increase overall water consumption if caps for abstraction are not in place.[96] Allocation arrangements therefore need to account for effects of water use by one user on water use by others, specifying consumption rates of various uses and return flows, including the water quality of the same or different water entitlements.[97]

Water use in agriculture

Agricultural priorities have traditionally dominated national water allocation arrangements globally. Being afforded such high priority has been due largely to agriculture's direct connection to food security and rural livelihoods. In many countries, agriculture's position has also been challenged by growing water demand from other sectors and uses such as industries and tourism. Agriculture limits availability of water for other uses due to its commonly dominant share of total water use and pollution loading (e.g. excess nutrients, use of pesticides, herbicides and fungicides). Conversely, agricultural practices can add to water availability due to their relative flexibility in accommodating variability (e.g. annual rather than fixed capital costs) and via major return flows. Furthermore, in many regions and in the case of many crops, water demands for agriculture occur at certain periods of the year and may be of limited duration when water availability is low. In years of surplus water availability, agriculture may be best positioned to utilize more abundant allocations, and agricultural land, irrigation and drainage systems may also regulate the excesses in flows.[98] Now and in the future, agricultural water use must be balanced with uses in other sectors, especially in drought conditions.

There is potential for major water savings in agriculture, providing both for the growing needs of other sectors and the need for an increase in food production.[99] Increased water productivity (crop/value per drop) can be achieved, for example, with improvements in water use efficiency (SDG 6.4) (e.g. more efficient irrigation technologies, fertilizer use and soil management) and crop management (e.g. change of crops, crop rotation). These changes are generally supportive of downstream needs when providing improved water availability and water quality (SDG 6.3), but they should also accommodate dependency on previous return flows if improved efficiency leads to their reduction.

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[95] Kohli, Frenken and Spottorno (2010).

[96] Chris Perry and Pasquale Steduto, *Does Improved Irrigation Technology Save Water? A Review of the Evidence: Discussion Paper on Irrigation and Sustainable Water Resources Management in the Near East and North Africa* (Cairo, FAO, 2017).

[97] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).

[98] Speed and others (2013).

[99] FAO, *The State of Food and Agriculture: Overcoming Water Challenges in Agriculture* (Rome, 2020).

CASE STUDY 7: Allocation for irrigation with monitoring and maintenance systems in the Zarumilla River Basin

Water stress is a critical characteristic of the Zarumilla River Basin shared between Ecuador and Peru, particularly in the extended dry seasons. It is a relatively dry region between both States with important presence of water-intensive crops such as rice, sugar cane and fruits. The socioeconomic characteristics of this basin demand high volumes of water to satisfy agricultural needs, aquaculture (shrimp farms) and human consumption.

In 1944, the critical water condition forced Ecuador and Peru to cooperate in order to share a water infrastructure channel aimed at assisting irrigation in the border area, sharing costs but also sharing benefits through a simple coordinated water allocation mechanism. The Zarumilla International Water Channel (part of the Zarumilla Basin) was built in 1947. This approach was feasible for the particular context of the Zarumilla because the watercourse acts as a border and, at the same time, agricultural fields surround both sides of the watercourse, creating a common need to share flows.

According to the agreements signed by both countries, the allocation of flows establishes 55 per cent for Ecuador and 45 per cent for Peru. However, when flows are below 1.5 m^3/s (which happens in various months), both countries will take turns to use the flow, for an equal number of days. The agreement also establishes a permanent e-flow of 0.4 m^3/s to maintain ecosystem health in the waterway to the ocean.

The maintenance and cleaning of the Zarumilla channel are performed jointly by the countries in cooperation with subnational governments. Today, channel maintenance is conducted by the countries alternately, with Ecuador responsible for cleaning and paying the infrastructure insurances and associated costs in one year and Peru the next. The monitoring and enforcement of water allocations is overseen by the water user associations of both countries, who have been cooperating for decades in securing the correct use of the waters they rely on (see Chapter VIII, section 3).

Water use in industry and energy production

Industrial water use is typically dependent on sustained quantity and quality of water, whereby sudden reductions in water availability can potentially lead to higher costs and/or production losses. Water quality requirements vary significantly depending on the type of industry, food and beverages and pharmaceuticals exemplifying the highest standards. Besides its growing prioritization for economic reasons, industrial water use may limit water availability for other uses due to point-source pollution. Water use efficiency (SDG 6.4) in industries and energy generation can generally be improved with optimized processes, more efficient technologies and recycling, reuse, reduction or even, where appropriate, replacement of water use with waterless alternatives.[100] Curbing water pollution from industries (SDG 6.3) goes hand in hand with efficiency improvements and provides cost savings and lower water-related risks to business.[101] For further information on complementary approaches on water and energy to transboundary water allocation, see Chapter IV, section 2.

Availability of water in the energy sector is critical for society and gaining increasing international attention as demand for resources mounts and governments continue to struggle to ensure reliable supply to meet sectoral needs.[102] Water shortages may lead to power outages or significant generation losses, with typically widespread impacts on all other sectors and their water use systems. In transboundary water management and allocation contexts, an especially important aspect to consider is flow regulation. The production of hydropower is mainly associated with reservoirs, which, in many cases, have a continuous multipurpose

[100] Andrea Rossi, Ricardo Biancalani and Lucie Chocholata, "Change in water-use efficiency over time (SDG indicator 6.4.1): analysis and interpretation of preliminary results in key regions and countries", SDG 6.4 Monitoring Sustainable Use of Water Resources Papers (Rome, FAO, 2019).
[101] CDP, *Cleaning Up Their Act: Are Companies Responding to the Risks and Opportunities Posed by Water Pollution?* (London, CDP Worldwide, 2020).
[102] Diego J. Rodriguez and others, "Thirsty energy", Water Papers, No. 78923 (Washington, D.C., World Bank, 2013).

function, such as flood protection, navigation, as a source for consumptive use of water, or recreational water use activities. Since hydropower is commonly generated to meet peak demands, however, hydropeaking may occur and, if not adjusted upon high flows, flooding may be aggravated downstream.

Dams, particularly large-scale hydropower dams, may cause a range of direct or indirect impacts, including: environmental impacts, such as altered fish spawning, biodiversity loss and reduced sediment loads; social impacts, such as loss of livelihood and involuntary resettlement of local communities; and potentially exacerbating climate change impacts.[103] Any such impacts that could cause significant transboundary harm should be addressed in both the planning and operationalization phases, if not already at a stage of strategies and policies (e.g. designation of no-go zones). Measures to address impacts include the placement, size (capacity) and design of individual dams, which need to be subject to environmental impact assessment (EIA), including for transboundary impacts, along with prior notification and consultation. Depending on the outcomes, this may require further negotiation, redesign or searching for alternative solutions. Additionally, it is beneficial for States to seek to agree on an operational regime that reconciles different needs and cascades of dams with different operation regimes. This requires cooperation and potentially joint infrastructure development, which can further facilitate broader benefit-sharing.[104]

CASE STUDY 8: Vuoksi River hydropower generation and flow levels

The flow of the Vuoksi River, shared between Finland and the Russian Federation, and levels of the connected Lake Saimaa are governed by two main agreements, the 1989 Vuoksi Discharge Rule and the 1972 Vuoksi Hydropower Agreement. The main aims of these agreements are to ensure the efficient use of four hydropower stations, two on either side of the border, and to manage floods and droughts.

The 1972 Vuoksi Hydropower Agreement governs the daily regulation of streamflow in a way that ensures efficient use of two hydroelectric stations, one on the Finnish side of the border (upstream) and one on the Russian side (downstream). The daily regulation of the streamflow at the Russian "Svetogorsk" hydroelectric stations downstream to the Finnish "Imatra" hydroelectric station upstream must follow certain water flows and upstream water levels detailed in the Agreement. By maintaining these flows, the parties have identified and agreed that this causes the permanent loss of 19,900 MWh per year of electric energy at Imatra and agree that the loss is to be compensated by Russia through annual energy transfer (see also Chapter VI, Case Study 19 re transboundary harm and compensation).

Under the 1989 Vuoksi Discharge Rule, Finland, as an upstream country, must release water from Lake Saimaa in such a manner that the water level of the lake and the flow into the Vuoksi River remain as far as possible within normal limits. Finland must monitor changes in water conditions in the Vuoksi River system, prepare a preliminary appraisal of them and inform the Russian Federation of changes in the normal water release. The normal water limits are + or - 50 cm from the median water level specified in the Discharge Rule. If it becomes apparent that water levels higher or lower than normal are imminent, water releases may be adjusted at the first opportunity so that any damage which may be anticipated can be effectively prevented in time. Every effort must be made to prevent too great a rise in the water level of Lake Saimaa (NN + 76.60 m). At the same time, every effort shall be made to minimize any possible damage to the Vuoksi River. Under this rule, lowering the water level below minimum levels

[103] See, for example, Dominique Égré and Pierre Senécal, "Social impact assessments of large dams throughout the world: lessons learned over two decades", *Impact Assessment and Project Appraisal*, vol. 21, No. 3 (2003), p. 215–224; Marcus W. Beck, Andrea H. Claassen and Peter J. Hundt, "Environmental and livelihood impacts of dams: common lessons across development gradients that challenge sustainability", *International Journal of River Basin Management*, vol. 10, No. 1 (2012), p. 73–92; Zali Fung and others, "Mapping the social impacts of small dams: the case of Thailand's Ing River basin", *AMBIO: A Journal of the Human Environment*, vol. 48, No. 2 (2019), p. 180–191; Bridget R. Deemer and others, "Greenhouse gas emissions from reservoir water surfaces: a new global synthesis", *BioScience*, vol. 66, No. 11 (November 2016), p. 949–964; see, generally, Asit K. Biswas, "Impacts of large dams: issues, opportunities and constraints", in *Impacts of Large Dams: A Global Assessment*, Cecilia Tortajada, Dogan Altinbilek and Asit K. Biswas, eds. (Berlin-Heidelberg, Springer, 2012.)
[104] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water* Cooperation (2015).

(NN + 75.10 m during the shipping season and NN + 75.00 m at other times) must also be prevented whenever possible. As a result, every effort must be made to maintain a certain velocity of flow (300 m^3 per second).

Domestic water use

While minor in comparison to water use in agriculture, industries and energy production, ensuring water of safe quality for domestic use is of high priority, and where appropriate, of the highest priority, due to its vitality for human health and well-being (see SDG 6.1, 6.2) (see also Chapter V, section 3c).[105] Water use efficiency at homes depends heavily on behavioural choices of households (influenced by climate, cultural traditions, pricing of water services) besides the technologies and systems available.[106]

Water use sectors and functions in transboundary water allocation contexts

At the national and subnational levels, granting water rights and entitlements for different uses and functions is predominantly a matter of national and subnational water governance within a particular jurisdiction (see Case Study 18 on the Murray–Darling Basin), which should, however, keep in mind governance at the basin level.[107] In fact, while national needs inform negotiations on transboundary water allocation, they are best coordinated as part of basin-wide planning, integrating consideration of future scenarios. These processes could benefit from the possibilities regarding cost- and benefit-sharing and further opportunities from applying the water-energy-food-ecosystem nexus approach (see Chapter IV).

4. Impacts on Allocable Water

a. Water management infrastructure

Infrastructure as an enabling and limiting factor in water allocation

Water management infrastructure sets the physical basis for, and constraints on, how allocable water can be used. Freshwater infrastructure traditionally includes:

- dams for hydropower, flow regulation, storage and water withdrawal;
- reservoirs;
- pumping stations for rivers and aquifers for supply of water;
- irrigation systems;
- water purification and wastewater treatment plants and water and wastewater networks, and outlets returning wastewater to these systems;
- dredging, channelization or straightening of rivers for navigation;
- basin transfer pipelines and canals;
- natural and human-made ponds and swamps;
- monitoring systems and networks.[108]

Historically, growing demand for water was typically first met with infrastructure development, increasing access to available water.[109] Investing in upkeep, repairs and modernization of existing infrastructure (e.g.

[105] Both domestic and international water laws recognize the human right to water, and in particular Article 10(2) of the 1997 Watercourses Convention provides that "In the event of a conflict between uses of an international watercourse, it shall be resolved with reference to articles 5 to 7, *with special regard being given to the requirements of vital human needs*" [emphasis added].
[106] FAO and UN Water, *Progress on Water-use Efficiency: Global Baseline for SDG Indicator 6.4.1* (Rome, 2018).
[107] See, generally, Garrick, *Water Allocation in Rivers under Pressure* (2015).
[108] Alternative water sources such as harvested rainwater or desalinated water have their own infrastructure, which in a larger scale may be linked to main networks and systems.
[109] McCracken and others, "Typology for transboundary water allocation" (forthcoming).

canal networks) has significant potential to improve water efficiency and various demand management means overall. It may also reduce the need to spend on expanding new development for additional supply. Allocation planning is therefore useful in the development and operation of certain infrastructure and related water uses that pertain to the transboundary allocation of water resources.

Past infrastructure choices can limit existing and future allocation options. Large dams, water transfers and large-scale irrigation systems typically have profound impact on flow regulation, groundwater, the environment and downstream water uses. Poorly maintained large-scale infrastructure can lead to major transboundary risks of losses or water wastage, exacerbating water scarcity, water contamination and accidents such as dams breaks and flash floods. Inadequate infrastructure further reduces adaptive capacity to respond to drought and floods and longer-term changes in water availability and variability.[110] Disparities in infrastructure between/among States sharing transboundary water resources may also create unequal water utilization opportunities. Existing and planned transboundary infrastructure systems must carefully assess how to be equitable, avoid harm and evaluate ways to minimize transboundary environmental impacts (e.g. fish passages or outlets for e-flows on hydropower dams) and socioeconomic impacts.[111]

CASE STUDY 9: Joint management of water infrastructure in the Chu–Talas River Basin

In the Soviet period up to 1991, intra-State principles and conditions were used to allocate water resources of the Chu and Talas River Basins between the Kazakh and Kyrgyz Soviet Socialist Republics. In 2000, Kazakhstan and Kyrgyzstan signed the Agreement on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas. The Agreement covers six water infrastructure objects in upstream Kyrgyzstan (reservoirs, canals, waterworks).

According to the Agreement, downstream beneficiary Kazakhstan reimburses Kyrgyzstan for the operational costs of maintenance, repair, overhaul and reconstruction of inter-State water management facilities in proportion to the volume of water it receives. For each year, the required amount of funds is agreed between the parties. Kazakhstan finances most of its costs by conducting maintenance and construction works itself. A standing bilateral commission on an equal footing with the permanent secretariat sets an operational schedule and defines required expenditures. There is a desire to add further water infrastructure objects for joint management and to clarify the status and financing of the permanent secretariat.

Kyrgyzstan used the Agreement as a model when signing a similar agreement with its other downstream neighbour, Uzbekistan, in 2017 for joint management of the Orto–Tokoi (Kasansay) water reservoir.

Developing sustainable infrastructure for water allocation

The larger the infrastructure, the more careful its selection, size and choice of location needs to be and the more comprehensively co-riparian States and all other key stakeholders should be engaged in its development. Appropriate infrastructure choices, including size and location, may contribute to fairer water allocation between parties, avoid harm, provide more value to users and maintain a healthy environment.[112] Large-scale infrastructure is typically expensive to build and expected to last and serve for decades. In order to ensure its

[110] UNESCO WWAP, *Managing Water under Uncertainty and Risk*, United Nations World Water Development Report 4, vol. 1 (Paris, UNESCO, 2012).
[111] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water Cooperation* (2015).
[112] Ramsar Convention Secretariat, *Water Allocation and Management: Guidelines for the Allocation and Management of Water for Maintaining the Ecological Functions of Wetlands*, Ramsar Handbooks for the Wise Use of Wetlands, 4th ed., vol. 10 (Gland, Switzerland, 2010); Karen G. Villholth and Andrew Ross, *Groundwater-Based Natural Infrastructure (GBNI)* (n.p., n.d.), available at https://gripp.iwmi.org/wp-content/uploads/sites/2/2018/08/GBNI_Intro.pdf; Groundwater Solutions Initiative for Policy and Practice (GRIPP), "Groundwater-based natural infrastructure: GBNI" (n.d.), available at https://gripp.iwmi.org/natural-infrastructure/.

functionality in changing circumstances (e.g. impacts of climate change, structural changes in the economy, technological innovations), infrastructure needs to pass sensitivity and risk analyses and environmental and social impact assessments in different simulations and scenarios.

Nature-based solutions to water allocation infrastructure rarely have negative transboundary impacts, while they simultaneously help to meet environmental requirements. Nature-based solutions may include those for managing water availability (e.g. natural wetland forests and wetlands' improved soil and vegetation management), water quality (e.g. forest, wetlands, grasslands) and water-related risks, variability and change (e.g. flood plains, surface and subsurface water storage and managed aquifer recharge).[113]

CASE STUDY 10: Value of investing in nature-based solutions and implementing measures where they make a difference, even across borders: flood protection in the Rhine River Basin

Under the Interreg Rijn Maas (IRMA) programme, the Netherlands contributed some €5 million to the construction of the Bislicher Insel retention area in Germany. The retention measure was included in the International Action Plan on Floods on the Rhine adopted by ministers of the Rhine riparian countries in 1998. The measure consisted of putting back a band embankment and lowering the old band embankment in parts, so that the water can flow into an old arm of the Rhine in both summer and winter when a certain water level is exceeded, hence reducing flood waves. With this solidary co-financing, the Netherlands contributed to the realization of the whole package of measures implemented in the Action Plan, aimed at reducing extreme water levels, with a positive effect for the country.[114]

Water scarcity as a central challenge for sustainable water allocation

Water scarcity occurs when demand for freshwater exceeds supply.[115] It seriously affects the functioning of societies and undermines possibilities for sustainable development. Population growth, urbanization and changing consumption patterns, increased demand from irrigated agriculture, industry and hydropower, as well as inadequate water management, all contribute towards scarcity of water resources. Water scarcity may compromise water supply and sanitation services and have negative impacts on human health. It may also threaten food security and limit economic growth because of declining agricultural production, while the environment suffers from reduction in environmental flows. Water scarcity may lead to conflict within and across countries and exacerbate forced migration.[116] It is estimated that, in arid and semi-arid regions, climate-change-induced water scarcity may displace up to 700 million people by 2030.[117]

Climate change further accelerates the effects of scarcity. The results can be an increase in the frequency and intensity of droughts and floods, changes in precipitation patterns, higher surface water evaporation and depletion of glacial and surface water sources (see subsection 2c above on the cross-cutting impacts of climate change). In transboundary contexts, water uses in one riparian State can impact or exacerbate water scarcity in another. Water scarcity sets absolute or relative limits to allocable water. Water scarcity thus forms a central challenge for sustainable allocation of transboundary water resources as "ever-increasing withdrawals of water from the world's freshwater ecosystems are creating new threats as water stress leads

[113] UNESCO WWAP, *The United Nations World Water Development Report 2018: Nature-Based Solutions for Water* (Paris, 2018).
[114] An evaluation of all retention measures implemented along the Rhine can be found in International Commission for the Protection of the Rhine (ICPR), "200. and 199.: Balance on the implementation of the Action Plan on Floods between 1995 and 2010". 26 July 2012. See also Interreg Rhein-Meuse Activities (IRMA), "Germany". Available at www.irma-programme.org/b_projects/list_germany.htm.
[115] FAO, "Coping with water scarcity: an action framework for agriculture and food security", FAO Water Reports, No. 38 (Rome, 2009).
[116] UNECE and INBO (2015).
[117] Elizabeth Hameeteman, *Future Water (In)Security: Facts, Figures, and Predictions* (Brussels, Global Water Institute, 2013).

to pervasive, catchment-scale reductions in ecosystem functions. Catchment-scale challenges such as these, with widespread social, economic and environmental consequences, can no longer be addressed by local engagement at a limited number of sites, but require broader solutions: effective water allocation mechanisms are required that match the scale of the problem."[118]

Definitions and aspects of water scarcity

Water scarcity has multiple definitions and aspects. Physical water scarcity arises out of the low availability and shortage of water resources, while social water scarcity is caused by unbalanced power relations, poverty and related inequalities.[119] Another important aspect of water scarcity is economic water scarcity. This occurs due to lack of investment in water infrastructure or a lack of human capacity to satisfy the demand for water.[120] Scarcity of capacity (organizational scarcity) and scarcity of accountability are further measures of water scarcity.[121] It is useful to make a distinction between absolute and perceived scarcity. Absolute scarcity exists when there is no affordable source of additional water within a given area, or where the costs of additional water supplies exceed the benefits of their provision. Even scarcity that is perceived as absolute may be relative and related more to structural problems regarding water supply or distribution. These perceptions therefore need to be addressed before there is actual "measurable" scarcity.[122]

BOX 5: "Water stress vs "water scarcity"

Water stress is commonly used to mean scarcity in situations where water use exceeds natural renewal capacity of water resources. SDG indicator 6.4.2 defines the level of water stress as freshwater withdrawal as a proportion of available freshwater resources, where over 70 per cent is serious water stress.

Source: Food and Agriculture Organization of the United Nations (FAO) and UN Water, *Progress on Level of Water Stress: Global Baseline for SDG 6 Indicator 6.4.2 2018*, IMI-SDG 6 SDG 6 Progress Reports (Rome, 2018).

A good summary of when and how allocation approaches may typically be employed to address water scarcity that has often led to water stress is provided by WWF: "There typically comes a point, however, at which engineering solutions will no longer suffice to meet increased demand, or are considered to be economically, socially or environmentally undesirable. When this happens, over-abstraction from the ecosystem leads to water stress, with serious negative impacts on social and economic development and the deteriorating health of aquatic ecosystems. Where there is no further water available for use, catchments are referred to as 'closed'. When such water stress is reached, a new and more sophisticated approach to water management is required. Rather than an engineering approach, these approaches seek to restore river flow through a multi-disciplinary and multi-stakeholder process of managing water withdrawal. Effective water allocation mechanisms need to be developed that manage the use of the scarce resource. In more prudent cases, such allocation systems may be introduced before catchments experience major water stress, but often a crisis is required to inspire reform."[123]

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[118] Le Quesne, Pegram and Von Der Heyden (2007), p. 8.

[119] M. Falkenmark and others, "On the verge of a new water scarcity: a call for good governance and human ingenuity", SIWI Policy Brief (Stockholm, Stockholm International Water Institute, 2007).

[120] David Molden, Charlotte de Fraiture and Frank Rijsberman, "Water scarcity: the food factor", *Issues in Science and Technology*, vol. 23, No. 4 (Summer 2007), p. 39–48.

[121] World Bank, *Making the Most of Scarcity: Accountability for Better Water Management Results in the Middle East and North Africa* (Washington, D.C., 2007).

[122] UNESCO WWAP, *Managing Water under Uncertainty and Risk*, United Nations World Water Development Report 4, vol. 1 (2012).

[123] Le Quesne, Pegram and Von Der Heyden (2007), p. 8.

Combating water scarcity in transboundary water allocation

The different aspects of water scarcity highlight important challenges for transboundary water resources management. Four billion people, nearly half the world's population, experience water scarcity at least one month a year and half a billion live in conditions of permanent water scarcity.[124] Hence, the transboundary dimension of water scarcity has attracted more international attention. For example, SDG target 6.4 is to substantially reduce the number of people suffering from water scarcity, while SDG target 6.5 is to implement integrated water resources management at all levels, including through transboundary water cooperation. Development of new allocation agreements and other arrangements, and renegotiation of existing ones, should in turn be aligned with these and other SDG targets.

Recognition that water scarcity conditions are likely to become more severe and frequent in the future supports reconsideration of certain prevailing approaches to water allocation in many river basins and aquifers around the world. Combating water scarcity requires reconsidering traditional supply management strategies such as increasing capacity of water infrastructure.[125] The focus needs to be shifted to demand management options such as increasing water use efficiency and water productivity. For successful integration of mitigation and adaptation strategies addressing water scarcity within transboundary allocation frameworks, the drivers and impacts of water scarcity need to be identified and understood in each context. Therefore, in water-scarce regions especially, "countries need to focus on the efficient use of all water sources (groundwater, surface water and rainfall) and on water allocation strategies that maximize the economic and social returns to limited water resources, and at the same time enhance the water productivity of all sectors. In this endeavour, there needs to be a special focus on issues relating to equity in access to water and on the social impacts of water allocation policies."[126]

b. Water quality

Water quality as a factor of water availability

Water availability is not only a question of quantity, as deteriorating quality limits water uses for multiple purposes. Changes in volume and timing of flow as a result of withdrawals and discharges or dam storage equally affect water quality by altering the amount of dissolved oxygen, channel erosion, compound condensations and suspensions, and turbidity, and, in some cases, temperature. Water quality varies naturally along rivers and aquifers, influenced by altitude, geology, in-stream habitat, wetlands and floodplain connectivity, as well as over time due to changes in climate and flow regime.[127] Freshwater ecosystems have major water-quality-managing functions, but they are also heavily affected by human impact. Water quantity and quality, combined with ecosystem health, should therefore be approached as equally important aspects in water availability and any related allocation measures.

Drivers and impacts of water quality degradation

Water quality degradation is a sum of alterations of flow regimes, ecosystems, climate change and polluting discharges. Over 80 per cent of the world's wastewater, including sewage, agricultural run-off and discharges from industry, is estimated to be released into the environment without treatment.[128] Both point-source and diffuse pollution degrade water quality. Point-source pollution originates from pipes, outlets and ditches of

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[124] Mesfin M. Mekonnen and Arjen Y. Hoekstra, "Four billion people facing severe water scarcity", *Science Advances*, vol. 2, No. 2 (2016), e1500323.

[125] David Molden, "Scarcity of water or scarcity of management?", *International Journal of Water Resources Development*, vol. 36, No. 2–3 (2019), p. 258–268.

[126] UN-Water, *Coping with Water Scarcity: A Strategic Issue and Priority for System-wide Action* (Geneva, 2006), p. 2.

[127] Christer Nilsson and Birgitta Malm Renöfält, "Linking flow regime and water quality in rivers: a challenge to adaptive catchment management", *Ecology and Society*, vol. 13, no. 2 (2008), 18.

[128] United Nations WWAP, *The United Nations World Water Development Report 2017: Wastewater: The Untapped Resource* (Paris, UNESCO, 2017).

sewage treatment plants, industrial sites and livestock operations. It causes the worst water quality impacts during low flows when water bodies have reduced dilution capacity. Storm and flood events can also cause overflows from sewerage systems. Diffuse pollution refers to nutrient run-off and leaching from agriculture and forestry, atmospheric deposition of nitrogen oxides from energy and transport emissions, and run-off of petroleum hydrocarbons and heavy metals from urban surfaces to surface and groundwaters. It continues to be a major problem, even in regions where point-source pollution has been effectively curbed.[129] In water bodies, polluting solutes and particles such as pathogens, organic matter, salt, hazardous chemicals and materials, pharmaceutical residues, microplastic and endocrine-disrupting chemicals are transported downstream or infiltrate into aquifers, making pollution also a transboundary problem.[130]

Water quality in transboundary water allocation

Deteriorating water quality has been a driver for several recent allocation reforms.[131] It decreases the available resource pool and the need for treatment increases the costs of water use. Water quality degradation reduces the value derived from in-stream uses including ecosystem functioning, fisheries and recreational uses.[132] However, in many transboundary river basins, water quality data are not collected or exchanged by riparian States in a uniform manner, if at all.[133] The number of measured water quality parameters varies by State and comparability is limited by the temporal and spatial representativeness of data. Moreover, national water quality monitoring may be the responsibility of several different agencies.

CASE STUDY 11: Addressing water quality in transboundary water allocation for the Great Lakes

The Great Lakes and especially Lake Erie are experiencing severe blue-green algal blooms. The source of the nutrient pollution is tributaries within the United States and Canada. For this and other reasons, the Great Lakes Water Quality Agreement (GLWQA) between the Governments of Canada and the United States was amended in 2012. The GLWQA entered into force in 1978, with amendments in 1983, 1987 and 2012. The GLWQA is implemented by the parties to the Agreement. Article VII of the GLWQA contains a standing reference to the International Joint Commission (IJC). The GLWQA tasks the IJC with a number of responsibilities, including the review of progress in achieving the general and specific objectives of the Agreement and reporting on any problem of water quality of the Great Lakes. Under the GLWQA, the two federal governments monitor and conduct research on water quality.

Under the GLWQA, the IJC has two very effective Great Lakes Advisory Boards. The binational Great Lakes Water Quality Board (WQB) is a very active and progressive board consisting of 28 members, 14 from each country. Half its members represent government agencies and the other half represent basin users and local and tribal governments. It is a unique binational group of experts from all sectors—government, NGOs, academic institutions, etc. The binational Great Lakes Science Advisory Board consists of two committees, the Research Coordination Committee (RCC) and the Science Priority Committee (SPC). Members of the RCC consist primarily of the government agencies responsible for monitoring, research and regulation of the Great Lakes. The SPC consists primarily of university researchers. The SPC focuses on research and data management issues. The WQB focuses on policy.

The worst algal bloom ever experienced on Lake Erie occurred in 2011, prompting the IJC to make binational investigation into the science and opportunities for action by governments to reduce algal-bloom-causing pollution a

[129] OECD, *Diffuse Pollution, Degraded Waters: Emerging Policy Solutions* (Paris, 2017).
[130] United Nations Environment Programme (UNEP), *A Snapshot of the World's Water Quality: Towards a Global Assessment* (Nairobi, Kenya, 2016).
[131] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).
[132] Ibid.
[133] United Nations Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Working Group on Monitoring and Assessment, Fifteenth meeting, Geneva, 6 December 2019,"Outlook for developing monitoring cooperation and exchange of data and information across borders: background paper to the Global workshop on exchange of data and information and to the fifteenth meeting of the Working Group on Monitoring and Assessment under the Water Convention (Geneva, 4–6 December 2019)" (ECE/MP.WAT/WG.2/2019/INF.1).

priority.[134] Daily water quality and river flow monitoring data at key locations were incorporated into appropriate water quality models (e.g. binational SPAtially Referenced Regression On Watershed attributes (SPARROW) modelling) to determine loading of phosphorous and nitrogen amounts into Lake Erie and the originating sources of the pollution. The loading numbers were then used to calculate target reduction concentrations in shore and deep lake regions of Lake Erie that would be needed to reduce or eliminate severe algal blooms, as documented in a 2014 Report of the Lake Erie Ecosystem Priority.[135]

The GLWQA requires the IJC to evaluate, every three years, how well the Canadian and United States Governments are meeting the general and specific objectives of the Agreement. Following publication of the State of the Great Lakes Report in 2016, and after extensive public engagement and review of the report, the IJC prepared its first Triennial Assessment of Progress Report on Great Lakes Water Quality in November 2017. The report provides advice and recommendations to assist the United States and Canadian Governments to better meet the general and specific objectives of the GLWQA. The IJC, its Great Lakes Regional Office and Water Policy and Science Advisory Boards are continually refining and updating their analyses to better determine the sources of nutrient pollution and additional mitigation strategies. The federal governments have a responsibility to address nutrient pollution in the Great Lakes consistent with the objectives of the GLWQA.

Addressing water quality issues in transboundary water allocation demands both national and transboundary coordination. Agreeing on acceptable water quality levels should be informed by desired uses for the given water source, and international and national environmental, chemical and health standards, as described in Chapter VII. Cross-sectoral interdependencies should also be addressed, as water quality objectives of an allocation regime may be undermined by incentives in other sectors that encourage pollution.[136] It should also be taken into account that reaching acceptable water quality levels for environmental requirements and human and sectoral needs may require dilution of flows or reservoir management that reduces the total volume of allocable water for all.[137]

c. Ecosystem degradation

The dual linkage of ecosystems degradation to water allocation
Ecosystem degradation is linked to water allocation in two major, interrelated ways. First, healthy ecosystems typically help to maintain overall availability of water, while, conversely, ecosystem degradation reduces it. Second, unsustainable water allocation and water use regimes have a negative impact on freshwater ecosystems, other ecosystems dependent on them and their biodiversity.

In terms of the first linkage, changes in upstream water use in different sectors and for different functions is the dominant external factor influencing the status of the water resources situation downstream. Notwithstanding, the status of ecosystems also affects the quantity, quality and variability of allocable water. Land ecosystems, especially vegetation, play a key role in regulating evapotranspiration and run-off from land. Vegetation typically supports water availability but, in some cases, removal of forests and alien species, for example, may also release more water to streams.[138] As surface and groundwater systems are connected, plant cover may also have a significant impact on groundwater recharge, which, when reduced, may lead to reduction or drying of rivers in low-flow seasons. Furthermore, freshwater ecosystems have multiple

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[134] International Joint Commission (IJC), *A Balanced Diet for Lake Erie: Reducing Phosphorus Loadings and Harmful Algal Blooms: A Report of the Lake Erie Ecosystem Priority* (Washington, D.C., 2014), p. 2.
[135] IJC (2014).
[136] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).
[137] Speed and others (2013).
[138] D. C. Le Maitre and others, “Invasive alien trees and water resources in South Africa: case studies of the costs and benefits of management”, *Forest Ecology and Management*, vol. 160, No. 1–3 (2002), p. 143–159.

functions in flow and water quality regulation, as well as an important role in many other ecosystem services, ranging from food production, including freshwater fisheries, to recreational and cultural values.

In terms of the second linkage, multiple stressors are involved in having negative impacts on freshwater ecosystems. Changes to river flow regimes and connectivity as a result of water withdrawals and dam construction, water pollution and the general undervaluation of aquatic ecosystems and ecosystem services have contributed to the loss of over 80 per cent of freshwater species populations since the 1970s, with climate change further exacerbating the situation.[139] Loss of biodiversity fundamentally weakens the balance and future resilience of the ecosystems. In turn, there are widespread impacts on both society and the environment through the weakening of the provisioning, regulatory, cultural and habitat-supporting services healthy freshwater ecosystems provide. These realizations have resulted in water allocation frameworks that increasingly prioritize the needs of ecosystems.

Meeting minimum requirements for ecosystem well-being

Natural freshwater ecosystems have evolved to thrive in dynamic hydrological conditions. In almost all contexts, variations in flows and water levels are essential for freshwater species and for ecosystem functions such as sediment transport and fisheries. However, people need water too. In many contexts, the question of meeting ecosystem requirements is less about how to maintain pristine ecosystems and more about understanding how to maintain essential aspects of flow variation even while using water for human social and economic purposes.[140] Environmental flow assessment tools and approaches focus on providing answers to this question (see also Chapter III, subsection 3a; Chapter VII, section 5).[141]

While environmental flow assessment is underpinned by science, decisions about how much water to take from an ecosystem for human use are ultimately social and political in nature. It is crucial that such decisions are made with an understanding that maintaining healthy freshwater ecosystems is not in competition with human water uses; rather, safeguarding or restoring key aspects of ecosystem functioning, such as downstream water supply, freshwater fisheries or sediment transport to low-lying delta regions are strategically important.[142] Thus, ecosystem health should be a foundation of water allocation in a transboundary context as it is crucial for the long-term sustainability of the world's shared freshwater sources.

CASE STUDY 12: Identifying ecologically sustainable levels of take: an intracountry, cross-border example from the Murray–Darling River, Australia

The Commonwealth Water Act governing the cross-border Murray–Darling River in Australia requires the Basin Plan to identify sustainable diversion limits (SDLs) for the basin. The SDLs aim to provide an ecologically sustainable level of take at which "key environmental assets and key ecosystem functions" are not compromised. The SDLs define how much surface and groundwater can be extracted for urban water supply, irrigation and other economic activities. The SDL is set for the entire basin and is being set for each subregion (each major river valley) and each groundwater management unit. The basin-wide surface water SDL is set at 10,873 gigalitres per year (GL/y) on a long-term average. A basin-wide long-term average limit of 3,472 GL/y has also been set on groundwater use. To meet the requirements of the SDLs, the Australian Government has been "recovering" water through a combination of water buy-backs and efficiency projects. The basin-wide water recovery target is 2,075 GL/y.

[139] WWF, *Living Planet Report 2020: Bending the Curve of Biodiversity Loss*, Rosamunde Almond, Monique Grooten and Tanya Petersen, eds. (Gland, Switzerland, 2020).

[140] Speed and others (2013).

[141] Avril C. Horne and others, eds., *Water for the Environment: From Policy and Science to Implementation and Management* (London, United Kingdom, Academic Press, 2017).

[142] Arthington and others (2018).

Preventing ecosystem degradation in transboundary water allocation

Preventing ecosystems degradation has been the main driver for national water allocation reforms in past years.[143] At the transboundary level, ecosystem protection is gradually gaining recognition but requires enhanced cooperative and coordinated efforts. SDG target 6.6 is to protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes, by 2020.[144] As this target was not met in the originally intended timeframe and, instead, there is evidence of accelerating negative consequences for both humans and the environment,[145] conservation efforts in the coming years need to respond to growing challenges. New and revised transboundary allocation arrangements and environmental requirements should be assessed and an environmental reserve be set aside before allocating water to other uses (see also Chapter III, sections 1 and 3a; Chapter VII, section 5).

5. Balancing Different Water Uses and Needs

a. Considering historical, current and future uses

Development trajectories of water use

Water use and water allocation has a strong temporal dimension across years and even decades. While water allocation typically focuses on current and (short-term) future water uses, it builds on historical use and development, and should also consider longer-term needs. Consideration of this temporal dimension thus links to the broader view on water and its role in the development of societies, including linkages to food and energy security, as well as the environment. The temporal dimension of water allocation in this regard can be considered through three main trends, or development trajectories: changes in the total water use of a society; comparative changes in the water use between sectors and functions; and changes in water availability due to changing climate and other alterations in the hydrological system. The first two changes can be considered as socioeconomic trajectories that drive water use and which are discussed in this section, while the third is a physical, though human-influenced, trajectory, discussed in sections 1 and 2 of this chapter.

CASE STUDY 13: Allocation lessons from Australia's governance of intracountry cross-border rivers

The Murray–Darling Basin (MDB) covers nearly 1 million km^2 of south-eastern Australia. It contains the largest and most complex river system in Australia, with 77,000 km of rivers, many of which are connected. The MDB includes 16 internationally significant wetlands, 35 endangered species and 98 different species of waterbirds. Indigenous peoples have lived in what we now call the MDB for more than 50,000 years and the Basin contains many sacred and spiritually significant sites (see Case Study 18 on Indigenous cultural flows). The MDB has been the site of most Australian intracountry, cross-border water governance experiences, with six governments involved: the federal (Commonwealth) government and those of four States and the Australian Capital Territory.

For about 160 years there have been agreements and plans about how much water can be used from the River Murray and the Basin as a whole. Over the decades more and more water was being extracted. The health of the Murray–Darling system was in decline. The water was overallocated. In 1995 the MDB cap on surface water diversions was introduced, and thereafter annual auditing of compliance with the cap began. It became obvious that further significant changes were needed to the water law, water allocation and water use practices. A devastating drought from 1997 to 2009 catalysed further community and political action. This led to a National Plan for Water Security in 2007 and the Commonwealth Water Act (2007). Australia's Water Act is an ambitious piece of legislation that seeks to return water allocations in the MDB to sustainable levels and to coordinate planning and decision-making at the Basin level.

The Act established the Murray–Darling Basin Authority (MDBA), which was given responsibility to: prepare, implement, and review an integrated Basin Plan; operate the River Murray system and efficiently deliver water;

[143] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).
[144] See https://sdgs.un.org/goals/goal6.
[145] WWF (2020).

measure, monitor and record the quality and quantity of the Basin's water resources; support research; advise the Minister; provide water information to facilitate water trading; and engage and educate the community. The MDBA is responsible for assessing and monitoring Basin State compliance with sustainable diversion limits (SDLs) by towns, communities, industry and farmers. Limits are being set for 29 surface water areas and 80 groundwater areas across the Basin.

The aim of the Basin Plan is to bring the Basin back to good health, while continuing to support farming and other industries for the benefit of the Australian community. It took five years to develop and agree to a plan to manage the Basin as a whole, connected system. For surface water, the Basin Plan requires, on average, a reduction of 2,075 GL of water used for consumption annually across the Basin.

Underpinning the Basin Plan, under preparation, are 33 subbasin water resource plans (WRPs) for surface water and groundwater. These will be legally binding. WRPs must contain: evidence of compliance with SDLs and water trade rules; protection of water for the environment, water quality and salinity objectives; Indigenous objectives and outcomes for values and uses; measuring and monitoring protocols; and arrangements for extreme weather events.

The Murray–Darling Basin Plan, in place since 2012, and backed by $A 13 billion, is one of Australia's most scrutinized pieces of public policy. Since 2012, the overall average water take is down from ~14,000 GL/y to ~11,000 GL/y. Water extractions in the Basin are capped (now to a lower level than previously) and new enterprises can only be established if they purchase existing water entitlements from others. There is no net additional water extraction as a result of such trades.

Problems remain, however, including establishment of accurate water accounting and effective compliance regimes, ecosystem health (as evidenced by fish kills in the summer of 2019), only a tiny volume of surface water holdings being in the hands of Indigenous entities, and maintaining community support and interjurisdictional political buy-in. These are all areas recognized as requiring further attention and improvement. Water entitlements yielding an average of 2,000 GL/y have been acquired for the environment by the federal government, via a combination of government buy-backs and infrastructure modernization. There is an additional ~1,000 GL/y of environmental water. This is a substantial transfer of water from the consumptive pool. It is the largest redirection of water to the environment in any large river basin in the world. The Commonwealth Environmental Water Holder (CEWH, created by the Water Act (2007)), in concert with relevant State government agencies, now routinely and competently delivers these secure water entitlements. Over the past four years, Commonwealth and other environmental water has been used in more than 750 planned watering events to improve the health of rivers and wetlands.

In September 2020, the MDBA has committed to a new range of initiatives to further boost transparency and collaboration. These include: increasing communications about river operations; using new engagement methods tailored to suit local communities; boosting the diversity of MDBA consultative committees, including the addition of Indigenous members; and splitting out the MDBA compliance role to a separate statutory authority.

In conclusion, years of overallocation degraded the ecosystem and climate change is making the recovery task even harder. Climate change projections indicate a small increase in total rainfall in the northern Basin is likely; however, decreasing winter and spring rainfall is consistently predicted for the southern Basin. However, of the many large river basins in the world grappling with water scarcity and conflict between users, the Murray–Darling Basin is one with a strong rules-based order, including clearly defined water entitlements, a cap on extractions, a large environmental water reserve, substantial (but imperfect) transparency and a systematic audit process. For these reasons, when it comes to the complicated business of sharing water among competing interests, basin managers from around the world look to Australia to observe a functioning example of work in progress.

The first development trajectory of total water use has demonstrated a strong upward trend globally over the past 50 years, with water use in all key water-using sectors increasing dramatically.[146] Irrigated land area,

[146] M. Kummu and others, "Is physical water scarcity a new phenomenon? Global assessment of water shortage over the last two millennia", *Environmental Research Letters*, vol. 5, No. 3 (2010), 034006; M. Kummu and others, "The world's road to water scarcity: shortage and stress in the 20th century and pathways towards sustainability", *Scientific Reports*, vol. 6 (2016), 38495.

abstraction of groundwater, reservoir and hydropower capacity, as well as water use for industrial and domestic uses, have all grown significantly in almost all countries and river basins globally, yet regional differences exist. For example, total withdrawals are now decreasing, on average, in OECD countries.[147] This is partly a result of heightened scarcity, deteriorated water quality and heightened environmental degradation, and partly due to efficiency improvements and lower than expected demand in specific water use sectors. Overestimating demand has led to hugely oversized infrastructure and major costs. Global water withdrawals have been projected to further grow by 55 per cent from 2000 to 2050, as a result of increasing demands from manufacturing (400 per cent), thermal electricity generation (140 per cent) and domestic use (130 percent).[148] While population growth and increasing production and consumption require more water, the potential for efficiency improvements and demand management measures should not be neglected to avoid oversized allocations.

The second development trajectory considers comparative changes in water use between sectors and functions. It may differ greatly, even within an individual river basin, both temporarily (e.g. between different decades and seasonally) and spatially (e.g. between different countries and/or their regions). This trajectory relies strongly on existing policies, as the changes occur through decisions and activities that can increase and decrease both the comparative and actual water use of different sectors and functions. Examples of structural changes on this trajectory include shifts to more water-efficient technologies (e.g. as directed by best available techniques (BAT), less water-intensive crops (e.g. shifting from cotton cultivation to cereals), alternative power generation technologies that are less water intensive, or prioritizing higher economic value and less water-intensive sectors (e.g. tourism and recreation over water-intensive agriculture, where appropriate).

Understanding water use in transboundary settings over time

Different approaches can be applied to understand how water use changes over time in a transboundary river basin or aquifer. One option is to make use of the concept of basin closure or "closed" basins. Basin closure indicates the stage when the majority of water resources within a basin are allocated for various water uses and little to no water from the natural flow and sources remains to be further used and allocated.[149] Three general phases are linked to the concept of basin closure—*development*, *utilization* and *allocation*:

- In the development phase, water may be abundantly available and water infrastructure is developed to access the resources;
- In the utilization phase, the focus moves from infrastructure construction to improved water management, typically when water availability starts to become constrained;
- In the allocation phase, water availability is limited and decisions need to be made for the allocation or reallocation of water between different uses, without causing harm, and consistent with the principles of international law and the law of treaties.[150]

[147] OECD, *OECD Environmental Outlook to 2050: The Consequences of Inaction* (Paris, 2012).
[148] OECD (2012).
[149] Jack Keller, Andrew Keller and Grant Davids, "River basin development phases and implications of closure", *Journal of Applied Irrigation Science*, vol. 33, No. 2 (1998), p. 145–163; François Molle, "Development trajectories of river basins: a conceptual framework", Research Report, No. 72 (Colombo, Sri Lanka, International Water Management Institute, 2013).
[150] David Molden, R. Sakthivadivel and M. Samad, "Accounting for changes in water use and the need for institutional adaptation", in *Intersectoral Management of River Basins: Proceedings of an International Workshop on 'Integrated Water Management in Water-Stressed River Basins in Developing Countries: Strategies for Poverty Alleviation and Agricultural Growth', Loskop Dam, South Africa, 16–21 October 2000*, C. L. Abernethy, ed. (Colombo, Sri Lanka, International Water Management Institute and German Foundation for International Development (DSE), 2001), p. 73–87.

Each of the phases consists of different water management practices, such as water diversions and storages and, in the later phases, demand reduction. These practices aim to balance the water availability with (growing) water demand.

CASE STUDY 14: Storage infrastructure and joint monitoring for flow reallocation needs in the lower Orange–Senqu River system

The Orange–Senqu River system in Southern Africa, shared by Botswana, Lesotho, Namibia and South Africa, is highly regulated, because of the historical and ongoing extensive abstraction and dam infrastructure deployed in the upper and middle section of the river to address demand gaps. The lower Orange–Senqu region is well known for producing table grapes and other fruits for the export market in Europe and other parts of the world. Due to its unique climate and rich soils, the region enjoys early harvests and is therefore very competitive and is of significant national economic importance. The challenge to the irrigation farmers hinges on access to predictable and adequate water flow, especially during the season when the farming operations need such flow. Another challenge is ensuring adequate flows for ecological functions, including the river mouth, which is designated as a wetland of international importance (Ramsar site) on both sides of the common border.

The Noordoewer/Vioolsdrift Joint Irrigation Authority (JIA) was established in 1992 to enable Namibia and South Africa to jointly operate and maintain a canal built in the 1930s to supply water for irrigation, and control abstraction of water to farmers in the river valley on both sides of the border through a weir close to the border towns of Noordoewer and Vioolsdrift. In conjunction, the Permanent Water Commission (PWC) between Namibia and South Africa, also established in 1992, was mandated to advise the State parties on matters related to development and utilization of water resources of common interest to them. In relation to water allocation in the area of the JIA, the two State parties adopted volumetric allocation set at 20 million m^3 per annum in 1992. However, water needs for the region have been increasing, mainly as a result of increased productivity and increased uses upstream of the region. Complaints have been reported on the insufficient flows and inadequate water for irrigation, especially during the October to February period when the farmers need it most.

In order to address the allocation challenges, Namibia and South Africa identified a solution to build a flow-regulation dam at Noordoewer/Vioolsdrift. The purpose of the flow-regulation dam is to secure sustainable long-term water resources yield for the lower Orange–Senqu River, including environmental allocations for the river mouth. In this regard, the dam would serve the purpose of retaining any additional flow releases from upstream during the winter months, as well as scheduled flow releases and flood water during the rest of the year, and release the required flows according to farmer needs and to address ecological flow requirements towards the river mouth.

The Orange–Senqu River Commission (ORASECOM), the river basin authority established in 2000, is mandated to provide technical advice to the four State parties, in utilization, development, conservation and management of the overall basin. The ORASECOM IWRM plan articulated joint measures, including a suite of infrastructure solutions and environmental initiatives, to promote cooperation and sustainable development of the shared river basin, in its entirety. The Noordoewer/Vioolsdrift dam feasibility study is currently ongoing, jointly financed by Namibia and South Africa. In the interim, the two States have installed gauging stations along the common border, equipped with advanced flow measurement and transmission capabilities. Joint field observations and monitoring of the flow gauging network continues, including joint field excursions to consult key role players such as local irrigation boards, water user associations and the JIA. The ORASECOM Secretariat has been co-opted to join the joint field excursions and consultations with key role players, especially when complaints regarding water allocations have been reported. The PWC regularly reports and updates ORASECOM on all major developments, including progress on deployment of the Noordoewer/Vioolsdrift dam.

b. Balancing water uses and needs in transboundary water allocation

Transboundary water allocation today and in the future needs to balance multiple growing needs and, at the same time, deal with the increasingly limited and varying availability of water. Furthermore, different water uses have different scopes for coping with change and improving efficiency. Allocation in a transboundary context may thus include difficult and potentially contested decisions on water use priorities. The allocation process requires the assessment of available water resources and understanding of different water uses and needs across both temporal (current and future uses) and spatial (in different States, jurisdictions and geographical, hydrographical and geohydrographical settings) scales. It should address water availability, water entitlements and the potential conflicts among different water use needs in terms of water quantity, quality and timing. In cases where all water use needs and demands cannot be met with the available water resources, parties need to discuss their priority at both transboundary and national levels.

