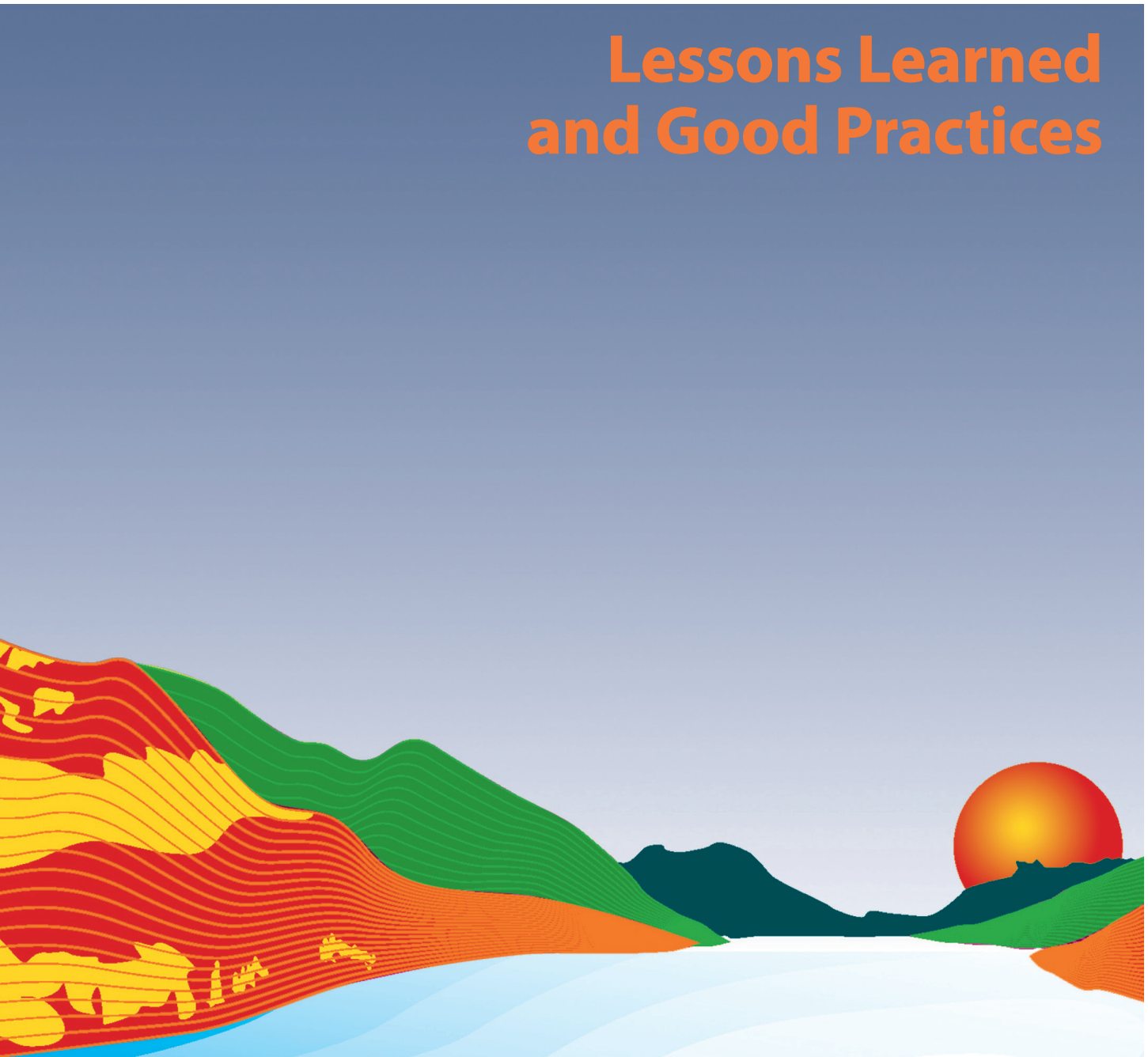


UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE
INTERNATIONAL NETWORK OF BASIN ORGANIZATIONS

Water and Climate Change Adaptation in Transboundary Basins:

Lessons Learned and Good Practices



UNITED NATIONS



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Schweizerische Eidgenossenschaft
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Confederaziun svizra

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Ministry of Infrastructure and the
Environment

Contact Information

Convention on the Protection and Use of
Transboundary Watercourses and International Lakes
United Nations Economic Commission for Europe
Palais des Nations
CH - 1211 Geneva 10, Switzerland
Tel.: +41 22 917 1218
Fax: +41 22 917 0107
E-mail: water.convention@unece.org
Website: www.unece.org/env/water

International Network of Basin Organizations
International Office for Water
21 rue de Madrid
75008 Paris France
Tel.: +33 (0)1 44 90 88 60
Fax: +33 (0)1 40 08 01 45
secretariat@inbo-news.org
www.inbo-news.org

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FOREWORD

In many water basins around the world, the impacts of climate change on ecosystems and on society are becoming more and more visible. Building resilience becomes a major issue as climate change affects water quantity and quality, water temperature, water-related ecosystems and the magnitude and occurrence of extreme weather events such as floods and droughts. Through its impacts on water resources, climate change is affecting many sectors, including agriculture, energy, fisheries, tourism, health and biodiversity.

Both water and climate change know no borders. Transboundary cooperation in adaptation to climate change is therefore necessary to enable the sharing of the costs and benefits of adaptation measures, ensure their optimal location in a river basin and prevent the possible negative effects of unilateral adaptation measures. Transboundary cooperation on adaptation can also bring additional benefits in terms of conflict prevention, socioeconomic development and human well-being, and can even motivate transboundary cooperation in other areas. But how can this be done?

The United Nations Economic Commission for Europe (ECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) provides an important legal and institutional framework for transboundary water management and climate change adaptation. Following the entry into force of an amendment to the Convention on 6 February 2013, the treaty is open to all Member States of the United Nations. Indeed, since 2011, the climate change activities under the Convention have been one of the drivers of the global interest in the Convention, attracting participants from all over the world.

When the Task Force on Water and Climate under the Water Convention was created in 2006, the level of awareness of climate change impacts on water resources was much lower than today. When the ECE Guidance on Water and Adaptation to Climate Change was adopted in 2009, adaptation efforts were mainly being undertaken at the national level. Since then, member States engaged in a platform for the exchange of experience and a programme of pilot projects, resulting in the creation of a global network of basins working on climate change adaptation in 2013. The network is managed by ECE together with the International Network of Basin Organizations (INBO), which has 188 members from all over the world.

The Guidance, the network and the pilot projects have together given a significant boost to adaptation efforts and have contributed to much recent progress. Many countries have developed national adaptation strategies and plans and some transboundary basins, especially some with basin organizations, have started addressing climate change adaptation from the transboundary perspective. Several major river basins, such as the Danube, Dniester, Mekong, Neman, and, most recently, the Rhine, have developed adaptation strategies or are in the process of doing so. In addition, the importance of water and transboundary cooperation has been recognized in several international policy frameworks such as the Nairobi work programme on impacts, vulnerability and adaptation to climate change under the United Nations Framework Convention on Climate Change and the European Union's Strategy on Adaptation to Climate Change.

However, numerous challenges regarding climate change adaptation in transboundary basins still persist. Many basin organizations have not yet begun or are only just starting to address the issue, there remain many uncertainties about how best to adapt water management to climate change and those basins that do have adaptation strategies need now to move towards implementing them. In addition, transboundary aspects are rarely considered in national adaptation strategies.

The present publication therefore collects a vast range of experiences to date, in order to illustrate the different steps in developing a basin-wide adaptation strategy with concrete examples and thereby to distil some recommendations to take into account in similar efforts in the future. It complements the Guidance by describing experiences in following many of the steps of the adaptation process.

The importance of water and transboundary cooperation in climate change adaptation needs to be recognized in global and regional legal and policy frameworks on climate change. We hope that this publication will encourage and facilitate this process as well as motivate and support additional cooperation on climate change adaptation in transboundary and national basins.



Christian Friis Bach,
ECE Executive Secretary



Jean-Francois Donzier,
Secretary General of the International Network
of Basin Organizations



Melanie Schultz van Haegen-Maas Geesteranus,
Minister of Infrastructure and the Environment,
the Netherlands



Doris Leuthard,
Federal Councillor and Head
of the Federal Department of the Environment,
Transport, Energy and Communications,
Switzerland

KEY MESSAGES

Climate change impacts are both episodic, such as extreme weather events, and long-term and permanent, for example, due to changes in flow regimes and absolute water balances. To address uncertainties that exist about the direction, speed and intensity of climate change, water resources policy and management should include practices that ensure that water usage is ecologically sensitive, are consistent with sustainable development and are robust across a wide range of climate futures.

Because of the complexity of climate change impacts on the water cycle and how these impacts can be expressed in one part of a basin but felt in other, far distant parts of the same basin, effective adaptation to climate change requires coordination, integration and coherence across political, sectoral, ecological and institutional boundaries.

Authorities in some water basins — particularly the 14 members of the ECE/INBO global network of basins working on climate change adaptation — have already started the planning and development of activities related to adaptation to climate change. It is crucial to benefit from their experiences by identifying and collecting the good practices from around the world and by sharing those good practices and lessons learned — the aim of this publication. The key messages that emerge from those experiences include:

- On the one hand, adaptation within a transboundary basin is a particular challenge, as it requires strong cooperation between the riparian countries on a cross-cutting issue (i.e., climate change) that demands attention at all levels and across all sectors and institutions and necessitates the involvement of many stakeholders with conflicting and competing needs across multiple physical, political and jurisdictional boundaries. On the other hand, transboundary cooperation can enable more efficient and effective adaptation, by pooling available data, models, scenarios and resources and enlarging the planning space for locating adaptation measures.
- Proper institutional arrangements and the application of the principles of integrated water resources management are essential elements for transboundary cooperation in climate change adaptation. A basin organization can play a crucial role in climate change adaptation and should be given a mandate to address it.
- A flexible legal framework, such as a transboundary agreement, can support the development and implementation of adaptation strategies and measures.
- Proper communication is important to allow transboundary cooperation, among others, as a critical channel for fostering a common understanding of vulnerability, adaptation policy and action in a transboundary setting.
- A joint group of experts from all riparian countries should be set up for a basin-wide assessment of problems, priorities and solutions and for developing joint scenarios, modelling and vulnerability assessments.
- Uncertainty about future impacts, and how therefore to develop flexible policy and institutional responses, means that there is a significant need to build capacity among diverse stakeholders. Capacity development needs to result in a common understanding among the stakeholders in the basin of the concepts of vulnerability, opportunity, impacts and uncertainties related to climate change. Capacities for developing an adaptation plan are essential, particularly for managing the uncertainties in the development of scenarios and implementation of measures, for using the appropriate tools and for integrating adaptation into the basin management plan.
- Decision makers need to be involved in the adaptation process from the beginning, to ensure that the process is connected with policymaking and to ensure the transfer of knowledge from science to decision makers and the political sphere.

- Climate change should be viewed as one of the drivers of change in the basin and one of many pressures on water resources. Scenarios for the basin should therefore take into account not only climate change but also other changes, such as in demography, economic growth, food preferences, etc. These scenarios should, as far as possible, be designed in cooperation with neighbouring countries, particularly with agreement on the data and the models to be used.
- The preparation of an adaptation plan (national or transboundary) at the basin scale (river, lake and aquifer basins), which could subsequently be integrated into an (existing) basin management plan, is a good approach to address climate change in the water domain.
- A vulnerability assessment should be relevant to decision-making and be seen as an ongoing process. To view vulnerability assessment as a purely technical exercise or a single-use or permanently relevant report will consume limited resources, reduce credibility with decision makers and stakeholders and underestimate the inevitable information gaps around climate change and future impacts.
- A vulnerability assessment is especially important at the transboundary basin scale, as reducing vulnerability in one part of the basin can affect vulnerability elsewhere in the basin. For this reason, developing a common understanding of the vulnerability in a basin is necessary, alongside the development of common models and scenarios, based on commonly agreed information and methodologies. The vulnerability assessment can then be the basis for elaborating a basin-wide adaptation strategy and plan to address climate change impacts.
- Comprehensive information and data from the entire basin are needed for developing the strategy and the scenarios and to identify the vulnerabilities and impacts. The collection and sharing of the necessary data, information and models from the entire basin and across the water cycle has therefore to be ensured. A monitoring system is necessary for the regular update of the assessments, the scenarios of change, and the water balance projections in order to ensure flexible adaptation.
- Based on the scenarios and the vulnerability and impact assessments, a set of adaptation measures may be proposed, combining structural and non-structural measures. The identification of these measures should involve other sectors and ministries. Measures should be prioritized taking into account the urgency of the measures and the assessment of the economic, environmental and social costs and benefits.
- Basin-wide adaptation strategies should prioritize adaptation measures beneficial from the basin perspective and avoid measures that transfer vulnerability within the basin to another location. As much as possible and politically feasible, adaptation measures should be located at the “optimal” location in the basin. That may involve payments for measures located in other riparian countries.
- It is important to ensure synergies and linkages between adaptation actions at different government levels (local, national, regional, transboundary) and between different (economic) sectors. This can be facilitated through cross-references to strategies at other levels, the regular exchange of information between representatives of the different levels and wide stakeholder engagement.
- As water management is an important linking factor between climate change adaptation and mitigation, it is recommended to take mitigation aspects into account when developing adaptation measures and vice versa.
- Adaptation strategies, measures and plans should be developed in a flexible way so that they can be adapted according to the changing climate and socioeconomic conditions.
- Due to the high uncertainty associated with climate change impacts, it is useful to implement low- or no-regret measures even when there is still some uncertainty about the climate change impacts, i.e., to start reducing vulnerability while impact assessments are still ongoing.
- Transboundary cooperation on adaptation usually starts at a technical, or expert, level, but can later positively influence cooperation in general, also at a political level.

These key messages and the 63 lessons learned from basins around the world set out in this publication should provide stakeholders in transboundary basins with the means to take more effective measures to adapt to climate change. Transboundary cooperation provides the foundations for such progress to be achieved.

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Natalia Alexeeva, Global Water Partnership

Nicholas Bonvoisin, ECE Water Convention secretariat

Nickolai Denisov, Zoï Environment Network

Kathleen Dominique, Organization for Economic Cooperation and Development

Anna Kaplina, ECE Water Convention secretariat

Sonja Koepfel, ECE Water Convention secretariat

Nicolina Lamhauge, Organization for Economic Cooperation and Development

John Matthews, Alliance for Global Water Adaptation

Isabel Riboldi, World Meteorological Organization

Juan Carlos Sanchez, International Union for Conservation of Nature and IHP-HELP Centre for Water Law, Policy and Science under the auspices of the United Nations Educational, Scientific and Cultural Organization, University of Dundee

Jos Timmerman, Alterra Wageningen University and Research Centre, the Netherlands

Daniel Valensuela, International Network of Basin Organizations

The secretariat also wishes to praise the efforts of the **drafting group** that was responsible for preparing and reviewing the publication. The drafting group was, in addition to the members of the editorial group, also composed of:

Antonio Guerreiro de Brito, School of Agronomy, University of Lisbon, Portugal

Alistair Rieu-Clarke, IHP-HELP Centre for Water Law, Policy and Science under the auspices of the United Nations Educational, Scientific and Cultural Organization, University of Dundee

Roman Corobov, Eco-TIRAS International Environmental Association of River Keepers, Republic of Moldova

Vladimir Korneev, Central Research Institute for Complex Use of Water Resources, Belarus

Amadou Lamine Ndiaye, Senegal River Development Organization

Hanna Plotnykova, Organization for Security and Cooperation in Europe

Eugene Simonov, Rivers without Boundaries

Giacomo Teruggi, World Meteorological Organization

Vahagn Tonoyan, Armenian National Policy Dialogue, Armenia

Nguyen Huong Thuy Phan, Mekong River Commission Secretariat -Climate Change and Adaptation Initiative

Case studies, comments and other contributions were provided by:

Susanne Arnold, Helmholtz Centre for Environmental Research

Alexei Andreev, BIOTICIA Ecological Society

Gherman Bejenaru, State Hydrometeorological Service, Republic of Moldova

Debora de Block, Wageningen University, the Netherlands

Damien Brunel, International Commission of the Congo-Ubangi-Sangha Basin

Vangelis Constantianos, Global Water Partnership

Ali Dakiche, Western Regional Directorate, National Water Resources Agency, Algeria

Chantal Demilecamps, ECE Water Convention

Jean-Francois Donzier, International Network of Basin Organizations

Victor Dukhovny, Scientific Information Center of the Interstate Commission for Water Coordination (SIC-ICWC), Central Asia

Mats Eriksson, Stockholm International Water Institute

Teodoro Estrela, Júcar River Basin Authority and Technical University of Valencia

Norbert Fenzl, GEF /UNEP/ACTO Amazon project “Integrated and sustainable management of transboundary water resources in the Amazon river basin considering Climate variability and change”
Arancha Fidalgo, Júcar River Basin Authority
Oleg Goroshko, Daursky State Biosphere Reserve
Françoise Goulard, Water Agency Adour-Garonne, France
Sally Haddad, ECE Water Convention
Iuliia Isaeva, ECE Water Convention
Alejandro Iza, International Union for the Conservation of Nature
Kidanemariam Jembere, Global Water Partnership Eastern Africa
Khatim Kherraz, Sahara and Sahel Observatory
Vadim Kiriliuk, Daursky State Biosphere Reserve
Dejan Komatina, International Sava River Basin Commission
Nataliya Kruta, Lviv Regional Department of Water Resources, Ukraine
John Labadie, University of Washington
Carolina Latorre, International Water Association
Martine Lejeune, Communicatie en Ecologie
Annukka Lipponen, ECE Water Convention
Bjørn-Oliver Magsig, Helmholtz Centre for Environmental Research
Raimund Mair, International Commission for the Protection of the Danube River
Cammile Marcelo, ECE Water Convention
Owen McIntyre, University College Cork and International Union for the Conservation of Nature - World Commission of Environmental Law
Hilary Motsiri, International Federation of Red Cross and Red Crescent Societies
Ruby Moynihan, University of Edinburgh and Helmholtz Centre for Environmental Research
María E. Milanés Murcia, Sindicato Central de Regantes del Acueducto Tajo-Segura
Yurii Nabyvanets, Ukrainian Hydrometeorological Institute
Aliaksandr Pakhomau, Central Research Institute for Complex Use of Water Resources, Belarus
Frederik Pischke, Global Water Partnership
Rafael Clemente Oliveira do Prado, independent expert
Nikola Rass, Sahara and Sahel Observatory
Carmen Regidor, Júcar River Basin Authority
Josh Roberts, Client Earth
Susanne Schmeier, German Agency for International Cooperation (Deutsche Gesellschaft für internationale Zusammenarbeit)
Adrian Schmid-Breton, International Commission for Protection of the Rhine
Anne Schulte-Wülwer-Leidig, International Commission for Protection of the Rhine
Michael Scoullas, Global Water Partnership
Amparo Sereno, Lusiada University of Lisbon
Daniel Sighmnou, World Meteorological Organization
Eugene Stakhiv, International Center for Integrated water resources Management under the auspices of UNESCO (Visiting scholar)
Dan Tarlock, Global Water Partnership
Blaise-Léandre Tondo, International Commission of the Congo-Ubangi-Sangha Basin
Tais Tretyakova, ECE Water Convention
Sibylle Vermont, Swiss Federal Office for the Environment
Tatirose Vijitpan, Mekong River Commission Secretariat-Climate Change and Adaptation Initiative
Niels Vlaanderen, Ministry of Infrastructure and the Environment, the Netherlands
Dinara Ziganshina, Scientific Information Center of the Interstate Commission for Water Coordination (SIC-ICWC), Central Asia
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ABBREVIATIONS

ADAPT	adaptive, dynamic, active, participatory, thorough
AMESD	African Monitoring of Environment for Sustainable Development
AMICE	Adaptation of the Meuse to the Impacts of Climate Evolutions
ATU	Administrative-territorial units
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CICOS	International Commission of the Congo-Ubangi-Sangha Basin
COED-PANDO	Centro de Operaciones de Emergencia Departamental de Pando
CREAM	clear, relevant, economic, adequate, monitorable
CRT	Columbia River Treaty
EBA	ecosystem-based adaptation
ECE	United Nations Economic Commission for Europe
Eco-TIRAS	Eco-TIRAS International Environmental Association of River Keepers
EIA	environmental impact assessment
ENVSEC	Environment and Security Initiative
EU	European Union
EU Floods Directive	European Union, Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks
EU WFD	Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy; European Union Water Framework Directive
GDP	gross domestic product
GEF	Global Environment Facility
GWP	Global Water Partnership
ICPDR	International Commission for the Protection of the Danube River
ICPR	International Commission for the Protection of the Rhine
IJC	International Joint Commission (managing the Great Lakes shared by the United States of America and Canada)
INBO	International Network of Basin Organizations
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWMPE	improving water management and protection of water-related ecosystems
IWRM	integrated water resources management
km	kilometres
km²	square kilometres
LDRS	Lower Dniester Ramsar Site
MAP	Madre de Dios (Peru), Acre (Brazil) and Pando (Bolivia)
Mekong Agreement	Agreement on Cooperation for the Sustainable Use of the Mekong River Basin
MRC	Mekong River Commission
MRC-CCAI	Mekong River Commission-Climate Change and Adaptation Initiative
NAPA	National Adaptation Programmes of Actions
NBI	Nile Basin Initiative
Nile-IS	Nile Information System
NGO	non-governmental organization

NWSAS	North-Western Sahara Aquifer System
OECD	Organization for Economic Cooperation and Development
OKACOM	Okavango River Basin Water Commission
OSCE	Organization for Security and Cooperation in Europe
OSS	Sahara and Sahel Observatory
Ramsar Convention	Convention on Wetlands of International Importance especially as Waterfowl Habitat
RBOs	river basin organizations
Sava FRMP	Flood Risk Management Plan for the Sava River Basin
SEA	strategic environmental assessment
SEO	Spanish Ornithological Society
SMART	specific, measureable, attainable, realistic, timely
SPICED	subjective, participatory, interpreted, cross-checked, empowering, diverse
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-IHE	UNESCO Institute for Water Education
UNFCCC	United Nations Framework Convention on Climate Change
United Nations Watercourses Convention	United Nations Convention on the Law of the Non-navigational Uses of International Watercourses
WACDEP	Water, Climate and Development Programme
Water Convention	Convention on the Protection and Use of Transboundary Watercourses and International Lakes
WFD	Water Framework Directive

Chapter 1



An aerial photograph of a town, likely in a mountainous region, showing a river flowing through the center. The buildings are clustered on the banks, and the terrain appears to be hilly. The image is partially obscured by a yellow banner at the top and a white text area on the right.

Introduction

1.1 Background and objectives of the document

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014), the impacts of climate change on natural and human systems are observed on all continents and across the oceans. Most climate change impacts are experienced through changes in the hydrological cycle. Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will very likely become more intense and more frequent by the end of this century. At the same time, droughts and low flows are expected to increase in number and to become more severe.

Most water basins are experiencing increased flow variability, which is due at least in part to climate change, while some basins are experiencing “transformation”, as hydrological changes accrue and alter them substantially. Both trends are expected to accelerate over the course of this century. Not all of these impacts are negative, but many of them complicate decision-making processes.

Transboundary and national basins around the world are therefore starting to address these changes by developing climate change impact assessments, vulnerability assessments and adaptation strategies. However, they are faced with numerous challenges: uncertainty of climate change impacts on water resources and in other sectors linked to water resources (e.g., energy, ecosystems and significant wild species, agriculture, fisheries, forestry and land use); a lack of coordination between national and local adaptation activities; a lack of capacity; a lack of knowledge about climate change impacts and possible adaptation measures; and a lack of resources. Many of these challenges are best addressed at the basin level.

International legal frameworks such as the United Nations Economic Commission for Europe (ECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) and the United Nations Convention on the Law of the Non-navigational Uses of International Watercourses (United Nations Watercourses Convention) can help countries to jointly adapt to climate change.

For these reasons, the Task Force on Water and Climate under the ECE Water Convention developed the Guidance on Water and Adaptation to Climate Change (ECE, 2009), which was adopted by the Meeting of the Parties to the Water Convention in 2009, as well as a programme of pilot projects and a platform, including regular workshops, to collect and exchange experiences and good practices on water and adaptation to climate change in transboundary basins. In 2013, a global network of basins working on climate change adaptation was created together with the International Network of Basin Organizations (INBO).

The Parties to the ECE Water Convention decided at their sixth session (Rome, 28–30 November 2012) to develop a publication on good practices and lessons learned on water and adaptation to climate change in transboundary basins. The Task Force on Water and Climate was entrusted with the elaboration of the publication in cooperation with INBO and many other partners. The development of the collection of lessons learned and good practices was also an outcome of the Sixth World Water Forum (target 3.3.2) and the publication was launched at the seventh World Water Forum in 2015 in the Republic of Korea.

The present publication was produced in 2014–2015 by a drafting group composed of nominated experts from different countries and organizations working on water and climate change adaptation. Each topic was prepared by a lead author in cooperation with numerous contributors. The material was compiled and integrated by an editorial group (see the list of acknowledgements).

The publication seeks to compile, analyse and disseminate experiences, and thereby to demonstrate and illustrate important steps and lessons learned as well as good practices to take into account when developing a climate change adaptation strategy for water management in the basin or transboundary context. It includes lessons learned and good practices mainly from the programme of pilot projects (see annex 1) under the ECE Water Convention implemented since 2010 in cooperation with partner organizations, such as the Organization for Security and Cooperation in Europe (OSCE) and the United Nations Development Programme (UNDP), in the framework of the Environment and Security Initiative (ENVSEC). It also includes lessons and examples from the global network of basins and numerous other organizations working on water and climate change in transboundary basins, such as the International Union for Conservation of Nature (IUCN), the Global Water Partnership (GWP) and many others.

The publication serves as a complement to the *Guidance on Water and Adaptation to Climate Change* as well as to the previous INBO handbooks. It is not legally binding and does not supersede the legal obligations arising from the Water Convention and other legal instruments.

A **lesson learned** in this publication is a recommendation about a certain concept or approach that has proven to be beneficial or effective as derived from practical experience. A **good practice** (see case studies throughout the publication) is a case situation in which certain concepts or approaches proved to be beneficial or effective and where adaptive capacity has been increased.

1.2 Target audience

The target audience of this publication includes all those working on adaptation to climate change in transboundary, but also national, basins, including joint bodies, such as basin commissions and other institutions for transboundary cooperation, as well as the national representatives in such joint bodies; developers of adaptation strategies, especially in transboundary basins; decision makers; specialists working on water and/or climate change in ministries; and other authorities, scientists and Non-Governmental Organizations.