CASE STUDY 15: Determining allocation priority uses and proposal for a risk-based approach in the Incomati River Basin

The Incomati River Basin is a transboundary watercourse in southern Africa. It covers approximately 46,500 km^2 shared by South Africa (28,600 km^2, 61 per cent), Mozambique (15,300 km^2, 33 per cent) and Eswatini (2600 km^2, 6 per cent). The Basin is in a relatively semi-arid area with annual rainfall in the order of 750 mm. Like elsewhere in Africa, inter- and intraannual variability in rainfall is high. Droughts prevail in some years, floods in others. The Kruger National Park, an internationally recognized hotspot for wildlife, covers a large portion of the Basin.

The current Interim IncoMaputo Agreement (IIMA), signed by the three countries in 1998, makes water allocations that distinguish between so-called First Priority Use and Irrigation Use and specify the amount of water for maximum utilization under “average” conditions. However, as assurances of supply are not specified, the IIMA does not explicitly address situations where a water deficit occurs. The IIMA does not include environmental flow requirements as a consumptive water use but allows for minimum in-stream flows at key points in the Incomati watercourse to sustain the ecology.

The IIMA allocated water based on past water use and estimates of the availability of water in 2002 to the three countries for first priority supplies, irrigation and afforestation in the Incomati Basin. The Tripartite Permanent Technical Committee (TPTC) comprising representatives of South Africa, Mozambique and Eswatini, has also agreed and implemented the Progressive Realization of the IncoMaputo Agreement (PRIMA) since 2010, upon which current allocations are based. Moreover, when the TPTC determines that a drought condition exists and that water use by the parties must be reduced, irrigation use shall be the first to be reduced.

The IIMA allocations may need to be revisited, as the most recent hydrology study of the Komati, Crocodile and Sabie subcatchments recorded less water than was originally assumed, due in part to the effects of climate change. A risk-based approach has been proposed for the allocation of water in the Incomati Basin, i.e. assurances of supply are assigned to the various user sectors in the system. This approach allows for greater flexibility while providing a consistent manner in which to operate the overall Basin. For each user category, allocations are refined into proportions for risk categories that should be supplied at different levels of assurance. This means, for instance, that an irrigator will have a large proportion of his or her water at a low assurance and a small proportion at a much higher assurance, while, conversely, a first priority user may have a large proportion or all of his or her water at a high assurance and a small proportion at a lower assurance. Included in the allocation system are mechanisms to realize the potential benefits that could accrue during a surplus situation. The risk-based approach, however, provides the flexibility for water users to adapt to both situations, whether surplus or deficit.

Decisions on balancing water uses are generally informed by socioeconomic aspects, existing water uses, assessments of environmental requirements and pre-existing institutional frameworks, among other factors. Such decisions are best coordinated as part of basin-wide planning, integrating consideration of future scenarios, BAT and water management practices. Principles of international water law, including equitable and reasonable utilization, no significant harm, and protection of the environment, as well as the human right to water, provide a guiding framework for negotiations (see Chapter V, subsection 3c). Considering that water allocation for human consumption, some national security-related uses and environmental requirements have limited scope for negotiation, the socioeconomic aspects should be analysed in detail, providing opportunities to understand how to make interventions in different water uses, and what both the best practices and the potentially sensitive and contested aspects are.

Socioeconomic aspects commonly focus on water-related livelihoods and economic sectors such as agriculture, industry and energy production, cultural features and well-being, including domestic water supply, as well as broader food security and energy security issues. The water needs for the different socioeconomic uses need to be evaluated against, and aligned with, the overall development and climate scenarios in the given context (see Chapter II section 1; Chapter VI section 4). Furthermore, after water for vital human needs and the environment has been allocated, national allocation among sectors may be made based on highest value uses (economic, cultural) (see also subsection 3c above).[151] In a transboundary context, benefit-sharing and a nexus approach may provide means to further balance the socioeconomic interest of different parties and address challenging upstream–downstream dynamics (see also Chapter IV).[152]

[151] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).
[152] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water* Cooperation (2015); UNECE, *Methodology for Assessing the Water-Food-Energy-Ecosystems Nexus* (2018).

CHAPTER IV: Limitations to Water Allocation and its Linkages with Broader Approaches

SUMMARY:
This chapter highlights the conceptual and procedural limitations to water allocation and the broader approaches to transboundary water resources management and cooperation with their linkages to water allocation. Several recognized broader approaches—IWRM, basin-wide planning, benefit-sharing and the water-energy-food-ecosystem nexus—to consider in conjunction with transboundary water allocation, are presented with case studies and further resources for reference.

1. Limitations of Water Allocation

While potentially useful, water allocation has its limitations. Conceptually, the focus on water quantity, quality and timing means that water allocation does not really consider the broader aspects of water use, such as the linkages to sectors such as food and energy and to the broader development agenda, including the SDGs. Focus on water allocation may also conceal the need to progress from supply management options to demand management measures. Such measures include improved efficiency, the growing water demand rather than actual availability often being the limiting factor to development and human and environmental well-being.

The actual process of water allocation has additional limitations. First, in transboundary contexts, practically all agreed allocations are based on a simplification regarding the diverse and dynamic nature of shared waters. This is further amplified by the fact that most transboundary allocation arrangements have fixed mechanisms for water quantity, with over 30 per cent of the agreements with an allocation mechanism designating a fixed quantity or volume of water (see Chapter II).[153] While these mechanisms establish a clear structure for allocation, they also mean that fixed allocation mechanisms have a limited capacity to consider the changes that, for example, climate change or land use cause for shared waters (see Chapter III). Many water allocation arrangements can therefore lack the necessary flexibility to adapt to the changing nature of water resources.

Second, while water allocation arrangements benefit greatly from long-term observations and shared databases, as well as shared observation networks, these are not always in place; this hampers the operationalization of water allocation and may even lead to misleading decisions regarding it. Third, operationalization of transboundary arrangements may also face challenges at a national level. Results from a 2015 OECD survey of national arrangements on allocation indicated that, while important building blocks were in place in many cases, the design and implementation of the arrangements had significant flaws.[154] Finally, given that transboundary water allocation is typically agreed between the governments of riparian States, other key actors, such as the private sector and civil society, may have limited possibilities to participate in and influence water allocation.

Yet these limitations do not render water allocation irrelevant. Instead, they highlight the importance of clearly describing and comprehending the important but focused role water allocation has in transboundary water resources management and the related governance, and the necessity to link it to broader social, environmental and economic development planning.[155] This also means that water allocation plays a critical

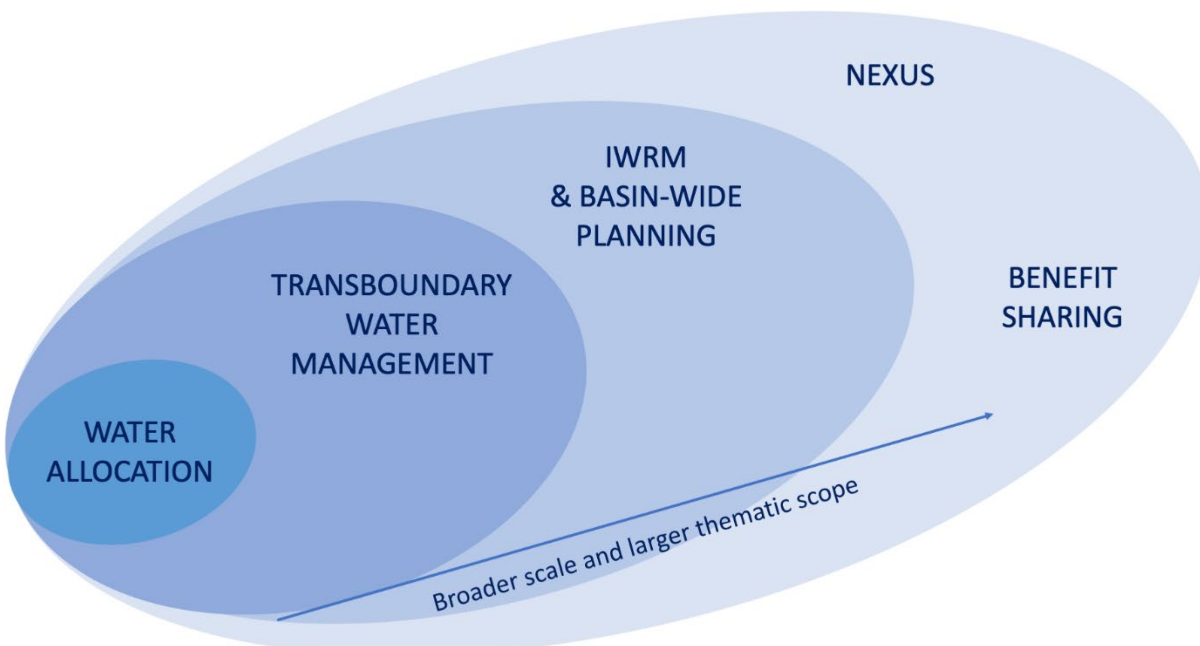
[153] McCracken and others, "Typology for transboundary water allocation" (forthcoming).
[154] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).
[155] Speed and others (2013).

part in many related, complementary or broader approaches used in transboundary water cooperation. The central ones are discussed next.

2. Broader Approaches to Consider

Water allocation forms an important part of transboundary water resources management, establishing an agreed baseline for water quantity, quality and timing. At the same time, water allocation links to the broader approaches that are commonly used to both initiate and advance transboundary water cooperation and the related governance arrangements. Understanding the linkage that water allocation has to such approaches—and its own focused but limited role—is important in order to put the allocation into the right context, also indicating how the limitations of water allocation can be addressed. Such approaches typically consider larger spatial scales and cross-sectoral aspects and themes of water resources management and governance and involve a more diverse group of stakeholders. The four broader approaches discussed below, which have been developed internationally, are particularly relevant to consider with water allocation.

Figure 8
Simplified visualization of linkages between water allocation and complementary approaches



Source: M. Keskinen, 2020.
Note: The figure also indicates their general hierarchy in terms of geographical scale and thematic scope: both of these increase when moving from left to right in the figure.

a. Integrated water resources management

As emphasized, water allocation is closely connected to the broader activities of transboundary water resources management. While there are many ways to describe the key principles for water resources management, integrated water resources management (IWRM) (Figure 9) is highlighted here due to its importance and well-recognized role within both the Water Convention and the water-related SDGs. SDG 6.5 specifically sets a target to implement IWRM at all levels by 2030, including through transboundary cooperation as appropriate.[156] The common definition of IWRM is provided by the Global Water Partnership (GWP): "IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment." [157]

Table 3

Allocation characteristics vis-a-vis broader approaches to transboundary management and cooperation

	Water allocation	**IWRM**	**Basin-wide planning**	**Nexus (e.g. water-energy-food security)**	**Assessing and sharing benefits and costs and minimizing harm**
Focus (simplified)	WATER: Quantity, quality and timing of water at a given point (country border)	WATER: Coordinated development and management of water integrating different uses and water sources	BASIN: Strategic planning of economic, social and environmental priorities within a shared water basin	SECTORS: Facilitating the synergies between water and related sectors such as food and energy	REGION: Considering regional economic and political benefits derived from transboundary water cooperation
Main scale	At a specific defined point; typically a country border	Transboundary basin, building on national management plans	Transboundary basin; beyond States	Applicable at different scales, here considered at regional scale	Regional scale (i.e. in and beyond basin scale)
Timing	Targeted, to ensure meeting a need or to address a specific issue	Short medium, long term	Medium to long term	Medium term and preferably also *before* sectoral plans impact on water use	Medium to long term
Scope of action	Water supply/bulk water	Water resources management, mainly at operational and tactical level	Water resources management, mainly at strategic level	Trade-offs and synergies between sectors	Seeing water's role for regional economic and political cooperation

Source: UNECE Water Convention secretariat, 2021.

Note: The characteristics are simplifications and intentionally emphasize the differences between the closely related and partly overlapping approaches.

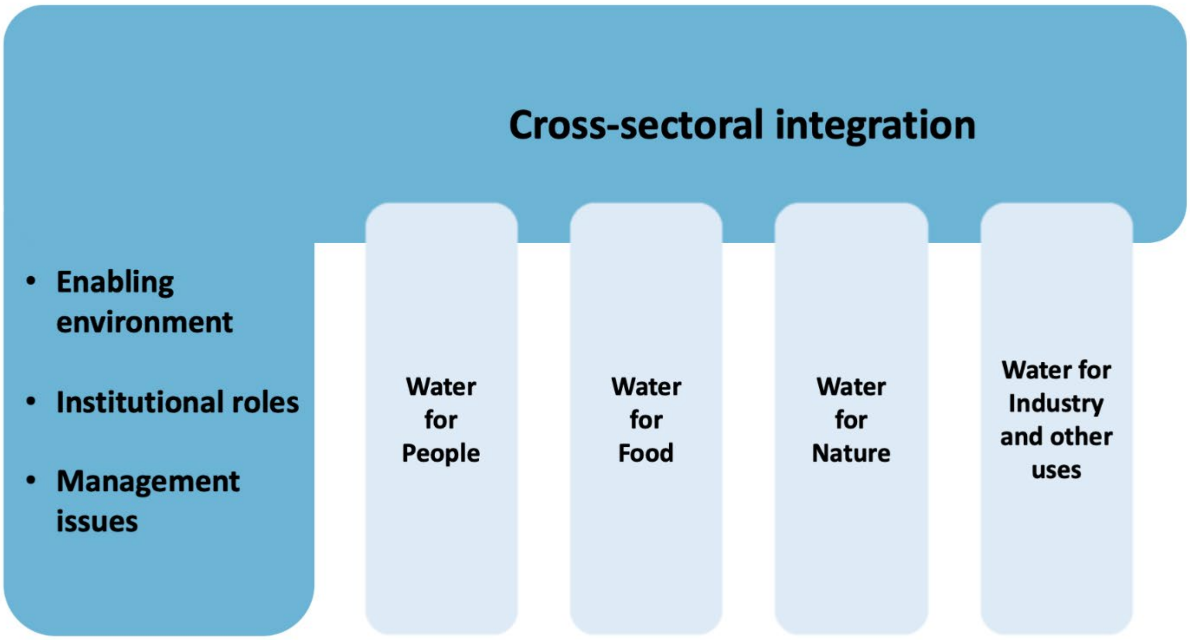
IWRM thus aims to ensure sustainable and equitable use of water and related resources with the help of key management instruments (e.g. allocation) and key institutions, as well as a broader enabling environment (e.g. policies and cooperation forums) and financing. According to the recent progress report on SDG 6.5, a

[156] See https://sdgs.un.org/goals/goal6.

[157] Anil Agerwal and others, "Integrated water resources management", TAC Background Papers, No. 4 (Stockholm, Global Water Partnership, 2000).

great majority of countries have already established a firm institutional foundation for IWRM, including in transboundary basins. The actual degree of implementation varies greatly, however.[158]

Figure 9
Conceptualization of integrated water resources management and its related subsectors



Source: Anil Agerwal and others, "Integrated water resources management", TAC Background Papers, No. 4 (Stockholm, Global Water Partnership, 2000).

b. Basin-wide planning or strategic basin planning processes

During the past decade, basin-wide planning or strategic basin planning processes (Figure 8) have emerged to complement IWRM implementation. Their best practices exemplify 10 golden rules:

- Develop a comprehensive understanding of the entire system;
- Plan and act, even without full knowledge (or perfect foresight);
- Prioritize issues for current attention, and adopt a phased and iterative approach to the achievement of long-term goals;
- Enable adaptation to changing circumstances;
- Accept that basin planning is an inherently iterative and chaotic process;
- Develop relevant and consistent thematic plans;
- Address issues at the appropriate scale by nesting local plans under the basin plan;
- Engage stakeholders with a view to strengthening institutional relationships;
- Focus on implementation of the basin plan throughout;
- Select the planning approach and methods to suit the basin needs.[159]

At their core are shared scenarios and visions for the future of the basin, which are crucial for reaching joint understanding on allocation needs and requirements.

[158] UNEP, *Progress on Integrated Water Resources Management: Global Baseline for SDG 6 Indicator 6.5.1: Degree of IWRM Implementation* (Geneva, 2018).
[159] Speed and others (2013).

c. The water-food-energy-ecosystem nexus approach

The nexus approach to managing interlinked resources has equally gained prominence during the past decade as a way to enhance water, energy and food security.[160] Resource management and economic policy decisions in agriculture and energy are taken outside the sphere of water management but they translate into impacts and demands on water, and vice versa. The nexus approach aims to increase resource efficiency, reduce trade-offs, build synergies and improve governance among and between sectors, while simultaneously protecting ecosystems. Integrated planning, coherent policies and multipurpose investments are among the means to address nexus issues. Intersectoral or nexus assessments and dialogues, supported by analysis to varying degrees, have sought to point at such opportunities in policy and in taking technical measures.[161]

Identifying and addressing intersectoral trade-offs and synergies can inform water allocation decision-making processes, foster transboundary cooperation and increase resource use efficiency. The need for water allocation measures to address scarcity or its impacts could potentially be avoided by integrated planning and informed sectoral policies that are coordinated and take into account availability and variability of water resources. For example, in areas suffering from water scarcity, locating water-intensive primary production or industries in areas with more abundant water resources or importing water-intensive commodities, and thus "virtual water",[162] is an example of nexus strategy that helps to expand the pool of water resources available for different uses and needs. Another nexus strategy is to explore alternative renewable energy technologies such as solar, wind and tidal that are less water intensive than conventional energy generating methods, such as hydropower. Doing so may relieve the pressure on water resources use and trade-offs between power generation and irrigation or other water uses. Using the nexus approach can help to identify the stress points where hydropower development is creating concerns.[163] UNECE has developed a methodology to assess such nexus interactions and synergistic solutions and applied it in eight basins to date.

d. Identifying, assessing and sharing benefits of transboundary water cooperation

Identifying, assessing and sharing benefits of transboundary water cooperation increases the scope of benefits considered from pure water allocation to benefits from improved water management and enhanced trust for and beyond economic activities. Those may include, among others, economic, social and environmental benefits, as well as regional economic integration benefits and enhanced peace and security benefits.[164] Sadoff and Grey (2005)[165] outline a process leading to capturing shared benefits through implementation of relevant projects, starting from assessing cooperatively the opportunities for potential benefits in the region in question, followed by negotiating a bundle of projects, benefit-sharing arrangements and legal agreements. The analysis of potential for sharing benefits can be revisited to continue the cycle.

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[160] UNECE, *Methodology for Assessing the Water-Food-Energy-Ecosystems Nexus* (2018).

[161] UNECE, *Reconciling Resource Uses in Transboundary Basins: Assessment of the Water-Food-Energy-Ecosystems Nexus* (New York and Geneva, United Nations, 2015).

[162] J. A. Allan, "Virtual water – the water, food, and trade nexus. Useful concept or misleading metaphor?", *Water International*, vol. 28, No. 1 (2003), p. 106–113.

[163] UNECE, *Deployment of Renewable Energy: The Water-Energy-Food-Ecosystem Nexus Approach to Support the Sustainable Development Goals: Good Practices and Policies for Intersectoral Synergies to Deploy Renewable Energy* (Geneva, 2017).

[164] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water* Cooperation (2015); Laura López-Hoffman and others, "Ecosystem services across borders: a framework for transboundary conservation policy", *Frontiers in Ecology and the Environment*, vol. 8, No. 2 (2010), p. 84–91.

[165] Claudia W. Sadoff and David Grey, "Cooperation on international rivers: a continuum for securing and sharing benefits", *Water International*, vol. 30, No. 4 (2005), p. 420–427.

The broad-ranging benefits from transboundary cooperation are illustrated by the outcomes of the assessment of benefits in the Drina River Basin (see Case Study 16). Focus on benefits in strictly economic terms (quantifiable and monetized, e.g. by hydro-economic modelling) does not lessen the importance of other benefits which may not all even be quantifiable. Identification of qualitative benefits of cooperation can be equally helpful, helping to create enabling conditions, including political willingness to strengthen cooperation. Besides sharing benefits, sharing of costs may be a central part of joint management of shared water resources, such as in the case of the Chu–Talas Basin between Kazakhstan and Kyrgyzstan (see Case Study 9).

The potential for sharing benefits from the use of water resources can help to prioritize water uses and needs. Integration of clear benefit-sharing measures into water allocation arrangements, including priority water needs to be secured and how any costs incurred in exceptional or changing circumstances should be dealt with, can help prevent related tensions and disputes (see also Chapter V, section 4 on adaptability of allocation arrangements). Understanding the benefits from the use of shared water resources and from transboundary cooperation broadly can: i) inform and help design a more equitable water allocation; ii) reinforce cooperation on basin management that contributes to, for example, sustaining the allocable water resource, ensuring the functioning of the necessary built or natural infrastructure and reducing transboundary impacts; and iii) with a cross-sectoral (nexus) perspective, extend and diversify the types of benefits that can be realized through cooperation engaging economic sectors.

CASE STUDY 16: Identifying benefits of cooperation with a nexus approach as a broader perspective to revisit flow regulation in the Drina River Basin

The Drina River, shared mainly by Bosnia and Herzegovina, Montenegro and Serbia,[166] serves various flow-related needs: there is currently important hydropower generation and also plans for further development; the population's water needs are met partly from the river (while groundwater is also important); recreational activities, notably water sports, are practised on the tributaries; and valuable ecosystems and their services depend on the Drina. Various sections of the river are also at risk of flooding.

All economic activities in the Drina River Basin depend on the timely flow of adequate quantities of water, with quality fit for purpose. Currently, the regulation of flow is uncoordinated and suboptimal, and this has an impact on both water availability and water quality.

The identification and assessment of benefits of transboundary cooperation in the Drina River Basin (see Table 4) was integrated into a participatory assessment of the water-food-energy-ecosystems nexus[167] under the Water Convention, which aimed to foster transboundary cooperation by identifying, jointly with the riparian States' concerned ministries, intersectoral trade-offs and synergies. To capitalize on the benefits, coordinated policy and technical actions in the fields of water management, energy and environmental protection, at different levels, across borders were proposed.

In the nexus assessment of the Drina River Basin,[168] some benefits were quantified: energy system modelling allowed the estimation that cooperative operation of hydropower dams could deliver more than 600 GWh of electricity over the 2017–2030 period, compared with optimization of dam operation on a single unit basis. Overall system savings for the three countries could amount to $136 million over the entire modelling period with the assumptions made. Setting aside 30 per cent of dam capacity for flood control would have a cost (in terms of lost energy production) equivalent to 4 per cent of the combined operational cost of the electricity system in the three countries. The analysis also points to the value of increasing energy efficiency to reduce pressure on hydropower generation.

[166] A very small part of the Drina River Basin (less than 1 per cent) is in Albania.
[167] UNECE, *Assessment of the Water-Food-Energy-Ecosystems Nexus and Benefits of Transboundary Cooperation in the Drina River Basin* (New York and Geneva, United Nations, 2017).
[168] Ibid.

Table 4
Benefits of transboundary cooperation identified in the Drina River Basin

	Economic activities benefits	Benefits beyond economic activities
From improved water management	**Economic benefits** • Expanded activity and productivity in economic sectors • Reduced cost of carrying out productive activities • Reduced economic impacts of water-related hazards (floods, droughts etc.)	**Social and environmental benefits** • Health impacts • Employment and reduced poverty impacts • Improved access to services (electricity, water supply, etc.) • Preservation of cultural resources or recreational opportunities • Avoided/reduced habitat degradation and biodiversity loss
From enhanced trust	**Regional economic cooperation benefits** • Development of regional markets (for goods, services and labour) • Increase in cross-border investments • Development of transnational infrastructure networks	**Peace and security benefits** • Strengthening of international law • Increased geopolitical stability • Reduced risk and avoided cost of conflict • Savings from reduced military spending

Source: UNECE, *Identifying, Assessing and Communicating the Benefits of Transboundary Water Cooperation: Lessons Learned and Recommendations* (Geneva, 2018).

Various issues are still to be solved in the Drina River Basin, including some border-related and historical compensation issues, and the riparian States are still negotiating and looking for feasible solutions. Paths to solving these issues include water management, including bilaterally and in the framework of the International Sava River Basin Commission (ISRBC), but also the field of energy, where possible new development opportunities are at stake as the sector grapples with the challenge of a sustainable transition.

Sharing benefits and costs: hydropower as an example
Based on global data,[169] one of the predominant purposes for allocation has been hydropower but, in fact, States often allocate benefits from hydropower rather than allocating water volumes to hydropower projects. Benefits from hydropower are shared or divided, among other approaches, as fixed quantities of power, percentages of power and value generated from power sales (see Table 5).

Table 5
Hydropower division of benefits according to the method of water allocation classification used in the Handbook

Hydropower Benefits Division	
None: Only generally describes a hydropower project and does not detail any benefits (e.g. power, money) shared/allocated	Percentage of power generated

[169] Source: Oregon State University, College of Earth, Ocean, and Atmospheric Sciences, “Transboundary Freshwater Dispute Database”.

Fixed quantities of power: generated from a hydropower project	Fixed value of electricity generated: determined by an agreed pricing mechanism, such as market pricing
Variable quantities of power: generated from hydropower projects; may vary due to water availability, time, etc.	Consultation: States must consult with other parties to determine or change the division of benefits from a hydropower project
Percentage of assessed value of electricity generated: such as an assessed value determined by market pricing mechanism	Other: States use a different mechanism than listed above. In such a case, this will be specified in the hydropower text code.

Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

CASE STUDY 17: Cooperation on the use of water and energy resources of the Syr Darya River Basin (Central Asia)

Over the Soviet period, water allocation in the Syr Darya River Basin and in the broader Aral Sea Basin, centrally decided as a domestic issue, was based on the irrigation conditions of the main reservoirs and compensatory energy supplies were ensured to the upstream Soviet republics.

With the establishment of new sovereign States in the region (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan) in 1991, the conditions for using water resources fundamentally changed: the countries' resource base and economic development led to different priorities, which were—and are still—not compatible at all times, with upstream Kyrgyzstan and Tajikistan developing and operating hydropower with generating peak in winter and downstream Kazakhstan and Uzbekistan needing water for irrigation in spring and summer. With a market economy and no central enforcement mechanism, the former seasonal exchange of water and energy carriers between now newly independent countries ceased to work.

However, just a few months after gaining independence, five Central Asian countries signed an agreement in early 1992, stressing that earlier structures, principles and agreements on water allocation will remain valid. In an attempt to regulate the crucial water–energy nexus, an Agreement on the Use of Water and Energy Resources of the Syr Darya River Basin was signed in 1998 by Kazakhstan, Kyrgyzstan and Uzbekistan, with Tajikistan joining a year later. The Agreement concentrated on multi-annual regulation of the Naryn Syr Darya cascade and Toktogul reservoir in Kyrgyzstan. The compensation from downstream countries was foreseen in energy resources, such as coal, gas, electricity and fuel oil, and the rendering of other types of products (labour, services), or in monetary terms as agreed upon.

Water consumption quotas among the countries to implement the Agreement were to be agreed in the framework of the Interstate Commission on Water Coordination (ICWC); for its role in water allocation and its functioning, see Case Studies 29 and 31 on the Amu Darya Basin). The ICWC was established in 1993 with a secretariat with the mandate to elaborate and approve annual water consumption quotas for five Central Asian countries, as well as schedules for reservoir operation regimes, based on forecasts and actual flow. However, the agreed water consumption quotas among the countries to implement the Agreement soon began to be neglected and the Agreement ceased to work after a few years.

The assessment of the water-food-energy-ecosystems nexus in the Syr Darya River Basin[170] provided for a dialogue about the intersectoral challenges on a broader basis. It illustrated the value of actions such as diversifying energy sources—including for energy security—from the current heavy reliance on hydropower in the upper reaches, as well as improving energy efficiency and developing a regional electricity market and trade. The nexus assessment also recommended improvement of water efficiency to reduce dependency on water, which would be particularly effective in the lower reaches.

[170] UNECE, *Reconciling Resource Uses in Transboundary Basins: Assessment of the Water-Food-Energy-Ecosystems Nexus in the Syr Darya River Basin (shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan)* (New York and Geneva, United Nations, 2017).

PART 2 - OPERATIONALIZING

CHAPTER V: Objectives of Water Management and Related Principles of International Law to Guide Transboundary Water Allocation

SUMMARY:
This chapter begins by discussing cross-cutting objectives of IWRM and their related legal principles, to be considered when initially developing transboundary water allocation processes and outcomes. Core principles of international water law, both substantive and procedural, which should guide transboundary allocation of surface and groundwater resources, are then examined, with particular attention given to provisions of the Water Convention and Watercourses Convention. Additional principles of international law that are applicable to water allocation are then described. Finally, emerging legal principles relevant to water allocation in a transboundary context are outlined.

1. Cross-cutting Objectives of Water Management (and Related Principles) Relevant to Allocation

a. Reconciliation of different water uses and needs

Transboundary waters have many uses for the riparian States, including freshwater supply, flood control, irrigation, navigation, recreation and tourism and hydropower production. States may differ greatly in their characteristics, interests and relations with one another. Hence, water cannot be allocated for a single purpose; whereby different water uses and needs of co-riparian States need to be reconciled.[171] In relation to transboundary allocation, the principle of equitable and reasonable utilization provides guidance on how to balance different water uses and needs when considered in conjunction with related principles such as no harm and cooperation. From a more technical point of view, the broader approaches, such as the nexus approach and basin-wide planning, discussed in Chapter IV, can also serve the objective of reconciliation of uses.

Priority of uses as an allocation approach
Reducing conflicts between, and ensuring water for, competing water uses are the collective central aims of the principles of equitable and reasonable utilization and no significant harm. Once the overall availability of the shared water resources and the different uses and needs of the co-riparian States have been identified, it is possible to define water use priorities and formulate transboundary water allocation rules (see also Chapter III, subsection 3d). The prioritization of uses of transboundary waters is guided by the principles of international water law and may be specified in an agreement among co-riparian States or through custom. The parties to an agreement may determine, for instance, that vital household needs are to be met first,

[171] Aaron T. Wolf, "Criteria for equitable allocations: the heart of international water conflict", *Natural Resources Forum*, vol. 23, No. 1 (1999), p. 3–30; Sergei Vinogradov and Patricia Wouters, *Sino-Russian Transboundary Waters: A Legal Perspective on Cooperation*, Stockholm Papers (Stockholm-Nacka, Institute for Security and Development Policy, 2013).

followed by the needs of the environment, subsistence farmers, agriculture, hydropower and industry. The agreement may define which water uses are to be prioritized within the basin, which are allowed to continue as usual and what limitations need to be put in place. A transboundary water agreement may also prescribe precise water allocations (with numerical values) among the parties.[172] Determining the prioritization of uses is thus an established allocation approach and can be adaptable to the available water flows and to changing water demands.[173] In practice, transboundary agreements have examples on prioritization, but specific water uses have been prioritized only occasionally.[174]

Relationship between different water uses in the United Nations global water conventions

The United Nations global water conventions provide guidelines on how to determine the relationship between different water uses in water allocation. The Watercourses Convention indicates that, in the absence of an agreement or a custom to the contrary, no use enjoys inherent priority (Art. 10(1)). Furthermore, where a conflict of uses of an international watercourse arises, it shall be resolved with reference to Articles 5 to 7, with "special regard" to be given to the requirements of "vital human needs" (Art. 10(2)). The concept of vital human needs has been defined in the preparatory works of the Convention to refer to "sufficient water to sustain human life, including both drinking water and water required for the production of food in order to prevent starvation".[175] Also, factors to be considered when determining what constitutes equitable and reasonable utilization include the population dependent on the watercourse in each State.[176] The Water Convention follows a similar approach whereby the *Guide to Implementing the Water Convention* specifically makes references to and follows the approach of the Watercourses Convention on this issue. Under the Water Convention, the Protocol on Water and Health also aims to provide access to drinking water for everyone within a framework of integrated water-management systems (Art. 6).[177] The United Nations global water conventions additionally highlight the importance of ecosystems, as discussed in subsection c below. The Water Convention requires the parties to take all appropriate measures to ensure conservation and, where necessary, restoration of ecosystems (Art. 3), while the Watercourses Convention states that the ecosystems of international watercourses must be protected and preserved (Art. 20).

Existing and potential uses

Water allocation methods and discussions on the priority of uses under transboundary water agreements are often based on historical and existing water uses.[178] There is continuous debate on the relationship between existing and potential uses in transboundary water allocation, and on the principle of the equality of rights among riparian States.[179] Changing the status quo of water allocation is often very difficult, even though transboundary water resources and water use needs may have changed. Moreover, the potential uses and their impacts can be difficult to predict.[180] Existing and potential water uses may be consumptive and non-

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[172] Wolf (1999); Juan Carlos Sanchez and Joshua Roberts, eds., Transboundary water governance: adaptation to climate change, IUCN Environmental Policy and Law Papers, No. 75 (Gland, Switzerland, IUCN, 2014), p. 67–68.
[173] Sanchez and Roberts, eds. (2014), p. 67–68.
[174] Wolf (1999).
[175] International Law Commission (ILC), Convention on the Law of the Non-Navigational Uses of International Watercourses: Report of the Sixth Committee convening as the Working Group of the Whole (A/51/869), para. 8.
[176] See Attila Tanzi and Maurizio Arcari, *The United Nations Convention on the Law of International Watercourses: A Framework for Sharing* (The Hague, Kluwer Law International, 2001), p. 138–142; Alistair Rieu-Clarke, Ruby Moynihan and Bjørn-Oliver Magsig, *UN Watercourses Convention User's Guide* (Dundee, IHP-HELP Centre for Water Law, Policy and Science, 2012), p. 129–133; Christina Leb, *Cooperation in the Law of Transboundary Water Resources* (Cambridge, United Kingdom, Cambridge University Press, 2013), p. 203.
[177] See Attila Tanzi, "Reducing the gap between international water law and human rights law: the UNECE Protocol on Water and Health", *International Community Law Review*, vol. 12, No. 3 (2010), p. 267–285.
[178] See, for example, Frank A. Ward, "Forging sustainable water-sharing agreements: barriers and opportunities", *Water Policy*, vol. 15, No. 3 (2013), p. 386–417.
[179] Ibid.
[180] See McIntyre (2017), p. 239.

consumptive (see Chapter III, subsection 3.b). The former means that water is removed from a water body or its quality is changed, while the latter means that water is not withdrawn from, or it is returned to, the same water body and may be reused or recycled.[181]

While the United Nations global water conventions ascribe no specific priority to existing versus potential future uses of transboundary surface and groundwaters, the Watercourses Convention refers to "existing and potential uses of the watercourse" as one of the factors relevant to equitable and reasonable utilization (Art. 6.1.e). According to the Watercourses Convention, States need to use and develop international waters "with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse".

b. Water quality and good status

Water quantity and quality and water use timing are the main elements of water allocation arrangements that operationalize the principles and objectives of international water law. Water quantity is most commonly specified as an average volume of water (per year, month or other period). It may also be defined as a minimum volume, as a percentage of available supplies (a share of flow or of the volume in storage) or by a particular access rule (e.g. right to abstract a certain volume under particular circumstances). The quantity of available water in a transboundary basin is affected by consumptive uses such as irrigation, which reduces the absolute quantity of water, as well as non-consumptive uses such as hydropower, which can change the timing of water flow if it is not of the run-of-river type.[182]

The allocation elements of transboundary water agreements often focus on the availability of water in terms of quantity. However, water allocation mechanisms also affect the quality of international waters. The clearest link between water quality and allocation in a transboundary context actualizes when poor quality reduces the quantity of water resources available for allocation. When the water allocation arrangement provides for a certain volume and distribution of flow, it also impacts indirectly on water quality, in particular where those flows are important for diluting concentrations of substances. Quality problems are often caused by pollution, but may also be the result of water allocation affecting, for example, water flow and sedimentation. Sometimes transboundary water agreements require a minimum quality of water linked to specific uses such as the production of drinking water.[183] Timing of water allocation is linked to seasonal variabilities of water and floods and droughts, as well as to non-consumptive uses such as hydropower production. Changing the timing of water allocation according to flow variabilities and needs of basin States may solve some allocation challenges in a setting where the water flows are irregular.[184] The operationalization of water quantity and quality regulation and water use timing in transboundary water allocation arrangements is discussed in more detail in Chapter VII. The Water Convention imposes an obligation on parties to set water-quality objectives and criteria (Art. 3).

The Water Convention requires each party to define water-quality objectives and adopt water-quality criteria (Art 3.3). The task of joint bodies is to elaborate joint water-quality objectives and criteria and to propose measures for maintaining and improving the existing water quality of transboundary waters (Art. 9.2). Annex III to the Convention sets guidelines for developing water-quality objectives and criteria. Each party and joint body needs to establish programmes for monitoring and joint monitoring the conditions and water quality of

[181] See Kohli, Frenken and Spottorno (2010).
[182] See Speed and others (2013), p. 63–66.
[183] See Ibid., p. 51–66.
[184] Speed and others (2013).

transboundary waters (Arts. 4, 9.2, 11).[185] According to the Watercourses Convention, States may set joint water-quality objectives and criteria to prevent, reduce and control pollution (Art. 21.1).[186]

In addition, the Water Convention includes provisions on the exchange of information related to water quality. First, the parties have a general obligation to provide for the widest exchange of information (Art. 6). Second, the riparian countries must exchange reasonably available data on environmental conditions of transboundary waters (Art. 13.1).[187] The Watercourses Convention similarly requires that riparian States regularly exchange readily available data and information on the conditions of shared waters (Art. 9).[188] From a pan-European regional perspective, the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention) requires that the public has access to environmental information (Art. 4), some of which may be relevant to water allocation.[189]

In relation to water quality, the Water Convention stipulates the setting of emission limits for discharges from point and diffuse sources at the national level.[190] Point-source emission limits must be based on respective best available techniques (BAT), authorizations for wastewater discharges and the application of at least biological or equivalent processes to treat municipal wastewater. Best environmental practices (BEP) are called for to reduce the input of nutrients and hazardous substances from agriculture and other diffuse sources (Art. 3.1).[191] Moreover, the Protocol on Water and Health to the Water Convention aims at water quality that does not endanger human health (Art. 4). For this purpose, the parties need to establish targets, for example, for the quality of discharges from wastewater treatment installations and waters used as sources for drinking water or for bathing, aquaculture or the production or harvesting of shellfish (Art. 6.2.h, j).[192] The Watercourses Convention stipulates that States need to prevent, reduce and control pollution that may cause significant harm to other watercourse States or their environment, uses of the waters or living resources of the watercourse. Accordingly, the pollution may mean any detrimental alteration in the composition or quality of the waters of an international watercourse that results directly or indirectly from human conduct (Art. 21).[193] Thus, the provision may apply to transboundary water allocation that, for example, decreases water flow, resulting in transboundary pollution.[194]

Concerning transboundary groundwaters, Annex III of the Water Convention stipulates that the water-quality objectives and criteria must take into account specific requirements regarding sensitive and specially protected waters and their dependence on groundwater resources. According to the Draft Articles on the Law

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[185] See UNECE, *Guide to Implementing the Water Convention* (New York and Geneva, United Nations, 2013), p. 60–62, 70–76, 80–82; see also UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (2006); Rémy Kinna, "The development of legal provisions and measures for preventing and reducing pollution to transboundary water resources under the UNECE Water Convention", in *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation*, Attila Tanzi and others, eds., International Water Law Series, vol. 4 (Leiden, Brill/Nijhoff, 2015), p. 211–227.
[186] See Rieu-Clarke, Moynihan and Magsig (2012), p. 173–180.
[187] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 82–84.
[188] See Rieu-Clarke, Moynihan and Magsig (2012), p. 126–128.
[189] See UNECE, *The Aarhus Convention: An Implementation Guide*, 2nd ed. (Geneva, United Nations, 2014), p. 78–94.
[190] For possible measures in this regard, see OECD (2017).
[191] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 40–52; UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (2006).
[192] See Kinna (2015), p. 221–222.
[193] See Rieu-Clarke, Moynihan and Magsig (2012), p. 173–180.
[194] See Owen McIntyre, "Environmental protection and the ecosystem approach", in *Research Handbook on International Water Law*, Stephen C. McCaffrey, Christina Leb and Riley T. Denoon, eds. (Cheltenham, United Kingdom, Edward Elgar, 2019), p. 129.

of Transboundary Aquifers, States need to take all appropriate measures linked to water quality to protect and preserve ecosystems within, or dependent upon, transboundary aquifers or aquifer systems (Art. 10).[195]

What constitutes good status of waters may vary from one region to another. The European Union Water Framework Directive (2000/60/EC) requires the European Union Member States to achieve good ecological and chemical status of surface water bodies, as well as good quantitative and chemical status of groundwater bodies, both of which incorporate transboundary basins (see also Chapter III, subsection 4c; Chapter V, subsection 2c). It provides an example of strict water quality requirements. The overall environmental objectives of the Directive are to achieve a good (or higher) status of water bodies and prevent its deterioration (Art. 4). The status of water bodies is classified through specific parameters, including ecological, hydromorphological and physico-chemical quality elements (Annex V). Water allocation infrastructure can impact on the hydromorphological assessment of a water body. The requirements of the Directive for the achievement of the environmental objectives of transboundary river basins must be coordinated among the Member States and they must also endeavour to coordinate them with the relevant non-Member States (Art. 3). In general, the Directive focuses more on water quality, particularly the ecological and chemical status of surface water, than water quantity management and transboundary water allocation.[196] Groundwater allocation is not mentioned in the Directive, but good quantitative status is required by the Directive for groundwater bodies (Annex V, Table 2.1.2). This is relevant to transboundary allocation as groundwater resources should not be overused, thereby depleting them.

c. Protection of ecosystems

In general, international water law is based on the idea that ecosystems are an integral part of sustainable transboundary water resources.[197] The United Nations global water conventions recognize the need to protect, conserve and, where appropriate, restore ecosystems. The Water Convention requires parties to take all appropriate measures to ensure conservation and, when necessary, restoration of ecosystems (Art. 2.2). When the ecosystem so requires, the parties need to apply stricter requirements to prevent transboundary impacts, even leading to prohibition in individual cases (Art. 3.1(d)). Also, the application of the ecosystems approach needs to be promoted as a part of sustainable water resources management (Art. 3.1). The Watercourses Convention requires States, individually and jointly, to protect and preserve the ecosystems of international watercourses (Art. 20). The protection of ecosystems is also addressed in the Draft Articles on the Law of Transboundary Aquifers. Accordingly, States must take all appropriate measures to protect and preserve ecosystems within, or dependent upon, their transboundary aquifers or aquifer systems. These measures need to ensure, for example, that the quality and quantity of water retained in an aquifer and water released through its discharge zones are sufficient for the protection and preservation of ecosystems (Art. 10).[198]

Concerning transboundary water allocation, water quantity is an important element in securing the integrity of ecosystems. Measures on water quantity also impact on the quality of transboundary waters.[199] The concept of environmental flow is not used in the United Nations global water conventions, but it is helpful in understanding the ecosystem requirements in transboundary water allocation. As outlined in Chapter II, environmental flows can be defined as the quantity, timing and quality of freshwater flows and levels

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[195] See Report of the International Law Commission, sixtieth session (5 May-6 June and 7 July-8 August 2008), *Official Records of the General Assembly, Sixty-third Session, Supplement No. 10* (A/63/10), p. 33–34.
[196] See Gábor Baranyai, "Transboundary water governance in the European Union: the (unresolved) allocation question", *Water Policy*, vol. 21, No. 3 (2019), p. 496–513. See also Götz Reichert, "Europe: international water law and the EU Water Framework Directive", in *Research Handbook on International Water Law*, McCaffrey, Leb and Denoon, eds. (2019), p. 397–413.
[197] See UNECE, *Guide to Implementing the Water Convention* (2013) p. 5. See also McIntyre (2019), p, 125–146.
[198] A/63/10, p. 33–34.
[199] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 27.

necessary to sustain aquatic ecosystems.[200] Maintaining minimum environmental flows can be seen as an emerging legal requirement that enhances the implementation of an ecosystem approach in transboundary basins.[201]

d. Indigenous water allocation and cultural flows

Increasing attention is being given to the importance of water allocation for use by Indigenous peoples, including for cultural flows.[202] Many water management regimes, including in a transboundary context, have ignored, and continue to ignore, Indigenous values, connections, knowledge and rights.[203] Indigenous peoples have often faced inequitable allocation rules. To enhance the situation, States should consider the participatory rights of Indigenous peoples and their ownership and custodianship of water resources when allocating water resources at the transboundary level and within a country. States may find the concept of cultural flows useful in that regard.[204] The cultural flows refer to specific cultural water allocations for Indigenous peoples. These water allocations meet their development aspirations as well as spiritual, cultural, social, economic and environmental management responsibilities.[205] The key is that the Indigenous peoples can decide where and when water is delivered on the basis of their traditional knowledge and aspirations.[206]

The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) recognizes Indigenous peoples' ownership over their cultural expression, including water. Accordingly, Indigenous peoples have the right to maintain and strengthen their distinctive spiritual relationship with their traditionally owned or otherwise occupied and used waters and to uphold their responsibilities to future generations in this regard (Art. 25). The centerpiece of the UNDRIP is the right to self-determination. By virtue of that right, Indigenous peoples can freely pursue economic, social and cultural development. The right to self-determination is regarded as a *jus cogens* peremptory norm of general international law, meaning that it is accepted as a fundamental legal principle to the international community that cannot be set aside (as by treaty).[207]

The United Nations global water conventions do not explicitly mention Indigenous peoples' water uses and interests. Nevertheless, in the Watercourses Convention, the population dependent on an international watercourse is one of the factors relevant to equitable and reasonable utilization. Considering the human right

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[200] Arthington and others (2018).
[201] McIntyre (2019), p. 142–144.
[202] See, for example, William D. Nikolakis, R. Quentin Grafton and Hang To, "Indigenous values and water markets: survey insights from northern Australia", *Journal of Hydrology*, vol. 500 (September 2013), p. 12–20; Rosalind H. Bark and others, "Operationalising the ecosystem services approach in water planning: a case study of indigenous cultural values from the Murray–Darling Basin, Australia", *International Journal of Biodiversity Science, Ecosystem Services & Management*, vol. 11, No. 3 (2015), p. 239–249; Elizabeth MacPherson, "Beyond recognition: lessons from Chile for allocating indigenous water rights in Australia", *UNSW Law Journal*, vol. 40, No. 3 (2017), p. 1130–1169; Sue Jackson, Darla Hatton MacDonald and Rosalind H. Bark, "Public attitudes to inequality in water distribution: insights from preferences for water reallocation from irrigators to Aboriginal Australians", *Water Resources Research*, vol. 55, No. 7 (July 2019), p. 6033–6048.
[203] Katherine Selena Taylor, Sheri Longboat and Rupert Quentin Grafton, "Whose rules? A water justice critique of the OECD's 12 Principles on Water Governance", *Water*, vol. 11 (2019), 809.
[204] See Jason Robinson and others, "Indigenous water justice", *Lewis & Clark Law Review*, vol. 22, No. 3 (2018), p. 901; Elizabeth Jane Macpherson, *Indigenous Water Rights in Law and Regulation: Lessons from Comparative Experience* (Cambridge, United Kingdom, Cambridge University Press, 2019).
[205] See Bradley J. Moggridge, Lyndal Betterridge and Ross M. Thompson, "Integrating Aboriginal cultural values into water planning: a case study from New South Wales, Australia", *Australasian Journal of Environmental Management*, vol. 26, No. 3 (2019), p. 273–286.
[206] Aboriginal and Torres Straits Islander Social Justice Commissioner, *Native Title Report 2008* (Sydney, Australian Human Rights Commission, 2009), p. 184.
[207] Robinson and others, "Indigenous water justice", *Lewis & Clark Law Review*, vol. 22, No. 3 (2018), p. 847–852.

to water, the United Nations Committee on Economic, Social and Cultural Rights highlights that States should give special attention to, for example, Indigenous peoples who have traditionally faced difficulties in exercising this right.[208] The developments in the field of the human right to water and sanitation and Indigenous rights may also increase the weight to be given to vital human needs (Art. 10 of the Watercourses Convention) when assessing the equitable and reasonable utilization of transboundary waters.

CASE STUDY 18: Indigenous water allocation and cultural flows in the Murray–Darling Basin

In Australia, since 1788 and colonization practices of removing Indigenous people from habitation (and management of) their Country, Indigenous peoples' access to ownership and management of water has been substantially eroded over time. This was through acts of land (and associated water rights) being "gifted" to settlers, and subsequent policy and legislation enacted to manage land and water through traditional British processes.

Indigenous people in the New South Wales portion of the Murray–Darling Basin (MDB) comprise nearly 10 per cent of the population but their organizations hold only 0.2 per cent of the available surface water, with the small base having reduced by almost one fifth between 2009 and 2018. In 2019, the Australian Government committed $A 40 million to enable Indigenous groups' access to water entitlements in the MDB, as a symbolic step to reverse this trend.

In Australia's national blueprint for water reform, the 2004 National Water Initiative, federal, state and territory governments agreed to recognize Indigenous needs in relation to water access and arrangements. It raised the need for Indigenous peoples' representation in water planning processes, inclusion of social, spiritual and customary objectives in water plans, and the possibility of native title rights.

The Millennium Drought, a devastating drought in Australia from 1997 to 2009, catalysed community and political recognition that significant changes were needed to manage the MDB's water (see Case Study 13).

The resulting 2012 Murray–Darling Basin Plan (the Plan) aims to bring the Basin back to good health (see Case Study 13). The Plan specifically recognizes and acknowledges that traditional owners and their Nations of the Basin have a deep cultural, social, environmental, spiritual and economic connection to their waters (and land and sky).

The Plan also requires that water management plans must be prepared, having regard to the views of Indigenous peoples with respect to cultural flows (section 10.54). The Plan provides States and territories with provisions to give regard to Indigenous cultural values and cultural flows in developing 33 subbasin water resource plans.

Additionally, the Plan acknowledges that "cultural flows will benefit Indigenous people in improving socioeconomic health, wellbeing and empowerment to be able to care for their country and undertake cultural activities". It also provides a definition of cultural flows from the 2007 Echuca Declaration: "Cultural Flows are water entitlements that are legally and beneficially owned by the Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations. This is our inherent right" (Murray Lower Darling Rivers Indigenous Nations, 2007). The cultural flows element of the Plan sets the policy foundation for change and reconciliation.