1.3 Why transboundary cooperation is important in climate change adaptation

As 60 per cent of global freshwater flows cross national boundaries, transboundary cooperation in adaptation is necessary to prevent or reduce possible negative impacts of unilateral adaptation measures on other riparian countries and to support the coordination of adaptation measures at the basin level. Cooperation can enable joint development of more cost-effective solutions, which offer benefits to all or several riparian parties. For example, uncertainty can be reduced through the exchange of information and combining the impact assessments and model results throughout the basin and thus increasing the reliability of modelling results. Transboundary cooperation in adaptation also helps to locate measures, such as flood protection infrastructure, in the basin where they can have the optimum effect, which may be in another riparian country. Transboundary cooperation thus helps to share costs and benefits of adaptation and to increase the overall efficiency and effectiveness of adaptation in a basin.

Transboundary cooperation can broaden the knowledge base and enlarge the range of adaptation measures, both to mitigate gradual changes as well as to prevent and/or increase resilience against disasters, which are expected to appear more frequently. Prevention of disasters from a proactive perspective reduces social inequity and is advantageous for investments as it reduces the risk that the fruit of these investments is destroyed by disasters. Disaster prevention as part of adaptation thus promotes social and economic sustainable development. The need for cooperation in climate change adaptation can even be an incentive for wider cooperation in transboundary basins.

Water is a cross-cutting issue, which demands attention at all levels and across sectors. Water issues involve many stakeholders with conflicting and competing needs, crossing multiple physical, political, institutional, disciplinary and jurisdictional boundaries, as recognized at the United Nations Conference on Sustainable Development in 2012. Cooperation is necessary to address issues such as water allocation decisions, upstream and downstream impacts of water pollution and water abstraction, infrastructure development, overexploitation and financing of water management. Water cooperation contributes to (United Nations, 2013):

- **Poverty reduction and equity.** More inclusive governance of water and cooperation between different users can help overcome inequity in access to water, which is essential for satisfying basic human needs, and will be crucial in achieving the Sustainable Development Goals. Adaptation is key, as especially poor people are affected by climate change.
- **Economic benefits.** Cooperation can lead to more efficient and sustainable use of water resources, e.g., through joint management plans creating mutual benefits and ultimately better living standards.
- **Promoting sustainable natural resources management of water and the ecosystems and species dependent on that water.** Cooperation facilitates the exchange of data and information and can help develop joint management strategies to preserve water resources and protect water-related ecosystems.
- **Promoting peace.** Cooperation on water can help overcome cultural, political and social tensions and build trust between communities, regions and States.

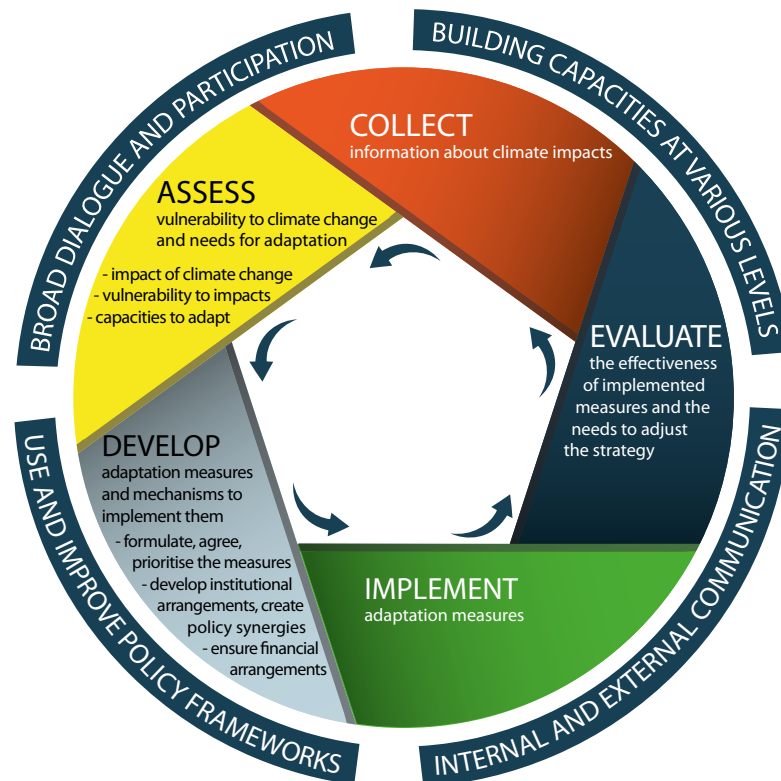
1.4 Structure of the document

This publication describes selected important lessons from experiences specifically in developing and implementing climate change adaptation strategies and measures in a transboundary context, and illustrates these with examples from all over the world. Consequently, it is not intended as a handbook as it does not provide detailed instructions related to the development of plans and programmes.

The lessons learned give advice on how to develop a joint adaptation strategy in transboundary basins, while recognizing that there are differences in the level of progress in transboundary cooperation and climate change adaptation in different basins. The recommendations presented in the lessons are neither meant to be comprehensive, nor prescriptive or universally applicable, but rather supportive and based on on-the-ground experience.

The publication is structured according to the key steps of the *Guidance on Water and Adaptation to Climate Change* (ECE, 2009) (see figure), starting with the enabling conditions for transboundary adaptation in water resources management (general principles, links with other concepts, policy, legal and institutional framework, etc.). Subsequently, the process of developing an adaptation strategy is described, i.e., assessing vulnerability, prioritizing measures and identifying sources of financing.

Framework for the development of a climate change adaptation strategy



Source: Zoi Environment Network, 2015

Chapter 2 describes aspects of the context in which the climate change adaptation strategy is developed. This includes incorporating the integrated water resources management (IWRM) approach and other general principles, the political, legal and institutional context on the national and international levels, and issues to take into account when organizing and managing the process of developing the strategy. Chapter 2 links to the policy, legal and institutional framework in the 2009 Guidance.

Chapter 3 looks at aspects of the data and information basis of a climate change adaptation strategy and the vulnerability assessment. This chapter links to the key step of understanding the vulnerability in the Guidance.

Chapter 4 details how to develop and prioritize measures and how to deal with the financial issues of climate change adaptation. This chapter links to the key step of developing, financing and implementing measures in the Guidance.

Chapter 5 describes aspects of the monitoring and evaluation of the implementation of the strategy. This chapter links to the key step of evaluation in the Guidance.



Chapter 2



The Context and the Process

2.1 Principles of basin adaptation

Most of our experiences in adaptation to climate change are very recent and transboundary water resources adaptation is an even newer field. Many relevant water management policies and actions undertaken until now in national and transboundary basins have been carried out within pre-existing IWRM or related frameworks (e.g., the European Union Water Framework Directive (EU WFD)) (EU, 2000). Some of these provisions and measures are essentially climate change adaptation responses, such as measures addressing droughts and floods.

Implementing IWRM can support climate change adaptation efforts. IWRM and climate change adaptation approaches can be quite complementary. For instance, the integration of water management decisions across sectors — which forms one of the key elements of IWRM — can also help identify potential climate change vulnerabilities and synergies. Moreover, the types of hydrological analysis often used in IWRM, such as charting trends in the frequency and severity of extreme events, can also help reveal national and transboundary patterns in realized or potential climate impacts.

While IWRM is a generally accepted framework among senior policymakers, different countries and sectors may define and implement the concept differently, which may hinder cooperation between riparian partners. This section will discuss some of the basic principles, within the context of IWRM, that have proven important in developing an adaptation strategy in a transboundary context.



2.1.1 Basin-wide approach to climate change adaptation

A basin-wide understanding of climate impacts and trends is necessary to understand the interconnections between regional impacts, taking into consideration the surface water and groundwater resources and including all riparian countries of a transboundary basin. IWRM can complement this effort and support cooperation between riparian countries.

Lesson 1. Develop an adaptation strategy at the transboundary level

Transboundary adaptation strategies usually define general principles for adaptation at the basin level to minimize unilateral adaptation measures that might have negative impacts on other riparian countries while maximizing adaptation measures beneficial from the transboundary perspective. Such strategies typically include a core set of components describing the basin, the realized and expected climate change impacts, anticipated vulnerabilities and general principles for adaptation, as well as proposing some priority adaptation measures. Transboundary adaptation strategies are usually developed by river basin organizations (RBOs). In basins without such organizations, adaptation strategies can be developed by other actors, such as international organizations, which, however, may make political acceptance in riparian countries more difficult. Depending on the political context, the process of developing such a strategy may focus on specific basin governance or implementation concerns, such as the decisions considered or mandate for the strategy, the strategy development and the eventual approval process. Section 2.3 contains more information on the process for developing a strategy.

Lesson 2. Ensure political support for the basin-wide strategy

In order for a strategy to be effective and subsequently implemented, its development needs to be endorsed by relevant policymakers. In the case of RBOs, such a decision is usually made by the commission and the finalized strategy is adopted by the same body. In basins where no transboundary institutions exist, the riparian Governments should assume this role.

If obtaining governmental approval for the development of a basin-wide strategy is challenging, one solution can be to avoid naming the document a strategy and to refer to the document as a “strategic framework for basin adaptation”, as happened in the Neman and Dniester Basins. While approval of the strategy by all riparian Governments would be the ideal solution, this goal is often not possible in the case of transboundary basins. An endorsement of the strategy by the respective ministries (namely those responsible for water management and/or ministries represented in the RBOs) is another mechanism to support implementation of the strategy.

Case study 2.1 First climate change adaptation strategy for the international Rhine River Basin: A new challenge!

Changes in climate values do have an impact on hydrological processes and the water regime. Therefore, in 2007 the Conference of Rhine Ministers requested the International Commission for the Protection of the Rhine (ICPR) to carry out a “Study of Scenarios for the Discharge Regime of the Rhine” along with a complementary study on the possible rise in temperatures of surface waters, and subsequently in 2013 to develop an adaptation strategy.

To that purpose ICPR put in place an international group of climate experts and, following a review of available literature in 2008 (ICPR Report No. 174), in July 2011 it published a common international study on the direct effects of climate change on the water regime (ICPR Report No. 188). In 2012 an international expert group was put in place to model and investigate the consequences of climate change on the water temperature of the Rhine (ICPR Reports Nos. 209, 213 and 214). These working steps were undertaken in order to evaluate the results of the studies (in the form of discharge scenarios for 2050 and 2100 resulting from climate scenarios) and to draft the climate change adaptation strategy.

On 30 and 31 January 2013, ICPR staged a workshop on “Impacts of climate change on the Rhine River Basin”, with the participation of about 80 experts in the field of water management and other fields in the Rhine Basin and representatives of non-governmental organizations (NGOs) and other international river commissions (water protection and navigation). The expected impacts of climate change were presented, possible approaches to solutions were discussed and cornerstones for an adaptation strategy were identified.

Case study 2.1 First climate change adaptation strategy for the international Rhine River Basin: A new challenge! (cont.)

Each of the three ICPR international working groups (on ecology, water quality and water quantity) assessed the potential effects of climate change for its thematic field. A special report on possible impacts on ecology (ICPR Report No. 204) was produced by the working group on ecology. Following this, the possible impacts on different uses, as well as possible measures to reduce these impacts, were studied by the working groups. The ICPR secretariat gathered the results from the different studies and the special information from the different working groups and drafted the first adaptation strategy. The draft was discussed several times in a new multidisciplinary ICPR working group (including hydrologists, chemists, ecologists, engineers, flood experts and NGOs) and finally adopted by the higher decisional levels at the end of 2014.

The studies described above and the assessment processes within ICPR resulted in the first adaptation strategy for the Rhine Basin, which was published at the beginning of 2015 (ICPR Report No. 219) and will now be implemented. The Strategy contains sections on the expected climate change impacts on water resources and water uses, as well suggested actions and adaptation measures.



Sources: International Commission for the Protection of the Rhine, *Strategy for the IRBD Rhine for adapting to climate change*, Report No. 219 (Koblenz, Germany, 2015). Available from http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Reports/219_en.pdf.

More information on the work of the ICPR regarding climate change impacts and adaption and all the reports mentioned above can be found at: www.iksr.org.

Lesson 3. Demonstrate the benefits of basin-wide cooperation in adaptation

Historically, IWRM at a transboundary level was aimed at balancing upstream and downstream development and environmental priorities and needs. Improved collaboration is necessary to sustain water so that these resources endure for future generations (see also section 1.3). Climate change adaptation should be based on the spirit of fair sharing of both benefits and burdens.

Lesson 4. Integrate climate change adaptation within river basin management planning

Linking climate change adaptation with river basin management and planning approaches and cross-sectoral integration methodologies can help mainstream adaptation approaches in decision-making, financing, awareness-raising and stakeholder participation, resulting in the more sustainable use of human and environmental resources. Many such approaches, such as traditional applications of IWRM, do not address non-stationary aspects of water management, including climate change, but when they are already in place they serve as an existing and powerful means of connecting institutions and as a platform for developing more flexible climate-aware water management techniques.

As mentioned in lesson 1, climate change adaptation in transboundary and national basins requires the elaboration of a strategy that covers the whole basin. However, this strategy is not an end in itself. To achieve concrete results, the strategy should be integrated into sectoral development strategies and plans/programmes, such as river basin management plans or national adaptation plans. Integration of climate change adaptation measures proposed in adaptation strategies into river basin management plans could also facilitate financing and implementation of these measures. Alternatively, a specific strategy implementation plan or programme should be elaborated. If not already included in the strategy, a programme of adaptation measures should be prepared and implemented at the large basin or sub-basin level.

An example is the EU WFD. The Basin Management Plan designed under the WFD requires accounting for all issues related to climate change in the basin, including vulnerabilities of the territories, climate change impacts in the basins and the definition of appropriate adaptation measures.

It is important to start this integration at the stage of the development of the adaptation strategy. For example, in the Dniester River Basin development of the adaptation strategic framework started at the same time as development of the river management plan in the Republic of Moldova and before the preparation of the management plan in Ukraine. Integration of the adaptation framework into the management plan in the Republic of Moldova is performed through continuous communication between stakeholders and experts. In Ukraine it was decided that the strategic adaptation framework together with its implementation plan will be used as a reference for relevant sections of the future basin management plan. The Dniester strategic framework could also help to identify joint approaches to development of the transboundary basin management plan in the future.

Case study 2.2 Developing a strategy for climate change adaptation in the Danube Basin

The International Commission for the Protection of the Danube River (ICPDR) works to ensure the protection and sustainable use of the Danube Basin's water resources, which are shared by 19 countries — making the Danube the most international river basin in the world. The Commission's work is based on the Danube River Protection Convention, the main legal instrument for transboundary water cooperation in the basin. ICPDR is furthermore the platform for the implementation of the EU WFD and the European Union (EU) Floods Directive (EU, 2007) on the basin-wide scale.

The countries of the Danube River Basin recognized that climate change impacts will pose an increasingly significant threat if the reduction of greenhouse gas emissions is not complemented by climate change adaptation measures. Therefore, ICPDR elaborated its first Climate Change Adaptation Strategy for the whole basin.

As a starting point, an international conference on Water and Climate Change in the Danube River Basin was held in December 2007, to raise awareness and draw initial conclusions on the way forward. The event opened a dialogue on climate change and adaptation in the basin. In order to take the required adaptation steps, ICPDR was asked in 2010 by the Ministers of the Danube countries to develop a Climate Change Adaptation Strategy for the whole basin. Germany was nominated as the lead country for this task, which was coordinated by the ICPDR River Basin Management Expert Group, comprising national experts and representatives from different stakeholders and observer organizations.

Subsequently, the "Danube Study — Climate Change Adaptation", was initiated by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and finalized in January 2012. The study, developed by the Ludwig Maximilian University Munich and discussed by national experts and stakeholders in the framework of a workshop, summarized all the latest available information on climate change and adaptation relevant for the basin. This was a crucial step towards the creation of a shared understanding on the expected changes and water-related impacts stemming from climate change, which is essential for joint decision-making. As a final step, and based on the research study, ICPDR (the secretariat and lead country together with the River Basin Management Expert Group) developed the Danube Climate Change Adaptation Strategy in 2012. The Strategy, adopted by the Danube countries in December 2012, provides guidance on how to address climate adaptation in the Danube Basin.

The Strategy provides for climate change adaptation measures to be incorporated in the existing institutional structures and water management planning instruments. The main tools for implementing the required measures are the River Basin and Flood Risk Management Plans. These are regularly updated based on a six-year planning cycle, allowing for an adaptive management of the basin and the consideration of progress in climate change-related research.

Case study 2.2 Developing a strategy for climate change adaptation in the Danube Basin (cont.)

Furthermore, the Strategy recognizes climate change adaptation as a cross-cutting issue with relevance for different sectors, making adaptation an integral part of IWRM on the basin-wide scale. The Strategy contains sections on the legislative framework, the knowledge base (climate change scenarios, impacts on water resources, vulnerability and an overview of possible adaptation measures) and guiding principles, integration and next steps.

Lessons learned include that water is key for adaptation. A shared scientific knowledge base is essential for taking the required adaptation steps. Due to the transboundary and intersectoral nature of water and related climate change impacts, adaptation requires a sound legal and institutional framework for transboundary cooperation, and needs to be integrated into transboundary IWRM planning activities and the involvement of stakeholders. A cyclic and adaptive approach makes it possible to deal with uncertainty, updated assessments and more targeted adaptation measures based on scientific progress achieved on climate change and water-related impacts. And, finally, a clear political mandate is crucial to enable administrations, experts and stakeholders to take action on climate change adaptation.

Sources: International Commission for the Protection of the Danube River and the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, "Danube Study — Climate Change Adaptation", final report (Munich, Germany, Ludwig Maximilian University, 2012). Available from <http://www.icpdr.org/main/activities-projects/climate-change-adaptation>.

International Commission for the Protection of the Danube River, ICPDR Strategy on Adaptation to Climate Change, (Vienna, 2013). Available from <http://www.icpdr.org/main/activities-projects/climate-change-adaptation>.

Lesson 5. Position river basin management planning and Environmental Impact Assessment/Strategic Environmental Assessment as legal instruments/regulations/policy to implement climate change adaptation

River basin management plans can include both passive and active approaches to adaptation. Examples of passive approaches include declaring some areas unsuitable for construction because of increased flood risk or hydrological sensitivity, or setting a minimum environmental flow. Active approaches might take the form of defining a water allocation hierarchy for scarcity and drought conditions, or ensuring that structural measures are integrated in the planning process, such as safety barriers.

In addition, well-defined methodologies such as IWRM, environmental impact assessment (EIA) and strategic environmental assessment (SEA) can serve as effective vehicles for identifying environmental stressors that are at least indirectly related to climate change, such as over abstraction, unsustainable fisheries, climate-mismatched infrastructure, limited ecological connectivity, and water pollution and other quality issues. Like EIA and SEA, river basin management planning and climate change adaptation planning should ultimately be embedded in a regulatory framework of water management. In order to be most effective, EIA and SEA should be prepared early in project cycles, when projects (EIA) or programmes and plans (SEA) are at the initial stage of conceptualization.

Case study 2.3 Environmental planning for the lower Dniester

The lower Dniester River in the Republic of Moldova faces a multitude of challenges, such as the loss of wetlands and the creation of new hydropower dams, and potential climate change risks, including water deficits, extreme floods, longer droughts and higher annual temperatures.

Water managers facing these challenges have sought to mitigate the effects of distorted flow regimes and land-use changes while simultaneously protecting the surface waters and ecosystems. This new approach is set out in the draft National Wetland Strategy of the Republic of Moldova. The concept follows the Protocol on Water and Health to the ECE Water Convention, especially article 5, paragraph (j), indicating that water resources should, as far as possible, be managed in an integrated manner on the basis of catchment areas, whether transboundary or not. The provision is often neglected, but the thinking behind the provision connects with the fundamental tenets of the National Ecological Network of the Republic of Moldova.

Case study 2.3 Environmental planning for the lower Dniester (cont.)

BIOTICA Ecological Society, a Moldovan NGO dealing with biodiversity conservation and environmental law and policy, created a project supported by the Austrian Development Cooperation entitled “Improving water management and protection of water-related ecosystems (IWMPE) in the Lower Dniester Ramsar Site”, which was incorporated in the Lower Dniester Ramsar Site (LDRS) Management Plan. Stakeholders approved the LDRS Management Plan, which has been approved by the National Ramsar Committee and the Moldovan Ministry of Environment. The adopted plan provides the policy basis for climate change adaptation projects in the lower Dniester.

In the Republic of Moldova, the core area of international importance in its National Ecological Network is the Talmaza wetland, which faces overall declines in flow from the Dniester but also increasingly variability. The wetland needs a water management system to continue serving as an area of rich fauna and ecosystem services, such as flood control. A river basin management plan resulted in an IWMPE project that produced the engineering design, construction and regulation for water locks and sustained flows.

Building on the success of the LDRS Management Plan, the IWMPE project has begun work on other climate change adaptation projects in the region. After flooding led to large losses of fish, resource managers now plan to create spawning grounds that have been positively assessed from hydrologic and ecological standpoints. Additionally, work has begun to plant trees along riverbanks to diminish the risks of dike breaches, which threaten farms and biological corridors of international importance.

Source: Alexei Andreev, Biotica Ecological Society, personal communication (2014).

2.1.2 Uncertainty and the need for flexibility

Lesson 6. Reconcile uncertainty and confidence in recommendations and strategy

Technical and scientific assessments often focus on uncertainty in projected impacts, particularly over timescales beyond a decade in the future or around topics that are not covered well by most climate models (e.g., shifts in climate variability or climate engines, such as the El Niño Southern Oscillation or the North Atlantic Oscillation) or scenario development (such as shifts in energy or economic policy). In practice, decision makers are often confused by or unsure how to interpret “scientific uncertainty” or calls from specialists for additional analysis. These terms may even provoke frustration or anger at technical personnel. Practical decision-making guidelines, qualitative descriptions and a range of actions that are keyed to the level of confidence will help ensure uptake by decision makers in their processes.

In effect, decision makers often prefer to have issues framed by the level of confidence behind a recommendation and how potential impacts (and their decisions) may constrain their decision-making ability. For instance, many infrastructure investments represent commitments spanning decades or centuries — they are almost inherently “regretful” decisions. A traditional “safety margin” approach may not be sufficient to prevent negative impacts with progressively stronger climate changes over an operational lifetime, potentially leading to the “stranding” of that infrastructure. The siting, design, operation and integration of one piece of infrastructure with other aspects of the landscape may allow more flexible, robust and reliable operations over longer timescales — lowering the amount of regret inherent in infrastructure. A hydropower facility, for instance, could be designed in a modular, extensible manner, so that its design could be altered as climatic and economic conditions change over time.

Gaps between available data and the needs of particular decision makers should be considered explicitly. Precipitation patterns at sub-annual scales — such as seasonal or monthly patterns — are hard to project more than a decade away using modelled data, but the tolerance for uncertainty is low. Changes in the intensity, frequency, variability, reliability and form of precipitation are very challenging to predict and model in a way that matches the needs of water managers and planners or the designers or operators of water infrastructure. Increased uncertainty therefore demands greater flexibility.

Lesson 7. Adopt a flexible approach to climate change adaptation in the transboundary basin

Climate change adaptation normally stands in contrast to “stationary” approaches, which are more likely to assume that climatic and environmental conditions are relatively fixed or only go through relatively minor variations. Given that future climate conditions — and the impacts from those conditions — are very difficult to predict, addressing high levels of uncertainty is a critical component of climate adaptation decision-making; indeed, climate adaptation is often shown as a circular, iterative, or cyclical process. These challenges are often compounded at a transboundary scale, where consensus about shared water resources may be difficult to negotiate (or in many basins to renegotiate) under stationary conditions, but becomes an even more difficult process with shifts in the water cycle that alter the timing, quality and quantity of water resources and the severity and frequency of extreme water-related events. For instance, basins with fixed quantitative water “delivery” agreements may see increased conflict as upstream countries face reduced water availability but inflexible demands by downstream countries, while efforts to reduce risks from more frequent flooding may exacerbate downstream damage. Perhaps the classic example of such fixed agreements is the Colorado River Basin in North America, which has quantitative delivery targets both between states in the United States of America and between the United States and Mexico. Recent climate changes have increased both variability in the basin and reduced overall mean quantity, with credible projections for additional decreases in coming years. Governance agreements such as the 1922 Colorado Compact no longer represent existing climate and hydrological conditions, but renegotiation of the Compact has proven very difficult.



The future has arguably always been difficult to predict and win-win measures and conscious attention to decision-making “pathways” (and how choices now may limit or enhance decision-making options in the future) are among the most appropriate approaches under such circumstances. The application of explicit adaptation pathways is one method to design a set of sequences of possible lines of action that facilitate long-term flexible decision-making. The method assumes a variety of possible futures and defines decision-making tipping points, which are the conditions under which an action no longer meets specific objectives, prompting a potential shift in strategy to another line of action. Illustrations of these pathways look like adaptation decision trees. Computational scenarios across a range of scenarios are typically used to assess the possible tipping points and consequential necessary actions.¹

If climate change presents a fundamental new challenge for decision makers, this is because climate is a fundamental driver of so many environmental and economic processes, most of which have not previously accounted for any kind of change in water availability, much less dramatic shifts resulting from new climatic conditions. Sustainable water management also requires sustainable governance agreements, which can serve to diffuse tensions and avoid or resolve conflict from

Case study 2.4 Transboundary Great Lakes studies — joint integrated assessments

Two important transboundary Great Lakes studies were conducted in conjunction with the restrictive diversion policy of the International Joint Commission (IJC) managing the Great Lakes shared by the United States of America and Canada, with climate adaptation as a main feature. They were the Lake Ontario-St. Lawrence River Study (1999–2005), followed by the International Upper Great Lakes Study (2007–2012). Both comprehensive studies were conducted by a binational independent Study Board, complemented by a Public Interest Advisory Group, and supported by technical study groups, each numbering close to 200 scientists, engineers, ecologists and economists.

Both studies were directed to improve the regulation and management of the lakes for the principal purposes specified in the 1909 Treaty (navigation, hydropower, municipal water supply and irrigation), while also improving conditions for the ecosystem, recreational boating and recreation, and lessening erosion and storm damage. The key was to develop regulatory and adaptive management plans both for the historical record of lake levels and inflows, as well as for a variety of climate change scenarios.

Study Board guidelines for both studies included specific objectives to maximize sustainability (economic and ecological performance), improve social well-being and devise options that were equitable (benefits for one sector should not come at the expense of another sector). Specifically, any recommended solution had to be robust for a range of climate scenarios, and management options had to include adaptation mechanisms that could deal with short-term surprises and provide flexibility to quickly adapt to rapidly changing hydro-climatic regimes.

In both studies (Lake Ontario and the Upper Great Lakes), the Study Boards were able to meet all their stated objectives and devise a range of suitable regulation and adaptation options that were robust under a wide range of climate scenarios. They did so while improving key ecosystem indicators, enhancing recreational boating opportunities (a multibillion dollar business) and reducing shoreline flood damage. The Study Boards were particularly successful in dealing with climate adaptation and achieving flexibility in managing for unexpected regime changes. This was done with a combination of flexible water regulation operating rules, coupled with a comprehensive adaptive management plan that focused on land-side changes, such as new flood-plain zoning regulations, flood warning mechanisms and other management measures for which local authorities were responsible.