For Indigenous people, environmental flows, while welcome, will not necessarily meet cultural, spiritual or social outcomes. However, if consulted early and appropriately, Indigenous people can advise on the best time and volumes of water to maximize cultural, spiritual or social outcomes. In 2020, through consultation with both the Northern Basin Aboriginal Nations (NBAN) and the Murray Lower Darling Rivers Indigenous Network (MLDRIN), Indigenous people gave guidance for the first time in long-term environmental watering activities in the Basin. Identifying cultural outcomes aligned with planned environmental flows was a key component of this guidance. Evidence received from NBAN and MLDRIN from this consultation and guidance on the watering activities suggests cultural outcomes were achieved.

[208] United Nations, Economic and Social Council, Committee on Economic, Social and Cultural Rights. General comment No. 15 on the right to water (2002) (E/C.12/2002/11), para. 7.

e. Water stewardship

Water stewardship has emerged in the past decade as a dominant concept in water management, capturing private sector engagement on water in public interest.[209] It is defined by the Alliance for Water Stewardship as a "use of water that is socially and culturally equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process that involves site- and catchment-based actions."[210] Its logic and business case is built on the major water use and the impacts of water use in the operations and value chains of companies, the resulting water risks and the disruptions to business the companies face with the growing water challenges, and the responsibility and opportunities that working for water security brings for companies and their stakeholders alike.[211] Water stewardship starts at the site, from the time water is accessed, extracted, used and processed, and extends to the time it is discharged back to the environment. Good water stewards understand and commit not only to improve their own water use but also to address shared basin-level concerns in terms of water governance, water balance, water quality, important water-related areas and ecosystems and water, sanitation and hygiene. They may also voluntarily choose to reallocate their own water use quotas for other uses.[212] The approach emphasizes stakeholder collaboration as water risks to business cannot be addressed merely with internal measures. The public sector is an important collaborator since sustainable water use and governance is ultimately under its mandate.

Water stewardship in transboundary water cooperation and allocation
When allocating water for private sector projects and operations, including those with transboundary reach and impacts, the water stewardship framework and criteria can be used to support implementation of national and international water-related targets, such as the European Union Water Framework Directive and the SDGs. Water stewardship aims and efforts are aligned with those of SDG 6.5, according to which IWRM should be implemented at all levels, including through transboundary cooperation. The water stewardship and IWRM frameworks are mutually complementary: stewardship provides a clear incentive and structure for corporate engagement in water management and governance beyond the company fence, while IWRM has the potential to scale up and integrate corporate efforts to public policy processes.[213] Examples may include large scale infrastructure, plantations and industrial sites but also cover partnerships of various sizes and types, addressing shared water challenges (see also SDG 17 on the global partnerships for sustainable development).

Water stewardship principles, policies and practices are therefore important to consider in conjunction with questions regarding sustainable and equitable water allocation, including in a transboundary context.[214] While to date there has been very limited research on water stewardship's direct application to water allocation, especially in a transboundary context, recent studies have noted this as an area for further assessment and application.[215] A key message to subsequently emerge is that "water allocation—a crucial

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[209] Peter Newborne and James Dalton, "Corporate water management and stewardship: signs of evolution towards sustainability", Briefing Note (London: Overseas Development Institute (ODI), 2019).
[210] Alliance for Water Stewardship, *International Water Stewardship Standard, version 2.0, 22.3.2019* (North Berwick, Scotland, 2019).
[211] UN Global Compact, "CEO Water Mandate"; Alexis Morgan, *Water Stewardship Revisited: Shifting the Narrative from Risk to Value Creation* (Berlin, WWF-Germany, 2018).
[212] Alliance for Water Stewardship (2019).
[213] Global Water Partnership (GWP), *Engaging the Private Sector in Water Security* (Stockholm, 2018).
[214] Newborne and Dalton, "Corporate water management and stewardship" (2019).
[215] See, for example, Yale D. Belanger, "Water stewardship and rescaling management of transboundary rivers in the Alberta-Montana borderlands", *Journal of Borderlands Studies*, vol. 34, No. 2 (2019), p. 235–255; Peter Newborne and James Dalton, "Review of the International Water Stewardship Programme - for lesson-learning: opportunities and challenges of promoting water stewardship, for practitioners, policy-makers and donors: report to DFID" (n.p., September 2019); Newborne and Dalton, "Corporate water management and stewardship" (2019).

issue in water resources management—tends to be side-lined in the discussion on water stewardship."[216] Consequently, discussions within the water stewardship approach as a whole "would benefit from refocusing on water withdrawals and water allocation across the geographies where companies operate, and on their interactions with other water users in those catchment and basins."[217] One example of how stewardship could be better applied taking into account these considerations is: "In planning for allocation of water resources to agriculture, what is grown where (the choice of crops, taking into account water availability) is as important as how it is grown (water-use efficiency)".[218]

f. Valuing water

The value(s) assigned to water resources within the context of a transboundary allocation framework will shape its processes and outcomes. Often, in the context of allocation, this is specifically related to economic valuations of water resources.[219] Moreover, value in economic terms can be tied to water pricing regimes, water markets and water trading schemes, which are all intended, primarily, to allocate water in order to maximize efficiency. However, water markets as allocating institutions and water trading practices have traditionally only been applied and studied within national or subnational jurisdictions rather than in transboundary contexts.[220] Notable examples of water markets in federal countries are the Murray–Darling Basin in Australia, the Colorado–Big Thompson Project in the United States and the transfers between the Palo Verde and metropolitan water districts in the United States.[221] Such approaches may be applicable in other national water allocation contexts, but they remain largely untested at the transboundary scale between co-riparian States.[222] Notwithstanding, their premise and conceptual frameworks for valuing water in economic terms may be generally helpful in guiding transboundary allocation framework planning and certain conceptualizations may potentially be adaptable at the transboundary scale, if so decided by the riparian States.[223]

[216] Newborne and Dalton, "Review of the International Water Stewardship Programme" (2019), p. 17.
[217] Ibid., p. 65.
[218] Newborne and Dalton, "Corporate water management and stewardship" (2019), p. 1.
[219] See, generally, Nihal K. Atapattu, "Economic valuing of water", IWMI Books, Reports H031121 (Colombo, Sri Lanka, International Water Management Institute, 2002); Kerry Turner and others, "Chapter 3: Economics of water allocation", in *Economic Valuation of Water Resources in Agriculture: From the Sectoral to a Functional Perspective of Natural Resource Management* (Rome, FAO, 2004); Julio Berbel and others, "Review of alternative water allocation options. Deliverable to Task A4B of the BLUE2 project 'Study on EU integrated policy assessment for the freshwater and marine environment, on the economic benefits of EU water policy and on the costs of its non-implementation" (Córdoba, Spain, WEARE: Water, Environmental and Agricultural Resources Economics and ECORYS, 2018).
[220] See, for example, Murray-Darling Basin Authority, "Water markets and trade", 30 March 2021.
[221] See, generally, Dustin E. Garrick, Nuria Hernández-Mora and Erin O'Donnell, "Water markets in federal countries: comparing coordination institutions in Australia, Spain and the Western USA", *Regional Environmental Change*, vol. 18, No. 6 (2018), p. 1593–1606; Gustavo Velloso Breviglieri, Guarany Ipê do sol Osório and Jose A. Puppim de Oliveira, "Understanding the emergence of water market institutions: learning from functioning water markets in three countries", *Water Policy*, vol. 20, No. 6 (December 2018), p. 1075–1091; R. Quentin Grafton and others, "An integrated assessment of water markets: a cross-country comparison", *Review of Environmental Economics and Policy*, vol. 5, No. 2 (Summer 2011), p. 219–239.
[222] See, generally, Takahiro Endo and others, "Are water markets globally applicable?", *Environmental Research Letters*, vol. 13 (2018), 034032.
[223] See, for example, Maksud Bekchanov, Anik Bhaduri and Claudia Ringler, "How market based water allocation can improve water use efficiency in the Aral Sea basin?", ZEF Discussion Papers on Development Policy, No. 177 (Bonn, University of Bonn, Center for Development Research (ZEF), 2013); Jason F. L. Koopman and others, "The potential of water markets to allocate water between industry, agriculture, and public water utilities as an adaptation mechanism to climate change", *Mitigation and Adaptation Strategies for Global Change*, vol. 22, No. 2 (2017), p. 325–347; Gui-liang Tian and others, "Water rights trading: a new approach to dealing with trans-boundary water conflicts in river basins", *Water Policy*, vol. 22, No. 2 (2020), p. 133–152.

More recent conceptualizations of the valuing of water have tried to go beyond narrow financial and economic objectives and take a more holistic approach.[224] Several initiatives and reports have attempted to raise the profile of valuing water holistically, including the United Nations' *World Water Development Report 2021: Valuing Water*.[225] Their common denominator is the message that water is generally undervalued in societies and its price does not usually reflect its cost, nor its value. The High Level Panel on Water lists the following principles on valuing water and recommends their integration to water-related policies, initiatives and projects at all levels:[226]

- Recognize and Embrace Water's Multiple Values;
  Principle 1. Identify and take into account the multiple and diverse values of water to different groups and interests in all decisions affecting water;
- Reconcile Values and Build Trust;
  Principle 2. Conduct all processes to reconcile values in ways that are equitable, transparent and inclusive;
- Protect the Sources;
  Principle 3. Value, manage and protect all sources of water, including watersheds, rivers, aquifers, associated ecosystems, cultural values and used water flows for current and future generations;
- Educate to Empower;
  Principle 4. Promote education and public awareness about the intrinsic value of water and its essential role in all aspects of life;
- Invest and Innovate;
  Principle 5. Ensure adequate investment in institutions, infrastructure, information and innovation to realize the many different benefits derived from water and reduce risks.

When accounting for transboundary water resources, each riparian country's portion of surface and groundwater resources should be identified and recognized in any allocation framework. The volumetric share of freshwater inflows from, and outflows to, neighbouring countries should also be identified to assist with ascribing values within any allocation framework. If there are any agreements or other arrangements on water allocation quotas, these can be recorded alongside the actual flows.[227]

UNECE supports the implementation of the System of Environmental-Economic Accounting (SEEA) as the global standard. SEEA can be an important tool to inform environmental-economic policies and measure sustainable development, and also SDG 6 on water and sanitation.[228] SEEA-Water includes managing water supply and demand as one of its quadrants of water policy objectives. The aim is to improve water allocation to satisfy societal needs as well as the needs of future generations and the environment. To achieve this aim

[224] See, for example, Dustin E. Garrick and others, "Valuing water for sustainable development", *Science*, vol. 358, No. 6366 (November 2017), p. 1003–1005; The Valuing Water Initiative, *Valuing Water: A Conceptual Framework For Making Better Decisions Impacting Water: Concept Note* (n.p., 2020); Huw Pohlner and others, *Valuing Water: A Framing Paper for the High-Level Panel on Water* (Canberra, Australian Water Partnership, 2016).
[225] See UNESCO WWAP, "Valuing water"; WWF, "Water Risk Filter: Valuing Water Database"; The Netherlands, "Valuing Water Initiative: better decisions impacting water"; United Nations, *The United Nations World Water Development Report 2021: Valuing Water* (Paris, UNESCO, 2021).
[226] High Level Panel on Water, "Value water" (n.d.).
[227] United Nations Department of Economic and Social Affairs, Statistics Division, *SEEA-Water: System of Environmental-Economic Accounting for Water* (New York, United Nations, 2012), p. 97.
[228] UNECE, "Environmental-economic accounting" (n.d.), at www.unece.org/stats/seea.html (accessed 29 November 2020).

it is important to monitor the amounts of water allocated for different uses, such as agriculture, energy production, water supply and industries, and measure the trade-offs in the allocation in economic terms.[229]

A legal approach to valuing water can be found in the European Union Water Framework Directive. The Directive introduces the principle of recovery of the costs of water services in accordance with the polluter pays principle in particular. The costs to be covered include environmental and resource costs. According to the Directive, water-pricing policies need to provide adequate incentives for users to use water resources efficiently and different water uses, disaggregated into at least industry, households and agriculture, have to adequately contribute to the recovery of the costs based on the economic analysis (Art. 9).

2. Core Principles of International Water Law to Guide Transboundary Water Allocation

Certain principles of international law should guide the decision-making and implementation processes and outcomes for water allocation in a transboundary context. Principles of international law have a distinct legal character that is normative in nature, meaning that each one sets a generally accepted basic rule or standard that States must adhere to, but without necessarily defining the specific elements comprised within that rule or standard.[230] Principles are thus frequently general in nature to allow for their elaboration and contextualized expression within treaties and other agreements between States.[231]

A distinction exists between substantive (which refers to those laws which create, define and regulate rights and obligations) and procedural (which describe the content of a formal process to be taken to enforce rights and obligations) international law. However, there appears to be increasing interconnectedness between substantive and procedural obligations in the interpretation of international environmental law and especially as it relates to international water law principles such as no significant harm.[232] In this regard, international courts and tribunals, through their judgments, often give further detail to the content and application of such principles.[233] For example, aspects of the substantive and procedural content of the equitable and reasonable utilization and no significant harm principles, including their close relationship to procedural duties of prior notification, consultation and negotiation, and exchange of information, were outlined by the International Court of Justice in the *Gabčikovo–Nagymaros* and *Pulp Mills* judgments, respectively, specifically as regards transboundary watercourses.[234] Certain elements of these procedural duties have been elaborated further in subsequent International Court of Justice decisions.[235]

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[229] UNESCO WWAP and United Nations Statistics Division, “Monitoring framework for water: the System of Environmental-Economic Accounts for Water (SEEA-Water) and the International Recommendations for Water Statistics (IRWS)”, Briefing Note (New York and Perugia, United Nations, 2011).

[230] See also Makane Moïse Mbengue and Brian McGarry, “General principles of international environmental law in the case law of international courts and tribunals”, in *General Principles and the Coherence of International Law*, Mads Andenas and others, eds., Queen Mary Studies in International Law, vol. 37 (Leiden, Brill/Nijhoff, 2019), p. 420.

[231] For example, Article 6 of the Watercourses Convention provides a non-exhaustive list of factors to be considered when assessing what constitutes equitable and reasonable utilization. See also Mbengue and McGarry (2019), p. 420.

[232] See Jutte Brunnée, *Procedure and Substance in International Environmental Law*, Pocketbooks of the Hague Academy of International Law, vol. 40 (Leiden, Brill/Nijhoff, 2020).

[233] See, generally, Owen McIntyre, “The World Court’s ongoing contribution to international water law: the *Pulp Mills* case between Argentina and Uruguay”, *Water Alternatives*, vol. 4, No. 2 (2011), p. 124–144; Alistair Rieu-Clarke, “Notification and consultation on planned measures concerning international watercourses: learning lessons from the *Pulp Mills* and *Kishenganga* cases”, *Yearbook of International Environmental Law*, vol. 24, No. 1 (2013), p. 102–130; Mbengue and McGarry (2019), p. 420.

[234] See, generally, McIntyre (2011).

[235] See Mbengue and McGarry (2019), p. 422. See also relevant decisions, *Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua)* and *Construction of a Road in Costa Rica Along the San Juan River (Nicaragua v. Costa Rica)*, International Court of Justice, 16 December 2015.

There are recognized core principles of international water law that pertain to allocation, namely, equitable and reasonable utilization, no significant harm and the principle of cooperation, as codified in the Water Convention and Watercourses Convention, respectively.[236] There are principles in other areas of international law that can also relate to allocation, such as principles of international environmental law and international human rights law detailed below. Sections 2 and 3 of this Chapter outline the basic principles that are applicable to water allocation in a transboundary context and should thus guide related decision-making and implementation processes and outcomes.

a. No significant harm (preventing, controlling and reducing transboundary impacts)

The requirement to prevent, control and reduce transboundary impacts is an expression of the no-harm principle. The no-harm principle is a customary international law principle and one of the normative cornerstones of the Water Convention along with the principles of cooperation and equitable and reasonable utilization.[237] The no-harm principle provides a due diligence obligation, i.e. an obligation of conduct, rather than an obligation of result. It means, on the one hand, that the origin State of an existing or potential transboundary impact must take all appropriate measures to prevent, control and/or reduce such impact. On the other hand, the origin State does not directly become internationally responsible for a breach of an international obligation if transboundary impact occurs, provided that it can show that it has taken all appropriate measures to prevent, control and/or reduce that impact.[238] Its responsibility is engaged, however, if it fails to take such appropriate measures.

The Water Convention requires the parties to take all appropriate measures to prevent, control and reduce any transboundary impact (Art. 2.1). Transboundary impact is a significant adverse effect on the environment within an area of another party resulting from a change in the conditions of transboundary waters (Art. 1.2). Transboundary waters include both surface and groundwaters, which mark, cross or are located on boundaries between two or more States (Art. 1.1).[239] Changes in the conditions of transboundary waters may occur as changes in water storage, quality or timing and amount of flows, which in turn, affects transboundary water allocation. The Water Convention further specifies the no-harm rule and measures needed for its implementation. First, the parties need to practically take specific legal, administrative, economic, financial and technical measures to prevent, control and reduce potential harm such as the application of low-waste technology, best available technology and best environmental practice and the prior licensing of wastewater discharges (Art. 3.1).[240] Second, in taking such measures as deemed appropriate, the parties have to be guided by the principles of precaution (action not to be postponed on the justification that scientific research has not

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[236] Attila M. Tanzi, "The inter-relationship between no harm, equitable and reasonable utilisation and cooperation under international water law", *International Environmental Agreements: Politics, Law and Economics*, vol. 20, No. 4 (December 2020), p. 619–629.

[237] UNECE, *Guide to Implementing the Water Convention* (2013), p. 15, 19. See also Stephen McCaffrey, "The contribution of the UN Convention on the law of non-navigational uses of international watercourses", *International Journal of Global Environmental Issues*, vol. 1, Nos. 3/4 (2001), p. 346–380; Owen McIntyre, *Environmental Protection of International Watercourses under International Law* (Aldershot, United Kingdom, Ashgate, 2007), p. 87–119; Attila Tanzi and Alexandros Kolliopoulos, "The no-harm rule", in *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation*, Tanzi and others, eds. (2015).

[238] UNECE, *Guide to Implementing the Water Convention* (2013), p. 10–11; Stephen McCaffrey, "Intertwined general principles", in *Research Handbook on International Water Law*, McCaffrey, Leb and Denoon, eds. (2019), p. 83–94.

[239] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 19–21; Tanzi and Kolliopoulos (2015), p. 133–145.

[240] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 41–44.

fully proved causal links), polluter pays (costs of measures to be borne by the polluter) and sustainability (ability of future generations to meet their needs) (Art. 2.5).[241]

Under the Water Convention, all appropriate measures to prevent, control and reduce transboundary impact include the exchange of information, and consultations between the origin and potentially affected States (Arts. 6, 9–10, 13). In terms of what constitutes "all appropriate measures", as this is a due diligence obligation, "the conduct of each Party shall be proportional to the degree of risk of transboundary impact. The 'appropriateness' of the measures also means that the measures depend on the capacity of the Party concerned, i.e. on the level of its economic development, and technological and infrastructural capacity. The 'appropriate measures' are therefore to be determined on a case-by-case basis."[242]

The no-harm principle is also included in the Watercourses Convention and the Draft Articles on the Law of Transboundary Aquifers. The Watercourses Convention stipulates that watercourse States shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse States (Art. 7).[243] In the same way, the Draft Articles on the Law of Transboundary Aquifers state that aquifer States shall, in utilizing transboundary aquifers or aquifer systems in their territories, take all appropriate measures to prevent the causing of significant harm to other aquifer States or other States in whose territory a discharge zone is located (Art. 6).[244]

Under the Watercourses Convention, where a State has taken all appropriate measures but significant harm is nonetheless caused, that State is required to do its best to stop or mitigate the harm through consultations with the affected State, with due regard to the principle of equitable and reasonable use. In addition, where appropriate, the States need to discuss the question of compensation (Arts. 6(2) and 7). States may also need to tolerate some transboundary impacts, where all appropriate measures have been taken to prevent, control and reduce them and those impacts can be established to be equitable and reasonable.[245] Interrelated provisions under the Watercourses Convention also oblige States to prevent, reduce and control pollution (Art. 20), protect and preserve ecosystems (Art. 21) and protect and preserve the marine environment, including estuaries (Art. 23).

CASE STUDY 19: Vuoksi River water allocation and compensation for loss due to transboundary harm

In the two main agreements governing the Vuoksi River between Finland and Russia there are provisions for compensating for loss regarding possible damage caused by adjustments in flow rates and reduced hydropower generating capacity.

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[241] See Ibid., p. 22–25, 28–31. See also Nicolas de Sadeleer and Mehdy Abbas Khayli, "The role of the precautionary principle in the Convention on the Protection and Use of Transboundary Watercourses and International Lakes", in *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation*, Tanzi and others, eds. (2015), p. 160–175; Leslie-Anne Duvic-Paoli and Pierre-Marie Dupuy, "The polluter-pays principle in the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes", in *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation*, Tanzi and others, eds. (2015), p. 176–194; Alistair Rieu-Clarke, "The sustainability principle", in *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation*, Tanzi and others, eds. (2015).
[242] UNECE, *Frequently Asked Questions on the 1992 Water Convention: With the Road Map to Facilitate Accession Processes* (Geneva, United Nations, 2020), p. 40.
[243] See Tanzi and Arcari (2001), p. 142–179; Rieu-Clarke, Moynihan and Magsig (2012), p. 117–122.
[244] See A/63/10, p. 30.
[245] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 10–12, 19–20. See also Rieu-Clarke, Moynihan and Magsig (2012), p. 100; Tanzi and Kolliopoulos (2015); Rieu-Clarke, Moynihan and Magsig, 2012), p. 100.

To maintain downstream flows at an optimum rate for the operation of the Russian "Svetogorsk" hydropower station, the streamflow is regulated whereby there is a loss of generating capacity incurred by the upstream "Imatra" hydropower station in Finland. Under the 1972 Vuoksi Hydropower Agreement, the parties declare that ongoing flow maintenance for the "Svetogorsk" hydroelectric station causes the permanent loss of electrical energy of 19,900 MWh per year at the "Imatra" hydroelectric station. Compensation of that amount of electrical energy shall be made annually on a retroactive basis by the supply of electric power from Russia. The supply of compensatory electricity is verified and possible differences in this regard settled by the relevant ministries.

The 1989 Vuoksi Discharge Rule governs water that is released from Lake Saimaa with the help of the upstream Finnish "Imatra" hydropower station. Under this agreement, a water release programme is approved by the parties every year, which aims to achieve the most advantageous result for both parties. The report details any estimated adjustments made to the natural flow and any possible damage and benefit resulting from them. After deviations from the natural flow rate, a final balance sheet must be drawn up of the damage or benefit. On the basis of the balance sheet, measures to compensate for possible damage are considered. The Joint Finnish–Russian Commission on the Utilization of Frontier Watercourses monitors the implementation of the 1989 Vuoksi Discharge Rule. The Commission also settles any differences concerning the interpretation or application of the Vuoksi Discharge Rule. If no agreement can be reached, including on compensation, the differences are settled through diplomatic channels.

b. Equitable and reasonable utilization

Principle of equitable and reasonable utilization

The principle of equitable and reasonable utilization is a main pillar of international water law and transboundary water allocation. It is regarded as part of customary international law, i.e. obligating even those States that are not parties to any agreement where the principle is enshrined. The principle implies the equal rights and limited territorial sovereignty of States over transboundary water resources.[246] In the case concerning the *Gabčíkovo–Nagymaros Project (Hungary v. Slovakia)* on the Danube River, the International Court of Justice made a reference to a State's "basic right to an equitable and reasonable sharing of the resources of an international watercourse" (paras. 78, 85) in 1997.[247]

The Water Convention prescribes that parties are to take all appropriate measures "to ensure that transboundary waters are used in a reasonable and equitable way, taking into particular account their transboundary character, in the case of activities which cause or are likely to cause transboundary impact" (Art. 2.2).[248] The Watercourses Convention lays the foundation for the reasonable and equitable utilization of shared watercourses. The Convention dictates that "Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse" (Art. 5).[249]

Regarding transboundary groundwater, the Draft Articles on the Law of Transboundary Aquifers stipulate that States shall utilize transboundary aquifers or aquifer systems according to the principle of equitable and reasonable utilization (Art. 4).[250] The UNECE Model Provisions on Transboundary Groundwaters also

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[246] McCaffrey (2001), p. 324–345; UNECE, *Guide to Implementing the Water Convention* (2013), p. 22–25; Rieu-Clarke, Moynihan and Magsig (2012), p 100–110.

[247] *Gabčíkovo-Nagymaros Project (Hungary/Slovakia), Judgment, I.C.J. Reports 1997*, p. 54–56.

[248] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 22–25; Owen McIntyre, "The principle of equitable and reasonable utilisation", in *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation*, Tanzi and others, eds. (2015), p. 146–159.

[249] See Tanzi and Arcari (2001), p. 95–117; Rieu-Clarke, Moynihan and Magsig (2012), p. 100–110.

[250] See A/63/10, p. 28–29.

underline that "the Parties shall use transboundary groundwaters in an equitable and reasonable manner, taking into account all relevant factors, including under agreements applicable between them" (Art. 2).[251]

Relevant factors and circumstances

To determine what equitable and reasonable utilization means in a particular case, all relevant factors and circumstances must be taken into account. Article 6 of the Watercourses Convention provides a non-exhaustive list of these factors (noting that no factor enjoys any inherent priority over another):

a. geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;
b. the social and economic needs of the watercourse States concerned;
c. the population dependent on the watercourse in each State;
d. the effects of the use or uses of the watercourses in one watercourse State on other watercourse States;
e. existing and potential uses of the watercourse;
f. conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
g. the availability of alternatives, of comparative value, to a particular planned or existing use.

The list can be divided into three broad categories: factors of a natural character; economic and social factors; and environmental factors. While economic and social factors are a common determinant of water use, addressing the environmental factors is often a prerequisite for sustainable water allocation, as discussed in Chapter II.[252] Similar to the Watercourses Convention, the Draft Articles on the Law of Transboundary Aquifers define factors relevant to the principle of equitable and reasonable utilization (Art. 5).[253]

Reconciliation of State needs and interests

The principle of equitable and reasonable utilization entitles each riparian State to an equitable and reasonable use of the transboundary waters situated in its territory. Furthermore, the principle creates the correlative obligation not to deprive other States of their respective rights. It highlights benefit-sharing in the uses and allocation of shared water resources and the corresponding rights and obligations of the riparian States.[254] In this regard, the principle represents a compromise between the principles of absolute territorial sovereignty and absolute territorial integrity over water resources. Absolute territorial sovereignty would mean that a State had an unlimited right to utilize water resources within its territory. Conversely, absolute territorial integrity would imply that a State had the right to the natural flow of the water from the upstream.[255] The principle of equitable and reasonable utilization therefore describes the community of interests of riparian States.[256] However, this principle does not provide riparian States with the right to equal allocation of water shares in a shared basin. Instead, all relevant factors and circumstances must be considered when allocating water resources. The above factors cover legitimate needs and interests of all co-riparian States and help in their balancing and weighting as would be needed in the context of water allocation.[257]

[251] See UNECE, *Model Provisions on Transboundary Groundwaters* (New York and Geneva, United Nations, 2014), p. 6–8.
[252] See Tanzi and Arcari (2001), p.120–135; Rieu-Clarke, Moynihan and Magsig (2012), p. 111–116; McIntyre (2019).
[253] See A/63/10, p. 28–30.
[254] See McCaffrey (2001), p. 95–135; Tanzi and Arcari (2001), p. 95–142; Rieu-Clarke, Moynihan and Magsig (2012), p. 100–105.
[255] See McCaffrey (2001), p. 113–174; Tanzi and Arcari 2001, p. 11–15; Rieu-Clarke, Moynihan and Magsig (2012), p. 100–105; McIntyre (2017).
[256] UNECE, *Guide to Implementing the Water Convention* (2013), p. 22–23.
[257] Tanzi and Arcari (2001), p. 99–103; Rieu-Clarke, Moynihan and Magsig (2012), p. 106–110; UNECE, *Guide to Implementing the Water Convention* (2013), p. 22–25.

In determining what constitutes equitable and reasonable utilization, the Watercourses Convention stipulates that each factor is to be accorded a weight in comparison to the other factors (Art. 6.3). After this weighting, all factors are considered together to determine what is equitable and reasonable in the specific circumstances.[258] Much in the same way, the United Nations Draft Articles on the Law of Transboundary Aquifers state that the weight to be given to each factor is to be determined by its importance with regard to a specific transboundary aquifer or aquifer system in comparison with that of other relevant factors (Art. 5.2).[259] In sum, co-riparian countries determine the content of equitable and reasonable utilization in their bi- or multilateral cooperation negotiation frameworks. On this basis, they may then enter into agreements or other arrangements on water allocation that account for all relevant factors in the context of their cooperation.[260] To implement these arrangements at the transboundary scale, national-level measures are then typically needed within each co-riparian State.

c. Principles of cooperation and good neighbourliness

Cooperation and good neighbourliness are collectively needed at every stage of the process of establishing and maintaining effective transboundary water allocation arrangements. Such cooperation may often prevail despite otherwise challenging relations between countries.[261] A State's general duty to cooperate is one of the main tenets of international law. It is regarded as a part of customary international law, implying an obligation on States even in the absence of an explicit agreement. In international water law, the principle of cooperation is a response to the interdependence of States and to the coordination requirements in the management and development of transboundary water resources.[262] In the Lake Lanoux arbitral award (*Spain v. France*) of 1957, concerning works for the utilization of transboundary waters, the tribunal declared that international practice obliges "States to seek, by preliminary negotiations, terms for an agreement".[263]

Under the Water Convention, the riparian parties must cooperate on the basis of equality and reciprocity. The aim for the cooperation is the prevention, control and reduction of transboundary impacts and the protection of the environment of transboundary waters and the environment influenced by such waters (Art. 2.6). The equality and reciprocity of cooperation implies that States should cooperate in good faith and not limit cooperation to purely formal procedures.[264] The Watercourses Convention highlights the principles of cooperation whereby watercourse States shall cooperate on the basis of sovereign equality, territorial integrity, mutual benefit and good faith. The objective is to attain optimal utilization and adequate protection

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[258] See Tanzi and Arcari (2001), p. 123–127; Rieu-Clarke, Moynihan and Magsig (2012), p. 111–116.
[259] See A/63/10, p. 28–29.
[260] See Wolf (1999), p. 9–15.
[261] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 32–39; Hamid Sarfraz, "Revisiting the 1960 Indus Waters Treaty", *Water International*, vol. 38, No. 2 (2013), p. 204–216.
[262] See Stephen McCaffrey, *The Law of International Watercourses*, 3rd ed. (Oxford, Oxford University Press, 2019), p. 309–404; Owen McIntyre, "The role of customary rules and principles of international environmental law in the protection of shared international freshwater resources", *Natural Resources Journal*, vol. 46, No. 1 (Winter 2006), p. 157–210; Christina Leb, "One step at a time: international law and the duty to cooperate in the management of shared water resources", *Water International*, vol. 40, No. 1 (2015), p. 21–32; Philippe Sands and Jacqueline Peel, *Principles of International Environmental Law*, 4th ed. (Cambridge, United Kingdom, Cambridge University Press, 2018), p. 161.
[263] See Lake Lanoux Arbitration (France v. Spain), 16 November 1957, reproduced in *Reports of International Arbitral Awards*, vol. XII (1957), p. 281–317 (in French); see also UNECE, *Guide to Implementing the Water Convention* (2013), p. 33.
[264] UNECE, *Guide to Implementing the Water Convention* (2013), p. 32. See also Patricia Wouters and Christina Leb, "The duty to cooperation in international water law: examining the contribution of the UN Water Conventions to facilitating transboundary water cooperation", in *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation*, Tanzi and others, eds. (2015), p. 285–295.

of an international watercourse (Art. 8).[265] Much in the same way, the Draft Articles on the Law of Transboundary Aquifers stipulate that aquifer States shall cooperate on the basis of sovereign equality, territorial integrity, sustainable development, mutual benefit and good faith in order to attain equitable and reasonable utilization and appropriate protection of their transboundary aquifers or aquifer systems (Art. 7).[266] This principle is operationalized primarily through legal agreements and joint institutions over shared waters (see Chapter VI) and via technical methods such as data exchange and information-sharing between co-riparian States (see Arts. 9–15 of the Water Convention and Arts. 9–13 of the Watercourses Convention).

CASE STUDY 20: Temporary cooperation arrangements bridging broader allocation disputes: the example of the Gabčíkovo–Nagymaros Project

In 1977, Hungary and the now former Czechoslovakia signed a treaty for the construction and joint operation of dams and other related projects along the section of the Danube River that borders both nations. The project was especially aimed at preventing catastrophic floods, improving river navigability, producing clean electricity and other uses of water. Both Czechoslovakia and Hungary began construction works in their territories. Due to the environmental concerns, Hungary suspended the implementation of the project. Negotiation could not resolve the concerns and finally Hungary unilaterally terminated the treaty. Hungary based its action on the fact that the damming of the River had been agreed to only on the ground of a joint operation and sharing of benefits associated with the project, and asserted that Slovakia had unilaterally assumed control of a shared resource. Slovakia in October 1992 chose to divert the Danube into Slovak territory and kept the development entirely within its borders. The construction of the Čuňovo dam was completed to mitigate economic damage and improve flood protection and water transport within this 43 km section of the Danube. Slovakia started to operate the Gabčíkovo dam for production of hydroelectricity. This action reduced the amount of water flowing into the present border river (to 20 per cent of the original flow), which had a significant impact on the water supply and environment of the area of Szigetköz on the Hungarian side of the border.

The case was submitted to the International Court of Justice in 1993. Both States requested the Court make a determination on: "(a) whether the Republic of Hungary was entitled to suspend and subsequently abandon, in 1989, the works on the Nagymaros project and on that part of the Gabčíkovo project for which the Treaty attributed responsibility to the Republic of Hungary; (b) whether the Czech and Slovak Federal Republic was entitled to proceed, in November 1991, to the 'provisional solution' and to put into operation from October 1992 this system (the damming up of the Danube at river kilometre 1,851.7 on Czechoslovak territory and the resulting consequences for the water and navigation course); and (c) what were the legal effects of the notification, on 19 May 1992, of the termination of the Treaty by the Republic of Hungary. The Court was also requested to determine the legal consequences, including the rights and obligations for the Parties, arising from its Judgment on the above-mentioned questions".[267] The Court's decision in 1997 stipulated that Hungary and Slovakia must negotiate in good faith in light of the prevailing situation. The Court also stated that both States must take all necessary measures to ensure the achievement of the objectives of the said treaty, in accordance with such modalities as they might agree upon. Negotiations are still in progress.

While negotiations have been ongoing, a water allocation scheme had been developed after the diversion of the Danube River took place, as the adjoining river branches were drained due to the dramatic changes of the water levels in the River. A technical group was established to develop a proposal. Experts represented relevant ministries and water management directorates from both States. After a long negotiation, Hungary accepted Slovakia's proposal, but only on a temporarily basis to assure a continuous flow into the original riverbed. Hungary is claiming the right to a greater share of water flow.

As a result, the "Agreement between the Government of the Slovak Republic and the Government of Hungary concerning Certain Temporary Technical Measures and Discharges into the Danube and Mosoni branch of the

[265] See Tanzi and Arcari (2001), p. 181–186; Rieu-Clarke, Moynihan and Magsig (2012), p. 123–125.
[266] See A/63/10.
[267] International Court of Justice, "Gabčíkovo-Nagymaros Project (Hungary/Slovakia): Overview of the case", available at www.icj-cij.org/en/case/92.

Danube" was signed in 1995. Due to the 1992 diversion of the Danube River, on average, 400 m^3/s was accepted on a temporary basis to provide water for the original Danube River and the adjoining inland delta branch system (Szigetköz). For the water supply of the Szigetköz area, pumps were used that proved to be ineffective. Later, an underwater weir was constructed to divert the necessary minimum quantity of water to the side arms. It is important to highlight that it is not a traditional hydraulic weir structure, but, rather, it is a stone construction that raises the water level to enable it to flow in a gravitational way. Allocation is monitored jointly, and jointly evaluated on an annual basis, with a quantity based on the average flow (floods are excluded from the calculation). Hence, despite the ongoing lack of clarity and contested nature of the Gabčíkovo–Nagymaros project, both countries have been able to move past the overarching dispute and cooperate in good faith to reach a temporary technical cooperation arrangement concerning transboundary water allocation. The two States also continue their mutual water management cooperation at bilateral (Transboundary Commission) and multilateral (European Union, International Commission for the Protection of the Danube River and European Union Strategy for the Danube Region) levels.

To be effective, cooperation must be based on mutual trust. Trust-building requires extensive dialogue between or among the riparian States and may take many years or even decades.[268] However, many transboundary river and lake basins are not entirely covered by these principles and the majority of transboundary aquifers totally lack a cooperative arrangement.[269] The global status of transboundary water cooperation is assessed through SDG indicator 6.5.2 that measures the proportion of transboundary basin area within a country covered by an operational arrangement for water cooperation. SDG 6.5 sets a target to implement integrated water resources management at all levels by 2030, including through transboundary cooperation.

Principle of good neighbourliness

The principle of good neighbourliness is another general principle of international law. It reflects the theory of limited territorial sovereignty by implying that a State's sovereignty over a territory not only entails rights but also duties. States must exercise their rights in a way that does not prejudice the rights of others. In addition, each State has to tolerate some level of inevitable interference in their territorial space by neighbouring States.[270] Limited territorial sovereignty is thus a central approach to any water allocation framework in a transboundary context.[271] The principles of cooperation and good neighbourliness are closely linked to the principle of equitable and reasonable utilization and the no-harm rule discussed below in subsection 2b.

The United Nations global water conventions include two references to good neighbourliness. The Water Convention stipulates that consultations between the riparian parties must be based on reciprocity, good faith and good neighbourliness (Art. 10), while the preamble of the Watercourses Convention affirms the importance of international cooperation and good neighbourliness. In the context of transboundary waters, the principle of good neighbourliness means, for example, that a State needs to enter into consultations with the other riparian parties (Water Convention, Art. 10) and notify other States that might be adversely affected by planned measures or emergencies occurring in its territory—which could impact on shared water resources (Watercourses Convention, Art. 12).

[268] UNECE, *Guide to Implementing the Water Convention* (2013), p. 33.
[269] UNECE, *Progress on Transboundary Water Cooperation under the Water Convention: Report on Implementation of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes* (New York and Geneva, United Nations, 2018), p. 19–24.
[270] See McCaffrey (2001), p. 137–149; Tanzi and Arcari (2001), p. 15–16; Leb (2013), p. 97–100.
[271] See Rieu-Clarke, Moynihan and Magsig (2012), p. 120.

CASE STUDY 21: Transboundary river basin legal regime for the Senegal River based on good neighbourliness

The creation of the Organization for the Development of the Senegal River (Organisation pour la Mise en Valeur du fleuve Sénégal (OMVS)) as the ultimate institutional instrument for the promotion of cooperation between its Member States for the control and rational exploitation of the water resources of the Senegal River Basin took place on 11 March 1972. At that time, OMVS Member States were Mali, Senegal and Mauritania, with Guinea as an Observer.[272] Together with a number of additional legal instruments (listed below), these agreements have collectively created the OMVS and subsequently enabled the OMVS to resolve all issues related to its functioning (institutional establishment, general operation and ongoing sustainability):

- The Convention of 11 March 1972 on the legal status of the River;
- The Convention of 11 March 1972 relating to the establishment of the OMVS;
- The Convention of 21 December 1978 on the legal status of the jointly owned structures;
- The Convention of 12 May 1982 on the financing modalities of the jointly owned structures;
- The Charter of the Senegal River Waters of 28 May 2002;
- The International Code of Navigation and Transport under ratification.

According to Mbengue, the following analysis can be gleaned from the OMVS experience on good neighbourliness and its application to other basins: "One of the main aspects to ensure that cooperation over the Senegal River would be based on an 'inclusive framework' – that is, all riparian States must be involved in the development of the river. For that purpose, it was essential that Guinea – as the upstream State – would become an OMVS member State after 30 years of absence.[273] The 2002 Water Charter explicitly insists on the necessity to consolidate the relations of good neighborliness between the 'riparian States' of the Senegal River and on the need to take into account the interests of the Guinean part of the basin in the elaboration of development policies and programs within the basin. The 2002 Charter in its Preamble also makes explicit reference to the general principles and customary principles of international water law, including good neighborliness, as codified in the 1997 Convention on the Law of the Non-navigational Uses of International Watercourses and their applicability within the Senegal River basin. Other African river basin organizations have followed in the steps of the OMVS by adopting their own water charters. This is the case for the Niger Basin Authority, which adopted the Niger Basin Water Charter in 2008 and the Lake Chad Basin Commission, which adopted a water charter in 2012."[274]

3. Additional Principles in International Law Relevant to Transboundary Water Allocation

a. Public participation and stakeholder engagement in allocation decision-making

Benefits and principles of public and stakeholder participation

Public participation and stakeholder engagement in transboundary water allocation are important for many reasons. First, they contribute towards securing stakeholder "buy-in" and ownership of the water allocation decisions and practices and fair sharing of water. Second, they promote the idea of good governance, including transparency, democracy and accountability. Third, public participation and stakeholder engagement enhance the implementation of water allocation arrangements. Fourth, public participation and stakeholder engagement are important opportunities to promote social and cultural learning in water

[272] Since 2006, Guinea is a full Member State of OMVS, not an Observer.

[273] Otherwise, Guinea, Mali, Mauritania and Senegal were all Members of the Office of the Riverine States of the Senegal River (OERS), the predecessor of the OMVS, which was created in 1968 in Labé (Guinea).

[274] Makane Moïse Mbengue, "A model for African shared water resources: the Senegal River legal system", *RECIEL: Review of European Community and International Environmental Law*, vol. 23, No. 1 (April 2014), p. 59–66.

resources management.[275] In practical terms, public participation and stakeholder engagement facilitate transfer of information, expertise and new ideas "from the field" to policymakers and implementing authorities. Sometimes specific stakeholders may even be responsible for the practical implementation or monitoring of water allocation policies and related activities such as water quality monitoring.[276]

In the context of transboundary water management, and specifically allocation, public participation and stakeholder engagement can be realized by a variety of ways and means. Relevant questions to address include:[277]

- Who are the stakeholders?[278] Which stakeholders should be involved?
- How can we enable/facilitate/encourage participation? How do we initiate the process?
- Should the engagement take place on an ad hoc basis or be integrated into the planning and management processes?
- At what level (local, regional, national, river basin) do we realize the participation?
- What methods of participation do we use?
- Should the engagement be one-way communication (mainly realized through access to information) or be built on real possibilities for influencing policymaking?

Regarding the nature and methods of engaging the public and stakeholders in decision-making for transboundary water allocation, some general guidelines can be discerned. Participation may take place through formal observer systems led by basin organizations or other management authorities,[279] or through public hearings, consultations and group discussions that may be open or limited to specific groups of stakeholders or the public. Participation may also be realized through stakeholders' active involvement in programme or project planning and through actively facilitating public access to information.[280] It is important to note that stakeholder engagement entails not only public participation but multi-stakeholder interaction, dialogue and learning.[281]

Stakeholder engagement entails some challenges in the transboundary context. For instance, the number of stakeholders may be high. Furthermore, stakeholders may represent different cultural backgrounds, associations and political systems.[282] Nevertheless, the involvement of a diverse range of stakeholders is important in the transboundary water management context. The participatory process requires careful planning and implementation with sufficient resources.[283] The process, including stakeholder analysis and engagement methods, is discussed in detail in Chapter VIII.

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[275] See, generally, for example, Uta Wehn and others, "Stakeholder engagement in water governance as social learning: lessons from practice", *Water International*, vol. 43, No. 1 (2018), p. 34–59; Nicole Kranz and Erik Mostert, "Governance in transboundary basins: the roles of stakeholders; concepts and approaches in international river basins", in *Transboundary Water Management: Principles and Practice*, Anton Earle, Anders Jägerskog and Joakim Öjendal, eds. (Abingdon, United Kingdom, Earthscan, 2010), p. 91–105.

[276] See, generally, for example, Wehn and others (2018); Kranz and Mostert (2010).

[277] See also Sabine Schulze, "Public participation in the governance of transboundary water resources: mechanisms provided by river basin organizations", *L'Europe en Formation*, vol. 2012/3, No. 365 (2012), p. 49–68, at p. 65–66.

[278] A stakeholder is usually defined as someone having an interest in a particular situation, even if this interest is not recognized or acknowledged by others (Wehn and others (2018), p. 36). In the context of transboundary water allocation, stakeholders include State actors such as ministries, officials, agencies and local governments, and non-State actors such as local communities, farmer organizations, industry organizations, international agencies, citizens and non-governmental organization (NGOs).

[279] These are basin specific, initiated from an application, typically by an NGO, and include a right to participate in the governance meetings, make initiatives, make statements, etc.

[280] See, for example, Schulze (2012), p. 63–64; Kranz and Mostert (2010), p. 96.

[281] Wehn and others (2018), p. 35.

[282] Kranz and Mostert (2010), p. 91.

[283] See also Ibid.

CASE STUDY 22: Public participation in overseeing allocation arrangements for the Zarumilla River

Ecuador and Peru have been successful in reaching a long-lasting agreement for the allocation of the Zarumilla River waters, in significant part due to the cooperation among local water users. This has been a vital factor that has enabled successful implementation of the treaty. In this regard, it is evident that the countries are supporting the agreement in their responsibility to clean and maintain the channel, but the local associations have been empowered to enforce the allocation without major problems to date. This is an important governance characteristic in the Zarumilla case, because local stakeholders have organized in a cooperative form, with regular meetings and well-organized distribution of tasks, to the extent that the involvement of the governments is marginal with regards to the administration of the channel. At the same time, the local governments are important allies in the channel-cleaning activities as they contribute with heavy machinery to conduct the cleaning activities, in coordination with the water agencies of Ecuador and Peru. This proves that decentralized water management schemes in transboundary basins is a positive and desirable approach to sustain agreements in the long term.

In 2009, the countries agreed to establish the Binational Commission for the Integrated Water Resource Management of the Zarumilla River Basin. To date, the water allocation scheme has worked without major problems; the distribution of water is coordinated at the basin level with the local user associations, who have developed a cooperative relationship to secure equitable use of the channel under the agreements signed by both countries. At the same time, the governments have complied with their agreed responsibilities to clean and maintain the infrastructure, alternating between States each year. Given the success of the allocation arrangements, the Zarumilla Binational Commission has been the model used to create a new umbrella commission in 2018 for the management of the nine shared basins between Ecuador and Peru. The new Binational Commission will absorb the Zarumilla Commission and the roles it performed will be replaced by the basin-level committee of the Zarumilla, under the framework of the new Commission.

A challenge ahead is to legalize water allocations, up to the moment the use of the waters in the channel have been allocated in an informal way, i.e. without legal licences for use on both sides of the border. However, the new water laws in Ecuador and Peru demand that every water user should have a user licence as a means to control and improve water allocation in river basins.

International principles in decision-making processes

International principles regarding decision-making processes in water allocation revolve around internationally recognized civil and political rights of groups and individuals. Procedural rights recognized in international human rights instruments such as the Universal Declaration of Human Rights and International Covenant on Civil and Political Rights include the freedom of expression, freedom of association and right of peaceful assembly. These rights enable citizens to participate in democratic processes within their respective countries.[284]

Within international environmental law, the procedural rights have been formulated as the right of the public to access environmental information, to participate in decision-making processes that concern the environment and the right of access to justice in environmental matters. These rights were codified in the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention). The Convention is built on these three pillars that seek to secure public engagement in environmental decision-making. In the context of transboundary water allocation, the provisions of the Aarhus Convention apply to those riparian States that are parties to the Convention. The Convention requires the parties to promote its principles in international decision-making processes and within the framework of international organizations (Art. 3.7).[285]

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[284] Sands and Peel (2018), p. 215.

[285] On the application of the Aarhus Convention in transboundary water management and the UNECE Water Convention, see UNECE, *Strengthening Water Management and Transboundary Water Cooperation in Central Asia: The Role of UNECE Environmental Conventions* (Geneva, United Nations, 2011), p. 109–113.

International water law approach to participation

The possibilities for and modalities of public and stakeholder engagement in transboundary water allocation depend partly on the applicable allocation strategy and method. For instance, a fixed allocation rule may include fewer public participation opportunities than allocation based on a priority of different uses (on transboundary water allocation strategies and methods, see Chapter I, subsection 2). Many transboundary water agreements address public participation. While the level of detail of the provisions varies, access to information produced by the basin governance bodies appears the most commonly secured participatory right under the agreements.

The Water Convention addresses "public information" in Article 16. Accordingly, the riparian parties are to ensure that "information on the conditions of transboundary waters, measures taken or planned to be taken to prevent, control and reduce transboundary impact, and the effectiveness of those measures, is made available to the public". The Watercourses Convention includes the equitable participation principle (Art. 5.2) but it concerns the watercourse States and is not a public participation provision as such. No definition of the "public" is given in the United Nations global water conventions. It has been established, though, that the relevant provisions of the Water Convention are to be applied in light of concepts and principles of the Aarhus Convention.[286] The Aarhus Convention has adopted a broad definition of "the public concerned", the term denoting "the public affected or likely to be affected by, or having an interest in, the environmental decision-making". In addition, the role of non-governmental organizations (NGOs) is given special recognition in the Convention (Art. 2.5).

Specific stakeholder groups to incorporate in transboundary water allocation

Transboundary water allocation decision-making should identify and explicitly recognize marginalized stakeholder groups that are easily disregarded in the relevant policymaking and implementation. While no group should be unfoundedly favoured over others, special measures are often needed to empower marginalized groups. These groups typically include Indigenous people, women and youth, and they often rely on transboundary water resources directly or through an intergenerational perspective.

Indigenous people: According to the Indigenous and Tribal Peoples Convention, 1989 (No. 169) of the International Labour Organization (ILO), people in independent countries are regarded as Indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonization or the establishment of present State boundaries. Indigenous people retain some or all of their own social, economic, cultural and political institutions (Art. 1). The ILO Convention stipulates that governments must consult Indigenous people whenever consideration is being given to legislative or administrative measures which may affect them directly (Art. 6). In addition, the governments need to establish means by which Indigenous peoples can participate at all levels of decision-making in administrative and other bodies responsible for policies and programmes which concern them and means for the full development of Indigenous peoples' own institutions and initiatives (Art. 6).