Finally, both studies developed long-term adaptation plans to encompass those unforeseen climate impacts that could not be accommodated solely by water-level regulation, and required other levels of government to implement land-side adaptation options (land-use regulations, zoning criteria, flood zone building codes, emergency evacuation plans, etc.). Each plan has been adopted by IJC as well as Canada and the United States.

Sources: International Joint Commission, Lake Superior Regulation: Addressing Uncertainty in Upper Great Lakes Water Levels, International Upper Great Lakes Study, final report (Ottawa and Washington, D.C., 2012).

International Joint Commission, Impacts on Upper Great Lakes Water Levels: St. Clair River, International Upper Great Lakes Study, final report (Ottawa and Washington, D.C., 2009).

Public Interest Advisory Group of the International Upper Great Lakes Study, “Report on Public Outreach Activities: A report to the Study Board and to the International Joint Commission regarding the work of the Public Interest Advisory Group in Year 1 and Year 2 of the Study” (15 December 2009).

The above reports are all available from <http://www.iugls.org>.

¹ More information on this and other similar methods is provided in García and others (2014).

shifts in the water cycle. The detection, attribution and anticipation of impacts, vulnerabilities, and opportunities are critical capabilities to ensure that transboundary institutions can respond to those impacts through the periodic negotiation and allocation of transboundary resources. Ideally, transboundary institutions should enable flexible water management decisions at smaller scales that balance and represent the needs of users throughout the basin by providing a framework for updating and adjusting management decisions as conditions evolve over time.

2.1.3 Ecosystem-based adaptation, green adaptation and green infrastructure

In recent years, interest has been growing in efforts to move beyond hard infrastructure solutions to climate adaptation, including the use of ecosystems or hydrological and ecological processes as an extension of or alternative to built approaches. Sometimes referred to as natural infrastructure, green-grey infrastructure, or green adaptation, so-called ecosystem-based adaptation (EBA) employs biophysical processes to help humans adjust to climate impacts.

Examples of ecosystem-based approaches in the water sector include disaster risk reduction through flood regulation and storm-surge protection, the use of aquifers as water storage mechanisms rather than above-ground built storage and the formal integration of riparian forests within water quality and purification processes (Jones and others, 2012). The ecosystem approach has been promoted for some time in international water law instruments, including the ECE Water Convention (1992),

Case study 2.5 Ecosystem Management and Restoration: Tancat de la Pipa

One of the most valuable wetlands in the Mediterranean region is the Albufera Natural Park of Valencia (Albufera de Valencia), which is included in the List of Wetlands of International Importance under the Ramsar Convention. This wetland, with a huge ecological value, is located south of the Spanish city and extends to 21,000 hectares. For centuries, the Albufera de Valencia has been a transformed wetland controlled by the successive generations of inhabitants that benefit from the natural resources in the area (salt, wood, game and fish).

In the eighteenth century the area changed from a salt marsh to a freshwater system, totally transformed to support rice crops. The ecological balance, nevertheless, was still stable. However, in the early 1970s, the strong urban, agricultural and industrial growth of Valencia and its surrounding villages caused a strong degradation in the water quality of the wetlands. This was due, on the one hand, to the continuous and growing untreated urban and industrial wastewater inflows and, on the other hand, to the nutrient-loaded run-off from crop fields. The pollution drastically increased the concentrations of dissolved nutrients (mainly nitrogen and phosphorous) resulting in hyper-eutrophication.

Since the 1980s, important investments in treatment and sanitation have been made. Among others, an artificial wetland forming the 40-hectare “Tancat de la Pipa” was constructed. The ecologic restoration project consisted in the transformation of rice fields into different habitats typical in wetlands. The Júcar River Basin Authority (Confederación Hidrográfica del Júcar) is the owner of the land and main implementer of the restoration works, together with the Regional Ministry for Infrastructures, Land and Environment.

So far, the benefits of the project have been:

- **An improvement in water quality.** The water ecosystems established in Tancat de la Pipa, both artificial wetlands with surface flow (Green Filters) and lagoons, have shown a great capacity to reduce suspended solids, total phosphorous, total nitrogen and phytoplankton in water.
- **An increase of biodiversity.** Submerged water plants have reappeared in the lagoons as a result of the clean water inflow from green filters. Shelter, nutritional value and oxygen are extremely important for many species. Some species have, once again and in a natural way, found in Tancat an appropriate spot to live and breed after being absent from the Natural Park for years.
- **Increased visits and social participation.** Since it officially opened to the public in 2009, more than 20,000 people have visited Tancat de la Pipa and participated in the numerous activities promoted at the site, such as guided visits and training and volunteering programmes. The Public Use Plan of Tancat de la Pipa aims to demonstrate the importance of preserving the huge patrimony of the Albufera de Valencia to all sectors of the population.

In order to optimize the site’s management, in 2011 the Júcar River Basin Authority signed land custody agreements with the NGOs Acció Ecologista-Agró and SEO/BirdLife, which directly run Tancat de la Pipa under the Júcar River Basin Authority’s supervision.

Source: www.tancatdelapipa.net.

the United Nations Watercourses Convention (1997), the Ramsar Convention (1971) and the Berlin Rules on Water Resources (2004). EBA approaches can also refer to the long-term sustainable management, conservation and restoration of ecosystems and ecosystem services in the context of other social, economic and cultural co-benefits. As such, EBA can address the crucial links between climate change, biodiversity, the integrity of natural processes such as groundwater recharge, and sustainable resource management.

Green infrastructure in particular can refer to the natural or semi-natural systems (i.e. wetlands) that provide services for water resources management with equivalent or similar benefits to conventional (built) “grey” water infrastructure. Green infrastructure explicitly refers to vegetation, soils and natural processes to manage water and create healthier urban environments. Green infrastructure can be seen as part of EBA and can be used in combination with or as an alternative to conventional infrastructures.

Lesson 8. Use ecosystem-based adaptation as a cost-effective alternative to “grey” infrastructure

Adaptation to climate change is likely to involve more investments in water resource infrastructure, such as dams and reservoirs to buffer against increased variability in rainfall and run-off. However, traditional engineered solutions may not always be the best option (Naumann and others, 2011, UNEP, 2014).

EBA can substitute for, provide a deferral of, or complement traditional infrastructure development by using biophysical services (World Bank, 2009). In addition to protection from climate change impacts, EBA provides many other benefits to communities, for example through the maintenance and enhancement of ecosystem services crucial for livelihoods and human well-being, such as clean water, water regulation and habitat, recreational opportunities and food. Furthermore, ecosystem-based approaches often provide employment opportunities. Appropriately designed ecosystem management initiatives can also contribute to climate change mitigation, for example, by reducing emissions from ecosystem loss and degradation (Doswald and others, 2011).

Implementation of EBA may require revisiting the priorities and relative value of “hard” water infrastructure versus green solutions to manage water resources. EBA is often less capital intensive and more easily reversible than engineered alternatives, thereby providing an additional “option” value. EBA is particularly relevant in transboundary basins as the downstream effects of such measures are usually relatively small and/or advantageous.

For the conservation of wetlands, the creation of protected areas as well as other measures such as the provision of environmental flow and the purity of water, are required. The creation of a protected area and other conservation measures may be complicated by competition for the territory and water resources with the local population. For example, in the upstream part of the Amur River Basin and the closed drainage basin of the Torey Lakes in the neighbouring regions of Mongolia, the Russian Federation and China, the network of protected areas was optimized resulting in an increase in the total area of the protected areas, including wetlands, by more than 700,000 hectares and in a reduction in vulnerability to climate change.

EBA and green infrastructure, such as restoring wetlands to reduce vulnerability to floods or to improve water quality, can be cost-effective adaptation options that are robust under a mix of different climate scenarios (European Commission, 2013). Financial incentives may be necessary, at least initially, to promote their uptake, such as tax advantages, land-use planning guidelines and payment for ecosystem services (PES) schemes (Wertz-Kanounnikoff and others 2011). For example, in Denmark, several cities are using EBA to address heavy rainfall and increasing flood risk (case study 2.6).

However, EBA is not a panacea, and these methodologies are still nascent and largely anecdotal. Challenges exist in both application and adoption of EBA. Traditional project accounting, design,

and management approaches to infrastructure and water resources management are difficult to adjust for the use of ecological or other biophysical applications (e.g., how do you calculate the maintenance costs of a wetland?). In addition, considerable uncertainty exists about how particular ecosystems will adjust to climate change over time, which could significantly modify the ability of ecosystems to deliver projected services. For instance, in the western United States, many urban water managers use forest management as a means of improving water quality by reducing sediment and nutrient loads in run-off, but in some cases these forests are changing their composition and structure significantly in response to shifting fire regimes, a process which is itself driven by climate change impacts on precipitation regimes. Some forests may even be transforming into savannah or grassland landscapes, with significantly different EBA properties. Ecosystems and biophysical processes such as groundwater recharge are themselves dynamic, non-stationary, and complex. EBA will surely become a more explicit and formal tool for water management in the future.

Case study 2.6 Ecosystem-based approaches and green infrastructure in Denmark

In Denmark, more intense rainfall events and rising sea levels in a changing climate have increased the urgency to provide flood protection for low-lying and densely populated areas. A recently restored wetland, Egå Engsø, is used to channel water from heavy rainfall, thereby providing flood protection near Aarhus, Denmark's second largest city, as well as reducing nitrogen leaching from surrounding agriculture. Further preventive measures are also considered. A new wetland, Hede Enge, has been proposed to reduce risk from extreme rainfall events, which are projected to become more frequent and severe with climate change. The cost of the proposed project is estimated at approximately DKK 25 million, most of which would compensate affected landowners for expropriation of land.

Source: Denmark, Climate Change Adaptation website, <http://en.klimatilpasning.dk/>.

Case study 2.7 Making the case for an ecosystem adaptation strategy in the Great Lakes Basin

Transboundary cooperation between the eight United States Great Lakes Basin states and Canada illustrates many good practices. The five Great Lakes contain about 20 per cent of the World's freshwater supply and are shared between Canada and the United States. The two nations have adopted binding legal instruments that recognize that nations have a duty to all inhabitants of the planet, present and future, to conserve this water resource for the benefit of humankind and have adopted a precautionary, ecosystem approach to adapt to climate change.

Starting in the 1980s, both States became concerned that trans-basin diversions from the Lakes could have an adverse impact on the ecosystem and future water use options in the region. Between 2001 and 2005, the eight United States Great Lakes states negotiated an innovative interstate agreement — the Great Lakes-St. Lawrence River Basin Compact. The Compact makes it very difficult to divert water outside the Great Lakes Basin. Even small communities that straddle the divide between the Great Lakes and other drainages must meet a high water conservation standard to gain access to water located only a few miles away.

Climate change was a factor in the negotiations because the Compact proponents faced a major challenge in justifying placing one fifth of the world's freshwater supply off limits to non-Basin users. Proponents used a binational institution (IJC), which administers a 1909 boundary waters treaty between the two countries, to help make the case for a precautionary, ecosystem adaptation strategy. IJC can investigate issues and recommend solutions to transboundary issues when asked to do so by the national Governments. When the IJC receives a Government request, called a "reference", it appoints a board with equal numbers of experts from each country to respond. In 1999 the two Governments agreed to an IJC reference on Great Lakes diversions. The resulting 2000 report concluded that the Lakes are "highly sensitive to climatic variability" and invoked the precautionary principle to justify a restrictive diversion regime, linking the policy to global climate change.

The Great Lakes provinces and states have chosen to adapt to climate change by trying to maintain and enhance the existing ecosystem. If projections of lower lake levels occur, the region is in a better position to adjust to them than if had encouraged trans-basin diversions.

Source: International Joint Commission, *Protecting the waters of the Great Lakes: Final Report to the Governments of Canada and the United States* (Ottawa and Washington, D.C., 2000). Available from http://www.ijc.org/en/_Reports_and_Publications.

2.1.4 Linking to other levels and sectors

Numerous adaptation activities are already ongoing at the local, national and regional levels, with Governments developing adaptation strategies, adaptation plans, sectoral plans and numerous other policy documents. Quite frequently the effectiveness of climate change adaptation policies is limited by the lack of expertise, knowledge and scientific evidence regarding climate risks, and especially their sector-specific economic implications in the national or regional context. Linking water and adaptation policies with sectoral ones by aligning the respective policy objectives poses major challenges at all governance levels.

Lesson 9. *Ensure synergies and linkages between adaptation actions at different government levels and across different sectors*

Effective resolution of environmental issues such as effluent treatment, overfishing, invasive species and demand management requires coordination across more than one governance level — e.g., municipal, county, province or state — and country jurisdictions, even when actions are led by one level. In a transboundary setting, the need to coordinate between adaptation actions at different government levels and different sectors can be particularly important.

Building multi-level governance capacity at a transboundary level first requires inter-institutional or intersectoral coordination and cooperation in planning and management, often referred to as “horizontal integration” (see Sanchez and Roberts, 2014). Second, it requires vertical integration and coordination by empowering actors at multiple levels to be able to adopt scale strategies (including legal and policy-related measures) and solutions to climate change problems. This, for example, would include integration of local governance approaches at the large-scale basin and international levels, where decisions about allocation of resources are made and adaptation priorities are set.

Ideally, transboundary adaptation strategies should be linked to national adaptation and sectoral strategies as well as river basin management plans in order to ensure implementation and to reduce gaps with policy (for example, see case studies 2.1 and 2.2 on the Rhine and Danube Basins). Such gaps can be prevented or reduced by cross-referencing national and transboundary strategies with one another in order to promote coherence. In practice, such interaction can be achieved by engaging the same individuals and institutions in both processes and by regular information exchanges. The use of dedicated institutions, inter-agency or interministerial teams, or cross-sectoral groups to coordinate climate change adaptation activities can be useful in this respect.