The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) states that Indigenous peoples have the right to participate in decision-making in matters which would affect their rights (Art. 18) and the right to maintain and strengthen their relationship with water, among other things, as well as to uphold their responsibilities for future generations (Art. 25). UNDRIP requires States to consult and cooperate in good faith with the Indigenous peoples concerned in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of water, among other resources (Art. 32). Indigenous peoples' participation may take place through representatives or representative institutions chosen by

[286] "… with respect to public participation in transboundary water management, as well as water management at national level, respective provisions of the UNECE environmental Conventions are mutually complementary and should be considered and applied as a single regulatory regime for participatory decision-making", UNECE (2011), p. 109.

themselves (Arts. 18, 19). In practice, however, Indigenous people are some of the most disenfranchised and underrepresented at the water negotiation table. Indigenous peoples should be included in transboundary water allocation processes since allocation may affect their use of water resources, including traditional cultural practices.[287] Additionally, Indigenous peoples' traditional lands often overlap State boundaries. Recognizing Indigenous water and land claims and rights is one of the key issues for ensuring sustainability and equity of transboundary water allocation arrangements (see subsection 5c below).[288]

Women: It has been argued that most of the international transboundary water management processes are based on a masculinized discourse.[289] Targets and formal policies are needed for gender equality and equity in transboundary water management and allocation to ensure genuine participation of women.[290] While there are no specific international legal rules on promoting women's participation in transboundary water management, the issue has received increasing attention in recent years on the basis that gender-balanced participation is vital for effective, fair and sustainable transboundary allocation processes and outcomes.[291]

Youth: When discussing sustainable natural resources management, young people always have a special interest. They represent the future generations for which these resources should be safeguarded.[292] However, young people, especially young women and those in marginalized groups, often face challenges to fully participating in natural resource use decisions, including for water.[293] Young people's participation in transboundary water management and allocation can be enhanced through information, consultation and their active engagement in water processes.[294] It also requires education on water challenges, communication to provide access to relevant information and platforms to engage with water professionals, and support for new and innovative ideas.[295]

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[287] See, for example, Australia, "Engaging indigenous peoples in water planning and management: a module to support water planners and managers develop and implement National Water Initiative consent, inclusive water planning and management processes that support indigenous social, spiritual and customary objectives", Module to the National Water Initiative (NWI) Policy Guidelines for Water Planning and Management (2017).

[288] Katherine Selena Taylor, Bradley J. Moggridge and Anne Poelina, "Australian indigenous water policy and the impacts of the ever-changing political cycle", *Australasian Journal of Water Resources*, vol. 20, No. 2 (2016), p. 132–147.

[289] Anton Earle and Susan Bazilli, "A gendered critique of transboundary water management", *Feminist Review*, vol. 103 (2013), p. 99–119.

[290] See, for example, Isabelle Fauconnier and others, *Women as Change-makers in the Governance of Shared Waters* (Gland, Switzerland, IUCN), 2018).

[291] See, for example, Southern African Development Community (SADC) and Southern African Research and Documentation Centre (SARDC), *Mainstreaming Gender in Transboundary Water Management in SADC: Evidence, Challenges and Opportunities* (Gaborone, Botswana; Harare, Zimbabwe, 2019); Lynette de Silva, Jennifer C. Veilleux and Marian J. Neal, "The role of women in transboundary water dispute resolution", in *Water Security Across the Gender Divide*, Christiane Fröhlich and others, eds. (Cham, Switzerland, Springer International, 2018); Karen Delfau and Pichamon Yeophantong, *State of Knowledge: Women and Rivers in the Mekong Region* (Oakland, California, International Rivers, 2020).

[292] See, for example, Water Youth Network: www.wateryouthnetwork.org/.

[293] GWP, *GWP Youth Engagement Strategy* (Stockholm, 2015), p. 4.

[294] Ibid.

[295] Ibid., p. 8.

b. Human rights and humanitarian law principles relevant to water allocation frameworks

The United Nations has declared safe and clean drinking water and sanitation as human rights.[296] Hence, it is the right of all people to access sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use.[297] In addition to the human right to water, other human rights law principles are relevant in transboundary water allocation.[298] Human rights arguments are increasingly used in the context of international water law and transboundary water cooperation.[299] Public participation rights are an important element through which a human rights approach can be realized in a transboundary setting, including in the context of allocation frameworks. When affected people are able to influence transboundary water allocation arrangements, not only are their participatory rights being fulfilled, but also the more substantive water-related human rights, such as the right to an adequate standard of living and the right to health (International Covenant on Economic, Social and Cultural Rights, Arts. 11–12), are likely to get fuller attention and implementation.

Domestic uses in human rights law and the Sustainable Development Goals

The United Nations General Assembly declared safe and clean drinking water and sanitation a human right in 2010 (A/RES/64/292). The right to water "entitles everyone, without discrimination, to have access to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use".[300] The definition underlines the adequate quantity and quality of water, reliable access to it (including timing) and affordability.[301] The human right to water has received increasing attention and recognition since the 1990s[302] and it is linked to many other human rights (such as the right to an adequate standard of living, health, life, housing, etc.). SDG 6, "Clean water and sanitation for all", involves a commitment to "ensure availability and sustainable management of water and sanitation for all". The subgoals include several references to domestic water uses, including drinking water, sanitation and hygiene and wastewater (Goals 6.1–6.3). These goals reaffirm the increasingly recognized human right to water at the international level and the priority of vital human water needs in the realization of the SDGs.[303]

Human rights apply primarily in the relationship between an individual and the State. Therefore, human rights are mainly a matter of domestic implementation. However, the transboundary context is particularly relevant for the human right to water because of the hydrological interdependence between States and transboundary impacts on shared freshwater resources. In this regard, the human right to water receives

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[296] In November 2002, the United Nations Committee on Economic, Social and Cultural Rights adopted general comment No. 15 on the right to water (E/C.12/2002/11); subsequently, on 28 July 2010, the United Nations General Assembly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realization of all human rights (A/RES/64/292). For further information on the human rights to water and sanitation, see: www.unwater.org/water-facts/human-rights/.

[297] See www.unwater.org/water-facts/human-rights/.

[298] See, for example, United Nations, General Assembly, Declaration on the Rights of Peasants and Other People Working in Rural Areas (A/RES/73/165), which contains references to water.

[299] See, for example, Knut Bourquain, *Freshwater Access from a Human Rights Perspective: A Challenge to International Water and Human Rights Law*, International Studies in Human Rights, vol. 97 (Leiden, Martinus Nijhoff, 2008); Takele Soboka Bulto, *The Extraterritorial Application of the Human Right to Water in Africa* (Cambridge, United Kingdom, Cambridge University Press, 2014); Jimena Murillo Chavarro, *The Human Right to Water: A Legal Comparative Perspective at the International, Regional and Domestic Level* (Cambridge, United Kingdom, Intersentia, 2015).

[300] United Nations, General Assembly, The human rights to safe drinking water and sanitation (A/RES/70/169).

[301] See, for example, Inga T. Winkler, "The human right to water", in *Research Handbook on International Water Law*, McCaffrey, Leb and Denoon, eds. (2019), p. 242–254 at p. 244–245.

[302] For more, see, for example, Winkler (2019).

[303] Ibid.

protection through the application of the equitable and reasonable utilization principle and no-harm rule at transboundary scale. According to the United Nations Committee on Economic, Social and Cultural Rights, States have to respect the enjoyment of the right to water also in other countries and not interfere with that directly or indirectly. Any activities undertaken within one State's jurisdiction should not deprive another State of the ability to realize the right to water in its jurisdiction. In this regard, the Committee refers to the social and human needs as a factor of the equitable and reasonable utilization, the no-harm rule and special regard being given to vital human needs in the Watercourses Convention.[304] The SDGs are strongly interlinked and their implementation requires an integrated approach with close involvement of multiple sectors. The transboundary element of water management and cooperation has been recognized as having an important effect on the realization of the SDGs.[305]

Humanitarian law principles

General humanitarian law principles are foundational principles applicable in armed conflict, specific elements of which are relevant to water allocation. Two of the most central are the principle of humanity and the principle of military necessity. In addition, international humanitarian law recognizes, for example, the principle of distinction between civilians and combatants, and between civil objects and military objectives; and the principle of proportionality.[306] These principles are applicable to shared freshwater resources during situations of armed conflict. For example, attacks against water infrastructure in armed conflict may lead to severe consequences on transboundary water resources with serious impacts on human lives. The Geneva Principles on the Protection of Water Infrastructure[307] were launched in December 2019 as a legally non-binding guideline for States and non-State actors for enhancing the protection of water infrastructure during and after armed conflicts.

c. Sustainable development

Sustainable development is a normative concept, or sometimes alternatively referred to as a principle, of international law, which can be defined as "development in accordance with customary international environmental law".[308] The sustainable use of transboundary waters is closely linked to this norm in international law. It requires, first, that economic, social and environmental values are balanced in water uses. Second, sustainable use needs to be based on long-term carrying capacity of transboundary waters.[309] On a procedural level, as noted by the arbitral tribunal in *Indus Waters Kishenganga Arbitration (Pakistan v. India)*,[310] sustainable development as a principle of international law translates into "the duties to conduct an EIA and, more generally, to prevent environmental harm"[311] by taking all appropriate measures. In transboundary water allocation, the sustainable management or use of water resources is regulated in more

[304] E/C.12/2002/11, para 31. See also United Nations, General Assembly, Report of the Special Rapporteur on the human rights to water and sanitation (A/74/197), which discusses the impact of megaprojects on the realization of those rights.

[305] See, for example, United Nations and UNESCO, *Progress on Transboundary Water Cooperation: Global Baseline for SDG Indicator 6.5.2* (Paris, 2018), p. 14.

[306] See, for example, Nicholas Tsagourias and Alasdair Morrison, *International Humanitarian Law: Cases, Materials and Commentary* (Cambridge, United Kingdom, Cambridge University Press, 2018).

[307] Geneva Water Hub, *The Geneva List of Principles on the Protection of Water Infrastructure* (Geneva, 2019).

[308] Jorge E. Viñuales, "Sustainable development in international law", C-EENRG Working Papers, No. 2018-3 (Cambridge, United Kingdom, December 29, 2018); Jorge E. Viñuales, "Sustainable development", in *The Oxford Handbook of International Environmental Law*, 2nd ed., Lavanja Rajamani and Jacqueline Peel, eds. (Oxford, Oxford University Press, 2019).

[309] Rieu-Clarke, Moynihan and Magsig (2012), p. 107–108; Rieu-Clarke (2015), p. 195–208.

[310] Permanent Court of Arbitration, *Indus Waters Kishenganga Arbitration (Pakistan v. India)*, para. 450. Available at https://pca-cpa.org/en/cases/20/.

[311] See Viñuales (2018), p. 20.

detail by individual transboundary water agreements and their specific allocation rules and arrangements. For example, an agreement may contain an abstraction limit (a "cap") to ensure that water will not be abstracted in excess volumes. In addition, transboundary water agreements often include rules on water quality and sometimes on ecological flows (see Chapter II, subsection 3).

The United Nations global water conventions address the sustainable use or management of water resources in a general manner. The Water Convention mentions it in the context of parties' obligation to prevent, control and reduce transboundary impacts. Accordingly, parties need to take measures to ensure that "sustainable water-resources management, including the application of the ecosystems approach" is promoted (Art. 3.1.i). The Convention also stipulates that "water resources shall be managed so that the needs of the present generation are met without compromising the ability of future generations to meet their own needs" (Art. 2.5.c). According to the Watercourses Convention, "an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof …" (Art. 5.1).[312]

Concerning transboundary groundwaters, the Draft Articles on the Law of Transboundary Aquifers stipulate that States shall not utilize a recharging transboundary aquifer or aquifer system at a level that would prevent continuance of its effective functioning (Art. 4).[313] Much in the same manner, the UNECE Model Provisions on Transboundary Groundwaters stipulate that the parties shall use transboundary groundwater in a sustainable manner, with a view to maximizing the long-term benefits accruing therefrom and preserving groundwater-dependent ecosystems. To that end, the parties must take into due account the functions of groundwater resources, the amount and the quality of groundwater in reserve and the rate of its replenishment, making their best efforts to prevent the diminution of the groundwater reserve from reaching a critical level (Provision 2).

4. Emerging Legal Principles Relevant to Transboundary Water Allocation

a. Community of interest approach

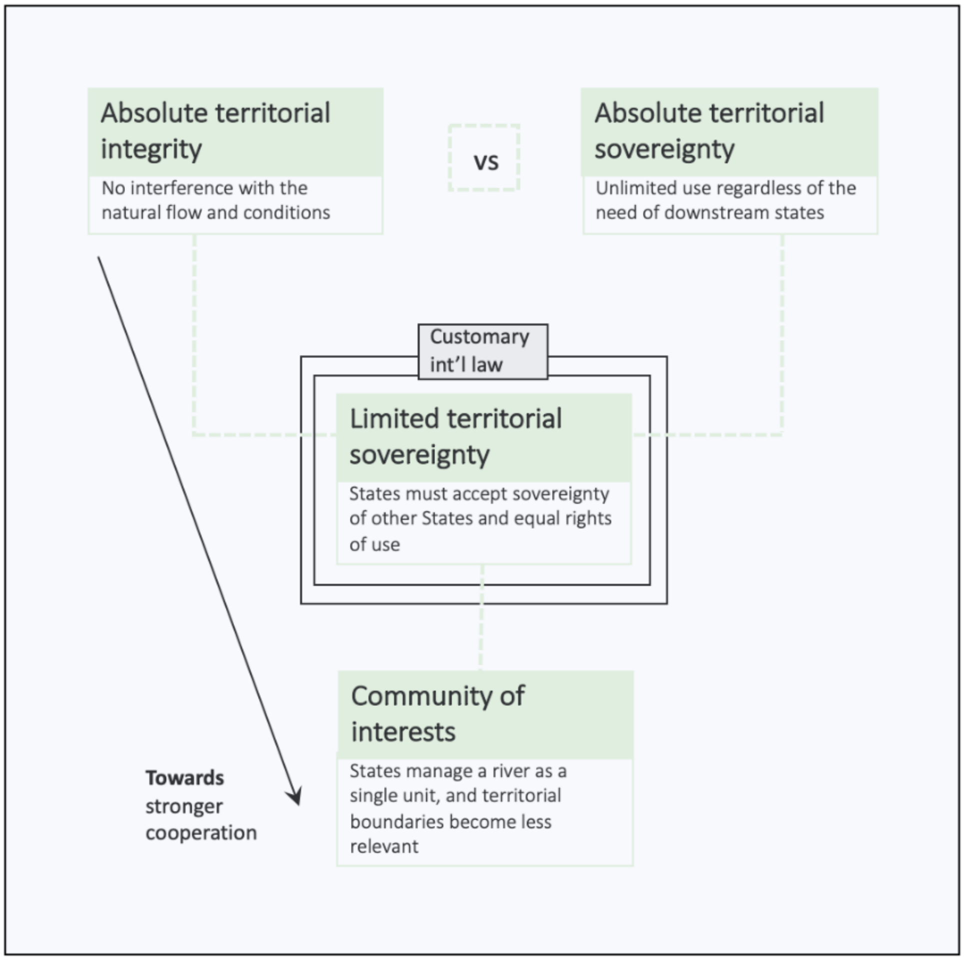
A community of interest approach (COIA) to international water law[314] is seen as a potential legal framework for the common management of international watercourses. It can be very useful when established and applied in a transboundary water allocation setting. In essence, the approach denotes that the riparian States shift their attention away from individual entitlements towards common interest and benefits of cooperation in water allocation. In practice, the COIA functions as follows: "Whenever watercourse States decide to establish a community of interest in the management of a shared watercourse, they agree on certain principles and norms that create the basis for the cooperation. These norms and principles become the framework within which explicit State consent to every decision is not required. The involved States have already agreed

[312] UNECE, *Guide to Implementing the Water Convention* (2013), p. 23; Rieu-Clarke, Moynihan and Magsig (2012), p. 107–108.
[313] See A/63/10, p. 28.
[314] See Julie Gjørtz Howden, *The Community of Interest Approach in International Water Law: A Legal Framework for the Common Management of International Watercourses*, International Water Law Series, vol. 8 (Leiden, Brill/Nijhoff, 2020); Bjørn-Oliver Magsig, "Overcoming state-centrism in international water law: 'regional common concern' as the normative foundation of water security", *Goettingen Journal of International Law*, vol. 3, No. 1 (2011), p. 317–344; Rieu-Clarke, Moynihan and Magsig (2012), p. 101–105.

explicitly to the process of management."[315] Joint infrastructure regimes, such as shared hydropower projects along a border, are commonly seen as an expression of the COIA in practice.

When used for transboundary allocation, COIA requires that co-riparian States share a common understanding of the applicable rules and principles for the governance and allocation of the shared water resource. The parties recognize their joint interests and benefits that can be gained from cooperation and, ideally, the maintenance of cooperation is fairly effortless.[316] The COIA presents challenges to traditional State sovereignty by committing the parties to cooperation with focus on common interests rather than sovereign entitlements (see Figure 10).[317] Within a COIA regime, the parties share not only interests/benefits but also the associated risks, expenses and environmental responsibility.[318]

Figure 10
Theories of allocation and a community of interest approach in international water law



Source: Alistair Rieu-Clarke, Ruby Moynihan and Bjørn-Oliver Magsig, *UN Watercourses Convention User's Guide* (Dundee, IHP-HELP Centre for Water Law, Policy and Science, 2012), p. 103.

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315 Julie Gjørtz Howden, "Aspects of sovereignty and the evolving regimes of transboundary water management", *Nordic Environmental Law Journal*, No. 1 (2015), p. 55.
316 Ibid., p. 56.
317 Julie Gjørtz Howden, "Communities of interest in the Nordic management of international watercourses", *Nordic Journal of International Law*, vol. 85, No. 4 (November 2016), p. 348–367, at p. 351.
318 Gjørtz Howden (2015), p. 56.

b. Rights of the river and ecosystems

There has been a gradual progression in certain rivers around the world being granted distinct legal rights, which in turn can have an impact on allocation frameworks.[319] A rights-of-rivers approach is a part of a wider idea of rights of nature, according to which nature has fundamental rights. Its roots arise from Indigenous traditions that regard humans as part of nature, not distinct from it. The rights of nature are sometimes also connected to human rights, such as the right to a healthy environment, or Indigenous rights, but the basic idea is to make a shift from an anthropogenic to an ecocentric approach. The rights-of-nature discussion can be seen as a response to modern environmental law that has not been able to adequately halt the ecological challenges.[320] The rights-of-nature approach can be distilled in three central elements:

1. Nature possesses fundamental rights. It is not only human property. These rights may contain, for example, the right to exist and thrive and the right to restoration.
2. The rights of nature can be defended in a court of law. Nature has a legal standing.
3. Humans have duties to act as guardians or stewards of the rights of nature. Nature often needs guardianship bodies to uphold its rights and interest.[321]

Rivers have a central role in the rights-of-nature discussion and have been the subject of many domestic cases in different continents. They have been linked to constitutions, treaties, legislation and case law. Nevertheless, the rights-of-rivers approach is novel and its practical impacts remain to be seen, including in the context of water allocation frameworks.[322]

[319] See Cyrus R. Vance Center for International Justice, Earth Law Center and International Rivers, *Rights of Rivers: A Global Survey of the Rapidly Developing Rights of Nature Jurisprudence Pertaining to Rivers* (Oakland, California, International Rivers, 2020); Erin O'Donnell and Elizabeth Macpherson, "Voice, power and legitimacy: the role of the legal person in river management in New Zealand, Chile and Australia", *Australasian Journal of Water Resources*, vol. 23, No. 1 (2018), p. 1–10.
[320] Cyrus R. Vance Center for International Justice, Earth Law Center and International Rivers (2020).
[321] Ibid.
[322] Ibid.

CHAPTER VI: Cooperative Frameworks for Transboundary Water Allocation

SUMMARY:
This chapter discusses the cooperative frameworks that form the basis for transboundary water allocation. It highlights the role of the United Nations global water conventions (1992 Water Convention and 1997 Watercourses Convention), regional and multi- or bilateral legal agreements and institutional arrangements that form the foundations to enable cooperative allocation. The aim and function of joint bodies in transboundary water allocation are analysed, and the role and relevance of informal arrangements are addressed. Finally, national law coherence with transboundary arrangements is highlighted as being important for coordination and implementation.

1. Transboundary Water Agreements

a. Framework from the United Nations global water conventions

The United Nations global water conventions can be seen as manifestations of the duty to cooperate and of the principle of good neighbourliness. The Water Convention obliges the parties to conclude bilateral or multilateral agreements and to establish joint bodies for the prevention, control and reduction of transboundary impacts (Art. 9). The Watercourses Convention stipulates that States may enter into, or consider harmonizing, existing watercourse agreements with the basic principles of the Convention and may consider the establishment or joint mechanisms or commissions (Arts. 3, 8).

b. Binational and multilateral agreements

Numerous transboundary water agreements have been established to govern transboundary surface and groundwaters, and to foster cooperation among the riparian States. It is estimated that more than 450 transboundary water agreements have been signed worldwide since 1820. The scope of these agreements covers a wide spectrum of issues, including rules for energy production, irrigation, fishing, and water quantity and quality. Transboundary agreements generally stipulate the common principles and rules for the protection and use of the shared waters by the co-riparian States.[323] They offer many benefits to inter-State relations and to the management of transboundary water resources. These agreements create stability in and provide predictability to the relationships of the riparian States, facilitate monitoring and information exchange, and generally promote cooperative arrangements for the management and allocation of water resources.[324]

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[323] Patricia Wouters, "International law – Facilitating transboundary water cooperation", TEC Background Papers, No. 17 (Stockholm, Global Water Partnership, 2013).

[324] See, for example, Jacob D. Petersen-Perlman, Jennifer C. Veilleux and Aaron T. Wolf, "International water conflict and cooperation: challenges and opportunities", *Water International*, vol. 42, No. 2 (January 2017), p. 1–16; Susanne Schmeier and Birgit Vogel, "Ensuring long-term cooperation over transboundary water resources through joint river basin management", in *Riverine Ecosystem Management: Science for Governing Towards a Sustainable Future*, Stefan Schmutz and Johan Sendzimir, eds., Aquatic Ecology Series, vol. 8. (Cham, Switzerland, Springer International, 2018); Stephen C. McCaffrey, "The need for flexibility in freshwater treaty regimes", *Natural Resources Forum*, vol. 27, No. 2 (May 2003), p. 156–162.

CASE STUDY 23: Southern African Development Community Revised Protocol and subsidiary instruments for developing transboundary water allocation arrangements

The Revised Protocol on Shared Watercourses in the Southern African Development Community (SADC Revised Protocol) was signed in 2000 and is an example of a regional multilateral agreement for transboundary water cooperation. The SADC Revised Protocol does not explicitly mention allocation, yet it establishes institutional frameworks for the Protocol's implementation, which includes SADC secretariat water sector organs whose functions include developing subsidiary regional water instruments and policies among SADC State parties (Art. 5). The SADC secretariat subsidiary instruments for transboundary water cooperation include "the Regional Water Policy, adopted in 2005; the Regional Water Strategy adopted in 2006 and Regional Strategic Action Plan on Integrated Water Resources and Development Management, which was first approved by SADC Summit in August 1998 to run in five-year phases".[325] Notably, both the Regional Water Policy and the Regional Water Strategy feature numerous mentions of water allocation, particularly equitable and sustainable/reasonable allocation,[326] for implementing the region's water resources development and management.[327]

2. Water allocation in transboundary water agreements

Transboundary water agreements may include specific arrangements for allocating water among the parties. These may appear, inter alia, as treaty provisions on elements such as priorities of uses and guidance regarding equitable and reasonable utilization within the basin in question, or as more specific decisions or guidance on the concrete realization of water allocation such as designated volumetric quotas. It is important to note that there are also numerous agreements which do not address the issue of allocation at all. Often this is simply because allocation is not the main water use challenge in the basin. Transboundary water agreements can promote effective cooperation and facilitate joint water management among riparian States, even without addressing allocation of the shared waters.

Transboundary water agreements are generally based on basin-level cooperation. This means that the territorial scope of the cooperation covers the whole basin. Activities by one riparian State affect the opportunities for the use and the protection of the basin and its resources by others. Similarly, treating the basin as one unit, including surface water and groundwater, may prevent harm to some riparian States and distribute benefits more equally among all of them.[328] Under bilateral and regional water treaties, different types of legal and policy arrangements on water allocation can be agreed. These may include specific protocols and other legal arrangements between and among the parties, and policy instruments such as flood management and water allocation plans. These instruments may also be developed in the absence of formal State-to-State agreements. Basin-level cooperation may be realized by a variety of actors through a variety of instruments and timelines.

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[325] See "SADC water sector", available at www.sadc.int/sadc-secretariat/directorates/office-deputy-executive-secretary-regional-integration/infrastructure-services/sadc-water-sector/.

[326] See, for example, SADC, *Regional Water Strategy* (2006), 4.1(b) Strategy: Promote equitable and sustainable allocation of water resources between competing and conflicting demands; SADC, *Regional Water Policy* (2005), 9.f.(iv) River Basin Approach: Water resources allocation and utilisation will be based on equitable and reasonable mechanisms through negotiations between watercourse States.

[327] See SADC, *Regional Water Policy* (2005); SADC, *Regional Water Strategy* (2006).

[328] N. Kliot, D. Schmueli and U. Shamir, "Institutions for management of transboundary water resources: their nature, characteristics and shortcomings", *Water Policy*, vol. 3, No. 3 (2001), p. 252.

CASE STUDY 24: Transboundary water allocation incorporated in the peace treaty between Israel and Jordan

The water arrangements between Jordan and Israel are part of the Treaty of Peace that was concluded between them in 1994. They are a good example of practical and sensible solutions for the most beneficial use of limited water resources in one of the most arid regions in the world. The water arrangements between the two countries are also part of an ongoing trust-building process following the conclusion of the Treaty of Peace and are implemented at a technical level by a Joint Water Committee that meets regularly.

The Treaty of Peace prescribes the respective water use allocations from the Yarmouk and Jordan Rivers, where these form the boundary between Jordan and Israel and further provides for the use by Israel of wells situated on the Jordanian side of the border in Wadi Araba, south of the Dead Sea.

Pursuant to Annex II of the Treaty of Peace, the waters of the Yarmouk River are for the use of Jordan subject to a priority right of Israel to pump an annual quantity of 25 million m^3 (12 million m^3 in summer and 13 million m^3 in winter). To facilitate the above, a diversion weir was constructed on the Yarmouk near the entry to the King Abdallah Canal (KAC) in Jordan. The diversion weir directs the Yarmouk waters to the entrance tunnel of the KAC while allowing Israel's share to flow downstream in the natural riverbed of the Yarmouk, from where Israel pumps its allocation. In addition, Jordan may allow (concede) Israel to pump up to 20 million m^3 from the Yarmouk during the winter, which water is returned to Jordan from the Jordan River during the summer, a de facto storage arrangement whereby Israel stores water for the benefit of Jordan.

Israel may continue its pre-Treaty use of the Jordan River waters along their common border and Jordan may use an equivalent amount provided such use will not harm the quantity or quality of the above Israeli uses. In addition, during the winter period, Jordan is entitled to store for its use a minimum average of 20 million m^3 of the floods in the Jordan River. Annex II also provides that Jordan is entitled to an annual quantity of 10 million m^3 of water from the planned desalination of about 20 million m^3 of saline springs that are diverted to the Jordan River. Therefore, until the desalination facilities are operational, Israel supplies Jordan with 10 million m^3 of Jordan River water during the winter period.

Jordan and Israel further agreed to cooperate in finding sources for the supply to Jordan of an additional 50 million m^3/yr of water of drinkable standards. Regrettably, such sources have not been found. Since 1997, Israel has transferred to Jordan 25 million m^3 annually. In order to transfer the waters from Israel to Jordan, such as the above-mentioned 10 million m^3, the concession and the 25 million m^3, a pipeline was constructed between the Bet Zera reservoir in Israel and the KAC in Jordan.

It was also agreed that excess floods in either the Yarmouk or the Jordan Rivers that are not usable in accordance with the above allocations and which will otherwise be wasted might be utilized by either side.

Along their southern border, Israel has the right to continue drawing water from certain wells on the Jordanian side of the Araba Valley and to replace those wells that fail.

a. Global trends in water allocation agreements

This section presents an overview of research into the global trends in the types of allocation mechanisms found in international freshwater agreements. The International Freshwater Treaties Database (IFTD) contains 599 agreements on international transboundary waters.[329] Using a methodology described in general terms below in relation to the research outcomes from McCracken and others[330] (see Annex for a more detailed summary of the methodology, its aims and rationale), the Database has coded these agreements in

[329] Oregon State University, College of Earth, Ocean, and Atmospheric Sciences and Program in Water Conflict Management and Transformation, "International Freshwater Treaties Database".
[330] McCracken and others, "Typology for transboundary water allocation" (forthcoming).

relation to specific criteria regarding allocation. As of 2017, 180 (30 per cent) of these international freshwater agreements contain a mention of at least one allocation mechanism for surface and/or groundwater. Nine agreements have at least one mechanism for both surface and groundwater.

The 180 agreements that mention one or more allocation mechanisms were further analysed using a method cataloguing and analysing allocation mechanisms in international water agreements that identifies two components of an allocation mechanism. The explanatory clause identifies how water is physically divided, while the context clause identifies why water is allocated or its purpose (see Annex). As demonstrated in Figure 4 (Chapter 1), there has been an increase in the number of agreements that include a mechanism for allocation over the past century and a half, with peaks in the 1950s and the 1990s. Since the 1970s, there has been a small but steady increase in the number of agreements with provisions for allocating groundwater, either in conjunction with surface water or solely focusing on groundwater.

Agreements that contain a particular explanatory clause on both surface and groundwater allocation mechanisms are examined in Table 6. An allocation mechanism can fulfil multiple categories; for example, a treaty might specify a set volume of water that changes depending on the month. This explanatory clause would be categorized as both "fixed quantity" and "variable according to time of the year". As shown in Table 6, nearly all the allocation mechanisms address surface water, with the most common explanatory clause being "fixed quantity". In more recently signed agreements, there is an increase in the diversity of explanatory clauses with mechanisms including provisions based on "variable by water availability", "percentage of flow", "consultation and/or prior approval", "fixed quantities" and "RBO (river basin organization), commission, and/or committee". This recent trend in the diversification of the type of explanatory clauses could aid in increasing the adaptive capacity and flexibility of allocation mechanisms, making water allocation more resilient in the face of uncertainties in water availability brought on by climate change.[331]

Table 6
Frequency of explanatory clauses in surface and groundwater allocation mechanisms in international water agreements

Explanatory Clause	No. of Agreements with a Surface Water Explanatory Clause (% of 175)	No. of Agreements with Groundwater Explanatory Clause (% of 14)	Total
Number of treaties with at least one allocation mechanism	175 (29.2% of 599)	14 (2.3% of 599)	180
Fixed quantity	47 (26.9%)	2 (14.3%)	49
Fixed quantity to a subset of riparians	17 (9.7%)	0	17
Percentage of flow	17 (9.7%)	0	17
Equal division	24 (13.7%)	0	24
Variable by water availability	30 (17.1%)	1 (7.1%)	31
Variable according to time of the year	15 (8.6%)	0	15

[331] Shlomi Dinar and others, "Climate change, conflict, and cooperation: global analysis of the effectiveness of international river treaties in addressing water variability", *Political Geography*, vol. 45 (March 2015), p. 55–66 ; Aaron T. Wolfe, Shira B. Yoffe and Mark Giordano, "International waters: identifying basins at risk", *Water Policy*, vol. 5, No. 1 (February 2003), p. 29–60; Aaron T. Wolf, Kerstin Stahl and Marcia Macomber, "Conflict and cooperation within international river basins: the importance of institutional capacity", Water Resources Update 125, Carbondale, Illinois, Universities Council on Water Resources, 2003; Olivia Odom and Aaron T. Wolf, "Institutional resilience and climate variability in international water treaties: the Jordan River Basin as 'proof-of-concept'", *Hydrological Sciences Journal*, vol. 56, No. 4 (2011). See, generally, Anoulak Kittikhoun and Susanne Schmeier, eds., *River Basin Organizations in Water Diplomacy* (Abingdon, United Kingdom, Routledge, 2020).

Water loans	13 (7.4%)	0	13
Allocation of entire or partial rivers/aquifers	15 (8.6%)	1 (7.1%)	16
Prioritization of uses	10 (5.7%)	1 (7.1%)	11
Allocation of time	1 (0.06%)	0	1
Benefits sharing	2 (1.1%)	0	2
Historical or existing uses	13 (7.4%)	0	13
Equitable use	13 (7.4%)	0	13
Sustainable use	6 (3.4%)	4 (28.6%)	9
Consultation and/or prior approval	15 (8.5%)	3 (21.4%)	19
RBO, commission, and/or committee	23 (13.1%)	1 (7.1%)	22
Cap, limit, or no allocation allowed	28 (16.0%)	7 (50.0%)	33
Market based	0	0	0
Unclear	30 (17.1%)	4 (28.6%)	34
Pumping rates	N/A	0	0
Water table impact	N/A	0	0
Spring outflow	N/A	0	0
Aquifer	N/A	1 (7.1%)	1

Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

Note: Percentages are based on the number of agreements that contain the explanatory clause of the mechanism listed in the first column. For surface water allocation mechanisms, this percentage would be calculated based on a total of 175 agreements, while groundwater allocation mechanism percentages would be calculated using a total of 14 agreements. The percentages do not add to 100 per cent as the agreements are counted multiple times when they contain more than one explanatory clause. The second component is the context clause—or the purpose for allocation.

Table 7 shows the trends in the number of agreements that contain a particular context clause for allocation mechanisms. Slightly more than half of the agreements with an allocation mechanism have an "undefined" purpose. The most commonly defined purposes for allocation are "agriculture/irrigation", "hydropower" and "domestic use". Allocations for environmental purposes, such as to maintain in-stream flow or water quality, are found in less than 20 per cent of agreements with surface and groundwater allocation mechanisms. However, it is important to note that these have become more common in recent years, 75 per cent of the agreements with these types of context clauses having been signed since 1980.

Table 7
Breakdown of allocation context clauses

Context Clause	% of Agreements with an Allocation Mechanism (n=180)
Minimum flow: not specified/undefined purpose	5.56%
Minimum flow: navigation	1.11%
Minimum flow: environmental needs	5.00%
Minimum flow: hydropower	2.78%
Minimum flow: tourism/recreation	0.56%
Environmental/in-stream flow	6.67%
Aesthetic/tourism/recreation	1.11%
Intrinsic/cultural/spiritual	0.56%
Hydropower	20.00%
Agriculture/irrigation	22.22%
Navigation	3.33%
Support of fish habitat and stocks/fishing rights	1.67%
Domestic uses	18.89%
Border/territory maintenance	0.00%

Water quality, such as a specific volume for dilution purposes	5.00%
Undefined purpose	56.67%
Other	6.67%

Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

Note: Percentages are based on the number of agreements that contain the explanatory clause of the mechanism listed in the first column. For surface water allocation mechanisms, this percentage would be calculated based on a total of 175 agreements, while groundwater allocation mechanism percentages would be calculated using a total of 14 agreements. The percentages do not add to 100 per cent as the agreements are counted multiple times when they contain more than one explanatory clause. The second component is the context clause—or the purpose for allocation.

b. Hydropower

As noted above, one of the predominant purposes for allocation is hydropower (20 per cent of agreements with an allocation mechanism). Yet, rather than allocating the water itself, States often allocate the benefits from hydropower (see Chapter III, subsection 3b, and Chapter IV, subsection 2c for a discussion of hydropower as an example of a shared benefit and how the method used categorizes these benefits). Table 8 presents a breakdown of how frequently the different mechanisms for hydropower benefits division are included in transboundary water agreements.

Table 8
Frequency of different mechanisms for hydropower benefits division

Hydropower Benefits Division	No. of Agreements with a Mechanism for Hydropower Benefits Division
Fixed quantities of power	9 (33.3%)
Variable quantities of power	0
Percentage of assessed value of electricity generated	3 (11.1%)
Percentage of power generated	10 (37.0%)
Fixed value of electricity	2 (7.4%)
Consultations	1 (3.7%)
Other	2 (7.74%)
Total	**27**

Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

Hydropower benefits are most frequently allocated by a percentage of the power generated. For example, a 1987 agreement between Syria and Jordan on the construction of the Wahdah dam and power-generating station allocates 75 per cent of the generated power to Syria and 25 per cent to Jordan. Similar to water, hydropower can also be allocated as a "fixed quantity" or through "consultations". While "market-based mechanisms" are not used to allocate water resources between countries, hydropower benefits allocations via "market-based mechanisms" occur in five agreements overall. These "market-based mechanisms" included allocations through the "fixed value of the electricity produced" (two agreements) and as "a percentage of the assessed value of electricity generated" (three agreements). For example, Argentina and Uruguay agreed to allocate the electricity generated in the Salto Grande area of the Uruguay River through a cost-price mechanism. This difference between the use of "market-based mechanisms" for water compared to electricity may be due to the fact that it is easier to assign a price to electricity produced via hydropower than to water.[332]

[332] Ariel Dinar, Mark W. Rosegrant and Ruth Meinzen-Dick, "Water allocation mechanisms: principles and examples", Policy Research Working Paper, No. 1779 (Washington, D.C., World Bank, 1997).

CASE STUDY 25: Developing an adaptable allocation treaty regime via a multi-phased project for Lesotho and South Africa

The Lesotho Highlands Water Project (LHWP) is a regional water resources management scheme and partnership between the Governments of Lesotho and the Republic of South Africa. The LHWP is "a multi-phased project to provide water to the Gauteng region of South Africa and to generate hydro-electricity for Lesotho. It was established by the 1986 Treaty signed by the governments of the Kingdom of Lesotho and the Republic of South Africa. The project entails harnessing the waters of the Senqu/Orange River in the Lesotho highlands through the construction of a series of dams for the mutual benefit of the two countries. Phase I of the project was completed in 2003 and inaugurated in 2004, and Phase II is currently underway."[333]

Based on the relative water abundance in Lesotho and enormous projected water demands in South Africa, initial feasibility studies were conducted in the 1950s and 1960s into diverting large quantities of water. Negotiation and further feasibility studies took place in the late 1970s and 1980s. Ultimately, both countries agreed in 1986 to proceed with the LHWP. Its stated purpose is "to enhance the use of the water of the Senqu/Orange River by storing, regulating, diverting and controlling the flow of the Senqu/Orange River and its affluents in order to effect the delivery of specified quantities of water to the Designated Outlet Point in the Republic of South Africa and by utilizing such delivery system to generate hydro-electric power in the Kingdom of Lesotho".[334] Under the Project, the region of Gauteng in South Africa was guaranteed to receive quantities of vital water and Lesotho would have hydropower infrastructure built to generate crucial electricity supply while also receiving royalties from the water transfer. Additional skills transfer and capacity-building to enable Lesotho to manage and maintain the infrastructure within the country and the development of future LHWP phases was also a key consideration.[335]

The legal basis for the LHWP and its sequential phases are established under the Treaty on the Lesotho Highlands Water Project between the Government of the Kingdom of Lesotho and the Government of the Republic of South Africa, which was signed into law on 24 October 1986. It codifies the rights and obligations of each of the State parties, including: the water quantities to be delivered; cost-sharing provisions; scope and calculation of the payments for water delivered; and principles for financing, constructing, operating and maintaining the system.[336] Notably, the Treaty committed the two countries to Phase I of the LHWP, noting that Phase I would be completed in two subphases (IA and IB), while providing for the potential construction of additional Phases, II–IV. The Treaty also establishes national and binational institutions to support the Project's development, including the Lesotho Highlands Water Commission (known as the Joint Permanent Technical Commission prior to 1999) which comprises representatives of both Governments. The Commission is responsible for overall monitoring and advisory functions of the Project and serves as a conflict resolution mechanism between the two State parties.[337]

Under the Treaty terms, different costs are borne by the two countries. South Africa funds all aspects of the water transfer component of the Project, including infrastructure construction, operation and maintenance, as well as any social and environmental mitigation measures, and all costs will be met regardless of the Project's performance. Lesotho funds the hydropower component of the Project, including infrastructure construction, operation and maintenance and all associated environmental and social costs. Both countries are separately liable for any ancillary developments within their respective countries. The parties also agreed to take all reasonable measures during implementation, operation and maintenance of the Project to ensure protection of the existing quality of the environment and to give due regard to maintaining the welfare of persons and communities immediately affected by the Project.[338]

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333 See www.lhda.org.ls/lhdaweb/.
334 Treaty on the Lesotho Highlands Water Project between the Government of the Kingdom of Lesotho and the Government of the Republic of South Africa, 1986, Art. 4(1).
335 International Water Power and Dam Construction, "The second phase", 12 November 2018.
336 Winston H. Yu, "Benefit sharing in international rivers: Findings from the Senegal River Basin, the Columbia River Basin, and the Lesotho Highlands Water Project", Africa Region Water Resources Unit Working Paper 1, Report No. 46456 (n.p., World Bank, Africa Region Sustainable Development Department, 2008).
337 Treaty on the Lesotho Highlands Water Project, 1986, Art. 16.
338 Ibid., Art. 15.

Two specific elements of the Project should be highlighted for transboundary water allocation: flexible minimum annual water quantity to be delivered to South Africa; and cost-benefit analysis for royalties paid to Lesotho for delivering water. The Treaty commits Lesotho to deliver an initial 38 m^3/s of water, rather than the full 70 m^3/s that was estimated to be achieved after development of all phases of the Project. However, after implementation of subphase IA, South Africa would be guaranteed an increasing minimum annual water quantity from 1995 to 2020, and after 2020 as listed in Annexure II, subject to adjustment based on certain conditions should there be a shortfall or surplus.[339] Regarding royalty payments, under Article 12 of the Treaty, South Africa undertakes to share with Lesotho royalty payments based on the net benefit (56 per cent for Lesotho and 44 per cent for South Africa) of the Project. Notable here is that "the royalties were not for the water explicitly, as the water would flow into the Republic of South Africa regardless, but rather the cost savings for undertaking LHWP".[340] This is because two alternative projects were considered to deliver South Africa a fixed amount of water, one based within South Africa and the other the LHWP. The LHWP was analysed as being more cost effective and thus the royalties represent this net benefit differential.

The LHWP provides lessons in the importance of an integrated approach to negotiating not only water allocation but water within a broader "basket" of resources.[341] In this regard, "South Africa receives cost-effective water for its continued growth, while Lesotho receives revenue and hydropower for its own development. The 1986 Treaty spells out an elaborate arrangement of technical, economic, and political intricacy. The elaborate technical and financial arrangements that led to construction of the LHWP provide a good example of the possible gains of an integrative arrangement including a diverse 'basket' of benefits. It is testimony to the resilience of these arrangements that no significant changes were made despite the dramatic political shifts in South Africa at the end of the 1980s until 1990".[342]

The LHWP Treaty exemplifies the importance of providing for possible renegotiation of allocation project terms over time. The Treaty only committed the parties to Phase I of the Project. "The hydropower and development components were undertaken by Lesotho, which received international aid from a variety of donor agencies, particularly the World Bank. Phase IA of the LHWP was completed in 1998, at a cost of USD2.4 billion. Phase IB of the project was completed in early 2004, as a cost of approximately USD1.5 billion."[343] The Phase II Agreement was subsequently signed in 2011 and ratified in mid-2013, whereby its implementation is currently in progress. Envisaged as a multi-phased project, the phases described in the Treaty may be modified by agreement between the two countries. This novel approach to the development of the LHWP has allowed the project planners to adapt and renegotiate allocation plans over time. In the absence of such a provision, the additional phases of the Project might have been implemented without adequate consideration of their feasibility.[344] In particular, changes in the projection of water demand in South Africa and climate change impacts on water supply in Lesotho, along with concerns over negative social and environmental impacts of the Project, have led to negotiations on the future phases.[345]

c. Groundwater

The methodology used as part of this research also allows for a distinction between allocation mechanisms for surface and groundwater. This distinction is important, as, historically, the focus of allocation mechanisms has been on sharing surface water. The same trends in surface water allocation mechanisms manifest in the smaller number of documents that allocate groundwater. Until recently, only one agreement available for the analysis included a groundwater allocation mechanism—the 1905 Constitution of the Joint Authority for the Study and Development of the Nubian Sandstone Aquifer Waters—although this allocation

[339] Ibid., Art 7(2).
[340] Yu (2008).
[341] Aaron T. Wolf and Joshua T. Newton, "Case study transboundary dispute resolution: The Lesotho Highlands Water Project" (n.p., n.d.), p. 4.
[342] Ibid., p. 3–4.
[343] Wolf and Newton (n.d.).
[344] Ibid.
[345] Ibid.

mechanism was vague and unclear. No other available agreements addressed groundwater allocations until the 1970s, when the agreement on the Genevese aquifer was concluded (see Case Study 26). Following this decade, new groundwater allocation mechanisms appear, albeit only in small counts, with a maximum of four agreements containing groundwater allocation in the 2010s. "Cap, limit, or no allocation allowed" was the most commonly used explanatory clause for groundwater allocations overall, particularly in the 2000s and 2010s. "Minimum flow: environmental needs", "environmental/in-stream flow", "agriculture/irrigation" and "domestic uses" were the only context clauses in these groundwater allocating agreements, with water most commonly allocated for an "undefined" or "domestic" purpose.

While groundwater resources are starting to receive more attention, the frequency of "undefined" allocation mechanisms shows that this focus remains limited and may still be underdeveloped for groundwater. One example of this is the 1992 agreement between Egypt and Libya attempting to manage their shared Nubian Sandstone Aquifer. In this agreement, a Joint Authority is in charge of this resource and its allocation; however, both the specific explanatory and context clauses for structuring the allocation mechanism are "unclear" and "undefined", respectively.

CASE STUDY 26: Genevese Aquifer Agreement, 1978: capping groundwater abstraction and managing aquifer recharge

A collaborative effort between Swiss and French authorities to establish and fund a joint water management system based on the Genevese aquifer was initially triggered when overpumping lowered the groundwater level in the 1960s and 1970s. After the option of simply reducing withdrawal, a decision was taken to set up an artificial aquifer recharge plant, which has been operated since 1980 by the Swiss canton of Geneva, replenishing the aquifer with water from the Arve River, the aquifer's main natural recharge source. A committee is mandated to propose the yearly management programme of the Genevese aquifer, taking into account the needs of all the users, and to formulate proposals for protection of the resource. Pumping is limited to a certain volume to obtain a satisfactory average groundwater level. The French authorities and communities undertook to ensure that total abstraction by users on their territory would not exceed 5 million m^3 per year. In 2008, the Agreement was replaced by a new one (see Case Study 33).

Several overarching conclusions can be drawn from the analysis done on the almost 600 treaties coded for allocation mechanisms within the IFTD. First, there is a generally positive trend, with some fluctuations, in the number of agreements that are including allocation mechanisms for surface and groundwater. This is beneficial as they are likely contributing to the institutional capacity governing these shared resources, as well as potentially adding to the adaptive capacity that will help in overcoming uncertainties due to climate change. Second, there has been a change in the type of mechanisms that States include in their agreements, moving towards indirect and principle-based explanatory clauses and away from direct mechanisms. Third, there is an increasing trend in the number of groundwater-specific allocation mechanisms since the 1970s; however, more work is needed to develop groundwater-specific mechanisms that consider the unique characteristics of international transboundary groundwater. Fourth, most allocation mechanisms do not define a purpose for their allocation (context clause). For those that do, "agriculture/irrigation", "hydropower" and "domestic use" are the most common; however, since the 1970s, "environmental needs" and "water quality" are becoming more common.

3. Joint Bodies and Cooperation Arrangements

a. Tasks of joint bodies

Joint bodies are an essential part of the governance structures of transboundary basins, interacting with the different actors, norms and measures that form the governing regime. The specific themes of the work of joint bodies are contained in the underlying transboundary water agreements or other arrangements that set out the operation of the bodies. The orientation, underlying principles and relevant issues addressed by joint bodies may be shaped by the characteristics of the parties and of the shared basin, as well as by the more general operating environment of the institution.[346] Joint bodies have an important role to play in transboundary water allocation processes and outcomes.

CASE STUDY 27: Dniester River Basin: a joint body preventing and resolving disputes

In the Soviet period in the 1980s, a decision was made to construct the Dniester Hydropower Hub to, inter alia, enhance flood protection and increase water availability during low-water periods for Moldova and Odessa City and oblast in Ukraine. In 2012, a treaty between Moldova and Ukraine was signed on cooperation in the field of protection and sustainable development of the Dniester River Basin. The Dniester Commission has been created, which is currently finalizing the operational rules of the Dniester Hydropower Hub to establish schemes for water allocation under different water availability conditions. The Commission serves also as a platform to study disputes arising from the use and protection of water and other natural resources and ecosystems of the Basin and seek a settlement.

The Water Convention defines a "joint body" as any bilateral or multilateral commission or other appropriate institutional arrangements for cooperation between the riparian parties. Article 9(2) of the Convention specifies a non-exhaustive list of the basic functions (10 categories) to be entrusted to the joint bodies to perform, several of which can be relevant to water allocation:

a) Collecting, compiling and evaluating data to identify pollution sources that generate a cross-border impact;
b) Developing joint monitoring programmes on the quality and quantity of the resource;
c) Developing inventories and exchange of information on pollution sources that generate a cross-border impact;
d) Establishing emission limits for wastewater and evaluating the effectiveness of control programmes;
e) Jointly defining quality criteria and objectives and the proposed measures to maintain and, if necessary, improve water quality;
f) Developing joint action plans to reduce polluting loads from accidental pollution and diffuse pollution;
g) Establishing alert procedures;
h) Providing a forum for information exchange on existing and planned uses of the resource and related facilities, which generate a cross-border impact;
i) Promoting cooperation and information exchange on best available technologies and fostering cooperation in scientific research programmes;
j) Participating in the environmental impact assessment of transboundary waters, in accordance with the relevant international rules.