Case study 2.8 Bugesera initiative and its link to the national level

The national climate vulnerability assessments carried out for Burundi and Rwanda identified the most vulnerable sectors to climate change as agriculture, water resources, energy and the environment/natural resources. Both the Burundian and Rwandan Governments have prioritized the Bugesera region in their National Adaptation Programmes of Actions (NAPAs). Subsequently, the GWP, under its Water, Climate and Development Programme (WACDEP), along with the African Ministers' Council on Water, started implementing a transboundary project in the Bugesera Basin to improve water security and climate resilience in the area. The project covers interventions that are within the NAPAs of both Burundi and Rwanda, which prioritized adaptation measures such as: rehabilitating degraded areas; erosion control; improving early warning systems; protection of buffer zones around lakes; promoting zero-grazing; energy/wood-saving techniques; education on climate change adaptation; rainwater harvesting; and introducing drought-resistant crops.

The WACDEP project in Bugasera has generated a lot of interest from communities and local governments. WACDEP interventions have been considered as integral parts of the Bugesera District Development Plan in Rwanda, which is useful in terms of the sustainability of the activities. Communities not currently targeted by WACDEP are requesting similar kinds of support from the programme.

The processes and lessons from implementing the WACDEP approach are being documented, and case studies will be developed to help promote the approach at a wider scale.

Case study 2.8 Bugesera initiative and its link to the national level (cont.)

Moreover, WACDEP has been implemented within the national frameworks of Burundi and Rwanda for climate change adaptation and water resources management. The national climate change policies and strategies (Rwanda's Green Growth and Climate Resilient Strategy, and Burundi's Climate Change Policy and Strategy), and IWRM plans or policies have provided the overall framework for the Bugesera project.



Source: Global Water Partnership, "Eastern Africa: Water, Climate and Development Programme for Africa — Water security for development". Available from <http://www.gwp.org/en/Search-result/?q=Eastern+Africa:+water+security+for+development>.

Lesson 10. *Involve all sectors and ministries in defining adaptation priorities*

Climate adaptation — like water itself — is inherently multi-institutional, multisectoral and interdisciplinary. Moreover, there are many decision makers and institutions that may be unaware of their exposure or sensitivity to shifts in climate. Hydropower operators, for instance, may view themselves as relevant to climate change primarily through their generation of clean energy (i.e., climate mitigation and greenhouse gas emissions) rather than vulnerable to climate shifts or in need of developing climate adaptation responses. Processes such as IWRM or institutions such as RBOs can provide an overall framework and governance mechanism for linking sectors, institutions and interventions. However, greater coordination by itself is not the same as climate adaptation. Involvement with many sectors may therefore require a process of education, capacity building and persuasion (see sections 2.3.2 and 2.3.3). Adaptation actions are most likely to be successful if they are "owned" by a wide variety of actors.

Case study 2.9 Disaster preparedness measures across diverse sectors in the Zambezi Basin

The Zambezi River has experienced an increasing number of disasters in recent decades including floods, droughts, migration and hailstorms, which often coincide with outbreaks of malaria, cholera and HIV/AIDS. Recurring disasters negatively impact community livelihoods and hamper sustainable development in the basin for the most vulnerable.

It was with this in mind that the International Federation of Red Cross and Red Crescent Societies and National Red Cross Societies from seven riparian countries of the Zambezi River (Angola, Botswana, Malawi, Mozambique, Namibia, Zambia and Zimbabwe) established the Zambezi River Basin Initiative in 2009. The Initiative was originally created to aid the Red Cross work following flood relief operations in all seven countries that year. It was recognized that only an integrated and comprehensive long-term approach could help to reduce vulnerability to flooding and other risks brought about by climate change, and help to foster sustainable, long-term change.

The member countries work across geographic and political boundaries to reduce the risk and impacts of current and future climate-related disasters, increase access to food during crises, reduce the number of deaths by illnesses following disasters and implement disaster preparedness, response and recovery operations. Cross-sectoral work has been accomplished through participatory approaches and community-based methodologies as well as leadership training.

Source: International Federation of Red Cross and Red Crescent Societies/Southern Africa, *Zambezi River Basin Initiative*. Available from http://www.ifrc.org/PageFiles/113731/Zambezi_River_Project_LR3_0.pdf.

At the same time, because of the multidisciplinary and multisectoral nature of climate change, there is a risk of no group or sector owning any responsibility. Leadership in fostering cooperation is a necessary catalyst to action. Regulatory approaches to coordination may be ultimately less effective — particularly in a transboundary setting — than less-forceful engagements, such as capacity-building and partnerships.

2.1.5 Climate as an added pressure

The effects of climate change do not occur in isolation, separate from other types of impacts on water resources. Therefore, climate change should not be considered in isolation.

Lesson 11. Ensure that adaptation policies consider climate change as one of many pressures on water resources

Climate change is frequently considered as just one more pressure in a series of so-called “global change” pressures, which include demographic change, migration, globalization of the economy, urbanization, “littoralization” (increasing population densities along coastlines) and shifting consumption, agricultural and industrial production patterns. In many countries, these trends are also non-stationary and non-linear, like climate change itself. However, climate change impacts can be intensified by interacting with these stressors and can lead to complex and difficult-to-predict feedbacks. Therefore, climate change should not be considered as a stand-alone pressure. Scenarios can be a powerful mechanism to explore the possible effects and interactions of different global change pressures (see section 3.2.2 for scenarios).

Case study 2.10 Addressing climate change and other pressures through technical innovations and hydro-agricultural and agricultural development in the North-Western Sahara Aquifer System

The North-Western Sahara Aquifer System (NWSAS), shared by Algeria, Libya and Tunisia, extends over 1 million square kilometres (km²) and includes two major aquifers: the Intercalary Continental and the Terminal Complex. The structural configuration and the climate of the region are such that the reserves are very little renewed: these are geological reserves whose natural outlets (springs and foggaras) had led to the development of oases where the centuries-old lifestyles long remained in perfect symbiosis with the Saharan ecosystem.

During the second half of the twentieth century the water demand increased from 0.6 to 2.5 billion cubic metres per year. Irrigated agriculture is the main user (80 per cent) of this resource. The increased water demand causes considerable stress on the system, which is exposed to the risks of saltwater intrusion and salinization, loss of artesian pressure, the depletion of natural outlets and the lowering of the water table.

Being located in an arid and semi-arid area, the NWSAS basin is threatened by climate change with a probable temperature rise between 2.5 to 4.5°C and an expected decrease in precipitation by 5 to 20 per cent by the end of the twenty-first century, as well as an increase in the occurrence of extreme events. The expected impacts of climate change are likely to increase the existing stress on the aquifer system.

The Sahara and Sahel Observatory (OSS) supports the three countries in better understanding and managing the NWSAS groundwater resources. The work of OSS culminated in 2008 in the formal creation of a tripartite Consultation Mechanism overseeing the joint management of the NWSAS.

In the context of its NWSAS III project, OSS carried out demonstration activities in six pilot projects in the three countries from July 2010 to December 2013, with the objective of providing the NWSAS users and policymakers with efficient solutions for increasing water productivity while ensuring the efficiency of investments, the improvement of farmers’ income and the conservation of the NWSAS basin.

The set of innovations devised concerned hydro-agricultural development and water resources and land management techniques, building on the achievements of best agricultural practices and research appropriate to local agricultural systems and local populations. One set of techniques that was introduced aimed to address the loss of artesian pressure through the introduction of solar-powered pumps (Ksar Ait Messaoud Oasis, Reggane, Adrar Algeria, and Kebili Oasis–Medenine Tunis) and the construction of groundwater drainage networks (Sidi Mahdi, Touggourt, Algeria) to improve water drainage in the oases.

Case study 2.10 Addressing climate change and other pressures through technical innovations and hydro-agricultural and agricultural development in the North-Western Sahara Aquifer System (*cont.*)

Another set of techniques aimed to give value to alternative water resources through the desalinization of brackish water (Medenine-Tunisia) and to make better use of geothermal water (El Hamma, Gabes, Tunisia). In all pilot projects, solutions for more efficient use of water were introduced, for example, localized irrigation systems combined with sustainable agricultural practices such as the introduction of adapted varieties and intercropping.

The pilot projects were successful in showing that more water-efficient agriculture helps to reduce the risks of saltwater intrusion and salinization, loss of artesian pressure, the depletion of natural outlets and the lowering of the water table, while at the same time raising farmer incomes. The demonstration projects therefore made it possible to define “low-regret” adaptation measures that can be included in the strategic adaptation documents (NAPAs and National Adaptation Plans) developed by the countries sharing NWSAS.

Sources: Sahara and Sahel Observatory, “Rapport final du projet SASS III sur les résultats de la composante “pilotes de démonstration agricole” d’Algérie, de Libye et de Tunisie”, final project report, 2013.

“Climate Axis” web page, <http://www.oss-online.org/en/climate-axis>.

2.2 Legal and institutional frameworks

Legal and institutional frameworks are important for climate change adaptation because they set out basic minimum provisions essential to water governance, such as water quality standards, goals of water management, mechanisms for resolving disputes and negotiating trade-offs, and the means for setting priorities for water allocation. Legislative frameworks also create institutions and designate specific bodies that will regulate the use and management of water. Legislation may also designate the stakeholders that can participate in basin-level decision-making. This section analyses specific provisions in legal frameworks that are fundamental in facilitating adaptive capacity within transboundary basins and the broader enabling factors underlying these provisions.

Legal frameworks have to ensure stability and certainty in relationships (through clear rules, standards and procedures and rigidity in following them) but provide for flexibility in approaches (for example through amendments, reviews or monitoring). Legal frameworks should be adaptive and flexible to respond to the uncertainties, complexities, shifting power differences and impacts of climate change in a transboundary context. Legal frameworks are especially powerful in creating the conditions that can enable (or impair) effective transboundary adaptation decisions and actions. Four major enabling factors that facilitate the resilience of legal frameworks are set out below:

- **Legal and institutional “flexibility”** (see section 2.2.1). How rigid are the relationships between institutions connected by water? Can they be adjusted or renegotiated easily as climate change alters relevant parameters in freshwater resources, precipitation regimes and variability? How are crisis periods handled? However, flexibility mechanisms might diminish the certainty and stability provided through the law; flexibility therefore needs to be reconciled with the rigidity of law.
- **Multi-level governance** (see section 2.1.4). How coherently are water management issues managed across scales of governance? How are new problems identified?
- **Stakeholder engagement and public participation** (see section 2.3.1). Can new institutions be incorporated into governance relationships? How are trade-offs evaluated? Who is identified as a stakeholder, and how are those voices articulated? What happens when needs or priorities for institutions change over time?
- **Environmental allocations** (environmental flows or e-flows) (lesson 14). How are environmental allocations identified, monitored, evaluated and compensated? Is there a clear voice for ecological and biophysical processes relating to water? Who “owns” water, and what vision of long-term eco-hydrological sustainability is used to guide values and decisions on the environment?

These enabling factors depend on and reinforce each other, and their operation influences the extent to which good practices can be successfully implemented. As climate change poses an immense challenge for water governance, institutional and legal frameworks can enhance or retard adaptive capacity and eco-hydrological and institutional integrity. Multi-level governance can also enhance the generation of

scale-specific legal strategies or regulations together with other adaptation measures to manage water-related impacts of climate change.

2.2.1 Adaptive legal frameworks

Legal frameworks define the formal processes for cooperation, such as how to communicate, how to allocate water and how to warn and assist each other in times of extreme weather events. They can include provisions on prevention of, preparedness for and response to flow variability (such as floods), information exchange, learning capacity and natural resources monitoring. Many provisions of international water law can also help climate change adaptation, such as the principles of equitable and reasonable use, the “no significant harm” principle and the precautionary principle. For example, according to the United Nations Watercourses Convention, climatic conditions are one of the factors determining equitable and reasonable use. In addition, international law contains procedural rules, such as prior notice and consultation, dispute resolution and data sharing which are important and useful for climate change adaptation (for more information see Sanchez and Roberts, 2014, chapter 3.3.2).

Case study 2.11 Creating a policy framework for negotiating uncertainty and trade-offs in the Mekong River Basin

The Mekong River Basin is expected to be increasingly vulnerable to the consequences of global climate change. The four countries of the Lower Mekong Basin — Cambodia, the Lao People’s Democratic Republic, Thailand and Vietnam — signed an Agreement on Cooperation for the Sustainable Use of the Mekong River Basin (Mekong Agreement) in 1995. Five other “procedures” were also developed by the Mekong River Commission (MRC) to provide more detailed implementation guidance with regard to the Mekong Agreement, accompanied by guidelines with more details on their implementation.

While not specifically targeting climate change and adaptation (and in fact not even mentioning it specifically), the Mekong Agreement contains a range of important legal and institutional provisions for adapting to change in the Lower Mekong Basin. This includes, most importantly, two key provisions of international water law: the principle of equitable and reasonable utilization (art. 5) and the obligation not to cause significant transboundary harm (arts. 7 and 8). The principle of equitable and reasonable utilization can help countries of the Lower Mekong Basin to ensure that their respective water resources needs and interests are taken into account even in times of climatic change. The obligation not to cause significant transboundary harm, on the other hand, ensures that water resources development projects do not harm co-riparian States, especially when potential impacts are aggravated due to climate change (e.g., hydropower projects whose influence on the river’s flow regime is further aggravated by climate change), and also that adaptation activities themselves, taken unilaterally by a country, do not negatively affect other riparian States (e.g., storage schemes for adaptation purposes in the agricultural sector). Since the Mekong Agreement does not tackle questions related to water allocation and water sharing, flexible mechanisms for addressing flow variability as called for in other transboundary basins are neither included in the agreement nor required at this point for successful cooperative adaptation efforts.

All the procedures supplementing the Mekong Agreement provide additional guidance on climate adaptation. “Procedures for Maintenance of Flow on the Mainstream” acknowledges hydrological variability, changes and development effects on the river’s flow. It regulates for a natural flow to be maintained except in times of severe droughts and floods. These Procedures provide a useful framework for ensuring the health of the river’s ecosystem and the sustainable development of its resources even under climate change conditions.

“Procedures for Data and Information Exchange and Sharing” ensures the regular exchange of data on climate-relevant issues, such as hydrology, ecology or floods. The use of these data by MRC can lead to the development of effective transboundary adaptation measures.

“Procedures for Notification, Prior Consultation, and Agreement” is the most well-known of the Procedures. It can also provide a basis for climate change adaptation if climate change impacts are taken into consideration when assessing the potential impacts of water resource development projects. Prior Consultation Project Review Reports incorporate climate change considerations and uncertainties associated with the impacts of hydropower projects.

The legal framework remains insufficient with regard to specific provisions on basin-wide climate change adaptation and the mainstreaming of climate-relevant aspects into more general water resources development activities. The MRC mandate in basin-wide adaptation needs to be sharpened, especially in relation to the linkages between national and regional adaptation measures and the mainstreaming of climate-relevant aspects into water resources development more generally.

Case study 2.11 Creating a policy framework for negotiating uncertainty and trade-offs in the Mekong River Basin (*cont.*)

MRC has created initiatives to acknowledge the need for climate adaptation. One of the most notable is the MRC Climate Change and Adaptation Initiative (MRC-CCAI), created in 2009 to support MRC member countries in integrating climate change in aspects of development planning and using the findings of studies and pilot projects to design frameworks that guide adaptation and monitoring of implementation progress and newly emerging trends.

The different Procedures, as well as SEA and EIA processes, provide a solid framework for cooperation between the countries of the Lower Mekong Basin. Creation of MRC-CCAI, in addition, provides for ample attention to be given to climate change issues in the Basin.

Source: S. Schmeier, *Governing International Watercourses: River Basin Organizations and the Sustainable Governance of Internationally Shared Rivers and Lakes* (Abingdon, United Kingdom of Great Britain and Northern Ireland, Routledge, 2012).

Lesson 12. Implement existing transboundary agreements in a flexible way

Legal frameworks alone are not enough by themselves, and no perfect framework can be created that will endure without amendment, modification, evolution and adjustment. However, many existing transboundary agreements were not developed to allow for flexibility. They assume relatively fixed water conditions in their relevant basins. Revising or amending them can take a long time and be very complicated. Instead of complete revisions, additional policy and strategy documents such as flood action plans, climate change strategies or additional protocols can be developed.

Legal frameworks should therefore foresee the creation of an institutional and organizational framework, e.g., a basin commission of a river, lake or aquifer, that can address issues of hard-to-predict or potential flow variability and flow change. Flexible institutional frameworks can discuss and address gaps in the legal framework, such as by developing climate change adaptation strategies and plans or by integrating climate change aspects into existing river basin management plans. Thus, instead of amending inflexible legal frameworks they can be implemented in a more open-ended way that acknowledges that change is certain, even if the specifics of that change and the mechanisms needed to adjudicate and resolve new concerns and issues have not yet been articulated. Such types of more open-ended approaches to transboundary water management require political willingness and sufficient resources and can be facilitated by the existence of a high-capacity secretariat.

The Sava River Basin is an example where the transboundary agreement did not address flow variability, a gap that was altered through an additional protocol (see case study 2.12). The Sava agreement was signed in 2002, when climate change adaptation and flood management did not yet play an important role or was not considered as a high priority by riparian countries. By 2010, when the importance of climate change adaptation and flood management became apparent, an additional Protocol on Flood Protection was elaborated.

Case study 2.12 The Sava Flood Protocol

The Sava River Basin, with a total area of 97,713 km², is the second largest sub-basin of the Danube River Basin, representing 12 per cent (%) of the territory of the larger basin. Over 8 million people inhabit the Sava River Basin shared by Bosnia and Herzegovina (39.3% of the Basin territory), Croatia (26%), Serbia (15.5%), Slovenia (12%), Montenegro (7%) and Albania (0.2%).

The Sava River was the largest national river in Yugoslavia, where flood protection was planned in an integrated manner. After the dissolution of Yugoslavia in the early 1990s, it has become an international river of recognized importance; however, emerging issues concerning the Sava could no longer be addressed in a comprehensive way. Therefore, the need for cooperation in management of the shared waters of the Sava River Basin led to the establishment of the International Sava River Basin Commission. Today, the Sava riparian countries have rather similar goals and in their achievement rely on national legislation that follows EU and other international legislation.

Case study 2.12 The Sava Flood Protocol (cont.)

The Sava Commission was established to implement the Framework Agreement on the Sava River Basin. The framework for cooperation and implementation of the activities aimed at creating the conditions for sustainable flood protection is set by the Protocol on Flood Protection to the Framework Agreement. The Protocol acknowledged the likely consequences of climate change on the water regime in the Sava River Basin and the need for effective adaptation measures. By signing the Protocol, the countries in the basin agreed to cooperate on flood risk management by taking into account the impacts of climate change. The pilot project “Building the link between flood risk management planning and climate change assessment in the Sava River Basin” supported the implementation of the Protocol and aimed to prepare the basis for the preparation of the first Flood Risk Management Plan for the Sava Basin. The pilot project and complementary study sought to establish the appropriate objectives of flood risk management, and consider the measures already defined by the countries in order to achieve common objectives of flood risk management. Valuable information in the assessment of measures at the national level has been provided by initial pilot project outcomes, such as the impact of climate change on trends in temperature and precipitation in the basin, and on the hydrologic regime of the Sava River, as well as a set of proposed adaptation measures of importance for the basin.

The project has shown that the legal framework for regional cooperation should not just oblige countries to consider the impact of climate change and adaptation measures for flood protection in the basin; projects implemented at the basin level should provide the countries with the necessary information to enable them to achieve the targets set in common legislation, and ultimately lead towards the achievement of sustainable flood protection in the basin.

Sources: Sava Commission, www.savacommission.org.

International Sava River Basin Commission (2010), Protocol on Flood Protection to the Framework Agreement on the Sava River Basin. Available from http://www.savacommission.org/basic_docs

International Sava River Basin Commission (2011), Strategy on Implementation of the Framework Agreement on the Sava River Basin. Available from http://www.savacommission.org/basic_docs

Dejan Komatina and Samo Grošelj, “Transboundary Water Cooperation for Sustainable Development of the Sava River Basin”, The Handbook of Environmental Chemistry, Vol. 31, Milačić, R. and others, eds. (Springer, 2014).

Lesson 13. Design new transboundary agreements to be flexible

The ability of many legal frameworks to adapt in response to or in anticipation of climate change impacts is also insufficient, since the means of evaluating such impacts from social, economic and ecological perspectives is likely to evolve in combination with climate conditions.

Legal flexibility can enable the restructuring of water policies and laws to deal with future climate change effects. Many existing transboundary instruments and numerous transboundary agreements lack robust mechanisms to ensure the flexibility necessary to respond to the uncertainties posed by climate change, such as fluctuating precipitation patterns which affect the balance between water demand and water availability (IPCC, 2014). Therefore, negotiators of new transboundary agreements should aim to include sufficient flexibility, where possible. Some international law instruments, such as the Berlin Rules on Water Resources (International Law Association, 2004) create procedural provisions in line with the practices highlighted above to strengthen the capacity of transboundary

Case study 2.13 Cooperation between Mexico and the United States

The decades-old transboundary cooperation treaty between Mexico and the United States of America was amended in 2013 to foster more flexibility in a basin that appears to be experiencing both increasing water demand and declining absolute water availability. The treaty includes one important flexibility provision: the possibility to revise or complement the treaty by adding “minutes”. After five years of negotiations, Mexico and the United States agreed on adding minute 319, which specifies, among other issues, measures to take in the Colorado River Basin in situations of water quantity fluctuations that might be due to climate change. This shows the flexibility of the regime, signed in 1944, and the willingness of the riparian countries to prepare transboundary agreements to address climate change. Reasons for this significant progress in the transboundary regime, increasing its adaptive capacity, were the sense of urgency generated by several extreme flood and drought events in recent years, an approaching change of government in Mexico and an accrued trust that has developed through continuing cooperation.

Sources: Regina M. Buono, “Minute 319: A Creative Approach to Modifying Mexico-U.S. Hydro-Relations over the Colorado River”, International Water Law Project Blog (2012). Available from <http://www.internationalwaterlaw.org/blog/2012/12/10/minute-319-a-creative-approach-to-modifying-mexico-u-s-hydro-relations-over-the-colorado-river/>.

International Boundary and Water Commission, “Minute No. 319: Interim International Cooperative Measures in the Colorado River Basin throughout 2017 and Extension of Minute 318 Cooperative Measures to Address the Continued Effects of the April 2010 Earthquake in the Mexicali Valley, Baja California” (2012). Available from http://www.ibwc.gov/Files/Minutes/Minute_319.pdf.

management systems to deal with uncertainties. Flexibility provisions play an important role in water-scarce river basins, such as between Spain and Portugal or Mexico and the United States.

The following two lessons illustrate how agreements on water quantity (lesson 14) or quality (lesson 15) could be made more flexible.

Lesson 14. Include flexibility mechanisms in water allocation schemes

On the one hand, 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. Treaties should define procedures for negotiation or renegotiation of water allocations.

Water allocation between countries based on a percentage of the flow allows flow regimes to respond to both wet and dry conditions, though this assumes that a linear relationship between availability and need exists between all users. Due to the uncertainties concerning climate change, such practices are vital to enhance legal flexibility so as to institute policy and management changes easily with the changing status of transboundary water resources. Such an approach requires mechanisms like regular communication and data sharing, flexible infrastructure and effective operating rules in order to be fully operational.

Case study 2.14 Legal framework for cooperation between Spain and Portugal

Spain and Portugal do not have a river basin commission with a permanent secretariat, but the legal framework for cooperation between these countries has been made more flexible by amending the 1998 Convention on Cooperation for the Protection and Sustainable Use of the Waters of Portuguese-Spanish Hydrographic Basins (Albufeira Convention). The Albufeira Convention is based on modern international and European law (art. 2) and goes beyond the EU WFD. The Convention regulates the transboundary waters in the shared basins between Spain and Portugal, namely the basins of the Minho-Lima/Miño-Limia, Douro/Duero, Tejo/Tajo and Guadiana Rivers, and covers issues such as bilateral information exchange, public information, assessment of and dialogue on transboundary impacts, pollution control and prevention, water uses, droughts and resource scarcity, assignment of rights and dispute resolution. The Convention already provided for extreme situations such as floods (art. 18) and droughts (art. 19), but these phenomena are expected to be increasingly common in the Iberian Peninsula. Therefore, the Convention was amended by the Additional Protocol of 2008 to guarantee some minimum flows that should enter in the Portuguese part of each basin, coming from the Spanish part, taking into account periods of water scarcity and droughts. However, the Parties may invoke exceptional circumstances for not complying with the flow regime, as recorded in some years. The joint bodies currently cannot address such situations.



Source: Amparo Sereno, *Ríos que nos separan, aguas que nos unen. Análisis jurídico de los Convenios Hispano-Lusos sobre aguas internacionales* (Valladolid, Lex Nova, 2011). Available from <https://sites.google.com/site/amparosereno>

On the other hand, water allocation in basins requires some stability in order to give certainty to riparian countries. Prioritization of water uses, such as drinking water supply versus agriculture, in situations of drought can help to address situations of water scarcity according to an agreed upon framework and thus to avoid controversies.

Lesson 15. Climate-proof regulations for water quality

Since climate change also has impacts on water quality (such as increased concentrations of pollutants during low-flow periods), transboundary legal frameworks focused on water quality should include provisions to assess the “what, how and when” of climate change impacts. Extreme weather events can also cause pollution due to storm-water overflows and flooding of contaminated sites, or result in harmful or unwanted temperature variations (e.g., water that is too warm for use by water-cooled thermal energy facilities, or water that is too cold for particular ecosystems or target species or livelihoods). Difficulties from a regulatory perspective may also arise as novel climate conditions emerge (e.g., extremely acid conditions in the Murray-Darling Basin in Australia during a severe drought).

How can existing approaches be modified, and can they be adjusted quickly, to limit damage and incentivize more effective solutions? Ideally, a system should be established to share information and data between all stakeholders about the relationship between weather, climate and water quality conditions, to promote a clear understanding of these impacts and to establish effective emergency response measures to deal with situations caused by the impacts of climate change, such as droughts and floods. Water quality regulations not only need to address local water conditions; acknowledgement of different water uses within the basin enable a more flexible way to manage water quality when facing natural constraints.

Case study 2.15 The Great Lakes Water Quality Agreement between Canada and the United States and its 2012 Protocol

The Great Lakes Water Quality Agreement signed in 1972 is usually referred as a good example of water quality regulation to cope with critical environmental health issues. This instrument is a precursor of regulations to control pollution in transboundary basins and ecosystems; its main objective is to maintain and restore the chemical, physical and biological integrity of the Great Lakes Basin ecosystem.