CASE STUDY 28: River basin authority charter and technical body to advise ongoing allocations for the Senegal River

In the Senegal River Basin, many activities, uses and environments (agriculture, fishing, drinking water, production of hydroelectricity, river transport, environment, etc.) need the regular and permanent availability of water resources for their development and protection. The water resources allocation is used to meet the various demands of these often antagonistic socioeconomic and environmental sectors, in order to allow the Organization for the Development

[346] See, for example, UNECE, *Principles for Effective Joint Bodies for Transboundary Water Cooperation under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes* (New York and Geneva, United Nations, 2018).

of the Senegal River (OMVS) Member States to better manage the distribution of water among sectors of activity and uses, depending on the demands and availability of water resources.

In 2002, aware of the need to take into account not only the needs, demanding activities and uses, but also the impacts and consequences resulting from the use of water resources on their available and usable volume and on their quantity and quality necessary for each type of use, the OMVS Member States developed the Senegal River Basin Water Charter. It sets the conditions and specifies the terms of water use to which all the Member States must adhere.

"The Charter embodies all key emerging principles on equity, IWRM and on the need to protect the environment. For example, there are provisions on water allocations in the Charters that require [sic] the dams in the basins to be managed so as to guarantee what we could consider an 'environmental flow' whenever the annual hydro-climatic condition[s] permit. For example, the Charter requires the Manantali Dam to generate releases to create an annual flood to respond to needs of recession agricultural [sic] and of the ecology of the floodplain".[347]

Based on the 2002 Water Charter, "an innovative body within the OMVS organisational set-up" is the Permanent Commission for Water (Commission Permanente des Eaux (CPE)). CPE is an advisory body composed of representatives of Member States (generally senior governmental experts), which is "in charge of defining the principles and modalities of water allocation between the various sectors".[348] The CPE constitutes a space for dialogue, consultation and exchange on the distribution of water among the different demanding sectors, according to the objectives to be achieved and the volume of water available. The CPE meets five times a year to discuss the distribution of water. The OMVS High Commission provides its secretariat.

The decision-making and problem-solving mechanism for water allocation measures takes place at the level of expert meetings, ministers' councils and/or heads of state and government conferences. Decisions are adopted by consensus and not by vote, at meetings organized by the OMVS. The resolution of a problem is submitted to the Ministers' Council when experts do not agree. Likewise, if ministers do not agree, they transfer the debate to the level of Heads of State who, in general, always agree on a political solution.

b. Joint bodies and transboundary water allocation

Joint bodies have an important role in water allocation in a transboundary context as they provide a forum and institutional framework for negotiating and planning water allocations within a shared basin. Joint bodies are permanent institutions with equal representation of the parties and are established to promote cooperation and coordination among the riparian States. Joint bodies should be neutral actors, safeguarding the interests of the shared basin and the riparian States as a whole, not of any individual basin State. In addition, joint bodies often form centres of information for monitoring and assessing transboundary water allocation. In practice, many joint bodies have water quantity issues included in their mandate.[349] That mandate, however, may refer to a number of different things and specific cooperative actions vary in this regard. Joint bodies may, for example, be engaged in the management of flows, floods and droughts, navigation and hydropower generation, as well as specific economic sectors, the overall sustainability of water uses and the implementation of international water law principles.[350]

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[347] Madiodio Niasse, "Integrated management of the Senegal River", SHARE Toolkit Case Studies (n.p., IUCN Water Programme, n.d.).
[348] Ibid.
[349] Of the 121 joint bodies captured in the Transboundary Freshwater Dispute Database (TFDD), 38 feature water quantity in their functional scope.
[350] Susanne Schmeier, *Governing International Watercourses: River Basin Organizations and the Sustainable Governance of Internationally Shared Rivers and Lakes* (Abingdon, United Kingdom, Routledge, 2013); Oregon State University, College of Earth, Ocean, and Atmospheric Sciences and Program in Water Conflict Management and Transformation, "International River Basin Organisation (RBO) Database".

Examples of joint body tasks that may be relevant to transboundary water allocation include the following:

- In recent years, one of the key tasks of the Permanent Okavango River Basin Water Commission (OKACOM) has been to manage flows by developing environmental flow requirements, especially with a view to protecting the Okavango Delta;
- The Tripartite Permanent Technical Committee on the Incomati and Maputo Rivers has been tasked to alleviate problems stemming from drought and floods;
- Both the Mekong River Commission (MRC) and the Zambezi Water Commission (ZAMCOM) have mechanisms in place to assess planned measures with regard to the no-significant-harm rule;
- Some joint bodies are mandated, among other things, to regulate flow in order to ensure minimum flows for navigation (e.g. the Commission Internationale du Bassins Congo–Oubangui–Sangha (CICOS) and the Finnish–Russian Commission on the Utilization of Frontier Waters);
- To achieve the objectives of the Albufeira Convention between Portugal and Spain, including compliance with the flow regime agreed under the Convention and, in the case of potential drought situations, implementing measures that are considered necessary to minimize their effects, two bilateral bodies of equal composition were established to carry out the functions of management and control of compliance, namely, the Conference of the Parties and the Commission for the Application and Development of the Convention (CADC);
- The Orange–Senqu River Commission (ORASECOM) is tasked to deal with water quantity concerning the sustainable water use by all countries involved; recently, this has included the management of the development of a transfer scheme extension from Lesotho and South Africa to Botswana.

Examples of specific transboundary water allocation mandates in joint bodies include the following:

- The International Water and Boundary Commission between the United States and Mexico is in charge of distributing water between the two countries and regulating the waters of the Rio Grande and other shared rivers, which is done through regular intergovernmental meetings and minutes of those that become binding on both parties;
- The Joint Water Committee between Israel and Jordan is tasked to work on water allocation and sharing between the parties;
- The Chu–Talas Commission between Kazakhstan and Kyrgyzstan is mandated to work on “water allocation among States”, among other issues.

CASE STUDY 29: Important role of a joint body in transboundary water allocation in the Amu Darya River Basin[351]

The Amu Darya River Basin extends into the area of five States: Afghanistan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The majority of water is used for irrigated agriculture and hydropower production.

Water is allocated among Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan according to the 1992 Almaty Agreement on Cooperation in the Field of Joint Management on Utilization and Protection of Water Resources from Interstate Sources, essentially validating continuation of the Soviet-era water allocation regime. Estimated water use by Afghanistan is deducted from water available for allocation. The Agreement established the Interstate Commission for Water Coordination of Central Asia (ICWC).

Functioning under the broader regional structure, the International Fund for saving the Aral Sea (IFAS), the tasks of the ICWC are to determine, approve, implement and monitor annual and seasonal water allocation along the Amu Darya River. The ICWC plays a prominent role in ensuring peace and stability in water allocation, even during

[351] For a comprehensive overview on water allocation practices in Central Asia and neighbouring countries, see IWAC, *The Allocation of Water Resources in a Transboundary Context to Strengthen Water Cooperation between Eurasian Countries* (Nur-Sultan, Kazakhstan, 2021).

extremely high- and extremely low-water years. It also provides a forum for information exchange, building capacity, elaborating new agreements, conducting research and joint projects, and facilitating mutual learning among the riparian States. The ICWC has indeed demonstrated good results in annual and seasonal water allocation planning to adjust to variability and extremes.

However, Afghanistan is not a party to the ICWC and Kyrgyzstan suspended its participation in 2016, claiming lack of reform. For the ICWC to deliver further, legal and institutional frameworks in the Basin need to be improved, in order also to better respond to changes in the countries' water use priorities and hydrological conditions due to climate change. Additionally, comprehensive assessment of future demands and its impacts has to overtake the current water allocation that is driven primarily by current needs.

Concerning transboundary water allocation, where joint bodies are operational, they can be mandated to advise/be the technical advisor/provide guidance to Member States with regard to water allocation. Implementation of agreed measures rests with riparian States. Only a few joint bodies globally are specifically mandated to perform water allocation. Their concrete role in water allocation varies considerably, from providing technical advice to providing concrete allocation proposals. Also, the success of joint bodies in water allocation varies.[352] Many joint bodies that have been tasked with water allocation have found it challenging to deal with water allocation over time. Nonetheless, empirical evidence demonstrates that those basins that have joint bodies in place do better in addressing contested issues around water quantity because they have a platform for regular exchange.

4. Adaptive Capacity of Water Allocation Arrangements

a. Climate and development outlook

Transboundary water resources are under multiple growing pressures, as detailed in Chapters I and II. Thus, many transboundary water allocation arrangements are subject to stress due to the changing circumstances. Water allocation schemes may no longer reasonably be based on a stationary setting with fixed rules and permanent quotas of water. The adaptive capacity of transboundary water agreements and other arrangements for water allocation has become increasingly important. The current types and rates of change facing transboundary basins may not have been envisaged when past transboundary water treaties and their related joint governing bodies were originally created, especially in relation to preserving the integrity of freshwater ecosystems.

CASE STUDY 30: Adaptive capacity of water allocation arrangements: the Portuguese–Spanish Albufeira Convention

The 1998 Agreement on Cooperation for the Protection and Sustainable Use of the Waters of the Spanish–Portuguese Hydrographic Basins (Albufeira Convention) conditions the uses of the water in both countries to a flow regime that is accepted by the two parties, having in mind downstream water needs in Portugal and environmental flows. Minimum annual, seasonal and weekly flows have been agreed at the entrance into Portugal (conditioning up to a certain amount of water use in Spain) and to the estuaries (conditioning water uses in Portugal).

In the Guadiana River Basin, the flow regime at the border of the two countries is defined in accordance with the rainfall and water stored in the main reservoirs in the Spanish part of the Basin. The more rainfall and water in the reservoirs, the more substantial the water flows. The two countries agreed in the Convention that the set of hydrometric and pluviometric stations and reservoirs provide data for the flow regime.

[352] Schmeier (2013); Oregon State University, "International River Basin Organisation (RBO) Database".

The minimum flows regime has been evolving in time. It started with minimum yearly flows (1998); later (2008), a minimum seasonal and weekly flows regime was agreed. In 2020, the two parties were negotiating an update of the minimum flows to address flows that are needed in the Lower Guadiana River and minimum daily flows. Modifications to the minimum flows are needed also, to adapt to the impacts of climate change.

b. Adaptive management

Flexibility of water allocation arrangements

In terms of specific measures within agreements and arrangements, historically, water allocation has been approached in terms of fixed volumes or quantities.[353] Of the 180 treaties with allocation mechanism(s) in the IFTD, just over 35 per cent of agreements with surface water allocation mechanisms and just under 15 per cent of agreements with groundwater allocation mechanisms designate a "fixed quantity" of water to at least one party to the agreement, under the categorization applied.[354] However, there is an increase in the number of allocation mechanisms that can contribute to adaptive management, such as those that address variability. For example, just under 20 per cent of the surface-water-allocating agreements include a provision for allocating water based on the variability in flow, such as using a mechanism that establishes allocation based on the percentage of flow or temporal variability. One example is an agreement in which South Africa and Eswatini allocated different amounts of water from the Komati River Basin during periods of high flow and periods of low flow, with additional shares set aside to compensate for water lost through evaporation.

At a broader, systems scale, the application of adaptive management in transboundary water allocation requires institutional and normative flexibility. Water allocation arrangements should be able to respond and adapt to changes and manage uncertainty. Transboundary water agreements and their governing bodies should be responsive to new information and different kinds of uncertainties. At the same time, they must be capable of reflecting the vulnerabilities, capacities, needs and priorities of the State parties and of the river basin ecosystems. This flexibility of transboundary water allocation arrangements needs to be carefully balanced with the needs of stability and legal certainty.[355] Transboundary water allocation arrangements can have either a proactive or reactive approach to changing circumstances, or a mix of them. A proactive approach is based on anticipating the changes on the basis of historical data and future projections of water flows, and studies on the expected changes in the relevant circumstances and uses of water. A reactive approach is focused on managing the changes as they come, for example, through emergency response measures.[356] With either of the approaches to adaptivity, the aim is that water allocation satisfies the needs of the riparian States.

Increasing the adaptive capacity of transboundary water allocation typically means the introduction of more complex and flexible arrangements between or among riparian States. The allocations can no longer be simple fixed amounts from year to year, based on an historically agreed scheme and historical uses and patterns. The existing arrangements may be difficult to change, but the introduction of enhanced adaptive capacity into the allocation regime may be necessary. Strengthening of adaptive capacity usually requires significant institutional capacity and, for example, robust water monitoring systems to be implemented. One example of an adaptive management process that supports water allocation in a transboundary context is the

[353] Shlomi Dinar and others (2015).
[354] See Oregon State University, "International Freshwater Treaties Database".
[355] T. Honkonen, "Water security and climate change: the need for adaptive governance", *Potchefstroom Electronic Law Review*, vol. 20, No. 1 (2017), p. 1–26.
[356] See, for example, Lea Berrang-Ford, James D. Ford and Jaclyn Paterson, "Are we adapting to climate change?", *Global Environmental Change*, vol. 21, No. 1 (February 2011), p. 25–33.

Great Lakes–St Lawrence River Adaptive Management (GLAM) Committee created by the International Joint Commission (see Case Study 38).[357]

Adaptive capacity in transboundary water allocation agreements and other arrangements

At present, many transboundary water agreements and allocation arrangements do not include strong mechanisms for addressing changing environmental, climatic, social or economic conditions. Notwithstanding, of the surface water treaties with an allocation mechanism in the IFTD that were analysed, 85 per cent allow for some flexibility to react to changes in the available supply, changing demand or an institutional change.[358] All the treaties with allocation mechanisms for groundwater included a flexible mechanism ("variable by water availability", "sustainable use", "consultation and/or prior approval"). However, not all allocation mechanisms are equivalent in increasing the adaptive capacity.

Using a methodology for categorizing allocation mechanisms (see Annex), we can further identify different components of allocation mechanisms that are not as flexible as others (please note that specific categories of allocation in the text are signified by inverted commas). The methodology identifies the following components of allocation mechanisms as having some flexibility: "variable by water availability", "variable according to time of the year", "equitable use, sustainable use", "equal division", "percentage of flow", "consultation and/or prior approval" and "water loans". Some mechanisms allow for greater flexibility than others. The degree of flexibility and the increase in the adaptive capacity it provides depends on the context of the basin or aquifer, including the physical and political characteristics of the resource. An example of this differing degree of flexibility according to the categorization would be "fixed quantities" vs. "percentage of flow". Allocating water by a "percentage of flow" allows water divisions to vary according to the seasonal or annual variability in the river's total flow rate while still maintaining a proportional division. Allocating water through "fixed quantities", on the other hand, does not account for variability in flow, such as droughts, since it still mandates a set volume of water. The flexibility of a "fixed quantity" allocation mechanism can be increased by including other components, such as "variable by water availability" or "variable according to time of the year". With climate change, as well as increases in water demand, it is crucial for States to consider the degree of flexibility of allocation mechanisms to increase both their institutional and adaptive capacities.

Under international law, the United Nations global water conventions do not directly address the adaptive capacity of transboundary water management. However, soft law tools under the Water Convention, such as the *Guidance on Water and Adaptation to Climate Change*,[359] adopted by the Meeting of the Parties and published in 2009, can provide step-by-step advice on how to adapt to climate change, with a special focus on transboundary basins. A collection of lessons learned and good practices on climate change adaptation in transboundary basins was subsequently developed in the period 2013–2015 to complement the *Guidance* document, and supports practical implementation.[360] Related issues are also covered under the principles of equitable and reasonable utilization and the no-harm rule, as well as by provisions on monitoring and joint bodies.[361] Broader systems-scale approaches can provide effective methods to enhance the adaptive capacity of transboundary water allocation arrangements. Such measures can include: monitoring and communication; information-gathering and management; financial and technical support; planned measures for emergency

[357] Detailed information is available at www.ijc.org/en/glam.
[358] McCracken and others, "Typology for transboundary water allocation" (forthcoming).
[359] UNECE, *Guidance on Water and Adaptation to Climate Change* (2009).
[360] UNECE and INBO (2015).
[361] According to the Water Convention, for example, "[t]he Riparian Parties shall, at regular intervals, carry out joint or coordinated assessments of the conditions of transboundary waters and the effectiveness of measures taken for the prevention, control and reduction of transboundary impact" (Art. 11.3). The Watercourses Convention includes climatic and hydrologic conditions as factors to be considered in the assessment of equitable and reasonable utilization (Art. 6).

situations and droughts and floods; and amendment and review of the provisions of agreements in accordance with the agreed procedures and relevant principles of international law.[362]

CASE STUDY 31: The Amu Darya River Basin: short- and long-term adaptability in water allocation

The Amu Darya River Basin extends into the area of five States: Afghanistan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The majority of water is used for irrigated agriculture and hydropower production.

Water is allocated among Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan according to the 1992 Almaty Agreement on Cooperation in the Field of Joint Management on Utilization and Protection of Water Resources from Interstate Sources. The Agreement established the Interstate Commission for Water Coordination of Central Asia (ICWC).

In the Soviet period, a framework for water allocation was set in "The Revised Schemes for Integrated Use and Conservation of Water Resources in the Amudarya" (1987). The Schemes' allocation planning focused on irrigated agriculture expansion, the development of infrastructure and possible interbasin transfer.

In the period of independence, the Soviet principles of water allocation were retained but the basin planning process changed. The ICWC has demonstrated good results in annual and seasonal water allocation planning to adjust to variability and extremes. But the achievements in medium- and long-term basin planning are less encouraging. Over recent decades, water allocation has been driven primarily by current needs, rather than a comprehensive assessment of future demands and its impacts.

In the future, given the increasing water demand and diminishing water supply due to climate change, more integrated basin allocation planning is required. A framework for water allocation planning should be able to optimize the benefits from the available water supplies, manage demand and meet environmental needs.

Drought and flood management as adaptive allocation

The management of droughts and floods is an essential element of adaptive transboundary water allocation. Prolonged or extreme drought conditions or massive flooding always pose challenges to water allocation. The risks for and actualization of floods and droughts can be directly taken into account in transboundary water allocation arrangements. The arrangements should anticipate changes in hydrological cycles and respond to the increased water stress.

The United Nations global water conventions contain many provisions that are relevant for these purposes. The Watercourses Convention lays down an obligation to prevent and mitigate conditions resulting from, inter alia, drought or flood that may be harmful to other States, also in emergency situations (Arts. 27–28). The Water Convention obliges parties to prevent, control and reduce transboundary impacts (Art. 2) and develop contingency planning (Art. 3.1). The riparian countries have an obligation to inform each other without delay about any critical situation that may have transboundary impact and set up joint communication, warning and alarm systems (Art. 14) with the aim of obtaining and transmitting information. The Guidelines on Sustainable Flood Prevention, issued under the Water Convention in 2000, recommend that joint bodies develop long-term flood prevention and protection strategies and action plans. The Model Provisions on Transboundary Flood Management, adopted in 2006, provide assistance in the development of these strategies and other measures for transboundary river basins and thus provide guidance for allocation initiatives. The European Union Floods Directive (2007) has significance in a transboundary context. According to the Directive, the Member States must coordinate their flood risk management practices in shared river basins, including with non-Member States, and not undertake measures that would increase the

[362] See, for example, UNECE, *Guidance on Water and Adaptation to Climate Change* (2009); Heather Cooley and Peter H. Gleick, "Climate-proofing transboundary water agreements", *Hydrological Sciences Journal*, vol. 56, No. 4 (2011), p. 711–718; Sanchez and Roberts, eds. (2014); UNECE and INBO (2015).

flood risk in neighbouring countries. Competent authorities are required to engage in information exchange and coordination in transboundary river basin districts.

CASE STUDY 32: Allocation of flood control and hydropower benefits through coordinated management of the Columbia River

The Columbia River flowing between Canada and the United States is prone to flooding and inefficient hydropower generation. A major flood in 1948 gave urgency to the need for coordination of infrastructure development and management. The result is the Columbia River Treaty regime to which Canada and the United States are signatories. The Treaty regime covers construction and operational management of three dams on the main stem in Canada and allocation of benefits from joint management. It also allowed the construction of Libby Dam in the United States. The Treaty regime encapsulates the 1961 Treaty itself, the 1964 Treaty Protocol and associated implementing arrangements for the Treaty that have been developed in the years since.

Over the years, Treaty implementation has been shaped by notes exchanged between the two governments, and through numerous operational and supplemental arrangements between the United States and Canadian implementing entities. This includes arrangements for shaping flow to meet ecosystem objectives in both countries. The Treaty regime's key contribution is how it defined and operationalized the allocation of shared benefits. The agreement focused on the shared benefits of four large mainstream dams to be managed cooperatively. "Benefits" were primarily conceived of as the economic value of decreased flooding and the increased hydropower generation resulting from management of four infrastructure projects. By estimating the tangible economic benefits of infrastructure for controlling floods and generating hydropower, the parties avoided the pitfalls of trying to allocate quantities of water across the border. It is noteworthy that the preamble of the 1961 Treaty recognized that other benefits would be made possible by securing cooperative measures for hydroelectric power generation and flood control.

What is allocated in the agreement is the economic value of increased flood control and the hydropower benefits generated by coordinated management. The United States paid Canada $64.4 million for the first 60 years of storage of potential floodwaters within Canadian dams—half the value calculated at the time for the damage that would not happen over that period. The two countries also divide equally the value of the additional hydropower generated through coordinated management of the three Canadian dams. Canada received $254 million for the first 30 years of hydropower benefits; its share of hydropower is currently delivered daily for use or resale. For the United States Treaty dam, the countries agreed that the benefits that occurred in either country from the operation of the dam would accrue to that country.

The Treaty required each country to name operating entities for day-to-day operations and established a Permanent Engineering Board to report on Treaty performance. The operating entities are BC Hydro (Canada) and the Administrator of the Bonneville Power Administration and Division Engineer of the Northwestern Division of the United States Army Corps of Engineers. The Treaty sets out goals for coordinated management, but no joint managing body. Thus it is a treaty of coordination rather than integration.

For that contribution, the Treaty deserves its reputation as one of the more creative of its kind. Nonetheless, the decision to focus on two criteria of benefits—flood control and hydropower—can constrain others of increasing import, especially ecosystem health and water quality. Despite the Treaty's primary focus criteria, the operating entities have used its flexibilities to enter operating arrangements to provide ecosystem benefits on both sides of the border. Ongoing challenges are thus more in terms of determining binational focus areas and prioritization than simply being restricted to considerations of hydropower and flood control. Consideration of major changes in values, representation or governance became an object of increased focus around 2010, when each operating entity launched regional processes concerning these issues and the potential for Treaty termination after 2024. Some operational arrangements for mutually beneficial operations to support fish in both countries have been implemented over the years, and non-Treaty entities have filled some of the dialogue/governance gaps.

5. National Water Laws' Coherence with Transboundary Arrangements

a. Implementation of transboundary water allocation arrangements at national level

Implementation of transboundary water allocation arrangements and agreements at national and subnational levels are crucial to their overall effectiveness. Domestic regulation of riparian States must usually be put in place or harmonized to implement the allocation of transboundary water resources agreed in transboundary water treaties. National laws may either support or constrain the implementation of these treaties. The interaction between domestic and international levels of regulation may become evident when national basin plans or thematic plans (e.g. on navigation, flood management or infrastructure development and management) concerning a transboundary basin are prepared. Alignment and coordination at these two levels should be taken into consideration as early as possible in the transboundary allocation planning process and relevant national water resources legislation should be harmonized where appropriate and to the extent possible. In addition, national bodies that manage a part of a transboundary basin may exist alongside a joint transnational treaty body. The need for coherence between transboundary and national water regulation becomes specifically apparent when different water allocation plans are being prepared and implemented. In addition to the transboundary context (cooperation between countries), these plans may focus on allocating water resources between or among basins or federated States in a country or at a regional level.

It should be in all parties' interest to ensure that no conflicts emerge between the entitlements granted at different governance levels and that the integrity of the allocation system as a whole can be maintained.[363] In concrete terms, this can be achieved through joint efforts to ensure consistency and equity between transboundary and national laws, policies and plans concerning a given basin (which may require revising them) and in the sharing of costs and benefits from the different uses of the shared water resources (e.g. the maintenance costs of jointly used basin infrastructure). Furthermore, institutional and technical capacity of all States' agencies relevant to water management should also be taken into consideration in transboundary water allocation implementation plans.

b. Subnational level

It is noteworthy that federal States, cantons and other subnational entities can sometimes be parties to transboundary water agreements.[364] This stems from the structure of the participating States (the constitution) but it also reflects the general decentralization development in water management.

CASE STUDY 33: Genevese Aquifer Agreement

The 2008 agreement on the use, recharge and monitoring of Franco-Swiss Genevese groundwater followed establishment of cross-border legal bases which provided for the French party to allow the creation of operational structures between local authorities and/or local public bodies with legal personality. The Karlsruhe Agreement (1996) makes it possible to delegate the exercise of a mission to one of the communities, and in this case a cross-border agreement among the communities concerned provides for exploitation of artificial groundwater recharge. The signatories were, on the French side, the communes of the greater Annemasse region and the commune of Viry and, on the Swiss side, the State Council of the Republic and the canton of Geneva and the Genevese communes.

[363] Speed and others (2013), p. 42.

[364] Gabriel de los Cobos, "The Genevese transboundary aquifer (Switzerland-France): the secret of 40 years of successful management", *Journal of Hydrology: Regional Studies*, vol. 20 (December 2018), p. 116–127.

The situation may require specific solutions for cooperation: coordination must be ensured between different levels of domestic regulation and action(s) to avoid ambiguities of parties' responsibilities and the varying interests of States and provinces.

CASE STUDY 34: Agreement between Bosnia and Herzegovina and the Republic of Croatia

The 2015 Agreement between the Council of Ministers of Bosnia and Herzegovina and the Government of the Republic of Croatia on the rights and obligations of using water from public water supply systems crossed by the State border provides a basis for preparing contracts between municipalities for existing technically unique water supply systems and for the water supply systems that could be built. One of the interested parties must seek the written approval of the bilateral Commission for Water Management for the contract to enter into force, and such a decision states the maximum quantity of water that can be delivered. For example, Neum in Bosnia and Herzegovina supplies water to some local communities near Dubrovnik in Croatia.

CHAPTER VII: Knowledge Base for Transboundary Water Allocation

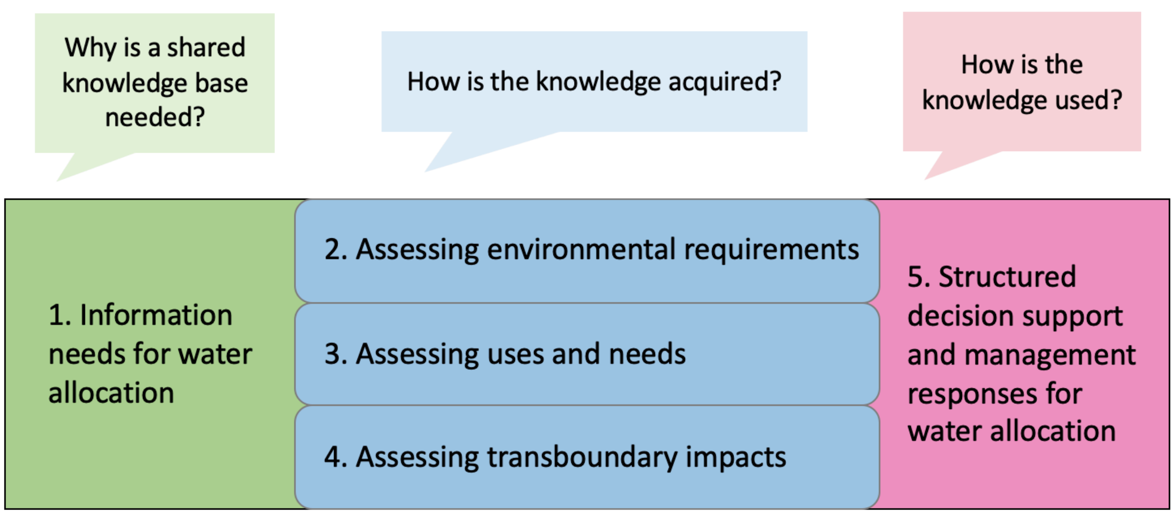
SUMMARY:
This chapter discusses the need for and importance of a shared knowledge base (e.g. available water resources, water uses and needs) at the basin or aquifer level in relation to transboundary water allocation. It also considers means to gather that knowledge, including water resources assessment, water uses and needs assessment and transboundary impact assessments. In addition, it presents structured decision-making approaches and systems as tools for building management responses in a transboundary context.

1. Information Needs for Water Allocation

a. Elements and importance of shared information and data harmonization

Water policy planning and implementation and functional water resources management are dependent on access to adequate data and information. In a transboundary context, the information should be shared by all riparian States in a commensurate manner to support decision-making and build trust. A robust shared knowledge base is a prerequisite for implementation of the Water Convention and can greatly contribute to the sustainable and equitable allocation of transboundary waters. This chapter presents the basic means through which to gather that knowledge, including water resources assessment, assessment of environmental requirements, water uses and needs assessment and assessment of transboundary impacts. In addition, the last section discusses structured decision-making and decision support systems (DSS) and how the shared knowledge contributes to management responses in the transboundary context. Figure 11 provides a general overview of the relations of these different elements and their sequencing in this chapter.

Figure 11
Sequencing of Chapter VII and the elements associated with a shared knowledge base in transboundary water allocation



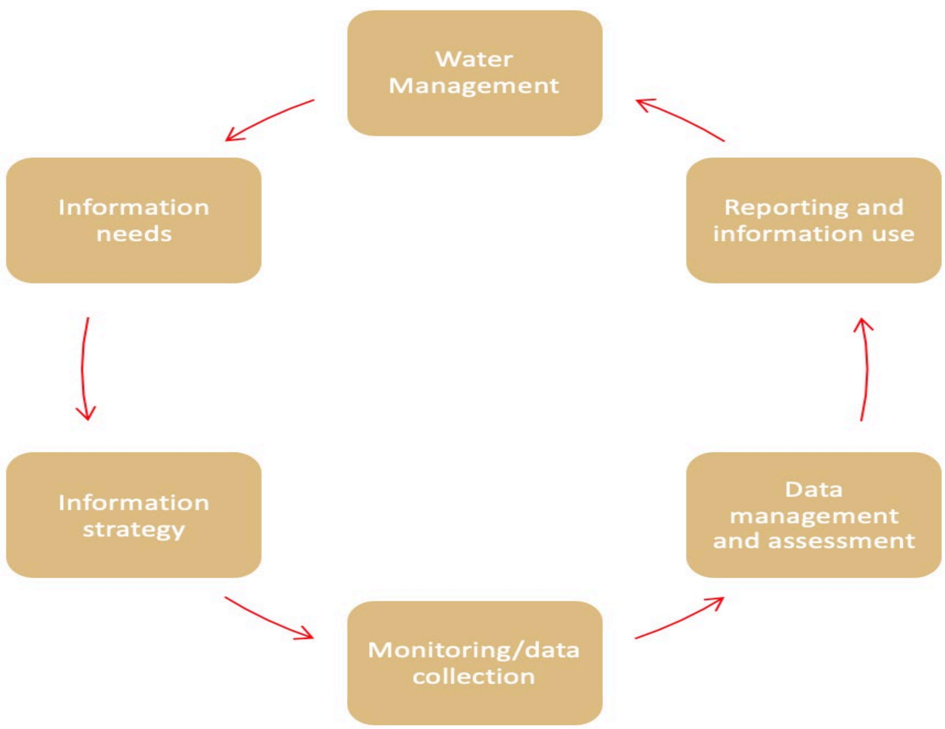
Source: UNECE Water Convention secretariat, 2021.

This chapter and Chapter VIII on operationalizing transboundary water allocation provide general ideal elements of the knowledge base for transboundary water allocation process. It should be emphasized that their actual application and sequencing is typically non-linear and their feasibility ultimately context specific and influenced by available resources and political priorities. On the other hand, selective information, knowledge and data-sharing may be subject to advancement of unilateral interests, to the detriment of all parties. This further highlights the importance of joint or coordinated assessment and monitoring systems as well as making data, information and indicators comparable in transboundary settings.

b. Joint monitoring and assessment of shared basins

A shared knowledge base at transboundary level requires harmonized and comparable monitoring and assessment methods and data management systems. These are best established in a form of systematic monitoring and assessment programmes that provide information for planning, decision-making and water management at all levels to both guide and complement the existing national-level practices. According to the Convention (Article 9) "the Riparian Parties shall establish and implement joint programmes for monitoring the conditions of transboundary waters, including floods and ice drifts, as well as transboundary impact". Transboundary monitoring and assessment ideally follows the monitoring cycle presented in Figure 12. Each step provides inputs for the following ones and at the end of the cycle the information needed is provided, for example, in the form of a report or a database. As more or different information needs emerge, when, for example, policies and targets change, the cycle starts again.[365]

Figure 12
The monitoring cycle in transboundary water management



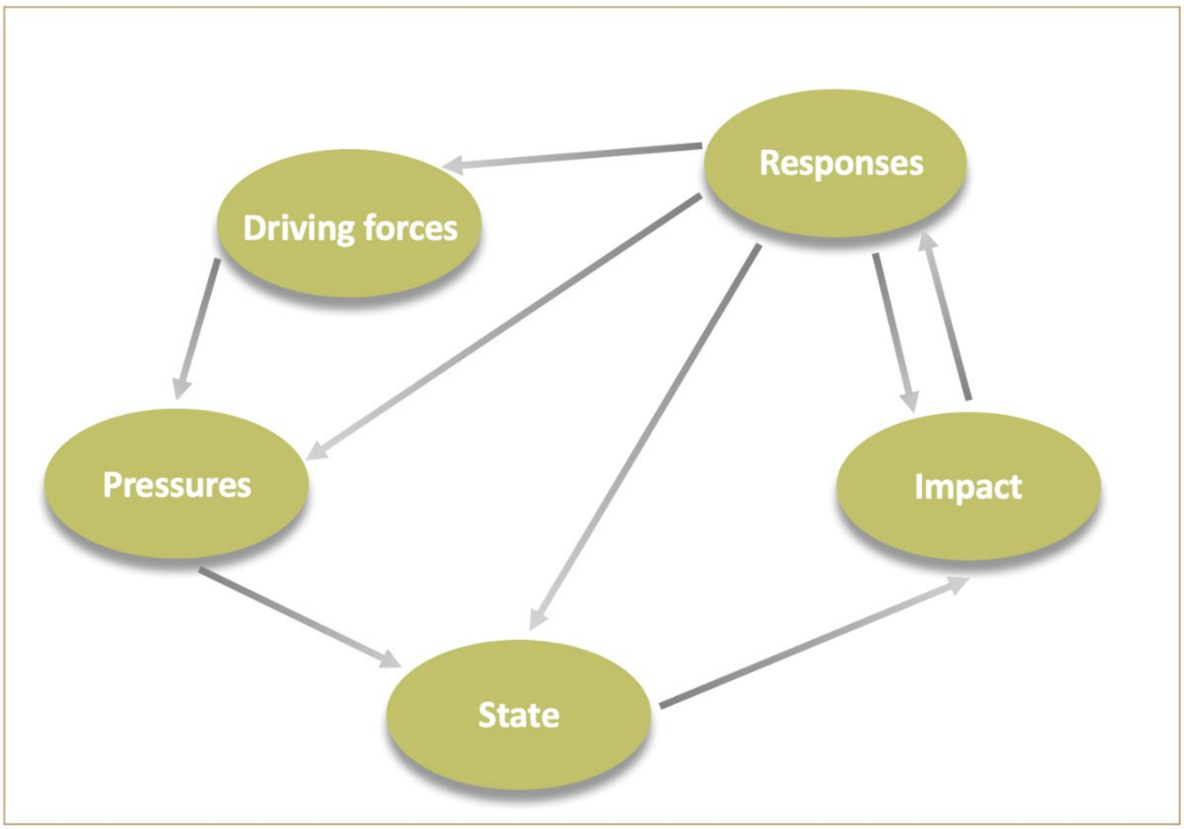
Source: UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (New York and Geneva, United Nations, 2006).

[365] UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (2006).

As a first step in the monitoring cycle, the key information needs related to water allocation cover water availability, different water uses and functions, and the allocation needs. The information needs may be further defined using relevant frameworks, such as the Driving Forces–Pressures–State–Impact–Responses (DPSIR) framework[366] (Figure 13) and/or identified water management issues. The transboundary context and scale of the allocation affects the detail and level of information needed. Monitoring programmes typically consist of selection of parameters, locations, sampling frequencies, field measurements and laboratory analyses. The parameters, type of samples, sampling frequency and station location should reflect the information needs.

The next step on the monitoring cycle, information strategy, defines the best practical way to gather the data from different sources (e.g. from national monitoring systems, surveys, experts and statistics). The strategy guides the following steps related to monitoring/data collection, data management and assessment, and reporting and information use. The information strategy has to adapt with each cycle when targets or policies change. However, continuity in time series is important, and monitoring programmes should always aim to be long term.[367]

Figure 13
DPSIR assessment framework



Source: UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (New York and Geneva, United Nations, 2006).

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[366] Ibid. The DPSIR framework was originally developed by the European Environment Agency, see Edith Smeets and Rob Weterings, “Environmental indicators: typology and overview”, Technical Report, No. 25 (Copenhagen, European Environment Agency, 1999).
[367] UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (2006).

CASE STUDY 35: Exchange of hydrological data in the Sava River Basin: diverse providers and users unified by a common policy and standards

The Framework Agreement on the Sava River Basin (FASRB), in force since 2004, with Bosnia and Herzegovina, Croatia, Serbia and Slovenia as parties, integrates different aspects of water management. The FASRB contains an obligation to exchange information on the water regime of the Basin on a regular basis. Additionally, the Protocol on Flood Protection to the FASRB states that the parties shall ensure timely exchange of meteorological and hydrological data, analyses and information important for flood protection, in line with the agreed procedure. The International Sava River Basin Commission (ISRBC), the implementing body of the FASRB, has established, in phases, an advanced data exchange system (operational since 2015) through the Sava GIS Geoportal (www.savagis.org), which by design is compliant with World Meteorological Organization (WMO) regulations and standards as well as relevant European Union Directives. The Sava GIS Geoportal is a scalable and flexible tool for data visualization and management; it supports multilingual usage (English and the six official languages of the parties) and implements open source technologies. Web application for editing, loading and retrieving data and metadata allows registered users to view, visualize, share and retrieve geographic information and data sets. Sava GIS database enables collection of data from the 13 governmental data provider institutions, their uploading using tools and processes to harmonize the data, and storing in a central database.

As an integral part of Sava GIS, the ISRBC has also established the Hydrological Information System for the Sava River Basin—Sava HIS (www.savahis.org), taking into account the Policy on the Exchange of Hydrological and Meteorological Data and Information, prepared in close cooperation with WMO and signed in 2014 by relevant organizations of the parties and Montenegro (a fifth Basin State). As a WMO exchange standard is implemented, the Sava HIS system enables storage of water observations time series data and spatial information in a standard format and their sharing and publication via web service for further use. Sava HIS is currently collecting observed data from 310 hydrological and 220 meteorological gauges, and the number is increasing with recognition of the efficiency and benefits of the system.

When it comes to the following steps, the composition of the knowledge base for transboundary water allocation can vary depending on the allocation needs, but certain data elements are usually present (e.g. environmental requirements, water availability and water use). National monitoring systems usually gather the information used in transboundary basins. However, the key organizations harmonizing and distributing the information in the transboundary context are the joint bodies or other similar institutions; they should thus be involved in defining the information needs and can provide a framework for detailing various information and data-related issues.[368] To allow data harmonization and support water allocation, the riparian States should agree on comparable monitoring and reporting methodologies or follow international standards. UNECE provides guidelines about the monitoring and assessment of transboundary lakes,[369] groundwaters[370] and rivers.[371] The World Meteorological Organization (WMO) has developed a series of hydrometeorological guidelines and regulations.[372] In addition, for example, the World Hydrological Cycle Observing System (WHYCOS) project implemented by WMO provides international guidelines on how data

[368] UNECE, *Capacity for Water Cooperation in Eastern Europe, Caucasus and Central Asia: River Basin Commissions and Other Institutions for Transboundary Water Cooperation* (New York and Geneva, United Nations, 2009).

[369] UN/ECE Working Group on Monitoring & Assessment (WGMA), *Guidelines on Monitoring and Assessment of Transboundary and International Lakes: Part A: Strategy Document* (Helsinki, 2002); UNECE, *Guidelines on Monitoring and Assessment of Transboundary and International Lakes: Part B: Technical Guidelines* (Helsinki, Finnish Environment Institute, 2003). Both are available at https://unece.org/environment-policy/publications/guidelines-monitoring-and-assessment-transboundary-and.

[370] UN/ECE Taskforce on Monitoring & Assessment, *Guidelines on Monitoring and Assessment of Transboundary Groundwater* (Lelystad, The Netherlands, RIZA, 2000).

[371] UN/ECE Taskforce on Monitoring & Assessment, *Guidelines on Monitoring and Assessment of Transboundary Rivers: First Review of the 1996 Guidelines on Water-quality Monitoring and Assessment of Transboundary Rivers* (Lelystad, The Netherlands, Institute for Inland Water Management and Waste Water Treatment (RIZA), 2000).

[372] A compilation can be found in ECE/MP.WAT/WG.2/2019/INF.1.

could be shared.[373] WMO is also creating the infrastructure enabling easier discovery, access and exchange of data and information through the Hydrological Observing System (WHOS), a portal to facilitate access to already available online real-time and historical data.[374] Timely and effective data exchange is particularly crucial for flood management, and the application of international standards and relevant regional guidelines helps to ensure harmonization (see Case Study 35). Remote sensing is also an increasingly useful method of providing harmonized data for many parameters across borders.[375]

c. Integration of different forms of knowledge

Transboundary water resources management builds on a variety of knowledge forms, calling for active knowledge exchange between different actors, including the riparian governments, scientists and other key actors in the society.[376] The knowledge base for transboundary water allocation ideally builds on the joint monitoring and assessment systems as described above. The system design and data gathered are best built on various forms of knowledge available about the characteristics of the water resources and management issues, including best available scientific knowledge, but also relevant local and Indigenous knowledge. Local and Indigenous knowledge on water can provide invaluable inputs to both science and policy processes through the powers of observation of long periods and the recall of knowledge passed down from generation to generation. Besides knowledge on water resources, Indigenous approaches to water allocation and conflict management may also provide useful methods to international negotiation settings.[377] For further details on public and Indigenous participation in transboundary water allocation, see Chapter V, subsections 4a and 5c.

Bringing such different sources and even contradictory forms of knowledge together is not easy, especially in a transboundary allocation context. It therefore requires well-structured facilitation. Key conditions for effective science-policy interaction in transboundary water governance include:

- recognizing that science is a crucial but bounded input into water resource decision-making processes;
- establishing conditions for collaboration and shared commitment among actors;
- understanding the role that social learning between scientists, policymakers and non-State actors can have to address complex water issues;
- accepting that the collaborative production of knowledge about hydrological issues and associated socioeconomic changes and institutional responses is essential to build legitimate decision-making processes; and
- engaging boundary organizations and informal networks of scientists, policymakers, and civil society when appropriate.[378]

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[373] WMO, *WHYCOS Guidelines for Development, Implementation and Governance*. Hydrological Information Systems for Integrated Water Resources Management (Geneva, 2005).
[374] For further information, see https://hydrohub.wmo.int/en/whos.
[375] Water Global Practice, *New Avenues for Remote Sensing Applications for Water Management: A Range of Applications and the Lessons Learned from Implementation* (Washington, D.C., World Bank, 2019); J. Sheffield and others, "Satellite remote sensing for water resources management: potential for supporting sustainable development in data-poor regions", *Water Resources Research*, vol. 54, No. 12 (December 2018), p. 9724–9758; UNESCO, "Application of satellite remote sensing to support water resources management in Africa: results from the TIGER initiative", IHP-VII Technical Documents in Hydrology, No. 85 (Paris, 2020).
[376] Anthony R. Turton and others, eds., *Governance as a Trialogue: Government-Society-Science in Transition* (Berlin, Springer, 2007).
[377] Aaron T. Wolf, "Indigenous approaches to water conflict negotiations and implications for international waters", *International Negotiation: A Journal of Theory and Practice*, vol. 5, No. 2 (2000), p. 357–373.
[378] Derek Armitage and others, "Science–policy processes for transboundary water governance", *Ambio: A Journal of Environment and Society*, vol. 44 (2015), p. 353–366.

The Shared Vision Model of the International Joint Commission (IJC) between the United States and Canada exemplifies bringing together different forms of knowledge for water allocation decision-making. It involves key water managers, knowledgeable scientists and leaders and key stakeholders in each country to create a system model that connects science, public preferences and decision-making criteria in a transparent manner (see Case Study 38).

d. Scenarios and transboundary water allocation

Scenarios help planners and decision-makers understand how the future may unfold and what kinds of changes and uncertainties affect it. Scenarios are not forecasts or predictions; rather, they are a set of images or stories about possible futures. Scenarios should be coherent, internally consistent and plausible descriptions of the future state of the world, and—in the context of transboundary waters—they should preferably be jointly developed by all riparian States. Climate change scenarios[379] are among the most important scenarios for planning transboundary water allocation (see Chapter III, subsection 2c). Yet other types of scenarios may also play a central role in allocation development, including scenarios about water demand, economic development or demography.[380]

Several different scenario approaches have been used in transboundary water contexts to date.[381] They typically exemplify two types: exploratory or anticipatory.[382] Exploratory scenarios view the future based on known processes of change as well as extrapolations from the past, building on trend analyses (see Figure 14). This makes exploratory scenarios relatively easy to use but less sensitive to potential major transitions. Anticipatory scenarios, on the other hand, build on different visions for the future, establishing first the desired future state and then recognizing the steps that are needed to reach it from the present situation. Anticipatory scenarios are therefore often more strategic but also subjective, making them particularly suitable for broader policymaking and shared visioning. Overall, negotiations can benefit from an assessment of present and future water needs in the riparian States, including a detailed diagnosis of potential water allocation scenarios.

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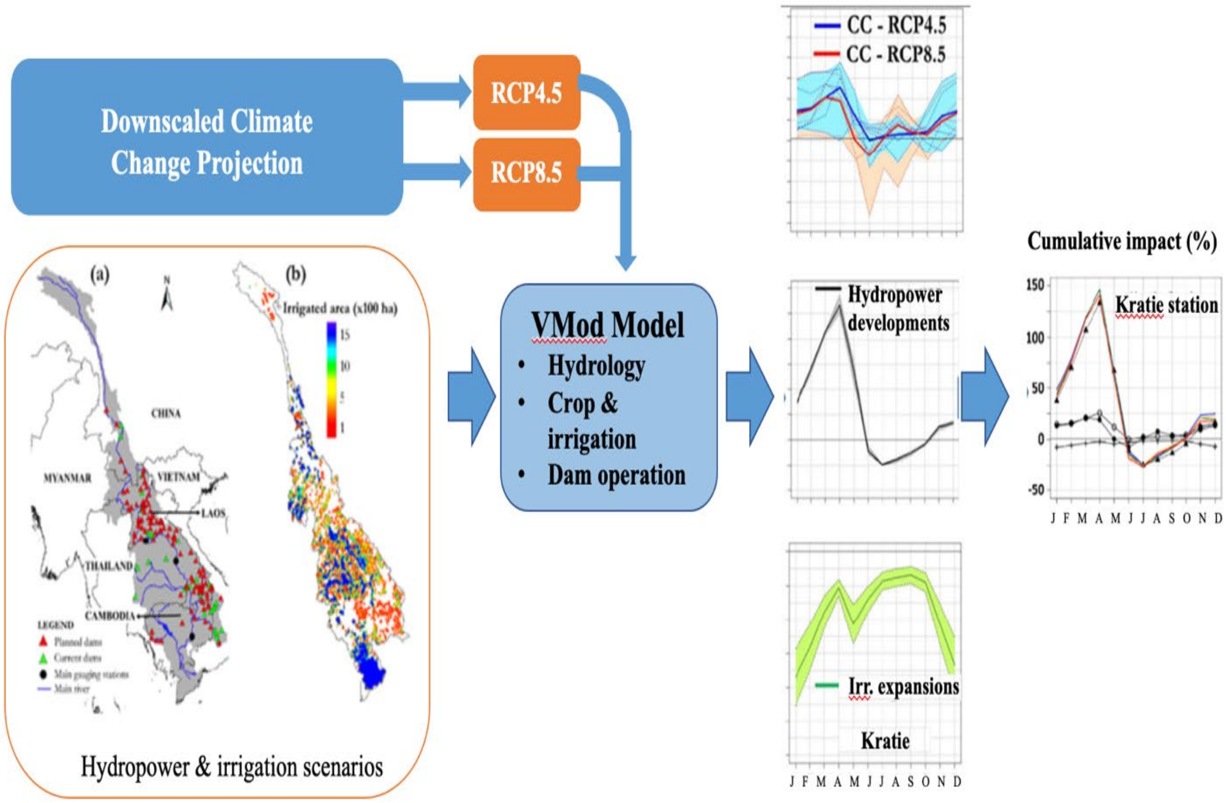
[379] Intergovernmental Panel on Climate Change (IPCC), "Global warming of 1.5ºC: an IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty", Valérie Masson-Delmotte and others, eds. (n.p., 2019).
[380] UNECE, *Guidance on Water and Adaptation to Climate Change* (2009).
[381] See, for example, F. Farinosi and others, "An innovative approach to the assessment of hydro-political risk: a spatially explicit, data driven indicator of hydro-political issues", *Global Environmental Change*, vol. 52 (September 2018), p. 286–313; Angela Gorgoglione and others, "A new scenario-based framework for conflict resolution in water allocation in transboundary watersheds", *Water*, vol. 11, No. 6 (2019), 1174; Marko Keskinen and others, "Using scenarios for information integration and science-policy facilitation: case from the Tonle Sap Lake, Cambodia", in *Sustainable Futures in a Changing Climate: Proceedings of the Conference "Sustainable Futures in a Changing Climate", 11−12 June 2014, Helsinki, Finland*, Aino Hattaka and Jahmo Vehmas, eds. (Turku, Finland Futures Research Centre, 2015), p. 282–292; David Phillips and others, "Trans-boundary water cooperation as a tool for conflict prevention and for broader benefit-sharing", Global Development Studies, No. 4 (Stockholm, Ministry for Foreign Affairs, 2006).
[382] Mohammed Mahmoud and others, "A formal framework for scenario development in support of environmental decision-making", *Environmental Modelling & Software*, vol. 24, No. 7 (July 2009), p. 798–808.

Figure 14
Example of climate change, irrigation and hydropower modelling in the Mekong as part of a scenario process



Source: Long P. Loang and others, "The Mekong's future flows under multiple drivers: how climate change, hydropower developments and irrigation expansions drive hydrological changes", *Science of The Total Environment*, vol. 649 (February 2019), p. 601–609.

e. Assessing available water resources

Assessing the quantity, quality and regime of available water resources for allocation

The riparian States and parties to a shared waterbody need a common understanding of the quantity, quality and regime of the available water resources for the purposes of allocation. Detailed guidelines about the monitoring and assessment of transboundary lakes,[383] groundwaters[384] and rivers[385] have been developed by UNECE. However, generally, the available water resources can be assessed with the following three main steps (as also presented in Chapter III):

1. **Delineating and agreeing on the basin and/or aquifer boundaries**, considering the biophysical and hydrological characteristics and administrative boundaries

[383] UN/ECE Working Group on Monitoring & Assessment (WGMA), *Guidelines on Monitoring and Assessment of Transboundary and International Lakes: Part A: Strategy Document* (2002); UNECE, *Guidelines on Monitoring and Assessment of Transboundary and International Lakes: Part B: Technical Guidelines* (2003).

[384] UN/ECE Taskforce on Monitoring & Assessment, *Guidelines on Monitoring and Assessment of Transboundary Groundwater* (2000).

[385] UN/ECE Taskforce on Monitoring & Assessment, *Guidelines on Monitoring and Assessment of Transboundary Rivers: First Review* (2000).

Topographic data are essential for determining the surface drainage area and its boundaries, as well as in understanding the direction of flow. It is useful to build a complete and harmonized GIS base map of the shared waterbody. Satellite data may be further used for defining the basin characteristics. If appropriate, additional layers of data (e.g. Lidar data) may be added to define floodway, floodplain and other relevant watercourse or aquifer information. For characterization of transboundary aquifer systems, including the boundaries, information about the geology and hydrogeology is necessary. While this can entail dealing with significant challenges and uncertainties, there is continuous progress in terms of mapping transboundary aquifers, from local to global levels, which can ultimately assist the data baselines for allocation.[386]

2. **Assessing the surface and groundwater availability and quality, taking into account inter- and intraannual variability, with hydrological and geohydrological analyses utilizing commensurate methods and data**

For water resources assessment, that is, the determination of the sources, extent, dependability and quality of water resources for their utilization and control, the World Meteorological Organization (WMO) provides helpful technical material.[387] Frequent or continuous water level and river discharge measurements lay the foundation for river basin management and water resources assessments.[388] Long-term, time series observations from stream gauges and piezometer levels can provide a sound basis for assessing variability and change in the interconnected surface water and groundwater resources over time. Water quality and sediment quality assessments and surveys give insight into the functioning of the aquatic ecosystem, and the point and non-point pollution sources and toxicity of pollutants in water bodies, which might affect the quality of the water available for allocation.

There are several universally applicable parameters for water quality. The indicators for SDG target 6.3.2 on the quality of inland waters include core physico-chemical water-quality parameters of dissolved oxygen, electrical conductivity, total oxidized nitrogen, nitrate, orthophosphate and pH, with their associated target values. SDG indicator 6.3.2 is also directly linked to indicator 6.3.1 on wastewater treatment and to target 6.1 on access to safe drinking water and target 6.6 on water-related ecosystems.[389] Other key parameters of water quality include, among others, physical characteristics of water system, salinity and other mineral composition, suspended solids and presence of specific pollutants, preferably reflecting the influence of anthropogenic pressures and impacts.[390] A water quality classification system for waters is provided, for example, by the European Union Water Framework Directive (2000/60/EC). European surface waters are classified based on their ecological status to five classes, from low to high quality, and groundwater by their quantitative status. In addition, both surface and groundwaters are classified by their chemical status.

Remote sensing is an increasingly applicable means by which to gather near real-time data on certain aspects of water resources and their quality. It can complement costly in-situ measurements. Advances in cloud storage and computing, connectivity and cheaper satellites make this data source increasingly competitive.[391]

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386 IGRAC, "Transboundary aquifers of the world map", 2015.

387 WMO, "Technical material for water resources assessment", Technical Report Series, No. 2 (Geneva, 2012); WMO, "Guide to hydrological practice: volume I: hydrology – from measurement to hydrological information", WMO No. 168 (Geneva, 2020); WMO, "Manual on stream gauging: volume II: computation of discharge", WMO No. 1044 (Geneva, 2010).

388 UN/ECE Taskforce on Monitoring & Assessment, *Guidelines on Monitoring and Assessment of Transboundary Rivers: First Review* (2000).

389 UNEP, *Progress on Ambient Water Quality: Piloting the Monitoring Methodology and Initial Findings for SDG Indicator 6.3.2* (n.p., 2018).

390 UNEP (2016).

391 Water Global Practice (2019). See also, generally, EU Copernicus Programme (www.copernicus.eu/en), particularly the European Drought Observatory (www.copernicus.eu/en/european-drought-observatory) and the Copernicus Climate Change Service (https://climate.copernicus.eu/).

When assessing the available volume of water, existing and potential augmentation of water resources is important to incorporate into the overall estimates. The augmentation can be achieved by, for example, desalination, reuse of water or managed aquifer recharge to augment groundwater resources. Such options entail trade-offs, which need to be carefully assessed. For example, recharging an aquifer from a surface watercourse reduces flow in that watercourse. Consequences of unintended allocation are equally important to consider: besides the formal processes of allocation, water shares, even large volumes, may also be gained via indirect action or inaction, for example, as a result of land use changes.[392] The role of timing has been underexplored and underutilized in most water allocation plans and arrangements to date. However, available water resources are not fixed in time, but vary inter-annually and seasonally. Understanding of flow regimes, inter-annual and seasonal variability and exceptional situations, i.e. floods and droughts, is therefore important to take into account in water resources assessments. Failures in understanding or allocating water for inter-annual variability often cause basin water management disagreements (see also Chapter III, section 2).[393]

3. **Estimating allocable water in different seasons and in different scenarios**, based on the previous steps

Relevant trend analysis may be calculated for both water quality and flow data as well as relevant statistical parameters (averages, medium, percentiles, etc). The historical flow data can be utilized to extend the period of record and climate change as projections allow.

Addressing diverging understandings
Common definitions, as well as exchanging data available, help to establish a shared understanding of the situation. Establishing a joint monitoring and assessment system with representation of officials, water experts and key stakeholders from the different States, as previously described, helps ameliorate potential disagreements and diverging understandings on the status and availability of allocable water resources. If disagreements threaten cooperation on the shared waterbody, joint bodies have a key role to play in dispute resolution. For further details on dispute prevention and resolution, see Chapter VIII, section 11.

Modelling of water resources
Allocable water may be estimated based on hydrological observations as described above. However, the observations can be complemented or estimated with hydrological models, i.e. rainfall run-off models[394] and more detailed three-dimensional integrated dynamic hydrological models considering both surface water and groundwater.[395] Hydrological modelling may enable spatially or temporally more extended hydrological data compared with observations, and also estimation of the future state of water resources. Models are also used with flood forecasting and travel-time calculations regarding industrial accidents and other flow spillages.[396]

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[392] Virginia Hooper and Bruce Lankford, "Unintended water allocation: gaining share from indirect action and inaction", in *The Oxford Handbook of Water Politics and Policy*, Ken Conca and Erika Weinthal, eds. (Oxford, Oxford University Press, 2018).
[393] Speed and others (2013).
[394] Ibid.
[395] Stefan Kollet and others, "The integrated hydrologic model intercomparison project, IH-MIP2: a second set of benchmark results to diagnose integrated hydrology and feedbacks", *Water Resources Research*, vol. 53, No. 1 (January 2017), p. 867–890.
[396] UN/ECE Taskforce on Monitoring & Assessment, *Guidelines on Monitoring and Assessment of Transboundary Rivers: First Review* (2000).

Hydrological models can be classified as empirical models, conceptual models and physically based models. The models need several inputs, the two most important being rainfall data and drainage area.[397] Usually, hydrological data is needed for calibration, and poor or lacking observations set restrictions on the model choice and usefulness of the models. The models can incorporate different scenarios and are a vital part of impact assessments and decision support systems (DSS), as described later in this chapter. Models do, however, have uncertainties and these should be always presented with the result. A basic understanding of the model being used helps understanding and coping with particular uncertainty. Global hydrological models can also help assess water resources and water use scenarios. The Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) provides climate-impact simulations, based on scientifically and politically relevant historical and future scenarios. Climate change impact assessments should always be based on several models and climate forcing data, which ISIMIP can provide.[398]

Understanding long-term trends
Monitoring programmes should aim to be long term, even when the issue at hand might not require it. Long-term time series data points are essential when trying to detect possible long-term trends in water levels, discharges and pollutant concentrations. All significant trends should be taken into consideration when agreeing on the water allocations. Models also require long-term data series for calibration. Climate change impacts are also more evident and more accurate to predict with long-term time series. The riparian countries or joint bodies may develop common scenarios and models to have a joint understanding of the effects of climate change on the shared basin, as also discussed in section 1.4 above. WMO provides a tool (Dynamic Water Resources Assessment Tool) for water resources managers and policymakers to assist with long-term planning and water resources assessment. The tool helps, for example, to assess land use changes and the impacts on water availability with different scenarios, including climate change.[399]

2. Assessing Environmental Requirements

a. Understanding water-related ecosystems and their contribution to livelihoods, development and economy

Sustainable water allocation should be based on knowledge about the river basin and aquifer flows and their interconnections to sustain ecosystem health. Environmental flow assessments are needed to build the scientific evidence for the choice of flow regimes required to meet ecological objectives. Flow assessments should evaluate how ecology, economic costs and benefits across sectors and social equity respond to alternative flow scenarios. They should include assessment of the contribution of biodiversity and ecosystem goods and services to livelihoods and poverty reduction.[400] As presented in Chapter III, section 3, a widely accepted definition of environmental flows comes from The Brisbane Declaration and Global Action Agenda on Environmental Flows (2018), which defines environmental flows as "[t]he quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems."[401]

[397] K. Devi Gayathri, B. P. Ganasri and G. S. Dwarakish, "A review on hydrological models", paper presented at the International Conference on Water Resources, Coastal and Ocean Engineering (ICWRCOE 2015), *Aquatic Procedia*, vol. 4 (2015), p. 1001–1007.
[398] ISIMIP, "The Inter-Sectoral Impact Model Intercomparison Project" (n.d.).
[399] WMO, "Dynamic Water Resources Assessment Tool" (2021).
[400] Speed and others (2013).
[401] Arthington and others (2018).

b. Different approaches to assessing environmental flows

There are more than 200 methods that have been applied in assessing environmental flows to date.[402] The simplest hydrology-based methodology (setting minimum flow levels) can be complemented with variability needs (flows mimicking seasonal natural flow variability) or, in the most holistic approaches, the aim is to take care of all aspects, including social and developmental. Properly implemented, environmental flows can help sustain and generate livelihoods, create economic value, preserve rivers, share benefits of basin development more equitably, and generally contribute to the sustainable management of rivers.[403] Existing methods differ in input information requirements, types of ecosystems they are designed for, time needed for their application and the level of confidence in the final estimates. No single environmental flow assessment technique suits all social, economic, hydrological and ecological contexts within a country. A comparison of different environmental flow (e-flow) assessment methods is presented in Table 9.

Table 9
Comparison of the three general categories of e-flows estimation methodologies

Methodology category	General purpose	Scale	Duration of assessment (months)	Relative costs	Relative frequency of use
Hydrological	Examination of historic flow data to find flow levels that naturally occur in a river and can be considered “safe” thresholds for flow abstraction	Whole rivers, applicable for regional assessments	1-6	€	+++
Hydraulic-Habitat	Examination of change in the amount of physical habitat for a selected set of target species or communities as a function of discharge	Applied at a study site / river segment scale, upscaling to whole river basin based on the assumption of “representative” site conditions	6-18	€€	++
Holistic	Examination of flows in an expert opinion workshop leading to recommendation of flows for all components of the river ecosystem, including societal and recreational uses	Whole rivers, applicable for regional or river specific scales	12-36	€€ - €€€	+ (increasing)

Source: European Union, “Ecological flows in the implementation of the Water Framework Directive”, CIS Guidance document No. 31, Technical Report, No. 2015 - 086 (Luxembourg, Office for Official Publications of the European

[402] See, for example, WMO, “Guidance on environmental flows: integrating e-flow science with fluvial geomorphology to maintain ecosystem services”, WMO No. 1235 (Geneva, 2019).
[403] Dharmadhikary (2017).

Union, 2015), adapted from Tommi Linnansaari and others, "Review of approaches and methods to assess environmental flows across Canada and internationally", Canadian Science Advisory Secretariat, Research Document, 2012/039 (n.p., Fisheries and Oceans Canada, 2012).

Note: Explanation of symbols pertaining to "relative costs" (€ = low cost; €€ = medium cost; €€€ = high cost) and "relative frequency of use" (+ = low frequency; ++ = medium frequency; +++ = high frequency).

c. Assessing and incorporating environmental flows into SDG indicator 6.4.2, including groundwater

The Food and Agriculture Organization of the United Nations (FAO) and partners provide guidance on assessing and incorporating environmental flows into SDG indicator 6.4.2 on water scarcity.[404] The guidance, accompanied by an interactive online tool,[405] helps Member States set goals for environmental flows and for reporting on required SDGs. Importantly in the context of conjunctive surface and groundwater allocation, the tool specifically assesses limits to groundwater abstraction in perennial river systems in order not to affect critical base flows for environmental flows.[406]

d. Environmental flows in a transboundary context: challenges in scope and effectiveness

Seven key challenges that can constrain the scope and effectiveness of environmental flow assessments and allocations in international river basins have been identified by Dharmadhikary (2017):

1. Stakeholder participation: In the case of international rivers, negotiations or discussions are mainly between governments and therefore can prevent or eliminate the role of local communities in environmental flows assessments.
2. Deliberations have to contend with the diversity of cultures, languages and governance systems across boundaries, and need to reconcile differences in national priorities and in national situations.
3. Environmental flows objectives are a societal and therefore a political choice. They often end up being reduced to a governmental choice even in purely domestic river basins; in transboundary rivers, this risk is much higher.
4. The sharing and verification of data is more difficult, especially for riparian communities.
5. In transboundary rivers, considerations of sovereign control can create difficulty for managing the river basin as a unit, creating problems in environmental flows assessments and implementation.
6. Often, the required multilateral legal and institutional frameworks are absent, and are not easy to create and sustain.
7. Ensuring that the downstream States use environmental flows only for the environmental purposes for which they were released is a big challenge.

Notably, this view is primarily from a surface water/river perspective and does not include considerations of the role of groundwater resources. As highlighted above, there is a critical need for increased conjunctive management of transboundary surface water and groundwater resources.[407]

[404] Chris Dickens and others, *Incorporating Environmental Flows into "Water Stress" Indicator 6.4.2: Guidelines for a Minimum Standard Method for Global Reporting* (Rome, FAO, 2019).
[405] Available at http://eflows.iwmi.org/.
[406] The baseline assessment for this part of the work is documented in Sood and others (2017).
[407] Lautze and others (2018).

CASE STUDY 36: E-flows knowledge base and capacity-building via stakeholder engagement in the Pungwe, Buzi and Save River Basins[408]

The transboundary Pungwe, Buzi and Save River Basins are shared between Zimbabwe and Mozambique in Southern Africa. Mozambique and Zimbabwe signed the Pungwe Basin Water Sharing Agreement in 2016 to institutionalize transboundary water management in the Pungwe Basin. Draft Agreements that were in place for the Buzi and Save Basin are similar to that of the Pungwe Basin. Article 9 of the Pungwe Water Sharing Agreement concerns "Protection, Preservation and Conservation of the Environment". It includes interim environmental flow recommendations pending detailed studies. On 29 July 2019, both Governments signed the Agreement on Co-operation on the Development, Management and Sustainable Utilization of the Water Resources of the Buzi Watercourse. Cooperation in these basins is driven by water resources development and management projects that require the two countries to cooperate as stipulated in the Revised Protocol on Shared Watercourses in the Southern African Development Community (SADC), which was signed in 2000.[409]

In the absence of a bilateral institution that will be responsible for the Agreement's implementation, the International Union for Conservation of Nature (IUCN) and Waternet developed a pilot project that aimed to increase stakeholder engagement and build capacity and a knowledge base utilizing innovative communication technology methods for environmental flow recommendations. Three phases were adopted. The first phase involved developing the awareness of policymakers and water resources managers about socioeconomic and ecological benefits from, and principles of integrating environmental flows in, transboundary water resources management (November/December 2015). The second phase involved demonstrating procedures for environmental flow assessment in a selected pilot river basin (July 2016). Finally, a learning-by-doing process was implemented, facilitating and guiding stakeholders and multidisciplinary country teams to jointly develop recommendations on environmental flows (August 2017–April 2018).

In the learning-by-doing phase, first, the Revue subbasin of the Buzi River Basin was selected to pilot the capacity-building approach. This was followed by the formation of multidisciplinary country teams in Mozambique and Zimbabwe along with the identification of key stakeholders to participate throughout the process. There was country-level and transboundary stakeholder participation in river basin situation analysis (identification of river-related ecosystems services and potential effects of river flow modifications on these services). Country teams jointly selected indicators for determining biophysical and socioeconomic responses to potential river flow modifications. Each country team collected data for selected indicators, and potential flow modifications. Country teams jointly evaluated biophysical and socioeconomic responses to potential river basin developments. Finally, country teams jointly recommended environmental flows for achieving agreed desirable levels of the provision of ecosystem services. The outcome was that the country teams jointly submitted environmental flow recommendations to policymakers responsible for transboundary management of the Revue subbasin. The country teams jointly presented policy recommendations for implementation of environmental flows.

A further idea to come out of the process was the possibility of developing an interactive mobile phone/web-based application for participatory environmental flow assessment. This would involve uploading data and information-sharing by country teams in Mozambique and Zimbabwe.

The pilot project in this context was initiated by IUCN and Waternet based on an assessment of clear opportunities and favourable conditions for transboundary cooperation in implementing environmental flows by Mozambique and Zimbabwe. Most importantly, there was a long history of excellent bilateral collaboration in all the sectors between both States. There was also explicit commitment from both States to improve bilateral cooperation through implementation of transboundary water sharing agreements, and specifically to determine and implement environmental flow provisions of the bilateral agreements. Additional favourable conditions for cooperation and strong stakeholder engagement involved the States' demand for developing capacity for planning and managing environmental flows and a shared commitment to stakeholder participation in IWRM.

[408] Dominic Mazvimavi, "Working with stakeholders linking environmental flows to transboundary governance in the Pungwe, Buzi & Save River basins", presented at the Global Workshop on Water Allocation, Geneva, 16 October 2017.
[409] Smart Water Magazine, "Mozambique and Zimbabwe sign agreement to enhance water cooperation in the Buzi Watercourse", 12 September 2019.

3. Assessing Uses and Needs

a. Determining sectoral water uses and needs

Changes in different water uses and needs are usually the main driver for water allocation and reallocation. Water uses are typically divided into domestic, agricultural and industrial, and water used for energy production, hydropower generation having the most central role in altering and regulating transboundary flows. Assessments of water requirements for environmental flows are discussed in detail in section 2 above. In addition, in-steam water uses like navigation can set boundary conditions for water abstraction and altering flows (see Chapter III, section 2).

Besides the quantity of water needed for different uses, its quality and timing of use or release are important to consider. Quality is especially critical for domestic and certain industrial uses that typically require purification before abstraction, whereby purification costs rise with decreasing quality of the source water. In addition to alterations in flows, ecosystems are sensitive to alterations in nutrients, sedimentation and pollutant concentrations (see Chapter III, subsection 4c). When it comes to timing, irrigation needs vary considerably between seasons, and ecosystems may be especially sensitive to flow alterations from hydropower at certain times of the year, for example.

An additional factor to consider when determining water needs and allocations is the possibilities for improved efficiency and productivity in different sectors and for different water uses. Especially in water-scarce contexts, allocations in a national context should be informed by the relative efficiency of different water uses, which in turn has ramifications for transboundary allocation.[410] Ultimately, as water resources available for allocation are becoming increasingly limited, balancing different water uses and needs and clarifying their priority is one of the key tasks in the allocation process. Different approaches and mechanisms are discussed in detail in Chapter II, section 3, Chapter III, and Chapter VI, section 3.

b. Methods for water use assessments

There are a few general approaches on how to assess water use: [411]

- **Monitored observed use**, which is usually reliable for large urban, industrial or irrigation schemes. Mass balance modelling can also be utilized.
- **Registered authorized use**, based on records via licensing, permitting or billing.
- **Estimation**, via proxies like irrigated area or number of households.

Water footprint assessments provide one option for the assessment of sectoral, basin-level or national water use.[412] Return flow estimation is especially important in a transboundary context, when assessing how much water is allocable downstream. Return flows can be assessed with the same approaches as water use in general. The starting point for the assessment of water uses and needs is usually national data collection and management systems. They typically suffer from inconsistencies and gaps, however, making transboundary data-sharing also challenging. Data on groundwater use is especially limited. In the absence of complete data sets, FAO Aquastat[413] and global hydrological models[414] can help with making initial estimates, and

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[410] Speed and others (2013).
[411] Ibid.
[412] Arjen Y. Hoekstra and others, *The Water Footprint Assessment Manual: Setting the Global Standard* (London, Earthscan, 2011); Arjen Y. Hoekstra and Mesfin M. Mekonnen, "The water footprint of humanity", *Proceedings of the National Academy of Sciences*, vol. 109, No. 9 (February 2012), p. 3232–3237.
[413] FAO, Aquastat.
[414] ISIMIP, "The Inter-Sectoral Impact Model Intercomparison Project".

developing harmonized water-use assessment systems is important to prioritize in the transboundary cooperation. In addition to existing water uses and needs, it is important to also assess potential and future needs. Historical time series data sets can help to estimate future uses, but the analyses should be then set into the overall context of the regional development, taking into account socioeconomic, environmental and climatic factors, as described in Chapter III and subsections 1 and 2 above.

c. Sharing information on sectoral water uses

Common approaches between and among riparian countries on sharing information on sectoral water uses are essential for determining equitable and reasonable water allocation, as well as avoiding significant harm, and help in identifying possibilities for water-food-energy-ecosystem nexus solutions[415] and benefit-sharing[416] (see also Chapter IV). Joint nexus assessments help to deal with the complexities of analysing several interconnected sectors with their associated stakeholders. The Transboundary Nexus Assessment Methodology (TBNA) developed by UNECE enables stakeholders to identify positive and negative linkages, benefits and trade-offs between/among relevant sectors in different climatic and socioeconomic scenarios (see Chapter IV, subsection 2c). The nexus linkages are first identified and mapped qualitatively in a participatory process involving experts and officials. Then the linkages that have been deemed "high priority" are quantified, utilizing available data and tools, including modelling. The nexus methodology further assists in identifying means for coherent integration of sectors and their needs.[417]

4. Assessing Transboundary Impacts

a. How to assess transboundary impacts of water allocation

Impact assessment is an essential part of the planning and decision-making processes related to any large projects, programmes or other initiatives, including those for or affecting transboundary water allocation. The aim of an impact assessment is to identify and evaluate the likely key effects (i.e. impacts) that the planned initiative is likely to have, along with the possible measures to prevent, reduce, mitigate and control adverse effects and to enhance positive effects. To do so, an impact assessment typically considers a set of alternative options for the planned initiative. To ensure its effectiveness, the assessment should also be carried out at an early stage of planning. Several tools exist for impact assessment, each with differing thematic and/or methodological emphasis. The most widely used tools are environmental impact assessment (EIA) and strategic environmental assessment (SEA). While both tools focus on the environment, their present-day use may also consider related societal impacts (e.g. health, economic, social, cultural and gender). Similarly, EIA and SEA may be complemented by other relevant impact assessment approaches, including those capturing also the broader impacts of the planned initiatives (e.g. social impact assessment or cultural impact assessment[418]), as well as approaches with a specific focus, for example on water (e.g. hydrological impact assessment, cumulative impact assessment). Furthermore, assessment of benefits provides an important alternative angle for identifying synergies in transboundary contexts (for further details, see Chapter IV).

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[415] UNECE, *Reconciling Resource Uses in Transboundary Basins* (2015).
[416] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water* Cooperation (2015).
[417] UNECE, *Methodology for Assessing the Water-Food-Energy-Ecosystems Nexus* (2018).
[418] Adriana Partal and Kim Dunphy, "Cultural impact assessment: a systematic literature review of current methods and practice around the world", *Impact Assessment and Project Appraisal*, vol. 34, No. 1 (2016), p. 1–13.

CASE STUDY 37: Assessments of cumulative transboundary impacts in the Lower Mekong River Basin

The Mekong River Commission (MRC) considered the development of water infrastructure, especially large-scale hydropower and irrigation, on the transboundary Mekong River mainstream as one of the most important strategic issues facing the Lower Mekong River Basin. As a result, the MRC Member States (Cambodia, Laos, Thailand and Viet Nam) commissioned a strategic environmental assessment (SEA) of planned mainstream dams to assist them in working together and to make the best decisions for the Basin. The SEA began in May 2009 and was completed 16 months later. The SEA complemented the 2010 MRC Basin Development Programme's Scenario Assessment of the countries' planned projects in hydropower and irrigation. The strategic decision at the time concerned whether and how best to construct hydropower dams across the Mekong River—a development that would have far-reaching economic, social and environmental implications, both positive and potentially adverse.

Twelve hydropower schemes had been proposed on the lower reaches of the Mekong mainstream. The SEA sought to identify the potential opportunities and risks, as well as the contribution of these proposed projects to regional development and the most appropriate mainstream Mekong hydropower development strategies. In particular, the SEA focused on regional distribution of costs and benefits with respect to economic development, social equity and environmental protection. The SEA, as well as the Basin Development Programme Assessment, provides the scientific basis for countries' discussion on benefits and trade-offs of planned developments, and contributed to the preparation of, and agreement on, the Basin Development Strategy for Mekong River Basin for 2016–2020.

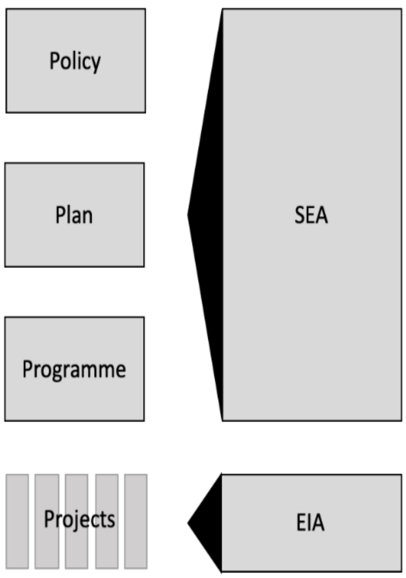
To close more knowledge gaps and include more planned water and related development sectors, the MRC released the Study on the Sustainable Management and Development of the Mekong (the Council Study) in 2017. The findings from the Council Study have been used by countries in debating the impacts of planned projects on water level, flows and quality, including fisheries and sediment, during the prior consultation process for mainstream dams. The strengthened knowledge of the MRC contributed to the preparation of, and agreement on, the latest Basin Development Strategy 2021–2030, which calls for more proactive regional planning to come up with new joint and basin-wide investment projects with multiple benefits, including flood management, drought relief, energy, navigation and environmental protection.

While EIA focuses on the environmental impacts of a single project, typically maintaining a rather technical focus, SEA addresses wider aspects of development, focusing on a broader set of environmental impacts of plans, programmes, policies and legislation covering a set of related projects (Figure 15). EIA is therefore particularly strong for detailed discussion on a clearly defined project(s), while SEA facilitates discussion about cumulative impacts and broader, more fundamental issues, such as what kinds of projects (and where) would best achieve the desired development with minimal adverse effects.[419] Although SEA can be considered a more appropriate tool in the context of general water allocation negotiations within a river basin, at best, any development with likely significant adverse transboundary impact makes use of both tools, with SEA focusing on broader aspects of development and EIA then providing a more detailed view on the impacts of the projects that are identified, based on the SEA process. In this context, future plans/programmes, as well as planned projects with likely significant adverse transboundary impacts, should be shared with the affected countries as soon as reasonably possible in accordance with the principles of prior notification and consultation.

As a general recommendation in transboundary contexts, it is important to define the methods and scale of the assessments together with the different parties, taking into account five key dimensions relevant for carrying out the assessment: geographic scope; sectoral mandate; level of integration; likelihood of compliance; and capacity to implement.[420]

[419] UNECE, *Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context* (New York and Geneva, United Nations, 2017).
[420] Christina Leb and others, *Promoting Development in Shared River Basins: Tools for Enhancing Transboundary Basin Management* (Washington, D.C., World Bank, 2018).

Figure 15
Simplified visualization of the main emphasis for environmental impact assessment (EIA) and strategic environmental assessment (SEA) (left) and their key characteristics (right)



SEA	EIA
The perspective is strategic and long term	The perspective is on the execution and in the short/medium term
The process is cyclical and continuous	The process is discrete, motivated by concrete intervention proposals
The aim is to help build a desirable, jointly agreed plan for future developments	The project to be assessed has to be known and described at a relatively detailed level
There is a large amount of uncertainty and the data is typically scarce and of varying quantity	The focus is relatively clear, and data typically rather well available or can be collected
Follow-up performed through the development of policies, plans, programmes and projects	Follow-up performed through the implementation of the selected option for a project
Putting the strategy into practice depends on the implementation of more detailed plans	Projects requiring an EIA are executed (or not), once their environmental feasibility is guaranteed

Source: Marko Keskinen and Matti Kummu, *Impact Assessment in the Mekong: Review of Strategic Environmental Assessment (SEA) and Cumulative Impact Assessment (CIA)* (Aalto, Finland, Aalto University, Water and Development Research Group, 2010) (modified).

b. Legal requirements regarding transboundary impacts of allocation

International law has several different frameworks with related substantive and procedural requirements for EIA, SEA and the prevention, reduction and mitigation of transboundary impacts that may be applicable to water allocation, depending on the context. According to the Water Convention, States need to ensure that EIA and other means of assessment are applied to prevent, control and reduce transboundary impact (Art. 3.1h).[421] For this purpose, one of the tasks of joint bodies is to participate in the implementation of an EIA relating to transboundary waters (Art. 9.2j). States must also carry out joint or coordinated assessments of the conditions of transboundary waters and the effectiveness of measures taken for the prevention, control and reduction of transboundary impact (Art. 11.3). A joint exercise at the regional level resulted in the Second Assessment of Transboundary Rivers, Lakes and Groundwaters.[422] In the Watercourses Convention, EIA is linked to notification concerning planned measures with possible adverse effects upon other riparian States. Accordingly, such notification must be accompanied by available technical data and information, including the results of any EIA (Art. 12).[423] The Draft Articles on the Law of Transboundary Aquifers include a similar provision in relation to transboundary aquifers or aquifer systems (Art. 15.2).

Transboundary EIAs and SEAs can be relatively complex processes, as the riparian States may have differing institutional settings and differing views regarding the process. In addition to the United Nations global water conventions, the UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) requires transboundary EIA and provides step-by-step procedural requirements,

421 See UNECE, *Guide to Implementing the Water Convention* (2013), p. 53–55.
422 UNECE, *Second Assessment of Transboundary Rivers, Lakes and Groundwaters* (2011).
423 See Rieu-Clarke, Moynihan and Magsig (2012), p. 142.

including for early notification, preparation of EIA documentation, consultations with authorities, public participation and taking into account their result in the final decision regarding the planned activity.[424] Accordingly, a State under whose jurisdiction a proposed activity is envisaged to take place must ensure that a transboundary EIA is undertaken prior to a decision to authorize or undertake a proposed activity listed in Appendix I that is likely to cause a significant adverse transboundary impact (Art. 2.3). Moreover, the International Court of Justice stated in *Pulp Mills on the River Uruguay (Argentina vs. Uruguay)* (Judgment of 20 April 2010) that EIA "may be considered a requirement under general international law". In this regard, States need to undertake EIA "where there is a risk that the proposed industrial activity may have a significant adverse impact in a transboundary context, in particular, on a shared resource". Furthermore, the Court observed that "due diligence, and the duty of vigilance and prevention which it implies, would not be considered to have been exercised, if a party planning works liable to affect the regime of the river or the quality of its waters did not undertake EIA on the potential effects of such works" (para. 204).[425]

Appendix I of the Espoo Convention covers the following projects that can be relevant to transboundary water allocation:

- large dams and reservoirs;
- groundwater abstraction activities or artificial groundwater recharge schemes (annual volume of water 10 million m^3 or more);
- transfer of water resources between river basins (over 100 million m^3/year if the transfer aims at preventing water shortages; or over 5 per cent of the 2,000 million m^3/year flow); and
- wastewater treatment plants (capacity exceeding 150,000 population equivalent).

Accordingly, a party of origin should notify potentially affected parties if a significant adverse transboundary impact from those activities is "likely" or cannot be excluded.[426] Ultimately, a transboundary EIA is only undertaken if an affected party responds positively to the notification.

According to the Espoo Convention, EIA shall, as a minimum requirement, be undertaken at the project level. In addition, States must endeavour to apply the principles of EIA to policies, plans and programmes (Art. 2.7). However, the Protocol on Strategic Environmental Assessment specifically requires that States must ensure that SEA at a national level is carried out for certain plans and programmes, including water management plans and programmes, that set the framework for future development consent for projects that require EIA (Art. 4.2) and are likely to have significant environmental, including health, effects. Annex I and II of the Protocol specifically list the water-related projects that might be covered by plans/programmes, some of which are directly relevant to water allocation in a transboundary context, including, among others:

- large dams and reservoirs (Annex I, Art. 11);
- groundwater abstraction activities in cases where the annual volume of water to be abstracted amounts to 10 million m^3 or more (Annex I, Art. 12);
- water management projects for agriculture, including irrigation and land drainage projects (Annex II, Art. 3);
- works for the transfer of water resources between river basins ((Annex II, Art. 78).[427]

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[424] UNECE, "Environmental assessment" (n.d.).
[425] See McIntyre (2011), p. 124–144.
[426] "Likely" is the terminology used in the Convention, including Appendix I, which is interpreted by the Espoo Convention's Implementation Committee to mean "cannot be excluded". See, for example, UNECE, Findings and recommendations of the Implementation Committee on compliance by the United Kingdom of Great Britain and Northern Ireland with its obligations under the Convention in respect of the Hinkley Point C nuclear power plant (ECE/MP.EIA/2019/14).
[427] For the full lists of water-related projects that might be covered by plans/programmes, refer to Annex I and II of the Protocol.

Article 10 of the Protocol provides for transboundary consultations on the plans and programmes and a related SEA report. The notification is required where a party of origin considers that the implementation of a plan or a programme is likely to have a significant transboundary effect or where the party likely to be significantly affected so requires. Similarly to the Convention, the Protocol sets requirements for carrying out an SEA, including for screening (identification of whether an SEA is required), scoping (identification of the scope of the SEA, i.e. what issues will it cover), preparation of an environmental report, public participation, and consultation with national environmental and health authorities and potentially affected parties, taking the results of SEA and all consultation into account in the final decision regarding the plan or a programmme.

In sum, transboundary water allocation may be subject to several substantive and procedural obligations related to EIA and SEA under a variety of frameworks in international law, depending on the specific context. Customary international law requires EIA when a planned activity, such as industrial works or an infrastructure project, may have a significant adverse impact in a transboundary context.[428] The United Nations global water conventions also contain certain EIA obligations for States parties and the duty to take all appropriate measures to prevent transboundary harm, which may be applicable to allocation processes and/or outcomes. Furthermore, the UNECE Espoo Convention and SEA Protocol require that assessments are extended across borders when a planned activity may cause significant adverse transboundary impacts or a plan or programme sets the framework for such an activity. Therefore, States may need to consider using EIA or SEA as tools or supporting procedures during their transboundary water allocation negotiations and planning processes. It is therefore strongly recommended to follow the guidelines that the Espoo Convention and UNECE documents provide on how best to carry them out.[429]

5. Structured Decision Support and Management Responses for Water Allocation

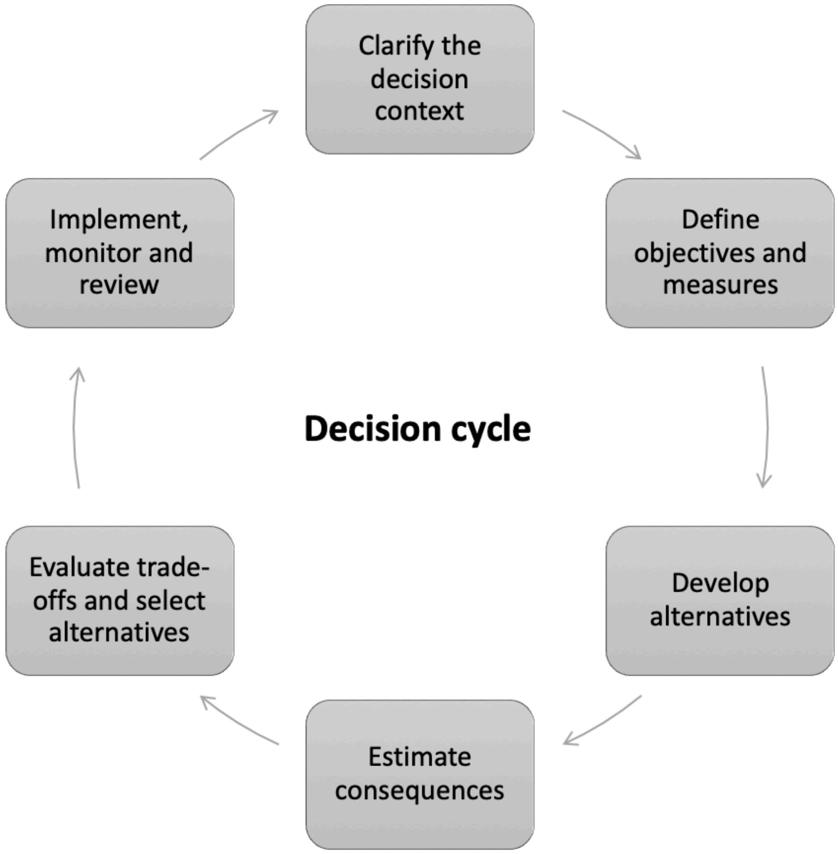
a. Knowledge base, structured decision support and decision support systems

The previous sections have introduced the key aspects needed to establish a knowledge base on water allocation for a specific transboundary context—assessment of water resources, environmental requirements, water uses and needs, and transboundary impacts. Such a knowledge base is required to make well-informed decisions regarding water resources management and related water allocation. Water allocation in a transboundary context typically concerns a variety of actors, all with differing interests and needs. Different kinds of decision-support approaches and methods can be used to make the best possible use of the variety of views, as well as the different forms of information available throughout the decision cycle and structured decision-making processes (Figure 16).[430] Two practical methods and tools that are increasingly applied for structured decision-making in a transboundary context are presented here:

- multi-criteria decision analysis (MCDA);
- decision support systems (DSS).

[428] Ibid.
[429] UNECE, "Introduction: Guidance on the practical application of the Espoo Convention" (n.d.); UNECE, *Guidance on the Practical Application of the Espoo Convention* (n.p., United Nations, 2006).
[430] Robin Gregory and others, *Structured Decision Making: A Practical Guide to Environmental Management Choices* (Chichester, United Kingdom, Wiley-Blackwell, 2012).

Figure 16
Decision cycle



Source: Robin Gregory and others, *Structured Decision Making: A Practical Guide to Environmental Management Choices* (Chichester, United Kingdom, Wiley-Blackwell, 2012).

b. Multi-criteria decision analysis in transboundary water allocation

Multi-criteria decision analysis (MCDA) is a general term for systematic approaches that support the analysis of multiple alternatives in complex problems involving different objectives, intangible and incommensurable impacts and uncertainties.[431] They are especially useful when evaluating trade-offs and selecting alternatives (Figure 17). MCDA methods aim at improving the quality of decisions by providing an overall view of the pros and cons of the different alternatives. The main phases of MCDA are: 1) identification of objectives; 2) structuring them into a form of hierarchy; 3) developing alternatives; 4) assessing their performance with regard to objectives; and 5) collecting preference information. The potential benefits of MCDA are presented in Figure 17. The MCDA process and its application are presented in Chapter VIII.

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[431] Valerie Belton and Theodor J. Stewart, *Multiple Criteria Decision Analysis: An Integrated Approach* (Dordrecht, Springer Science + Business Media, 2002).

Figure 17
Potential benefits of multi-criteria decision analysis

BENEFITS OF MCDA

- **Provides a structured framework for the planning**
- **Supports a synthesis of information and helps to identify data gaps and uncertainties**
- **Supports participants' learning and comprehensive understanding of the planning situation**
- **Supports systematic and transparent evaluation of alternatives**
- **Possibility to compare monetary and non-monetary impacts and identify trade-offs**
- **Facilitates discussion in a multi-stakeholder group**
- **Supports finding balanced and sustainable solutions**

Source: Finnish Environment Institute, 2021.

MCDA can be applied to help stakeholder involvement by collecting, structuring, integrating and analysing information from different sources. A collaborative MCDA-based process applied optimally should result in all involved parties learning from each other. Consequently, this can open up assessment and allocation processes by highlighting the diversity of opinions, conflicting interests, ignored uncertainties and new options. One of the strengths of MCDA is its ability to combine information from different sources and highlight the importance of values in decision-making. The role of facts is often overemphasized compared with that of values. Typically, the ranking of alternatives depends very much on the value placed on different criteria. An exception is a case where one alternative outperforms other alternatives with respect to all, or almost all, criteria. The number and range of MCDA applications is very large, but there are relatively few cases related to transboundary waters. Table 10 summarizes six examples of applications of MCDA in a transboundary context.

Table 10
Examples of multi-criteria decision analysis applied in transboundary water systems

Source	**Countries/water system**	**Topic**	**Methods**	**Criteria and weights**
Avarideh and others (2017)[432]	Iraq and Iran, Sirwan–Diyala River	Determining water share allocation to riparian countries	Weighted sum, pairwise comparison	32 indicators used, 3 different weight scenarios for factors (main criteria)
Dombrowsky and others (2010)[433]	Israel, Palestinian Authority, Kidron/Wadi Nar Basin	Comparison of wastewater management alternatives	Cost-benefit and multi-criteria analyses	6 selected physical-institutional management options; MCDA is not described in detail in the paper
Gorgoglione and others (2019)[434]	Brazil–Uruguay, Cuareim/Quaraí catchment	Exploring policy options in a water-sharing conflict	MCDA (PROMETHEE), scenario analysis	10 criteria covering environmental and socioeconomic aspects
Kapetas and others (2019)[435]	Greece, Republic of North Macedonia, Axios Delta	Sociotechnical evaluation of intervention options for improving water budget	DPSIR and multi-criteria analysis	3 criteria used: impact, cost, ease of implementation, 5 intervention options
Quba'a and others (2017)[436]	Israel, Jordan, Lebanon, Palestinian Authority, Syria, Turkey, Jordan River Basin	Comparative assessment of joint water development initiatives	MCDA (Simple Additive Weighting)	8 criteria, 8 weight scenarios, sensitivity analysis for criteria weight was performed

432 Faribah Avarideh, Jalal Attari and Ali Moridi, "Modelling equitable and reasonable water sharing in transboundary rivers: the case of Sirwan-Diyala River", *Water Resources Management*, vol. 31 (2017), p. 1191–1207.
433 Ines Dombrowsky and others, "How widely applicable is river basin management? An analysis of wastewater management in an arid transboundary case", *Environmental Management*, vol. 45, No. 5 (May 2010), p. 1112–1126.
434 Gorgoglione and others (2019).
435 Leon Kapetas and others, "Water allocation and governance in multi-stakeholder environments: insight from Axios Delta, Greece", *Science of The Total Environment*, vol. 695 (December 2019), 133831.
436 Rola Quba'a and others, "Comparative assessment of joint water development initiatives in the Jordan River Basin", *International Journal of River Basin Management*, vol. 15, No. 1 (2017), p. 115–131.

Srdjevic and Srdjevic (2014) [437]	Serbia, Romania, Djerdap I reservoir, Danube	Allocation of reservoir storage for main reservoir uses	Analytic Hierarchy Process	5 criteria used, 6 alternatives (main reservoir uses)

Source: Finnish Environment Institute, 2021.

c. Decision support systems

Many types of the knowledge and data described in the previous sections of this chapter can be used as inputs in a decision support system (DSS). Usually, a DSS refers to a computer-based system to support complex decision-making processes in a specific domain.[438] A DSS can combine databases, data and information management, simulation models, socioeconomic evaluation tools, decision analysis techniques, geographical information systems (GIS) and user interfaces in an informative way. A DSS in the water management sector is often tailored for a particular case and can integrate different generic components, tools, methods and existing software packages, depending on the river basin characteristics and the decision-making process at hand.

A significant benefit of a DSS is that it can facilitate communication between stakeholders and riparian countries by providing an efficient platform for sharing information and supporting discussion about potential decisions and their implications.[439] Hence, a DSS can provide greater transparency in the decision-making processes, which is a crucial component for transboundary water allocation. While a DSS can assist in decision-making, it does not replace well-trained, skilled managers and experts, and cooperative processes.[440] A DSS can be intended to be used on different time horizons. It can be used in long-range strategic planning and decision-making as well as analysing scenarios (e.g. hydro-climatic change, demand development, different policies and management plans).[441] On the other hand, a DSS can also be used for operational purposes in day-to-day allocation decisions, as well as in data- and information-sharing. Moreover, models included in a DSS represent different temporal and spatial scales and provide input to each other.[442]

To avoid an undesirable situation where an expensive system remains unused, an overall requirement is that the development of a DSS is based on a real need. A common feature of a successful DSS is that it is developed in close collaboration with end users, to ensure that it meets the requirements and to foster trust and commitment in the system.[443] If deployed as part of a transboundary water allocation framework, riparian States must therefore together acknowledge the validity of the DSS to inform the decision-making process.[444]

[437] Zorica Srdjevic and Bojan Srdjevic, "Modelling multicriteria decision making process for sharing benefits from the reservoir at Serbia-Romania border", *Water Resources Management*, vol. 28 (2014), p. 4001–4018.
[438] Carlo Giupponi, "D9.4/9.5: Using modern decision support systems for evidence based policy making in IWRM in developing countries: coordinating European Water Research for Poverty Reduction – SPLASH" (n.p., 2011).
[439] Peter C. von der Ohe and others, "Monitoring programmes, multiple stress analysis and decision support for river basin management", in *Risk-Informed Management of European River Basins*, Jos Brils and others, eds., The Handbook of Environmental Chemistry, vol. 29 (Berlin, Springer, 2014).
[440] GWP and INBO, *A Handbook for Integrated Water Resources Management in Basins* (Stockholm; Paris, 2009).
[441] Ibid.
[442] Aris P. Georgakakos, "Decision support systems for integrated water resources management with an application to the Nile Basin", in *Topics on System Analysis and Integrated Water Resources Management*, Andrea Castelletti and Rodolfo Soncini Sessa, eds. (Amsterdam, Elsevier Science, 2007), p. 99–116.
[443] Henrik Nygård and others, "Decision-support tools used in the Baltic Sea area: performance and end-user preferences", *Environmental Management*, vol. 66 (2020), p. 1024–1038.
[444] GWP, "The role of decision support systems and models in integrated river basin management", Technical Focus Paper (Stockholm, 2013).

d. Management responses for water allocation

After the knowledge base has been built and different alternatives for transboundary water allocation have been evaluated, with the potential help of tools such as MCDA and DSS, described above, the knowledge of the best options feeds forward to management and institutional-level responses. The management responses typically take their form in allocation arrangements, agreements and their national implementation, as described in detail in Chapter VIII on operationalizing transboundary allocation and elsewhere in this Handbook. As described in the decision cycle (Figure 16), management responses and their impact on the original allocation issue require continuous monitoring and evaluation. If the impact is not desired, the information needs and associated knowledge and data and the decisions should be adapted accordingly. The DPSIR framework (Figure 13) and management cycle (Figure 12) presented in this chapter help with iterating the information needs. Some impacts can be assessed through monitoring the outcomes. Some decisions linked to projects, programmes or policies, for example, can be assessed with impact evaluations.[445]

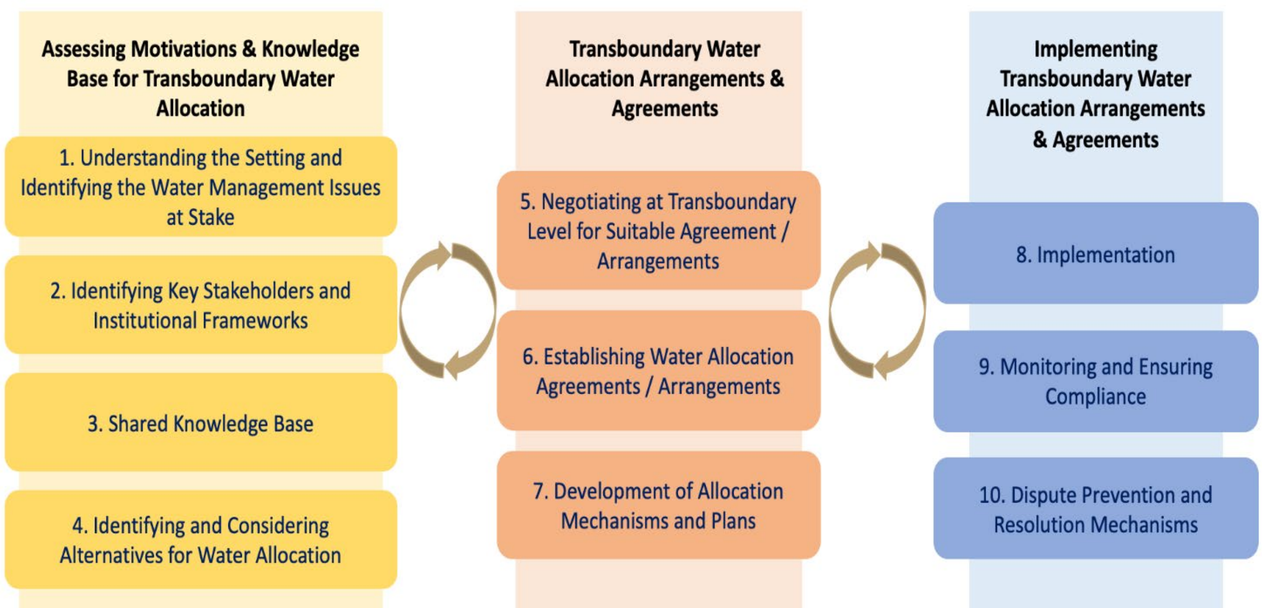
[445] Frans Leeuw and Jos Vaessen, "Impact evaluations and development: NONIE guidance on impact evaluation", NONIE No. 57490 (Washington, D.C., Network of Networks on Impact Evaluation (NONIE), 2009).

CHAPTER VIII: Operationalizing Transboundary Water Allocation: Processes, Mechanisms and Examples

SUMMARY:
This chapter outlines a set of technical, legal and institutional water allocation approaches, mechanisms and arrangements that can be adapted and applied to various transboundary contexts. A three-phase, 10-step modular process is presented that provides a variety of options for operationalizing water allocation. The chapter provides some guidance for measures to operationalize water allocation principles and objectives presented in previous chapters.

As discussed in the previous chapters, transboundary water allocation may be understood as both part of the water cooperation process and an outcome of that process. This chapter focuses on the process characteristics of allocation. It covers the different steps and elements of transboundary water resources management and governance leading to joint agreements, bodies and other mechanisms determining how much water, of what quality, where and when is shared between two or more States or other jurisdictions.

Figure 18
The 10 general steps across three phases of transboundary water allocation



Source: Finnish Environment Institute, 2021.

The chapter presents 10 steps along the transboundary water allocation process, grouped into three general phases, as illustrated in Figure 18. The first group of steps details the reasons/motivations and knowledge base required for establishing a new allocation arrangement, or revising existing arrangements, where appropriate. These steps help define whether allocation is even a solution to a given water issue, or whether the issue is better addressed with other means of transboundary cooperation or national measures. The second group tackles the foundations of transboundary negotiations for suitable arrangements or agreements, including development of allocation mechanisms and plans. The third group focuses on implementation after an arrangement or agreement has been reached, including national implementation, monitoring and ensuring compliance, and dispute prevention and resolution mechanisms. Importantly, the 10 steps are modular in that they are not always operationalized chronologically, can be non-linear in their assessment and application, and not all steps may be necessary in every context. Given the evolving nature of both water resources management and transboundary water cooperation, there may be feedback loops necessary between the steps, the steps may be prioritized differently, and/or information on some aspects may initially be missing.[446] Ultimately, this chapter seeks to provide a modular suite of options for co-riparian States to assess and adapt to their specific context in order to operationalize transboundary water allocation.

1. Phase 1: Assessing Motivations and Knowledge Base for Transboundary Water Allocation

a. Step 1: Understanding the setting and identifying the water management issues at stake

The process for transboundary water allocation might be motivated by a variety of issues and changing policy priorities and requirements (see Chapter II and Chapter III). The target water-related issues to be addressed should be carefully considered from the perspective of whether they are best addressed with allocation measures in consideration with their limitations and complementary approaches (see Chapter IV), and whether their management has transboundary impacts and interdependencies and should therefore be treated as a matter of transboundary concern and cooperation. The knowledge base required to tackle these two aspects may build on water resource and availability assessments, analyses of environmental requirements and use and impact assessments, preferably in different scenarios, as described in detail in Chapter VII and Step 3 below. The Shared Vision Model of the International Joint Commission between Canada and the United States demonstrates a participatory process helping to reach consensus on the transboundary water management issues at stake (see Case Study 38).

b. Step 2: Identifying key stakeholders and institutional frameworks

<u>*Stakeholder analysis and engagement methods*</u>

The primary actors in transboundary water allocation processes are typically the co-riparian States with their representative organizations. This may include subnational entities (see Chapter VI, subsection 5b) sharing a surface or groundwater basin. To understand the differing views and forms of knowledge linked to water allocation, it is also advisable to identify and engage other key stakeholders relevant for the process and outcome, including the general public (see Figure 19).[447]

As discussed above (Chapter V, section 4; Chapter VII, subsection 1c), public participation can bring several benefits to the allocation process, including an improved knowledge base and enhanced equity and sustainability of the arrangements. While the United Nations global water conventions do not provide a definition for the "public" to be engaged, the Aarhus Convention defines "the public concerned" as "the public affected or likely to be affected by, or having an interest in, the environmental decision-making". One way to identify the relevant stakeholders is to categorize them at different scales (e.g. regional, national and

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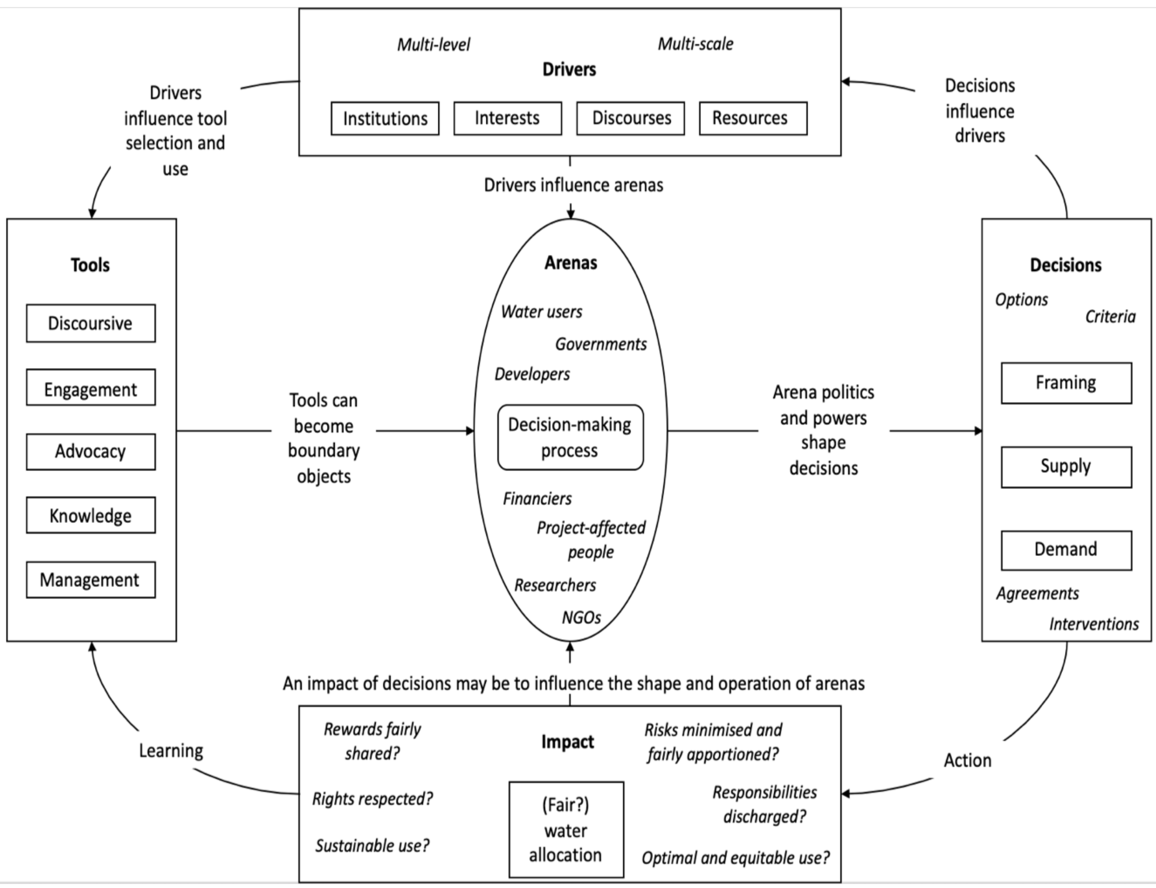
[446] See, for example, y, where it states that "The water allocation system should be flexible, and should be reviewed and adapted as the iterative nature of the process identifies requisite improvements or additions. Adjustment to the system as a result of trial and error is a legitimate feature and the legal obstacles borne out by practice and experience should be removed through a process of reform."

[447] See, for example, Marian J. Patrick, "The cycles and spirals of justice in water-allocation decision making", *Water International*, vol. 39, No. 1 (2014), p. 63–80.

local) and by relevant sectors of the society (typically, public, private, civil society and research institutes) (see also Figure 5 in Chapter II). At a regional level (i.e. transboundary basin), the key stakeholders include possible joint bodies and other regional organizations and networks. Such organizations and networks are usually public sector driven, but may also include representatives from the private sector, civil society and/or academia. At a national or State level, key stakeholders typically consist of relevant public authorities (e.g. ministries and line agencies) but may also include, for example, companies responsible for the operation of hydropower or other large-scale infrastructure. Similarly important may be the relevant civil society organizations and research institutes that have knowledge on, for example, water, energy and agriculture policies, as well as the environment.

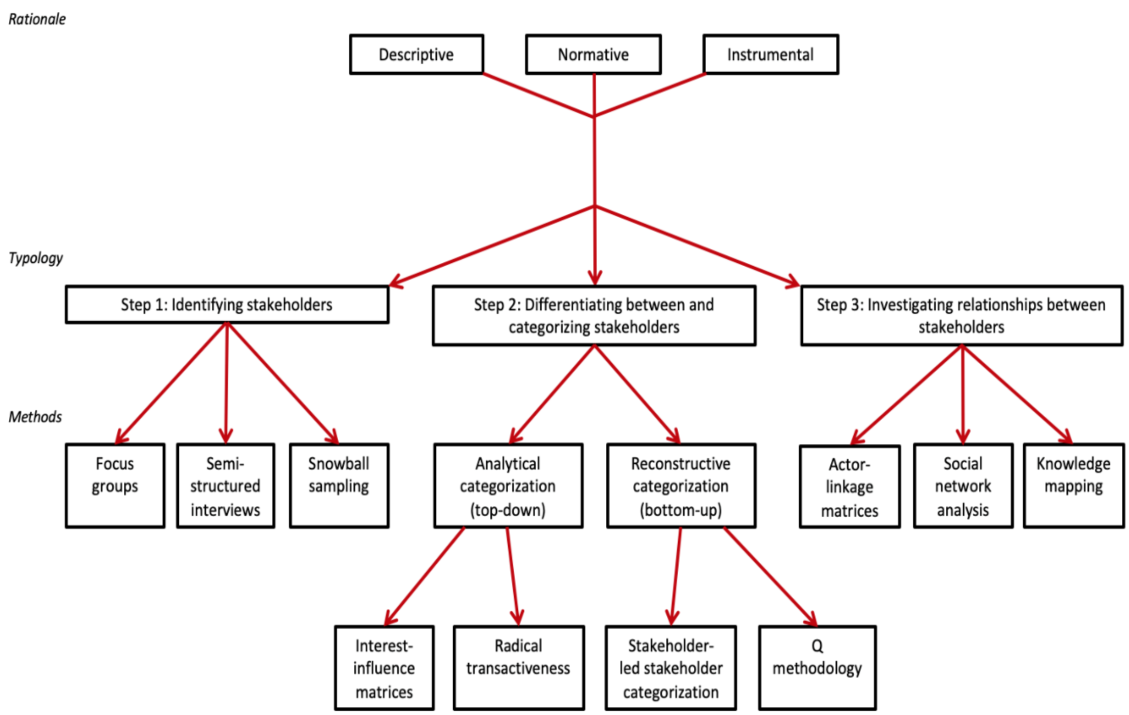
Figure 19
Conceptualizing actors and tools involved in water allocation processes



Source: "The water allocation complex: an explanatory framework" in John Dore and others, *CPWF Project Report: Improving Mekong Water Resources Investment and Allocation Choices, Project Number 67* (n.p., CGIAR Challenge Program on Water and Food, 2010).

At a local level, the key stakeholders may include different citizen organizations and networks (public and non-public) as well as other relevant organizations from different sectors of the society. Local communities, including Indigenous peoples, and those with water-using businesses, such as farmers, often represent the ultimate water end users. Engaging these communities and individuals early in the design phase of water allocation and reallocation processes enhances their participation and representation of their views and values. Due to the historical underrepresentation of Indigenous groups in particular in water governance processes, and power asymmetries between them and other parties, including in transboundary settings, room should be made for targeted stakeholder learning, and capacity- and trust-building.[448] Stakeholder analyses can be classified by their rationale and whether they aim at identifying, categorizing or investigating relationships between stakeholders, with associated methods (Figure 20).[449] Stakeholder analysis and engagement methods that have been tailored especially for water resources management in a transboundary context are provided by the Global Water Partnership (GWP) IWRM toolbox[450] and International Network of Basin Organizations (INBO),[451] for example.

Figure 20
Rationale, typology and methods for stakeholder analysis



Source: Mark S. Reed and others, "Who's in and why? A typology of stakeholder analysis methods for natural resource management", *Journal of Environmental Management*, vol. 90, No. 5 (April 2009).

CASE STUDY 38: Public participation and consensus-building in water management for the Great Lakes Basin

With more than 44 million people living within the Great Lakes Basin shared between Canada and the United States, it is difficult to satisfy the need to preserve critical ecosystem functions, protect riparian landowners and business from flood damage and drought impacts, and provide appropriate flows and lake levels for navigation, hydropower production, recreation and fishing and the many other beneficial uses. Public engagement is critical as is ensuring the decision-making process is consensus based and transparent.

[448] Rosalind H. Bark and others, "Adaptive basin governance and the prospects for meeting Indigenous water claims", *Environmental Science & Policy*, vols. 19–20 (May–June 2012), p. 169–177.
[449] Mark S. Reed and others, "Who's in and why? A typology of stakeholder analysis methods for natural resource management", *Journal of Environmental Management*, vol. 90, No. 5 (April 2009), p. 1933–1949.
[450] GWP, "Stakeholder analysis (C3.02)", 3 March 2017.
[451] INBO, *The Handbook for the Participation of Stakeholders and the Civil Society in the Basins of Rivers, Lakes and Aquifers* (Paris, 2018).

The International Joint Commission (IJC) was established by the Boundary Waters Treaty of 1909 between the United States and the United Kingdom relating to boundary waters between the United States and Canada. The Treaty requires uses, obstructions or diversions of boundary waters to be permitted by the authority of the United States and Canada within their respective jurisdictions and with the approval of the IJC. The IJC considers applications for projects such as dams which impact on water levels on the other side of the boundary. Conditions for the operation and maintenance of projects affecting boundary waters are provided in Orders of Approval. In the Great Lakes, the IJC has issued Orders of Approval for works at: Sault St. Marie, Ontario and Michigan; the outlet of Lake Superior, on the Niagara River; and the Moses–Saunders Dam at the outlet of Lake Ontario in Cornwall, Ontario and Massena, New York. Following multi-year binational studies, the IJC issued updated Orders of Approval for the regulation of water levels and outflows for Lake Superior and, in 2016, for Lake Ontario and the St Lawrence River. The International Upper Great Lakes Study[452] and the Lake Ontario St Lawrence River study both used a Shared Vision Model for reaching consensus-based decisions in developing recommendations for revisions to conditions in the applicable Orders of Approval.

The Shared Vision Model is the name of the computer model developed in the context of water-level studies to integrate the results from each of the technical work groups in one place. With this Model, various regulation plans could be run through an evaluation process and the results compared between interests and locations. The IJC uses an adaptive management and climate change framework to periodically review its Orders of Approval to evaluate whether the models used in formulating the regulation plans responded as anticipated over time. Detailed information is available in the Great Lakes Adaptive Management (GLAM) Committee's short- and long-term strategy documents.[453] Studies relating to the impacts of a changing climate, extreme events of floods and droughts, degradation of ecosystem functions and impacts on the many changing beneficial uses within the Basin are considered in the adaptive management strategy. The GLAM Committee reports to the IJC Great Lakes boards—the International Lake Superior Board of Control, International Lake Ontario–St Lawrence River Board and the International Niagara River Board of Control. The IJC consults with the United States and Canadian Governments on recommended revisions to regulation plans. The Orders must be consistent with United States and Canadian laws.

Under the Shared Vision Model, the IJC brings together an equal number of experts, decision-makers and stakeholders from both countries to create a system model that connects science, public preferences and decision-making criteria. It consists of five basic steps:

1. Establish binational working groups/committees. These working groups must be inclusive and balanced and include local interests and experts from within the basin areas:
   - A science group consisting of the best experts from the private sector, academia and governments to oversee the creation of the scientific foundation for negotiations;
   - A citizen advisory group representing community leaders, public interest groups and businesses.
2. The groups work together to define the issues and options to address in the negotiation process.
3. The groups become comfortable with the technical information and methods used.
4. The groups collect data and operate models to show the trade-offs between the various economic values for uses and important environmental indicators. They work together to refine models, options and outcomes.
5. The groups ensure that the process and outcomes are transparent and open to the public for the duration of the negotiation process.

Final outcomes and reports will be submitted to the United States and Canadian Governments for review and approval.

The success of the IJC's Shared Vision Model approach highlights the importance in transboundary allocation arrangements of obtaining public and political acceptance of the outcomes of these models that show the trade-offs among the various economic values for beneficial uses and important environmental indicators.

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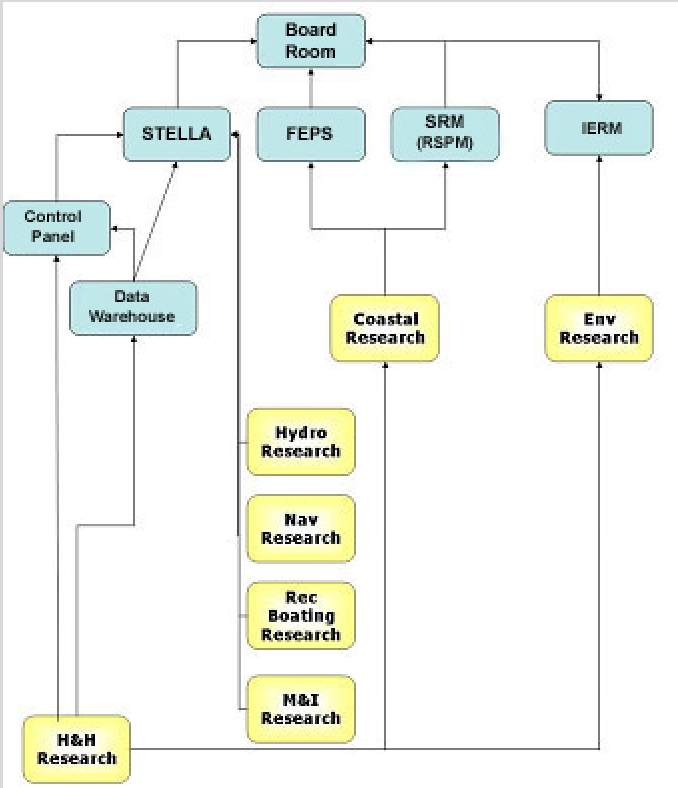
452 See Watershed Council, "International Upper Great Lakes Study", available at www.watershedcouncil.org/international-upper-great-lakes-study.html.

453 Great Lakes-St Lawrence River Adaptive Management Committee, *Short-term and Long-term Strategy: For Evaluating and Improving the Rules for Managing Releases from Lakes Ontario and Superior* (n.p., 2020).



Abbreviations

STELLA – Model programming software

FEPS – Flood and Erosion Prediction System

SRM (RSPM) – St Lawrence River Model

IERM – Integrated Ecological Response Model

H&H – Hydrology and Hydraulics

Env – Environment

Hydro – Hydropower

Nav – Commercial Navigation

Rec – Recreational Boating

M&I – Municipal, Industrial and Domestic Water Uses

Institutional analysis

Besides the water issues at hand and stakeholder views and needs, pre-existing agreements and institutional arrangements can often frame the development of transboundary water allocation plans between co-riparian States (see also Figure 1 in Chapter 1). The United Nations global water conventions and pre-existing transboundary agreements provide an overall framework for the arrangements and guide definition of the actual process for determining transboundary water allocation or reallocation in the given context. Other international agreements and arrangements related to, for example, flood protection, energy production and hydropower development, or environmental conservation and restoration, are equally important to consider as they may set prerequisites for the quantity, quality and timing of shared water.

At a national level, domestic legislation, strategies and guidelines inform the priorities and procedures of the allocation mechanisms and their implementation. At a local level, water management plans and practices define the ultimate water end use. Regardless of the level of stakeholder interaction of water governance, allocation processes require adequate institutional capacity to succeed.[454] Transboundary water allocation arrangements and official agreements require significant effort to accomplish. Sufficient levels of institutional, technical (including ability to do assessments and monitoring) and legal capacity are needed for all riparian States in order to carry out a functional transboundary water allocation process.[455] In addition to capacity, political will from all riparian States is essential in ensuring commitment. The national water allocation "health check" provided by OECD provides several aspects that are also applicable in the transboundary context for the institutional review of current allocation arrangements or estimating the need for new ones.[456] Chapters II, V and VI and steps 3 and 4 below present in detail the institutional elements of transboundary water allocation.

[454] Speed and others (2013).
[455] Ibid.; OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).
[456] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015).

BOX 6: The OECD "Health Check" for water resources allocation

Check 1. Are there accountability mechanisms in place for the management of water allocation that are effective at a catchment or basin scale?
Check 2. Is there a clear legal status for all water resources (surface and ground water and alternative sources of supply)?
Check 3. Is the availability of water resources (surface water, groundwater and alternative sources of supply) and possible scarcity well understood?
Check 4. Is there an abstraction limit ("cap") that reflects in situ requirements and sustainable use?
Check 5. Is there an effective approach to enable efficient and fair management of the risk of shortage that ensures water for essential uses?
Check 6. Are adequate arrangements in place for dealing with exceptional circumstances (such as drought or severe pollution events)?
Check 7. Is there a process for dealing with new entrants and for increasing or varying existing entitlements?
Check 8. Are there effective mechanisms for monitoring and enforcement, with clear and legally robust sanctions?
Check 9. Are water infrastructures in place to store, treat and deliver water in order for the allocation regime to function effectively?
Check 10. Is there policy coherence across sectors that affect water resources allocation?
Check 11. Is there a clear legal definition of water entitlements?
Check 12. Are appropriate abstraction charges in place for all users that reflect the impact of the abstraction on resource availability for other users and the environment?
Check 13. Are obligations related to return flows and discharges properly specified and enforced?
Check 14. Does the system allow water users to reallocate water among themselves to improve the allocative efficiency of the regime?

Source: OECD, *Water Resources Allocation: Sharing Risks and Opportunities*, OECD Studies on Water (Paris, 2015).

c. Step 3: Shared knowledge base

A shared knowledge base building on joint monitoring and assessment systems and commensurate data is essential for sustainable and equitable transboundary water allocation decision-making. As discussed in Chapter VII, the knowledge base ideally includes reliable time series assessments of available surface water and groundwater resources, environmental requirements (including e-flows), impact assessments and water uses and needs assessments. At the beginning of an allocation or reallocation process, a joint scientific foundation built by an international group of experts based on the latest available knowledge may help in building trust and enhance the robustness of arrangements (see Case Study 38). Because of constantly evolving circumstances, it can be helpful to put in place mechanisms and tools such as DSS, which allows for evaluation of the sufficiency and easy updating of data (see Chapter VII, section 5). Technical tools and approaches for determining the water needs of different sectors and users may range from national monitoring, mass balance modelling and estimation utilizing proxies, to water footprint assessments (see Chapter VII, subsection 3b). [457] In assessing future development of demands, combined demographic, socioeconomic and climate scenarios help in identifying possible future trajectories. When current or future water availability

[457] See, for example, Peter Droogers and others, "Water allocation in 2050: Tools and examples", in Primot and others, eds., *Green Growth and Water Allocation: Papers presented at a workshop held on 22–23 November 2012 in Wageningen, the Netherlands* (2013), p. 101–117.

and demands do not meet, to reach a sustainable balance, supply and demand management options, including any potential for efficiency gains in different sectors, need to be carefully investigated.

CASE STUDY 39: Jointly developed knowledge-based management of the transboundary deep thermal groundwater body in the Lower Bavarian/Upper Austrian Molasse Basin

By 1990, intensive uses of the thermal groundwater in the transboundary Lower Bavarian/Upper Austrian Molasse Basin had led to decreasing water pressures, due to use for geothermal energy in Austria and use of thermal water for balneological purposes in Germany (Bavaria). The sustainable, harmonized and closely cooperative management of the transboundary deep thermal groundwater body was needed to avoid overexploitation and guarantee sustainable use of the thermal water. The legal framework for cooperation between the two States concerned was provided by the Regensburg Treaty (1987) on Water Management Cooperation in the Danube River Basin between Austria and Germany, which is the basis for a Permanent Bilateral Water Commission. A bilateral Expert Group "Thermal Water" was established 1992, with representation of the key authorities from the German federated State (Land) of Bavaria and Austria. The Expert Group developed scientific knowledge and a combined and balanced monitoring programme with regular data exchange and appropriated tools, notably, a numerical groundwater model, to support the transboundary management of the groundwater body. In order to maintain the natural pressure level as far as possible, the obligatory reinjection of geothermally used water into the groundwater body is an essential management principle. Guidelines for the use of thermal water were developed to provide management principles and technical harmonized regulations, including concerning harmonized exploitation and monitoring for sustainable use of the transboundary deep thermal groundwater body.

d. Step 4: Identifying alternatives and addressing diverging understandings

Multi-criteria decision analysis (MCDA) and decision support systems (DSS) are two main methods, along with their accompanying technological systems, that may assist in identifying transboundary allocation options, relevant broader approaches and related alternatives, and, even more so, helping to decide which is the most effective choice or combination of choices. MCDA can provide the transparent and systematic evaluation of possible alternatives from different perspectives.[458] Carrying out the MCDA process in close collaboration with relevant stakeholders enhances social learning and enables inclusion of the public values and concerns in the process, increasing participants' trust as well as the process quality.[459] Various MCDA software tools and DSS technologies have been developed to support the application of MCDA methods in practice.[460] Graphical user interfaces, for example, offer various possibilities to visualize the process and the results. There are several ways and supporting tools to gather information for the MCDA process. Stakeholders' preferences can be collected via postal or online questionnaires, in a group meeting or in personal or small group interviews. In some cases, experts' preferences can be used when they are judged to sufficiently represent certain viewpoints. Joint bodies are best positioned to apply the MCDA methods and DSS in practice (see Chapter VII, section 5). In general, joint bodies have a central role in addressing

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[458] Gregory A. Kiker and others, "Application of multicriteria decision analysis in environmental decision making", *Integrated Environmental Assessment and Management*, vol. 1, No. 2 (April 2005), p. 95–108; Ivy B. Huang, Jeffrey Keisler and Igor Linkov, "Multi-criteria decision analysis in environmental sciences: ten years of applications and trends", *Science of The Total Environment*, vol. 409, No. 19 (September 2011), p. 3578–3594; Speed and others (2013), p. 149.
[459] Ahti Salo and Raimo P. Hämäläinen, "Multicriteria decision analysis in group decision processes", in *Handbook of Group Decision and Negotiation*, D. Marc Kilgour and Colin Eden, eds., Advances in Group Decision and Negotiation, vol. 4 (Dordrecht, Springer, 2010); Alexey Voinov and others, "Modelling with stakeholders – next generation", *Environmental Modelling & Software*, vol. 77 (March 2016), p. 196–220.
[460] Jyri Mustajoki and Mika Marttunen, "Comparison of multi-criteria decision analytical software for supporting environmental planning processes", *Environmental Modelling & Software*, vol. 93 (July 2017), p. 78–91.

diverging understanding among States, sectors and other stakeholders due to their commonly acknowledged mandate and because they provide a platform for continuous exchange and cooperation.[461]

Economics is a narrower basis of analysis for water allocation in a transboundary context, but one that can also support decision-making regarding potential options and alternatives. As stated by FAO, "[e]conomics contributes towards improved allocations by informing decision-makers of the full social costs of water use and the full social benefits of the goods and services that water provides. The main approaches that form the methodological basis for strategic economic appraisal are cost-benefit analysis and cost-effectiveness analysis."[462] Cost-benefit analysis is the more common tool, which "provides a rational and systematic framework for assessing alternative management and policy options. It entails identification and economic valuation of all positive and negative effects of alternative options. This involves the translation of all benefits and costs into monetary terms, including, where possible, non-marketed environmental, social and other impacts. It is based on the underlying assumption that individual preferences should determine the allocation of resources among competing uses in society"[463] (see Case Study 25 on the Lesotho Highlands Water Project for how this was implemented in allocation options decision-making). However, there are recognized constraints to this approach, particularly concerning intrinsic environmental and cultural values that perhaps cannot be quantified and monetized (see Chapter V, sections 1 and 4). Hence, for cost-benefit analysis to be used effectively to support transboundary water allocation decision-making, its limitations should be factored into any assessments of options, and any underlying assumptions appropriate to a specific situation should be explicitly acknowledged in order to ensure that the results are contextual, valid and reliable.[464]

Dealing with limited data and uncertainty

Lack of data is a common and critical problem in transboundary water resources management and allocation, Data accuracy, timeliness and completeness are often the issues. Notwithstanding this, all data is not always required. Sharing information and coproducing knowledge may already help unlock potential conflicts and provide understanding of shared benefits.[465] When dealing with limited data, it is essential to build in mechanisms and capacity to deal with uncertainty in the allocation arrangements. Furthermore, regardless of the availability of data, some level of uncertainty is always present and robust decision-making is possible under uncertainty. To deal with uncertainty, allocation decisions should avoid limiting future options but also allow for responding to unprecedented events, such as through uncertainty and sensitivity analyses, respectively.[466] Further approaches for dealing with uncertainty may include:

- adopting a precautionary and conservative approach in assessing available water resources and its allocation to different parties and users (see Chapter II, section 4);
- applying a mechanism recognizing inter- and intraannual variability in availability;
- establishing contingency allocations for exceptional and changing circumstances;
- strengthening adaptability of allocation arrangements (or enabling adaptability of allocation arrangements to changing circumstances) (see Chapter VI, section 4);
- ensuring environmental flows in different scenarios (see Chapter III, subsection 3a).[467]

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[461] See Schmeier and Vogel (2018); see, generally, Kittikhoun and Schmeier, eds., *River Basin Organizations in Water Diplomacy* (2020).
[462] Turner and others (2004).
[463] Ibid.
[464] Ibid.
[465] UNECE, *Policy Guidance Note on the Benefits of Transboundary Water* Cooperation (2015).
[466] Speed and others (2013), p. 149–150.
[467] Ibid. See also, Nikita Strelkvskii and others, *Navigating Through Deep Waters of Uncertainty: Systems Analysis Approach to Strategic Planning of Water Resources and Water Infrastructure Under High Uncertainties and Conflicting Interests*, IIASA Research Report (Laxenburg, Austria, International Institute for Applied Systems Analysis, 2019).

Identifying and Assessing Alternatives for Water Allocation

Establishing and implementing a transboundary water allocation arrangement is a major undertaking that should not be executed without proper consideration of the actual need for, and alternatives to, allocation. Identifying both the alternatives *of* transboundary water allocation, as described above, and the alternatives *for* water allocation should build on the knowledge base on shared waters and their use, and a structured process to recognize possibilities to address different needs and interests. The arrangements require and benefit from reconsideration or greater formalization, especially when water resources availability, uses and needs and their prioritization change, or when conflicting views arise regarding the status of these. The strength of water allocation is its concrete, measurable and verifiable focus on water quantity, quality and timing. At the same time, successful use of shared waters does not necessarily require water allocation; it may also take place through other means. In general, there are two main categories of alternatives for water allocation: broader alternatives and practical alternatives. Broader alternatives indicate the utilization of water resources management frameworks, river basin plans, a water-food-energy-ecosystem nexus approach or similar broader approaches to address water use and allocation in the given context (see Chapter IV). Practical alternatives consist of more focused arrangements, such as demand management measures, sharing benefits from hydropower dams or joint water quality management (see Chapters III and IV).

2. Phase 2: Transboundary Water Allocation Agreements and Arrangements

a. Step 5: Negotiating at transboundary level for suitable arrangements and agreements

The United Nations global water conventions set a framework for negotiating bilateral and multilateral transboundary arrangements or agreements. According to the Water Convention, the riparian countries must cooperate on the basis of equality and reciprocity and, in particular, through bilateral and multilateral agreements (Art. 2.6). They must hold consultations on the basis of reciprocity, good faith and good neighbourliness and these consultations must aim at transboundary cooperation (Art. 10). The Watercourses Convention requires that, when adjustments and applications of the provisions of the Convention are needed, States must consult with a view to negotiating in good faith for the purpose of concluding a watercourse agreement (Art. 3.5). In general, each riparian State has the right to participate equally in the negotiation of transboundary water allocation arrangements and agreements.[468] The Watercourses Convention requires that every riparian country ("watercourse State") is entitled to participate in the negotiation of, and become a party to, any transboundary agreement that applies to the entire transboundary watercourse. If a water agreement applies to only a part of the watercourse or to a particular project, programme or use, a State whose water use may be affected to a significant extent by the agreement is entitled to participate in consultations and negotiation in good faith with a view to becoming a party to the agreement (Art. 4).[469] The good faith principle is fundamental to the negotiation process and refers to carrying out consultations with honest intent, fairness, sincerity and no intention to deceive.[470]

Furthermore, as expressed by the International Court of Justice, States concerned "are under an obligation so to conduct themselves that the negotiations are meaningful".[471] According to the Water Convention, the bilateral and multilateral agreements or arrangements need to embrace relevant issues covered by the Water

[468] See Rieu-Clarke, Moynihan and Magsig (2012), p. 89; UNECE, *Guide to Implementing the Water Convention* (2013), p. 33.
[469] See Rieu-Clarke, Moynihan and Magsig (2012), p. 96–99.
[470] Ibid., p. 91.
[471] International Court of Justice, *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgment of 20 April 2010, para. 146.

Convention (Art. 9). The provisions of the United Nations global water conventions can be applied in, and tailored to the specific needs of, different kinds of transboundary river basins. Additionally, some of the provisions of the Water Convention are quite precise and specific.[472] While the riparian countries have considerable discretion to consider how the principles of international water law and of the conventions shall be applied between and among them, under the Water Convention, a transboundary water agreement "would not preclude the inequitable, therefore illegal, nature of a use that would be unsustainable, such as a use that would irreversibly affect the environment to the extent of impairing present or future vital human needs of the people living along the basin, or beyond."[473]

Negotiating for water allocation agreements and other arrangements should not be viewed as a non-recurring process, but, rather, as a part of ongoing transboundary water allocation cooperation. Cooperation is often a step-by-step process and it may only be possible to start with simple steps, for example, by organizing regular joint meetings between the relevant agencies of the co-riparian States concerned. The Water Convention specifically refers to the possible revision of existing agreements (Art. 9) and the assessment of equitable water use and allocation may need to be revised at a later stage if the circumstances and other relevant factors related to water allocation change.[474] States may also consider providing for public participation, including non-governmental organizations (NGOs), in the negotiation of transboundary water allocation agreements. The public may be granted access to the draft agreements or other arrangements and allowed to comment on them. Moreover, NGOs may be invited to observe and comment on intergovernmental allocation negotiations.[475] Depending on the consent of the co-riparian States involved, third parties may also be invited to play a role as facilitator, mediator or observer during the negotiation of transboundary allocation agreements, as did the World Bank in facilitating the Indus Waters Treaty between India and Pakistan (see Case Study 40).

CASE STUDY 40: Role of a third party in negotiating the Indus Waters Treaty

Several factors contributed to the success of third-party facilitation efforts in support of the Indus Waters Treaty negotiations between India and Pakistan. Ultimately, the success of negotiations is primarily an achievement of the negotiating parties. The first determining factor was continued active involvement at the highest level. From the outset, Eugene Black, the then President of the World Bank, was personally and directly involved in the attempts to resolve the dispute. The Prime Ministers of India and Pakistan had jointly sought the good offices of the Bank. The Bank appointed Mr. Raymond Wheeler, an engineering adviser, to assist with negotiations; later, Mr. William Iliff, then Assistant to the President of the Bank, was engaged as the chief mediator, and it was he who signed the Treaty on behalf of the Bank.

The Bank did not come with a fixed blueprint for the resolution of the dispute. Its initial approach was to develop joint planning for the Indus irrigation system. However, when it became clear to the Bank that this approach was not acceptable to the parties, and that division of the rivers of the Indus System was the only practical solution, the Bank abandoned that approach. With inputs from the two parties, the Bank developed its own proposal, which called for the allocation of the eastern rivers to India and the western rivers to Pakistan. Another reason for the success of the negotiations and third-party mediation was the willingness of both State parties to compromise. When negotiations were halted, the Bank threatened that, if negotiations were not resumed, the Bank would end its mediation and make the reasons known publicly, thus extending its powers of persuasion to exerting pressure.

At that time, the development plans of the two countries depended to a large extent on loans from the Bank, which gave the Bank more leverage and influence on them. Moreover, the Bank was successful in mobilizing the funds needed for implementation of the Treaty and creation of the Indus Basin Development Fund, which amounted to

[472] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 24–25.
[473] See Ibid., p. 25.
[474] See Ibid., p. 24–25, 33.
[475] Ibid., p. 66.

approximately $800 million. The ability to raise those funds, largely on a grant basis, no doubt gave the Bank tremendous strength in successfully concluding the mediation process. The Bank was willing to accept a wide range of responsibilities in the implementation of the arrangements agreed upon under the Treaty. Because of those responsibilities, the Bank is a signatory to the Indus Waters Treaty for the purposes specified in Articles V and X, and Annexures F, G, and H of the Treaty.

b. Step 6: Establishing water allocation agreements or arrangements

Joint arrangements, agreements and joint bodies established by riparian countries are key elements of well-functioning transboundary allocation systems, granting certainty and legal weight in the long term. As emphasized throughout this Handbook, there are no universally accepted criteria for allocating transboundary waters or establishing arrangements and agreements for this purpose. The principles and objectives of water allocation need to be interpreted in the context of each transboundary basin's unique setting. However, some guidelines can be drawn from the principles, objectives and mechanisms of transboundary water allocation, as presented in Chapters II, V, VI and VII. For example, the role of transboundary water governance institutions is important for water allocation and those institutions should be strong. New transboundary water allocation agreements and other arrangements must be designed to be adaptable in the medium and longer term in response to changing hydrological, climatic and other related factors (socioeconomic, geographical, cultural, etc.).

States may also consider revising existing water allocation agreements and other arrangements, or adopting subsidiary instruments (e.g. minutes; see Case Study 41), to make them more adaptable, in accordance with the general principles of treaty law. In doing so, it may be useful to jointly review pre-existing usage patterns and any transboundary allocation arrangements on which they are based in order to adapt to evolving conditions and demands. Such review should be based on equity and sustainability, especially as regards upstream and downstream water use allocations, including for the environment. In some cases, technical solutions, or informal or temporary arrangements may be instrumental in reaching a negotiated and acceptable short-term solution for allocation in a transboundary context.

CASE STUDY 41: The International Boundary and Water Commission's use of Minutes for adaptable transboundary water governance: updates governing the Colorado River[476]

The United States and Mexico established the International Boundary Commission (IBC) on 1 March 1889 as a temporary body to apply the rules that were adopted by the Convention of 1884. The IBC was extended indefinitely in 1900 and is considered the direct predecessor to the modern day International Boundary and Water Commission (IBWC).

Pursuant to the United States–Mexico Treaty on Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, signed 3 February 1944 (1944 Water Treaty), the IBWC has the status of an international body and consists of a United States Section and a Mexican Section. Each Section is headed by an Engineer Commissioner. Whenever there are provisions for joint action or joint agreement of the two Governments or for the furnishing of reports, studies or plans to the two Governments, it is understood that those matters will be handled by or through the Department of State of the United States and the Ministry of Foreign Relations of Mexico. Each Government affords diplomatic status to the Commissioner designated by the other Government. The Commissioner, two Principal Engineers, a legal adviser and a Secretary, designated by each Government as members of its Section of the Commission, are entitled in the territory of the other country to the privileges and immunities appertaining to diplomatic officers. The IBWC and its personnel may freely carry out their observations, studies and field work in

[476] Source: International Boundary and Water Commission (www.ibwc.gov/About_Us/history.html; www.ibwc.gov/Files/CF_CR_Minute_323_102517.pdf). United States and Mexican Government officials were given the opportunity to update the text.

the territory of the other country. Each Government bears the expenses of its respective Section; joint expenses, which may be incurred as agreed by the IBWC, are to be borne equally by the two Governments.

Decisions of the Commission are recorded in the form of Minutes. Minutes are binding agreements of the IBWC intended to implement the 1944 Treaty and they take effect once approved by both nations' foreign affairs ministries. There are 325 Minutes to date. Under the Minute system, the two Governments reached agreement for the solution of a long-standing problem regarding the quality of the Colorado River water allocated to Mexico under the 1944 Water Treaty, which was incorporated in Minute No. 242 of the IBWC dated 30 August 1973.

Under the 1944 Water Treaty, for the Colorado River, the United States is to deliver to Mexico a volume of 1.5 million acre-feet per year. When there are surplus waters, Mexico may receive an additional 200 kaf (1 kaf = 1,000 acre-feet). Mexico diverts most of its allocation at Morelos Dam. Under the terms of the Treaty, in extraordinary drought, Mexico is to receive reduced deliveries in proportion to reductions in the United States. To date, however, the United States has always met its delivery obligation.

A Joint Cooperative Process began on the Colorado River. Seven United States Basin States and the two federal governments asked the IBWC to convene stakeholders whereby four work groups were established in 2008. Minute No. 317 (2010) formalized those work groups and a framework for United States–Mexico Cooperation. Minute No. 318 (2010) allowed Mexico to store water in the United States system until it could fix earthquake damage. As a result of the Joint Cooperative Process, Minute 319 (2012) was signed on 20 November 2012. It was a five-year agreement in force through 2017, incorporating seven sections: Extension of Minute 318; Distribution of Flows Under High Elevation Reservoir Conditions; Distributions of Flows Under Low Reservoir Conditions; Intentionally Created Mexican Allocation (ICMA); Salinity Management; Water for Environment and ICMA/ICS (Intentionally Created Surplus) Exchange Pilot Program; and International Projects.

With Minute 319 scheduled to end on 31 December 2017, work between the United States and Mexico began in 2015 on a new agreement based on Minute 319. This new Minute was informed by Minute 319 and evolving basin conditions. A Minute Negotiating Group (MNG) met monthly, with meetings held in the United States and Mexico. There were also domestic consultations between binational meetings. Work groups were formed to assist the MNG: Salinity Work Group, Projects Work Group, Environmental Work Group and Hydrology Work Group. The Minute 319 Work Groups also helped.

Minute 323 was subsequently signed on 21 September 2017 in Ciudad Juarez, Mexico, and entered into force on 27 September 2017. Under previous Minutes, Mexico deferred deliveries after an earthquake because of damaged canals. Under Minute 323, Mexico's Water Reserve allows Mexico to defer water delivery on account of earthquakes, emergencies, conservation or new water sources projects. The water is available for subsequent delivery to Mexico, gives Mexico flexibility in water management and boosts Lake Mead elevation to the benefit of all users.

Minute 323 also dealt with specific areas of importance as listed below.:

- SURPLUS SHARING
  - Provides additional Colorado River water to Mexico during high elevation reservoir conditions;
- SHORTAGE SHARING
  - Principle that when one country is in shortage, the other country should be in shortage
  - Annual reductions to Mexico of 50–125 kaf based on three low elevation tiers at Lake Mead
  - Mexico may use its stored water to offset shortage, subject to limitations;
- BINATIONAL WATER SCARCITY CONTINGENCY PLAN
  - Requires water savings earlier to shore up drought-affected reservoirs
  - Commitment to reduce water orders at certain reservoir elevations
  - Water savings could be delivered in the future when reservoirs refill
  - Based on elements of the United States Lower Basin Drought Contingency Plan;
- SALINITY
  - Minute 242 (1973) requires salinity of deliveries to Mexico to be similar to water quality at Imperial Dam
  - Applies a salinity formula that is fair to both countries
  - The United States and Mexico will operate a system to minimize salinity impacts of Minute 319 actions

- Improved salinity monitoring;
- FLOW VARIABILITY
  - Treaty provides for a monthly delivery schedule to Mexico
  - Mexico users concerned about daily flow variability of deliveries
  - Minute 323 considers potential regulating reservoirs
  - Establishes water order and delivery targets to minimize daily variability;
- ENVIRONMENT
  - Generates water for the environment
  - 210 kaf+ of water for the environment
  - Water for the United States Government share through United States investment in Mexico to cover one third of this volume
  - Mexico and NGOs provide the remaining two thirds, split equally
  - Focus on water for habitat restoration sites;
- PROJECTS
  - $31.5 million from the United States for projects in Mexico
  - Mexico derives long-term benefits from waters conserved from United States investment
  - 109 kaf for water agencies, 70 kaf for the environment and 50 kaf for system storage
  - Consideration for future new water sources projects.

BENEFITS OF MINUTES 319 AND 323

- Provides certainty for water planning, especially in shortage;
- Storing Mexico's water boosts system storage in the United States;
- Cooperation and transparency benefits all parties;
- Avoids conflicts.

The mandates of transboundary joint bodies should be broad and governance should have enough capacity to adapt to changing circumstances. Concerning the actual allocation, the riparian countries should be able to determine allocable waters and current allocation, establish clear allocation rules and take into account annual flow variation, flow forecasts, environmental flows and future water use needs, for example. Water allocation mechanisms can be divided into three subcategories: direct mechanisms, indirect mechanisms and principle-based mechanisms (see Table 12).[477]

c. Step 7: Development of allocation mechanisms and plans

Transboundary water allocation arrangements and agreements often need to be further specified through developing allocation mechanisms and plans. The arrangements and agreements may be more or less detailed and water allocation mechanisms may differ in the clarity of the guidelines for allocation they provide. The mechanisms and plans are needed at the transboundary level, as well as the national and local levels of management of transboundary waters.

Historically, the focus of allocation mechanisms has been on sharing surface water. With growing attention to and interest in the shared management of groundwater, there is a need for groundwater allocation mechanisms that are based on the unique properties and physical characteristics of groundwater and that take into account the interactions with surface water. Therefore, in addition to separating allocation mechanisms for surface and groundwater, several groundwater-specific explanatory clauses have been established for how groundwater is physically divided between States (see Table 12). These include using pumping rates, water table levels and spring outflows to monitor or determine quantities for allocation, and pumping restrictions close to transboundary rivers and international borders, as well as mechanisms that divide water based on the

[477] Drieschova, Giordano and Fischhendler (2018); Giordano and others (2014).

pore space or storage capacity of an aquifer rather than the volume of water itself. However, many of these clauses have not been applied in existing agreements. In addition to the allocation mechanism, the purpose of water allocation can be specified in an arrangement or agreement (Table 11). For example, an agreement might divide water using a fixed volume or flow rate for the purpose of irrigation, or the riparian States may identify a percentage of flow that needs to be maintained to meet a basin's minimum environmental needs. Other potential contexts for allocation include minimum flows, hydropower and navigation.

Table 11
Purpose or context of transboundary water allocation mechanisms

Purpose of Water Allocation	
Purpose or Context of Mechanism	Minimum flow: not specified/undefined purpose
	Minimum flow: navigation
	Minimum flow: environmental needs
	Minimum flow: hydropower
	Minimum flow: tourism/recreation
	Environmental/in-stream flow
	Aesthetic/tourism/recreation
	Intrinsic/cultural/spiritual
	Hydropower
	Agriculture/irrigation
	Navigation
	Support of fish habitat and stocks/fishing rights
	Domestic and/or municipal uses
	Border/territory maintenance
	Pollution, such as a specific volume for dilution purposes
	Undefined purpose
	Other—if other, the purpose is described in detail in the Allocation Summary Code

Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

Transboundary agreements with water allocations should be able to accommodate and react to possible future changes in water availability. This can be done by including percentage allocations, escape clauses (i.e. special provisions for special situations such as extended droughts) or periodic reviews of usage and allocations. Arrangements and agreements should define procedures for negotiation or renegotiation of water allocations. If such procedures are not in place when circumstances previously defined as extreme and temporary become "the new normal", the risk for implementation problems and disputes grows.[478]

Table 12
Water allocation mechanisms

Water Allocation Mechanisms	
Direct Mechanisms	Fixed quantities: A set volume of water to each riparian party, once, annually or at other defined intervals
	Fixed quantities to only a subset of the riparian parties: A set volume of water is allocated to only some of the riparian parties and the undefined quantity of the remainder is allocated to other parties
	Percentage of flow: Percentages of flow are allocated to riparian parties
	Equal division: Water is divided equally between the parties; equal division could be in fixed quantities, percentage, by time, etc., or undefined

[478] Tuula Honkonen and Niel Lubbe, "Adapting transboundary water agreements to climate change: experiences from Finland and Southern Africa", *South African Journal of Environmental Law*, vol. 25, No. 1 (2019), p. 5–41.

	Variable by water availability: The allocation is dependent on the availability of water, includes inter- and intraannual variability (i.e. allocations for low or high flow, drought or flood)
	Variable according to time of the year: The allocation is dependent on the time of year, e.g. a monthly or seasonal schedule
	Water loans: This covers allocations that are recoupable in later periods if not met (e.g. when a riparian party is unable to meet a delivery, it can be delivered at a later period) and allocations that are able to be borrowed from another riparian party and paid back at a later time
	Allocation of entire/partial aquifer/river: Allocation is based on sole use (e.g. States are allocated sole use of an aquifer/river or sole use of segments/portions of an aquifer/river within their territory)
	Allocating time: Flow is allocated to a riparian party for a defined period of time
	Cap, limit, or no allocation allowed: Clearly defined cap or limit on the allocation allowed for the resource, and/or the text explicitly does not allow for any diversions from the resource
Indirect Mechanisms	Prioritization of uses: Allocation is divided based on the priority of use (e.g. domestic use first, hydropower second)
	Consultation and/or prior approval: Riparian parties consult or seek prior approval/consent of other riparian parties to determine allocations, make changes to allocations already defined, or for short notice/temporary changes to allocations, such as if one party requires a higher water use than usual because of the construction of an irrigation system
	River basin organization, commission and/or committee: Allocation mechanism is to be determined by a river basin organization, commission and/or committee; this could include an existing body or a newly established body with a broad mandate, as well as an existing or newly established body for the specific purpose of establishing and managing allocations
Mechanisms Based on Principles	Benefits sharing: The benefits of the allocated water are shared between/among parties (e.g. hydropower, flood control or other benefits that could be given a monetary value, which is shared); this is not an exchange of water with a non-water linkage (this is captured in a separate code: B.P. Non-Water Linkages)
	Historical or existing uses: Allocation mechanism is based on the prior, historical or existing uses of the riparian party or parties
	Equitable use: Allocation mechanism is defined using the principle of equitable and reasonable use
	Sustainable use: Allocation mechanism defines sustainable use for the aquifer/river, or allocates water based on the principles of sustainable use
	Market-based: Allocation mechanism uses a market instrument, such as a water market, to allocate water
Not Defined	Unclear: Allocation mechanism exists, but it is not clearly defined.
Groundwater-specific Mechanisms	Pumping rates: allocation mechanism specifies particular rates for abstraction from wells
	Water table impact: allocation mechanisms refer to or are limited by the groundwater table height (e.g. abstractions are prohibited if the water table falls below a certain level in monitoring wells)
	Spring outflow: Allocation mechanism is related to the spring outflow (e.g. the volume of allocation is dependent on the level of spring outflow)
	Aquifer: Allocation mechanism is related to or addresses the pore space and/or storage capacity of the aquifer, not the groundwater itself

Source: M. McCracken and others, "Typology for transboundary water allocation: a look at global trends in international freshwater agreements" (forthcoming).

The *direct allocation mechanisms* include both fixed and flexible allocation mechanisms. Fixed allocations set a volume of water to be delivered, for example, from a dam. Flexible allocations can be based on percentage shares of available flows, for example, and allow water allocation regimes to respond to changes in water availability. Flexible allocation requires flexible infrastructure, effective operating rules and regular communication and data-sharing.[479] It is also possible to combine fixed allocations with percentage allocations to provide a predictable and flexible water allocation mechanism. Particular principles of water

[479] Cooley and Gleick (2011) p. 715.

allocation, such as equity, rational use, no-harm and sustainability, may also be combined with this kind of arrangement.[480] A predefined sequence of priority of uses, as well as different kinds of cooperative arrangements between the riparian countries, can be used as *indirect allocation mechanisms*. The prioritization of uses sets out the priority of access to water according to types of uses or users. It may guide the overall allocation of water entitlements or be applied only during exceptional hydrological circumstances. Arguably, the mechanisms based on principles may provide guidelines for allocating water while maintaining the spirit of the underlying agreement at the same time.[481] However, using a mere principle instead of a clearly established allocation rule may not be the most feasible approach in the long run. Instead, a mechanism that prescribes both flexibility based on principles and specificity in the allocation of water seems to contribute positively to sustained cooperation among riparian States.[482]

<u>*Existing frameworks for developing transboundary allocation mechanisms*</u>

Transboundary water allocation planning must follow the principles and objectives discussed in Chapters V and VI such as equitable and reasonable utilization, no harm and cooperation. Speed and others (2013) provide 10 "golden rules" of basin water allocation planning based on international experience, all of which can generally also be applied in a transboundary setting:

1. In basins where water is becoming stressed, it is important to link allocation planning to broader social, environmental and economic development planning. Where interbasin transfers are proposed, allocation planning also needs to link to plans related to that development.
2. Successful basin allocation processes depend on the existence of adequate institutional capacity.
3. The degree of complexity in an allocation plan should reflect the complexity and challenges in the basin.
4. Considerable care is required in defining the amount of water available for allocation. Once water has been (over)allocated, it is economically, financially, socially and politically difficult to reduce allocations.
5. Environmental water needs provide a foundation on which basin allocation planning should be built.
6. The water needs of certain priority purposes should be met before water is allocated among other users. This can include social, environmental and strategic priorities.
7. In stressed basins, water efficiency assessments and objectives should be developed within or alongside the allocation plan. In water-scarce situations, allocations should be based on an understanding of the relative efficiency of different water users.
8. Allocation plans need to have a clear and equitable approach for addressing variability between years and seasons.
9. Allocation plans need to incorporate flexibility in recognition of uncertainty over the medium to long term in respect of changing climate and economic and social circumstances.
10. A clear process is required for converting regional water shares into local and individual water entitlements, and for clearly defining annual allocations.[483]

The need for water allocation planning is connected with the management of system-wide allocation challenges. Accordingly, a river basin management plan can set out a clear framework for allocation. A clear and transparent process to facilitate stakeholder engagement in planning is also often needed. The required scale of planning depends on the particular water allocation challenges and may vary from the basin to subcatchment and aquifer level.[484]

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[480] UNECE and INBO (2015), p. 21.
[481] Sanchez and Roberts, eds. (2014), p. 66.
[482] Shlomi Dinar and others (2015), p. 23.
[483] Speed and others (2013).
[484] OECD, *Water Resources Allocation: Sharing Risks and Opportunities* (2015), p. 121.

CASE STUDY 42: Regional recommendations on transboundary water allocation from Central Asia and the neighbouring States

Contributing to the preparation of the Handbook, the International Water Assessment Centre (IWAC) in Kazakhstan led with Kazakh partners a parallel regional project for Central Asia and neighbouring States on transboundary water allocation. The process was initiated by the Government of Kazakhstan's formal outreach to the countries with an invitation to engage, and led to development of two technical reports, on water allocation in a transboundary context and assessment of environmental flows. The conclusions and selected case studies were integrated into the global Handbook. The IWAC convened two online meetings for the States concerned to discuss the case studies and lessons learned.

The group of experts that was formed compiled and published a regional study on transboundary water allocation with inputs from Afghanistan, China, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Russia, Tajikistan, Turkmenistan and Uzbekistan.

The broad range of conclusions included the following:

- When planning new bilateral or multilateral water allocation agreements, it is recommended to use well-established principles of international water law, such as equitable and reasonable use and the obligation not to cause significant harm. To this end, cooperation and membership in relevant international and regional conventions are recommended.
- To increase the chances of success, bilateral or multilateral water allocation agreements should not only be declarative, but should always include mechanisms for monitoring and control, as well as an effective enforcement mechanism.
- Guaranteeing of environmental flows shall feature in transboundary water allocation agreements, recognizing the need to harmonize the level of environmental flows by seasons and years, depending on weather conditions and water availability.
- Implementation of an approach to managing water, energy, land and ecosystem services based on a system of relationships (nexus approach), aimed at the efficiency and sustainability of the use of these resources.
- For the Aral Sea basin, the existing water sharing cooperation structures, such as the International Fund for saving the Aral Sea (IFAS) and its regional commissions the Interstate Commission for Water Coordination of Central Asia (ICWC) and the Interstate Commission on Sustainable Development (ICSD) need reforms to make them fully effective and guarantee the unconditional participation of all countries sharing water resources. For any regional agreement, the key is to establish an open dialogue on water allocation and ensure participation of the energy sector.

The full set of conclusions can be found in IWAC, *The Allocation of Water Resources in a Transboundary Context to Strengthen Water Cooperation between Eurasian Countries* (Nur-Sultan, Kazakhstan, 2021).

The European Union Water Framework Directive provides an example of river basin management planning that can be applied in a transboundary setting. The Directive requires that Member States aim at producing an international river basin management plan when a transboundary basin (international river basin district) is located entirely in the area of the European Union. Member States must also endeavour to produce such a plan with non-member States when transboundary waters extend beyond the boundaries of the European Union (Art. 13). Related to water quantity, the plan must include, for example, estimation of pressures on the quantitative status of water, a summary of the economic analysis of water use, a report on the practical steps and measures taken to apply the principle of recovery of the costs of water use, and a summary of the controls on abstraction and impoundment of water (Annex VII).

Main points to consider

The development of allocation mechanisms and plans may provide flexibility for transboundary water allocation. Flexibility is required because uncertainties and changing circumstances, as consequences of climate change and other pressures affecting transboundary waters, may render stationary water allocation arrangements largely meaningless.[485] At the same time, the approach to transboundary water allocation should be holistic and give recognition to long-term perspectives instead of responding impulsively to a series of new projected impacts and scenarios.[486] Overall, when developing allocation mechanisms, the following points should be taken into consideration:

- How to develop specific and adaptive allocation mechanisms and plans based on transboundary agreements and other arrangements;
- Different scales of allocation mechanisms and plans;
- Examples of allocation planning at different scales, local, national and basinwide;[487]
- Key factors to consider when developing an allocation plan—physical characteristics of the resource, how water is accessed, how the resource pool is defined, etc.;[488]
- The role of the private sector and operators of water systems.

3. Phase 3: Implementation of Transboundary Water Allocation Arrangements and Agreements

a. Step 8: Implementation

The implementation of transboundary water allocation agreements follows similar steps outlined for the implementation of the main principles of the United Nations global water conventions. First, States must enact national law and regulations and enter into cooperative arrangements, such as establishing joint bodies. Second, States need to adopt sufficient administrative measures. Third, States need to make sufficient human, financial and technical resources available for implementation.[489] While allocation mechanisms may be formally enshrined in treaties and related mandates of RBOs, the plans and systems for implementation of water allocation arrangements may be more informal, depending on the arrangement. Such arrangements may take the form of policy documents and subsequent policy or legal/regulatory instruments. However, their implementation often requires the same steps as for the agreements.

CASE STUDY 43: Joint management of Doosti Dam by Iran and Turkmenistan

Following decades of planning during the Soviet period, in 1999, Turkmenistan signed an agreement with Iran to jointly construct a dam on the border Harirud River. The purpose of the dam and reservoir is to reduce the flood risks and provide regulated flow for development of irrigated agriculture in the two countries. Construction of the 78 m-high earthen Doosti dam was financed jointly by Iran and Turkmenistan and the countries have rights of equal shares of the water available.

For joint management of the dam, the Doosti Dam Common Coordinating Commission (DCC) was established in 2000 with equal representation from the local water management authorities of both countries. The DCC is in charge of implementation of the operational and maintenance manual for the dam and the downstream Shirtape diversion dam. It conducts joint measuring and monitoring and is also in charge of guaranteeing the environmental flow of approximately 30 million m^3 per year.

While an adequate transboundary legal framework brings predictability and allows for stability, practical experience show that a legal basis is not always necessary for transboundary cooperation, depending on the countries and their relationships. A common understanding and/or shared interests can also provide a

[485] Honkonen (2017), p. 3.
[486] Ibid., p. 9–10.
[487] Speed and others (2013).
[488] OECD (2015).
[489] See UNECE, *Guide to Implementing the Water Convention* (2013), p. 8.

functioning basis for practical cooperation. Moreover, when interests are aligned, national policies in the upstream country may, to a large degree, also respond to the needs of a downstream country, as may be the case for a flow regulation regime that serves multiple purposes, provided that there is good communication between the parties. In some cases, where political relations are tense (e.g. there is a territorial issue), informal technical-level realization may be the only possible way to implement the measures that might be necessary, for example, for safety reasons.

The implementation of the Water Convention already provides a comprehensive set of implementation measures at the national and international levels. These measures can be specified and complemented in transboundary water agreements and other arrangements. The Convention requires countries to take many national-level implementation measures related to water allocation, such as:

- promotion of sustainable water resources management;
- application of EIA and other means of assessment;
- prevention, control and reduction of the emission of pollutants at source (Art. 3.1);
- monitoring of the conditions of transboundary waters (Art. 4).

Concerning implementation measures at the transboundary level, the Water Convention stipulates that the agreements and arrangements must provide for the establishment of joint bodies and sets the following tasks, for example, for these joint bodies:

- elaboration of joint monitoring programmes concerning water quality and quantity;
- establishment of warning and alarming procedures;
- exchange of information on existing and planned uses of water and related installations that are likely to cause transboundary impact (Art. 9.2).

Depending on the State system, national water allocation is further divided into basin-level and regional water allocation. The transboundary shares are usually allocated to subnational jurisdictions, administrative regions and management entities that decide and grant water entitlements, permits and licences to individual water users and abstractors.

Main points to consider
Implementation of transboundary water allocation arrangements and agreements at national and subnational levels often requires the following elements:

- water allocation planning at different levels, from transboundary basin to subcatchment and aquifer;
- regional limits on water abstraction;
- water entitlement or licensing systems that take the limits into account;
- annual water allocation process that assesses available waters and allocates them among different regions or uses;
- other water management systems such as hydrologic modelling, data collection, monitoring and measures to guarantee compliance and enforcement.[490]

b. Step 9: Monitoring and ensuring compliance

Compliance is a central element of the implementation of water allocation arrangements and agreements. It can be defined as a State's behaviour in accordance with its commitments stemming from the allocation agreements. A compliance system includes rules and procedures such as a compliance review that assess, regulate and ensure compliance. Monitoring compliance is an essential element of that system. Non-

[490] See Speed and others (2013), p. 91–97.

compliance may be a result of a State's unwillingness and/or inability to meet its commitments but can also relate to ambiguity and indeterminacy in agreement language.[491]

Monitoring and assessment under the United Nations global water conventions

The United Nations global water conventions include many provisions that aim at monitoring and ensuring compliance with the conventions as well as transboundary arrangements and agreements based on them. The Water Convention requires States to establish programmes for monitoring the conditions of transboundary waters (Art. 4) and the riparian countries to elaborate joint monitoring programmes concerning water quality and quantity (Art. 9.2). The riparian countries shall also exchange information on transboundary waters and impacts (Art. 13), as well as inform each other about critical situations and set up warning and alarming systems (Art. 14). According to the Watercourses Convention, riparian countries shall exchange data and information on the conditions of transboundary waters (Art. 9). The Convention includes a specific Part III on planned measures that may have an effect on the conditions of transboundary waters (international watercourse in the Convention). Accordingly, States shall inform and consult and negotiate with each other on these effects and, if needed, provide other States with timely notification thereof. In addition, the Convention includes provisions on the reply to the notification and on consultations and negotiations concerning planned measures (Arts. 11–19).

Concerning transboundary water allocation arrangements and agreements, active reporting and regular exchange of information is an essential measure for monitoring and ensuring compliance. Joint bodies are often charged with a monitoring task when compliance review and support mechanisms are included in the arrangements. Joint bodies may play an important role in the compliance review process, for example, through monitoring of action plans and the efforts of States to meet objectives, standards and targets.[492] Often, there is a higher risk of experiencing transboundary conflict if water allocation agreements and other arrangements do not contain follow-up monitoring and enforcement mechanisms.[493] However, compliance mechanisms should be different from dispute prevention and settlement measures between co-riparian parties as contained in any allocation framework. Any compliance review procedure should be without prejudice to dispute settlement.[494]

Monitoring and the exchange of data and information should enable assessments of quantity and quality of transboundary waters, and their variability in space and time. It should support decision-making on transboundary water allocation, including in critical situations.[495] In general, the analysis of water allocation issues and challenges guides the specification of information needs related to water uses, their impacts and varying environmental circumstances, such as flooding and drought, sedimentation, salinization and pollution. Monitoring and the exchange of information increases transparency and thus promotes compliance. Ideally, a water allocation regime creates incentives for voluntary compliance with the arrangement or agreements. These incentives may be linked, for instance, to State reputation or benefits under the regime. In general, the lack of an explicit enforcement mechanism in a transboundary water agreement may discourage voluntary compliance by the parties.[496] In reality, however, compliance monitoring by joint bodies is rarely

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[491] UNECE, Geneva Strategy and Framework for Monitoring Compliance with Agreements on Transboundary Waters (MP.WAT/2000/5), Annex I, paras. 3–4.

[492] MP.WAT/2000/5, Annex I, paras. 3–7.

[493] Patricia Wouters, "Universal and regional approaches to resolving international water disputes: what lessons learned from state practice?", in *Resolution of International Water Disputes: Papers Emanating from the Sixth PCA International Law Seminar, November 8, 2002*, International Bureau of the Permanent Court of Arbitration, ed. (The Hague, Kluwer Law International, 2003), p. 111–154.

[494] MP.WAT/2000/5, Annex I, para 29.

[495] UNECE, *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (2006).

[496] Richard Kyle Paisley and Alex Grzybowski, "Some reflections on the resolution of state-to-state disputes in international waters governance agreements", *International Journal of Rural Law and Policy*, No. 1. (2011), p. 1–18.

imposed, and mechanisms for enforcing decisions and responding to monitored non-compliance are even rarer.[497]

UNECE published the Geneva Strategy and Framework for Monitoring Compliance with Agreements on Transboundary Waters in 2000. It is based on the following premises:

a) The parties agree to monitor compliance with their agreement(s) on transboundary waters through the establishment of a compliance review process. This commitment of States may be found in the agreement on transboundary waters, or in subsequent instruments or mechanisms, including, for example, a decision of the Meeting of the Parties or activities of joint bodies;
b) The compliance review process should be based on mechanisms designed to enhance, improve and ensure compliance, rather than on compliance control and enforcement tools and traditional judicial mechanisms. To this end, the regime created should focus on positive measures and incentives aimed at facilitating compliance;
c) The instrument embodying the compliance review procedure should be, ideally, legally binding. The obligations subject to compliance, however, may arise out of non-legally binding instruments, for example, guidelines, voluntary measures, targets and objectives, and may relate to assessment of efforts undertaken, and not only of results achieved;
d) The compliance review procedure is greatly enhanced by the elaboration of clear primary rules, objectives or targets; the elaboration of compliance information systems; the involvement of an institutional mechanism; a response to problems with compliance that, in the first instance, is positive, forward-looking, non-confrontational and non-judicial, and is supplementary to, and independent from, any settlement regime.[498]

Water Convention Implementation Committee supporting parties with implementation and compliance issues

Under the Water Convention, the Implementation Committee's objective is to "facilitate, promote and safeguard the implementation and application of and compliance with the Convention". The Committee is meant to deal with specific cases of difficulties with implementing the Convention and is intended as an alternative to a dispute settlement procedure. As a dispute prevention and resolution mechanism, it is intended to be simple, non-confrontational, non-adversarial, transparent, supportive and cooperative in nature, building on the distinctive collaborative spirit of the Convention. Concerning compliance with the Convention, the Committee may serve as a means to prevent situations from evolving into a dispute.[499] The Committee consists of nine members elected by the Meeting of the Parties. The members serve in their personal capacity. The Committee has specific advisory, submission, own initiative and information-gathering and consultation procedures.[500] The Committee may, for example:

- consider any submission relating to specific issues concerning difficulties in implementation and compliance;
- consider undertaking a Committee initiative;
- examine, at the request of the Meeting of the Parties, specific issues of implementation of and compliance with the Convention;
- take measures, including recommendations.

[497] Schmeier (2013).
[498] MP.WAT/2000/5, Annex I, para 8.
[499] Johan G. Lammers, "The implementation mechanism and committee established under the UNECE Convention on the Protection of Transboundary Watercourses and International Lakes", in *Research Handbook on International Water Law*, McCaffrey, Leb and Denoon, eds. (2019), p. 319–339.
[500] UNECE, Decision VI/1 on support to implementation and compliance (ECE/MP.WAT/37/Add.2), available at https://unece.org/sites/default/files/2021-05/DECISION%20VI-1ece.mp_.wat_.37.add_.2_eng.pdf.

To support implementation and to address cases of non-compliance the Committee may take the following measures, for example:

- suggest or recommend setting up and strengthening domestic regulatory regimes;
- request and assist the party or parties concerned to develop an action plan to facilitate implementation of and compliance with the Convention;
- invite the party concerned to submit progress reports to the Committee on the efforts that it is making to comply with its obligations under the Convention;
- recommend to the Meeting of the Parties to take specific measures such as to recommend that parties provide capacity-building measures or issue a statement of concern or declarations of non-compliance.

c. Step 10: Dispute prevention and resolution mechanisms

Dispute prevention

Cooperative management of a transboundary freshwater basin has considerable potential to prevent conflicts and to promote regional stability.[501] Cooperative management on the basis of the United Nations global water conventions and water allocation arrangements and agreements between the riparian countries aims to reconcile water uses and alleviate challenges stemming from, for example, water scarcity, pollution and flooding.[502] Environmental changes due to climate change and other pressures are likely to sharpen possible conflicts over water and trigger new ones.[503] Trust-building and the maintenance of legitimacy among the riparian countries are essential requirements for conflict prevention. In general, dispute prevention and resolution mechanisms in water agreements and arrangements can be seen as a sequence of steps that may include procedures for cooperative management, clarifying facts, negotiation, mediation and, as the last resort, dispute resolution.[504]

Joint bodies can play an important role in preventing water allocation disputes between the riparian countries. They can manage the use of shared water resources and stipulate rights and obligations in support of the underlying agreements and arrangements, and thus prevent disputes from escalating.[505] Many transboundary water regimes rely on joint bodies to prevent disputes, or to act as pragmatic conflict resolution facilitators.[506] Joint bodies often have expertise and enough neutrality to act in both conflict prevention and dispute settlement within shared basins. In practical terms, the following elements of transboundary water allocation can be central in preventing disputes:

- routines of water allocation and information exchange that create predictability;
- flexibility to adapt to changing circumstances;
- open communication and gathering of and access to information.

In some cases, possible water allocation disputes between/among the riparian countries may relate to the interpretation of water allocation agreements and the United Nations water conventions. Concerning the interpretation of the Water Convention, the Implementation Committee (see subsection 3b above) may serve as a non-adversarial means for preventing situations from evolving into a dispute. An advisory procedure under the Implementation Committee is a unique tool that distinguishes this body from other similar mechanisms and enables it to engage with countries seeking to resolve water issues in a non-confrontational

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[501] Benjamin Pohl and others, *The Rise of Hydro-diplomacy: Strengthening of Foreign Policy for Transboundary Waters* (Berlin, Adelphi, 2014).

[502] See Vinogradov and Wouters (2013).

[503] See, for example, Pohl and others (2014).

[504] See Paisley and Grzybowski (2011), p. 116–134.

[505] See Jaroslav Tir and Douglas M. Stinnett, “Weathering climate change: can institutions mitigate international water conflict?”, *Journal of Peace* Research, vol. 49, No. 1 (January 2012), p. 211–225.

[506] Wouters (2003).

manner.[507] Aimed at facilitating implementation and application of the Convention through the provision of advice by the Committee, an advisory procedure shall not be regarded as alleging non-compliance. Options that are open to the Committee in resolving an issue via an advisory procedure are:

"a) To provide advice and facilitate assistance to individual Parties and groups of Parties in order to facilitate their implementation of the Convention, which may include:
  - (i) Suggesting or recommending that domestic regulatory regimes be set up or strengthened and relevant domestic resources be mobilized as appropriate;
  - (ii) Assistance in establishing transboundary water cooperation agreements and arrangements for strengthening cooperation and sustainable management of transboundary waters;
  - (iii) Facilitating technical and financial assistance, including information and technology transfer, and capacity-building;
  - (iv) Assistance in seeking support from specialized agencies and other competent bodies, as appropriate;

(b) To request and assist, as appropriate, the Party or Parties concerned to develop an action plan to facilitate implementation of the Convention within a time frame to be agreed upon by the Committee and the Party or Parties concerned;

(c) To invite the Party concerned to submit progress reports to the Committee on the efforts that it is making to implement its obligations under the Convention."[508]

Dispute resolution

According to the Water Convention, parties to a dispute about the interpretation or application of the Convention must seek a solution by negotiation or by any other means of dispute settlement acceptable to them. Thereafter the dispute may be submitted to the International Court of Justice or arbitration for a compulsory dispute settlement if the parties have accepted such an option (Art. 22). The Watercourses Convention provides a list of options available to States in order to settle their possible controversies. Disputes concerning the interpretation or application of the Convention's provisions shall initially be the object of negotiations. If no negotiated settlement is found within six months, the States parties to the dispute shall, at the request of any of them, seek a settlement by diplomatic methods such as good offices, mediation or conciliation, or use the services of any joint watercourse institution entitled to deal with such disputes, or agree to submit the dispute to arbitration or to the International Court of Justice (Art. 33).

The Watercourses Convention stipulates, furthermore, that where the matter is not resolved by using traditional means of dispute settlement, the parties may resort to compulsory fact-finding by an ad hoc commission composed of one member designated by each party and a national of a third State chosen by the members already designated. The non-binding recommendations of the commission are aimed at achieving "an equitable solution of the dispute, which the parties shall consider in good faith" (Art. 33).

CASE STUDY 44: Indus Waters Treaty dispute resolution mechanisms

The Indus Waters Treaty governs allocation between India and Pakistan on their areas of the Indus Water System. The Treaty is rare in that it has survived various periods of disagreement between the parties since 1960. It includes unique dispute resolution mechanisms divided into three sequential streams: Questions, Differences and Disputes.[509]

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[507] See the example of Montenegro and Albania engaging in an advisory procedure: UNECE, "Water Convention's Implementation Committee provides advice to Albania and Montenegro on the transboundary Cijevna/Cem River", 11 February 2021.

[508] See ECE/MP.WAT/37/Add.2, Annex I, V, para. 22.

[509] This is a matter of Treaty interpretation. The Permanent Court of Abritration *Indus Waters Kishenganga Arbitration (Pakistan v. India)* decision differs from this specific view.

The first mechanism concerns any question that arises between the parties in relation to implementation or application of the Treaty, or existence of any fact that one party considers a breach of the Treaty. This shall be examined by the Permanent Indus Commission at first instance. If the Commission does not reach an agreement on any of the Questions referred to it, then a Difference shall be deemed to have arisen.

Differences shall be dealt with as follows: any Difference which, in the opinion of either Commissioner falls within the provisions of Part 1 of Annexure F of the Treaty shall be dealt with by a Neutral Expert, in accordance with the provisions of such Annexure. The Neutral Expert shall be a highly qualified engineer and shall be appointed by agreement by the two parties, or by a third party agreed upon by the two parties. If the two parties are unable to agree on a Neutral Expert, or on a third party to appoint the Neutral Expert, then the World Bank will appoint the Neutral Expert after consultations with the two parties. The decision of the Neutral Expert is final and binding on the parties. It is not appealable to the Court of Arbitration or any other body. If, in the opinion of either Commissioner, the Difference does not fall within the provision of Part 1 of Annexure F, or if the Neutral Expert decides that the Difference shall be treated as a Dispute, then the Difference will be treated as a Dispute.

For a Dispute, either government may invite the other government to resolve the dispute through negotiations. The two governments may agree to enlist the services of one or more mediators acceptable to them. A Court of Arbitration shall be established to resolve the Dispute: (i) upon agreement between the two parties; (ii) at the request of either party, if, after negotiations have begun pursuant to Paragraph (4), in its opinion the dispute is not likely to be resolved by negotiation or mediation; or (iii) at the request of either party, if, after expiration of one month following the invitation to resolve the dispute through negotiations, that party comes to the conclusion that the other government is duly delaying the negotiations. Unless otherwise agreed, the Court of Arbitration shall be composed of seven arbitrators: two arbitrators shall be appointed by each of the two parties. The three remaining arbitrators (called umpires) shall include the Chairman of the Court, an engineer, and an international lawyer, the three to be appointed in accordance with detailed procedures set forth in Annexures G of the Treaty. Such procedures involve the United Nations and the World Bank for the selection of the Chairman; the Massachusetts Institute of Technology and the Imperial College of Science and Technology in London for the selection of the engineer member, and the Chief Justice of the United States and the Lord Chief Justice of England for the selection of the legal member of the Court.

Since 1990, 61 per cent of international river basin agreements have incorporated some sort of dispute resolution mechanism.[510] Five different mechanisms and their shares of the total are: the use of diplomatic channels (39 per cent); arbitration (32 per cent); the creation of special commissions for conflict resolution (28 per cent); the agreement to submit a dispute to an existing permanent judicial organ, such as the International Court of Justice (8 per cent); and third-party involvement (6 per cent).[511] It is important that the mechanisms are clearly defined, applied in a timely manner and can bind disputing parties to a settlement that ensures their equal contribution to the solution.[512] The parties to the dispute need to feel that they have been treated fairly, the dispute has been handled impartially and effectively and the resolution is based on correct information and has come about through a legitimate process.

CASE STUDY 45: Dispute prevention and settlement provisions in the Mekong River Agreement

Within the Mekong River Agreement, the joint treaty body must take the initiative to resolve disputes between parties in matters covered by the Agreement. In the words of the Agreement, it is the task of the Council of the Mekong River Committee (MRC) "to entertain, address and resolve issues, differences and disputes referred to it […] on matters arising under the Mekong Agreement". Furthermore, the Joint Committee of the MRC is asked to "address and make every effort to resolve issues and differences that may arise between regular sessions of the Council, referred to it […] on matters arising under the Agreement". The dispute can be considered resolved only if "the

[510] Giordano and others (2014).
[511] Ibid.
[512] Susanne Schmeier, "Resilience to climate change: induced challenges in the Mekong River basin: the role of the MRC", Water Papers, No. 61810 (Washington, D.C., World Bank, 2011).

concerned parties are satisfied". Only after the Commission has proved unable to resolve a dispute in a timely manner shall the case be referred to the governments of the States for resolution through diplomatic channels. The Commission is the first instance to resolve disputes.

Dispute resolution mechanisms in international water agreements can be structured as a sequence of progressively intensive steps or elements from fact-finding to negotiation and dispute resolution:[513]

- **Negotiations.** Within transboundary water regimes, negotiation is the primary mechanism for resolving disputes between the parties. Negotiations may take place through diplomatic channels or meetings of experts and can be assisted by a joint body. Negotiations may lead, for example, to the creation of a memorandum of understanding between the parties
- **Mediation and good offices.** Mediation involves a neutral external party that guides the negotiation process and helps to identify potential solutions to the dispute. The role of a mediator may range from encouraging the parties to resume negotiations and facilitate dialogue (i.e. good offices) to the investigation of the dispute and active participation in finding a solution.[514] Mediation may only be undertaken by mutual agreement by the parties.
- **Conciliation.** In conciliation, an impartial person or a formal impartial commission studies the facts of the case, establishes the applicable law and makes solution proposals for the parties.
- **Fact-finding and inquiry.** An impartial person or commission investigates factual or technical matters.
- **Compulsory fact-finding.** According to the Watercourses Convention, a fact-finding commission can be established and it can make "such recommendation as it deems appropriate for an equitable solution of the dispute". However, the parties to the dispute are not bound by the commission's recommendation and may still invoke compulsory dispute settlement procedures, such as arbitration or adjudication (Art. 33).
- **Arbitration.** Arbitration means that a dispute is submitted to a third party for resolution. The arbitrator is always a neutral expert and is not involved with the parties or the governing organization of the regime within which the dispute has arisen. Arbitration requires the prior consent of each party to the dispute. In the Watercourses Convention arbitration is provided for in Article 33 and complemented by the Annex that sets out the rules for the establishment and operation of an arbitral tribunal. Arbitration can be a voluntary or mandatory forum (based on jurisdiction to hear the matter being accepted by the disputing parties) for dispute settlement, the outcome/decision of which is final and binding.
- **Dispute resolution by a joint body**. The role of a joint body in preventing and managing disputes largely depends on its characteristics, operating environment and tasks. The regulatory and implementation powers of joint bodies vary, as does their capacity to manage and prevent conflicts. An effective joint body is generally more akin to a multi-issue body that is able to adopt a balanced approach to issues and resolving conflicts. Sometimes a joint body may be designated as the first or primary actor to resolve a dispute between the parties.
- **Specific organizations.** Some organizations serve the conflict management needs of several transboundary water treaty regimes.
- **Adjudication.** It is sometimes possible to refer the dispute to a national or international court. Concerning the International Court of Justice, its general mandate includes the settlement of legal disputes submitted to it by States. No State can be brought to the Court without its prior consent.
- **Permanent international tribunals.** Unless otherwise agreed, a settlement of a dispute by a permanent international tribunal is final and binding and based on rules of international law.

[513] Paisley and Grzybowski (2011).
[514] Ine D. Frijters and Jan Leentvaar, "Rhine case study", IHP-VII Technical Documents in Hydrology, PC-CP Series, No. 17 (Paris, UNESCO, 2003).

Transboundary water regimes should be able to determine the conditions for dispute resolution. These include matters such as who may trigger a mechanism, what kinds of issues may be dealt with through it and what is the role of a joint body in dispute resolution. One example of a dispute resolution process mandated by treaty which related to transboundary water allocation occurred in 2010, when Pakistan instituted arbitral proceedings regarding India's Kishenganga Hydroelectric Project. In the matter of the *Indus Waters Kishenganga Arbitration (Pakistan v. India)*, the Court of Arbitration was constituted in accordance with the provisions in the Indus Waters Treaty and it then rendered a partial award on 18 February 2013.[515] In general, the use of a dispute resolution mechanism may be possible after a breach of the agreement, when its interpretation or application is uncertain, in the course of a periodical review, or when a sudden change in physical conditions of transboundary waters has taken place.[516]

CASE STUDY 46: Mechanism for settling differences and compensation in the Finnish–Russian cooperation framework

An example of a river basin organization (RBO) that has been actively involved in settling different, sometimes diverging, interests between the parties is the Finnish–Russian Commission on the Utilization of Frontier Waters. The underlying Agreement Concerning Frontier Watercourses generally provides that the parties may agree to refer any matters concerning the prohibition of pollution or altering the course or flow of a waterway to the joint Commission for a decision or opinion. This appears to also include possible matters under dispute between the parties. If the Commission fails to reach consensus on the matter, or if the consequences of the said measure on the territory of the other contracting party are significant, the matter must be submitted to the governments of the two States for consideration.

The role of the Commission in conflict resolution is further affirmed by Article 19 of the Agreement, which states that the Commission shall settle any differences of opinion arising from the interpretation or application of the Agreement. If this route proves unsuccessful, the matter will be settled by a Joint Board consisting of representatives of both governments. If the occurrence of transboundary harm cannot be avoided under the Finnish–Russian transboundary water regime, i.e. when the execution of certain measures by one contracting party causes loss or damage in the territory of the other party, the contracting party that permitted such measures can be held liable. The changes in water discharge volumes are agreed in the Commission, and parties may agree on reparation and the Commission shall decide upon any possible compensation to be paid to the party that has suffered losses.

The most significant test so far of the liability regime under the Agreement was a case in which a Finnish hydroelectric power station incurred losses due to construction of a dam and a hydroelectric power station in Svetogorsk in the Russian Federation. The Commission actively participated in settling the issue of compensation.

[515] For further information, see Permanent Court of Arbitration, "*Indus Waters Kishenganga Arbitration (Pakistan v. India)*".
[516] Charlotte De Bruyne and Itay Fischhendler, "Negotiating conflict resolution mechanisms for transboundary water treaties: a transaction cost approach", *Global Environmental Change*, vol. 23, No. 6 (December 2013), p. 1841–1851.

ANNEX: Typology for Transboundary Water Allocation

SUMMARY:
This Annex outlines the transboundary water allocation typology methodology developed for cataloguing and analysing allocation mechanisms in international water agreements that was used in a discrete piece of research specifically commissioned for this Handbook. The methodology and data used are just one approach to conducting a broad analysis of the global practice of allocation in international freshwater agreements.

1. Purpose of Research

Much of the literature on transboundary allocation outlines approaches to and considerations of how allocations can be negotiated between parties but provides minimal explanation for physically dividing and sharing transboundary waters between riparian States. In the process of developing the *Handbook on Water Allocation in a Transboundary Context*, the Water Convention secretariat, in conjunction with the Drafting Team, sought to include a broad assessment and synthesis from existing global practices and mechanisms in transboundary water allocation agreements.

The online International Freshwater Treaties Database (IFTD), housed within the Transboundary Freshwater Dispute Database (TFDD), contains both global and regional information in searchable tabular and spatial data sets, treaty and compact libraries, and GIS shapefiles available for download. Developed and maintained by Oregon State University College of Earth, Ocean, and Atmospheric Sciences, in collaboration with the Northwest Alliance for Computational Science and Engineering, the TFDD catalogues allocation mechanisms present within current and historical transboundary water agreements.

In order to provide an assessment and synthesis of global practice from international freshwater agreements, the full data set in IFTD has been extracted and coded using a new methodology developed for this research —Typology of Transboundary Water Allocation (TTWA). The TTWA was developed to catalogue and analyse allocation mechanisms present in international water agreements over transboundary surface and groundwaters. A synthesis of the results, including highlights and tables, is provided in the text of the Handbook.

This annex describes the new TTWA typology for cataloguing and tracking water allocation mechanisms to address the gap between previous methods for cataloguing and recent discourses. It outlines the methodology and analyses the general approaches and their practical application. It concludes by addressing the application of the TTWA and how it relates to the theoretical approaches to allocation and to flexibility and adaptive capacity.

2. Context and Data for Research

The TTWA methodology builds on previous work tracking transboundary water allocation mechanisms.[517] The typology is based on overarching theoretical approaches that have shaped the allocation of transboundary waters, as well as examples of considerations that can be used to interpret and apply these approaches when

[517] Hamner and Wolf (1997); Giordano and others (2014).

developing an allocation mechanism. Moreover, the allocation mechanisms in the TTWA take into account theoretical approaches to allocation and their respective considerations, as described below. Furthermore, the methodology also enables comparison of the types of mechanism, such as direct, indirect, principle based and groundwater specific.

The results of this analysis of past and present international freshwater agreements—spanning from the 1860s to 2017—using the TTWA methodology has been highlighted in the text of the Handbook (see Box 4; Chapter II, section 3; Chapter VI, section 2: Chapter VII, subsection 2c). This analysis accompanies a broader update, spanning the period 1820 to 2020 of the IFTD, which is in process and will soon be published.[518] At the time of writing, there are 744 entries in the treaties database;[519] of these, 599 are coded for allocation mechanisms.[520] Within this data set, there are 180 individual documents with at least one mechanism for surface and/or groundwater allocation. This figure can be compared with the 68 of 145 treaties identified by Hamner and Wolf in the first iteration of the IFTD,[521] and the approximately 80 of 215 treaties[522] considered by Giordano and others in 2014.

3. Typology for Transboundary Water Allocation Methodology

The TTWA (see Table 8 in Chapter VI and Table 12 in Chapter VIII), is comprised of three sections: groundwater allocation, surface water allocation, and hydropower benefits division. Consequently, these three sections are discussed separately in the Handbook, in Chapter VI, section 2.

Within the groundwater and surface water allocation components, the TTWA accounts for both why water is allocated (context clause) and how it is allocated (explanatory clause). It separates allocation mechanisms into these two components, pairing the explanatory clause with a context clause. The explanatory clause captures how water is physically allocated, divided or distributed between or among the riparian States. The second component of the TTWA is the context clause, which captures the purpose of the allocation mechanism, identifying why the water was allocated in a particular way. For example, a treaty might divide water using a fixed volume or flow rate for the purpose of irrigation, or the signatories may identify a percentage of flow that needs to be maintained to meet a basin's minimum environmental needs. Other potential contexts for allocation contained within the TTWA (see Table 7: Breakdown of Allocation Context Clauses) include minimum flows, hydropower, navigation or an undefined purpose.

As a result, the TTWA enables the study of how transboundary water allocation has changed over time, both in terms of the approaches used for allocation and *how* and *why* water was allocated. Through this, it is also possible to see how water allocation is context dependent. For example, it might be more common to delegate water in amounts that vary depending on the time of year in areas with high agricultural activity, in order to allow for irrigation planning.

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[518] McCracken and others, "Typology for transboundary water allocation" (forthcoming).
[519] This number includes all entries in the IFTD as of June 2020. Not all entries are treaties, nor do all of these fit the inclusion criteria. In addition, some maybe missing text or not coded.
[520] This number includes all entries in the IFTD as of June 2020 that are coded for allocation mechanisms using the TTWA. The other agreements may be missing or in a language that is not able to be coded at this time.
[521] Hamner and Wolf (1997).
[522] Note that these values are not directly comparable to the current numbers nor the Hamner and Wolf (1997) study, as the Giordano and others (2014) study considers treaties based on their lineage and linked nature between primary agreements, amendments, and replacements.

Additionally, the TTWA contributes a clarifying distinction between allocation mechanisms for surface and groundwater. Historically, the focus of allocation mechanisms has been on sharing surface water, which also forms the foundation for the approaches guiding transboundary water allocation. With growing attention and interest in the shared management of groundwater, there is a need for groundwater allocation mechanisms that are based on the unique properties and physical characteristics that distinguish groundwater from surface water. Therefore, in addition to separating allocation mechanisms for surface and groundwater, the TTWA also establishes several groundwater-specific explanatory clauses for how water is physically divided between States (see Table 6: Frequency of explanatory clauses in surface and groundwater allocation mechanisms in international water agreements). These include using pumping rates, water table levels and spring outflows to monitor or determine quantities for allocation, as well as mechanisms that divide water based on the pore space or storage capacity of an aquifer rather than the volume of water itself.

Past research has shown that one of the predominant purposes for allocation was hydropower; however, through new coding, McCracken and others found that States often allocate benefits from hydropower rather than allocating water volumes to hydropower projects.[523] This led to the creation of the third section of the TTWA, the Hydropower Benefits Division. This code identifies the legal mechanisms for how benefits are shared or divided from hydropower, such as fixed quantities of power, percentages of power and value generated from power sales. A breakdown of the Hydropower Benefits Division is provided in Table 8: Frequency of different mechanisms for Hydropower Benefits Division.

4. Analysing General Approaches to Allocation

As detailed in Chapter II, allocation mechanisms can be organized into six core theoretical approaches, as shown in Table 1. The six main approaches are: rights-based, needs-based, hierarchy, proportionate division, strategic development, and market-based. These theoretical approaches provide a perspective or lens through which States can develop their position, interests or needs for allocations. Some of these approaches can be used collaboratively or cooperatively, which can encourage States to develop joint interests and needs that ultimately lead to allocation mechanisms that are relevant to the basin or aquifer and provide shared benefits to the riparian States.

The different explanatory clauses, as outlined in the TTWA, can be associated with multiple approaches, depending on how they are used and applied through the lens of a particular approach. There are three categories of explanatory clauses for allocation mechanisms to address *how* water is allocated: direct mechanisms, indirect mechanisms and principle-based mechanisms.[524] Each of the approaches in Table 1 (in Chapter II) can be associated with multiple explanatory clauses and is paired with an example in an international water agreement. Also, there are explanatory clauses that can be used within more than one approach, such as “fixed quantity”. For example, a State can identify a set volume of water it requires based on its rights, needs or hierarchy of uses. The theoretical approach, therefore, influences how the volume is arrived at, as well as how the State might present an argument for requiring this volume in a negotiation. It is important to note that a “market-based” mechanism has yet to be implemented at the international scale, but this is increasing in the discourse at national and subnational scales. For example, new water entitlements based on “market mechanisms” have been issued for unallocated water or reallocated water at local and subnational levels.[525]

[523] McCracken and others, “Typology for transboundary water allocation” (forthcoming).
[524] Giordano and others (2014); Drieschova, Giordano and Fischhendler (2018).
[525] Speed and others (2013).

5. Application of the Typology

In applying the TTWA to the data set of international freshwater agreements extracted from the TFDD, it is clear that theoretical approaches to transboundary water allocation simply provide a general perspective or lens through which States can develop their position, interests or needs for allocations contextualized to their own situation. Some of these approaches can be used collaboratively or cooperatively, which can encourage States to develop joint interests and needs that ultimately lead to allocation mechanisms that are relevant to the basin or aquifer and provide shared benefits to the riparian States.

The other important element to note with respect to the application of the TTWA is that each allocation mechanism has differing degrees of flexibility that allow for effective reactions to changes in either the environment or political relations. As noted above, the presence of an allocation mechanism in a transboundary water agreement is a measure that has been used to evaluate the level of institutional capacity for the water resource.[526] An allocation mechanism, depending on its degree of flexibility, has the potential to increase the adaptive capacity—the ability of the actors to respond, create or shape the system[527]—of the institutional arrangements in the basin or aquifer.

This analysis of international water agreements from the 1860s to 2017 shows that there has been an overall increase in the number of treaties with allocation mechanisms over time, which has the potential to increase the institutional capacity in those basins. However, not all allocation mechanisms are equivalent in increasing the adaptive capacity, as some explanatory clauses are not as flexible as others. An example of this would be "fixed quantities" vs. "percentage of flow". Allocating water by a percentage of flow allows for water divisions to vary according to the seasonal or annual variability in the total flow rate for a river, while still maintaining a proportional division. Allocating water through fixed quantities, on the other hand, does not account for variability in flow, such as droughts, since it still mandates a set volume of water. The flexibility of a fixed quantity clause can be increased through the inclusion of other explanatory clauses, such as "variable by water availability" or "variable according to time of the year".

Of the 175 surface water treaties with at least one mechanism for water allocation analysed from the IFTD, 148 allow for at least some flexibility to react to changes in the system, such as in the available supply, changing demand or an institutional change. The following explanatory clauses were identified as having some flexibility in water allocation mechanisms: "variable by water availability", "variable according to time of the year", "equitable use", "sustainable use", "equal division", "percentage of flow", "consultation and/or prior approval" and "water loans". As for groundwater, all 14 identified treaties had at least one flexible mechanism ("variable by water availability", "sustainable use", "consultation and/or prior approval"). Some mechanisms allow for greater flexibility than others, and the degree of flexibility and the increase in the adaptive capacity it provides is dependent on the context of the basin or aquifer, including the physical and political characteristics of the resource. With climate change, as well as increases in water demand, it is crucial for States to consider the theoretical approaches and the degree of flexibility of allocation mechanisms to increase both their institutional and adaptive capacities.

[526] Elizabeth J. Kistin and Peter J. Ashton, "Adapting to change in transboundary rivers: an analysis of treaty flexibility on the Orange-Senqu River Basin", *International Journal of Water Resources Development*, vol. 24, No. 3 (2008), p. 385–400; Lucia De Stefano and others, "Climate change and the institutional resilience of international river basins", *Journal of Peace Research*, vol. 49, No. 1 (January 2012), p. 193–209.

[527] Margot Hill, "Characterizing adaptive capacity in water governance arrangements in the context of extreme events", in *Climate Change and the Sustainable Use of Water Resources*, Walter Leal Filho, ed. (Heidelberg, Springer, 2012), p. 339–365.

6. General Conclusions

While the specific outcomes of this research are detailed within the text of the Handbook, highlighted here are several general, overarching conclusions that were drawn from this brief synthesis of the analysis of the 599 treaties coded for allocation mechanisms within the IFTD undertaken using the TTWA. First, there is a generally positive trend, with some fluctuations, in the number of agreements that include allocation mechanisms for surface and groundwater. This is beneficial as they are likely contributing to the institutional capacity governing these shared resources, as well as potentially adding to the adaptive capacity that will help in overcoming uncertainties due to climate change. Second, there has been a change in the type of mechanisms that States include in their agreements, moving towards indirect and principle-based explanatory clauses and away from direct mechanisms. Third, there is an increasing trend in the number of groundwater-specific allocation mechanisms since the 1970s; however, more work is needed to develop groundwater-specific mechanisms that consider the unique characteristics of international transboundary groundwater. Fourth, most allocation mechanisms do not define a purpose for their allocation (context clause). For those that do, *agriculture/irrigation*, *hydropower*, and *domestic use* are the most common; however, *environmental needs* and *water quality* have become more common since the 1970s.

7. Disclaimer and Additional Information

It is important for readers to note that both the TTWA methodology and the data set used in conducting this discrete piece of research for the Handbook is one approach to conducting a broad analysis of the global practice of allocation in international freshwater agreements. Other approaches may be used and this research and the Handbook does not advocate for one approach over another. Nonetheless, the IFTD in the TFDD is generally recognized as one of the most comprehensive and up-to-date databases of international freshwater agreements in the world, and the TTWA has been developed by eminent researchers who have previous experience tracking transboundary water allocation mechanisms, which is why they were selected for this task.

Additional information can be found on the TFDD website:
https://transboundarywaters.science.oregonstate.edu/content/transboundary-freshwater-dispute-database

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Handbook on water allocation in a transboundary context

The question of how freshwater resources are allocated is becoming of increasing relevance to water managers today and will be heightened in the future. Demand for water is growing globally. At the same time, availability of water is increasingly limited by growing pressures such as water scarcity, deteriorating water quality, ecosystem degradation and climate change. The question of allocation is especially heightened in transboundary contexts. Over 60 per cent of freshwater resources globally cross national boundaries. Many of these shared basins are vulnerable to the effects of climate change and other growing pressures. Where adaptivity of the existing water management arrangements is low, this can exacerbate any issues. In turn, this can compound the difficulties of States reaching peaceful settlements on water sharing in the short-, medium- and long-term future.

This publication aims to cover global practice of transboundary water allocation. It seeks to be a practical guide providing an overview of the key elements, frameworks and modalities to consider in the application of transboundary water allocation, while recognizing that every allocation context is unique. A wide array of case studies from different continents and geographical regions has been selected for the purposes of achieving diversity and balance of representation in the global examples. It is intended to foster a better understanding of the benefits and challenges of utilizing water allocation in transboundary water cooperation, building the capacity needed to address this complex issue and contribute to the sustainable management of our transboundary waters.

The novelty of this publication and its added value to the existing resources on water allocation come via the intergovernmental process under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) through which it was developed and its specific framing on water allocation in a *transboundary* context, thus addressing an identifiable niche in the available literature on water allocation and doing so with a practical focus. It should be read as a compendium of different dimensions of transboundary water allocation, highlighting the need to strike a balance between robustness and flexibility when developing allocation arrangements. Chapters can be read in order, but the Handbook is also intended to be modular depending on specific needs.

This publication's primary audience is government officials, basin authorities and other water practitioners whose work directly concerns or relates to transboundary water resources, especially between States. Secondary audiences include all stakeholders with an interest in transboundary water allocation processes and outcomes. Such audiences would incorporate the general public, water user groups such as farmers and Indigenous peoples, specific interest groups such as non-governmental organizations (NGOs), and academics.

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