Within the framework of the Agreement, the Protocol of 2012 is one of the only (if not the only) instruments to address expressly and directly the impacts of climate change on water quality. This Protocol provides the obligation to coordinate efforts between the parties in order to identify, quantify, understand and predict these impacts and the duty to share such information in a timely and comprehensive manner. Such efforts must be transposed into regional-scale models linked to each chemical, physical and biological aspects of the Great Lakes Basin ecosystem. It also contains provisions to help coastal communities understand the impacts of climate change on water quality.

IJC implements the provisions of the treaty and its complementary instruments, such as the 2012 Protocol, in cooperation and consultation with local authorities and the public. IJC does this mainly by formulating recommendations to assist in the implementation of the treaty, collecting and analysing data and information and assisting in the coordination of joint activities. The conflict resolution system of the treaty, however, does not provide IJC with the power to act and resolve implementation issues independently, or to impose its decisions on the parties. This could eventually limit the effective implementation of this instrument and the protocols.

Sources: Canada and the United States, Great Lakes Water Quality Protocol, 2012. Available from http://www.ijc.org/en/_/Great_Lakes_Water_Quality.

UNEP and IWA under UN-Water, Project Report “Compendium of Water Quality Regulatory Frameworks –Which Water for Which Use?” (forthcoming).

2.2.2 Importance of context-sensitive and functional transboundary institutions for basin adaptation

Adaptation strategies are not developed in a void; the existing context (among others, the policy, legal and institutional setting, but also generally accepted concepts and approaches) largely determines the possibilities for developing and implementing a strategy. The existing frameworks may not be attuned to adaptation in most cases. However, often mechanisms are in place that can be employed to achieve a functional adaptation strategy.

Case study 2.16 Agreement between Kazakhstan and China on Water Quality

On 22 February 2011, the Governments of Kazakhstan and China signed a treaty for the protection of transboundary waters. The objective of this instrument is to establish cooperation between these countries in order to protect transboundary rivers against water pollution.

In accordance with the instrument, which covers all the rivers shared by China and Kazakhstan, the two countries agree to:

- Undertake research to determine what is an acceptable water quality for the rivers
- Regulate and establish preventive measures to protect and ensure good water quality
- Exchange relevant information
- Establish a joint commission and joint working groups to implement the instrument
- Organize academic activities and capacity-building
- Develop new technologies to better implement the agreement
- Identify pollution sources.

The joint commission is structured in two working groups: one in charge of analysis, monitoring and evaluation of the waters; and the other in charge of emergency response and prevention (such as those caused by the impacts of climate change).

No particular mechanism for conflict resolutions has been established, in which case the parties are bound to negotiate and consult each other. However, the greatest challenge this treaty presents are the national security issues. The parties have the right not to comply with their duty to cooperate and share information with regard to any of the topics covered in this agreement if such issues are considered to threaten national security.

Source: Ministry of Foreign Affairs of Kazakhstan, “The cooperation between the Republic of Kazakhstan and the People’s Republic of China in the field of use and protection of transboundary water resources”, 30 January 2015. Available from <http://www.mfa.kz/index.php/en/foreign-policy/current-issues-of-kazakhstan-s-foreign-policy/transboundary-rivers/the-cooperation-between-the-republic-of-kazakhstan-and-the-peoples-republic-of-china-in-the-field-of-use-and-protection-of-transboundary-water-resources>.

UNEP and IWA under UN-Water, Project Report “Compendium of Water Quality Regulatory Frameworks –Which Water for Which Use?” (forthcoming).

Coordination of climate change adaptation strategies, particularly within wider and more comprehensive frameworks, as well as the development of basin-wide adaptation strategies, is obviously not an easy task and cannot be achieved without joint institutional structures, such as a coordination body or a framework. Conflicts are less likely when well-established and smoothly operating institutions exist, even in cases where riparian countries have still unresolved political differences.

Lesson 16. Give a mandate to river basin organizations to address climate change

Effective RBOs can facilitate the development of adaptation frameworks and programmes between riparian countries, as well as the exchange of climate-relevant information and data, early warning in case of extreme events such as floods and droughts, or the preparation of common climate change impact and vulnerability studies. They may also play a role in dispute resolution with regard to flow variability and infrastructure operations or the development of climate change adaptation strategies, studies and measures, as was the case in the Danube Basin (see case study 2.2). However, whether an existing river basin commission works on climate change adaptation depends on many factors: evidence of climate change impacts; insightful leadership by affected riparian countries; and the political willingness of the other countries. The capacity of the RBO itself can play an important role — its organizational mandate, the existence of a permanent secretariat, resource levels (human and financial), the scope of authority given by the riparian countries, its competence, and regional and global recognition or donor support can all have an impact on the efficacy of the organization.

In general, a clear mandate is needed to develop a transboundary adaptation strategy. Additionally, having at least one national leader or advocate for the development of the adaptation strategy can help. Ideally, the mandate can already be included in the transboundary agreement creating the joint commission. In fact, numerous transboundary agreements were negotiated to address flow variability such as floods and droughts, but not necessarily climate change. If climate change or variability was not included, RBOs can discuss and add new topics to the transboundary cooperation, such as climate change adaptation. Ideally, riparian countries would give a mandate

to the commission to develop a transboundary strategy. Taking such decisions can be facilitated by leadership, learning capacity, political willingness, resources and flexibility in the interpretation of the agreement and by the bodies implementing it. Specific extreme events and international policy events can be an occasion to establish climate change adaptation as a regional or basin-wide priority.

Case study 2.17 River basin organizations and adaptation strategies

Most transboundary adaptation strategies developed so far have been elaborated in basins with the most developed RBOs in the world: the Danube and the Rhine. Some other basins, such as the Mekong, are in the process of developing adaptation strategies. The river basin commission with the most activities on climate change adaptation is probably the MRC, which has a Climate Change and Adaptation Initiative. The MRC-CCAI has a budget of over USD 10 million and around seven staff members dedicated to it. This initiative has implemented some pilot projects, works on basin-wide climate change impact assessments and scenarios and on developing a basin-wide transboundary adaptation strategy to be finalized by the end of 2015.

In the Rhine Basin, the Ministerial Conference in 2007 gave a mandate to the ICPR to assess climate change impacts and subsequently develop an adaptation strategy. Similarly, in the Danube, ministers decided in 2010 to develop a basin-wide adaptation strategy. This process was completed after two years and the strategy was adopted in December 2012 (also see case studies 2.1 and 2.2)

Sources: Mekong River Commission, International experiences on formulation and implementation of transboundary climate change adaptation strategies (Vientiane: 2014).

Mekong River Commission website, "Climate Change and Adaptation Initiative". Available from <http://www.mrcmekong.org/about-mrc/programmes/climate-change-and-adaptation-initiative/>.

Lesson 17. Create a specific working group responsible for climate change adaptation as part of a joint commission's institutional framework

A working group or expert group can be created that is responsible for climate change adaptation, such as in the Danube Commission. By empowering or chartering a specific group, adaptation can gain sufficient attention. Alternatively, the topic can be added to the mandate of existing bodies, such as a working group on floods. However, in such a case, adaptation runs the risk of being treated only from one perspective: e.g., if incorporated in a floods working group, adaptation can be seen as only relating to flooding. The Danube Commission therefore followed a two-fold approach by creating a special expert group on climate change, while also mainstreaming the issue of climate change into existing working groups (see case study 2.2).

Case study 2.18 Great Lakes

The International Joint Commission ensures both vertical policy and institutional integration of key requirements for each study, as well as horizontal integration of the interests and expertise of the various water-using sectors within the Great Lakes basin. This is a Unitary Treaty Organization having six commissioners (three from Canada, three from the United States) appointed by the President and Prime Minister. It operates from the Yukon to the Gulf of Maine.

Its key functions:

- Controls flows in boundary waters
- Prevents and resolves disputes over shared water and air
- Watchdog of Great Lakes restoration efforts
- Conducts studies for governments
- It has several boards and task forces (either thematic or water bodies-specific ones).

The United States-Canada transboundary IJC is rather unique in its decision-making processes. There are three main levels of decision-making in the numerous sub-basins along the 4,500 mile border:

- The Governments, which provide the basic study directives and receive IJC recommendations.

Case study 2.18 Great Lakes (cont.)

- IJC, which appoints independent binational study boards that conduct the studies and devise a wide range of feasible plans, engages in comprehensive public involvement, and puts forward a set of recommended (acceptable) regulation plans for public and government comment.
- The Study Boards, which undertake the scientific assessments, develop the study goals and objectives and requisite evaluation framework and criteria for decision-making.

Given the complexity and uncertainty surrounding climate change scenarios and vulnerability assessments, much of the work undertaken by the two Study Boards on this issue was quite innovative and original (see case study 2.4). All of the key scientific work was externally and formally peer-reviewed by the respective academies of science and national scientific and engineering organizations. The Study Boards then recommended a new regulation plan with public input.

There are five key lessons developed by the two studies, based on the IJC experience for decision-making under uncertainty, especially in dealing with climate uncertainty:

Lesson 1: To build confidence in the process, begin with the present and traditional approaches to dealing with climate variability — the “known knowns”.

Lesson 2: Build public trust via an iterative “shared vision planning” process.

Lesson 3: Develop and test the evaluation rules and decision criteria and focus on the decisions that are especially sensitive to uncertainty — i.e., benefit-cost criteria, equity and performance indicators that explicitly deal with uncertainty.

Lesson 4: Practice decision-making under uncertainty with the Study Board, the Public Interest Advisory Group and the Technical Work Groups.

Lesson 5: Develop adaptive management strategies for “unknown unknowns”, and make them part of the recommended implementation plan.

Source: Eugene Stakhiv, Visiting scholar, International Center for Integrated Water Resources Management under the auspices of UNESCO, personal communication, e-mail (20 February 2015).

Lesson 18. Use existing non-RBO institutions and mechanisms for transboundary cooperation to the extent possible

Some basins without a formal transboundary legal and institutional framework have other forums for discussion, such as informal working groups where representatives of the riparian countries meet and discuss issues of common concern, like flow variability, energy needs and trade and agriculture. The viability of starting a discussion on climate change adaptation in such forums should be assessed. There have been examples where joint projects to study climate change and adaptation in a basin were developed within such bodies. Bringing the results of such studies to the political level also sometimes results in the development of basin adaptation policies.

In some basins, no institutions or informal groups for transboundary cooperation exist at all. In these cases, the need for climate change adaptation may actually be a trigger for creating new groups, coalitions, or institutions. Often, the realization of negative climate change impacts on the entire basin serves as a catalyst for bringing critical stakeholders together to discuss how to make use of existing institutional arrangements or to develop new approaches. Thus, some conflicts (or the threat of future conflicts) may actually serve as a useful vehicle for establishing an effective institutional structure to address climate change adaptation concerns, as well as more general problems of transboundary cooperation.

2.3 Organizing the process of adaptation strategy development

Political frontiers often do not match hydrological boundaries and, as a result, hydrology and policy may not mix very well. These issues may be compounded with other types of “basins” with contrasting flows: ethnic, cultural and socioeconomic relationships. The public and stakeholders may be insufficiently

aware of how to take part in transboundary decision-making. Mechanisms of public participation are not well developed within many countries, much less at the transboundary level. This section addresses such issues in organizing the process of developing an adaptation strategy.

2.3.1 Dialogue and participation

The leading role of public authorities of sovereign States in promoting transboundary cooperation, including on climate change adaptation issues, is critical to sustained progress and effective action. But governmental action is not enough; the importance of a wider and systematic stakeholder engagement in the whole cooperation process is also widely recognized.

Stakeholders should include national and local authorities of riparian countries, established transboundary bodies and platforms, infrastructure management agencies (water, energy, land, transport, etc.), productive sector entities, including associations and businesses (natural resource management, agribusiness, forestry, fisheries, construction, tourism, mining, health, risk and disaster management, etc.), civil society, media, academia, minority groups and others.

Cross-cutting issues like gender and youth, employment, poverty and social equity should be fully integrated into considerations and deliberations. Among others, the questions related to the allocation of water rights and the potential/anticipated impacts of climate change should be analysed and explained to the stakeholders.

Stakeholder involvement as a general rule is well described through IWRM processes, but stakeholder engagement may be much more important for climate change adaptation because of the uncertainties around future impacts and the potential for conflict and mistrust.

There are multiple benefits from engaging stakeholders on climate change adaptation including:

- Fostering information exchange and communication channels with all involved parties towards a more thorough understanding of issues, potential solutions and alternative perspectives.
- Assisting the transparency, quality and effectiveness of decision-making processes by gaining better insight into potential equitable outcomes, solutions to conflicts and mutual benefits.
- Strengthening implementation, monitoring and adaptation-to-change capacities by increasing understanding, early warning, confidence and skills.
- Improving the sustainability of impacts by increasing functionality and acceptance among sectors and partners.

Long-term stakeholder engagement is a time- and resource-intensive investment. Moreover, assessment results need to be tailored to the needs of each particular stakeholder group. Institutions and organizations that are regional or have a regional presence, such as ECE or GWP, can play a facilitation role at the transboundary level, as they are considered to be neutral and can assist with building local capacities and trust. In some cases they may facilitate very flexible arrangements among riparian countries. A unique example of such an agreement is the Drin River Basin Memorandum of Understanding.

International water law prescribes prior notification and consultation. In practice, however, there are serious challenges in involving all stakeholders and ensuring public participation on water issues, despite provisions on public participation in environmental decision-making in international instruments — such as the ECE Water Convention and the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters — as well as basin-level agreements. Such legal frameworks need to be used to create a platform for inclusion of stakeholders and the public through practices such as joint basin management, multi-level coordination, cooperation and collaborative learning. Including stakeholders and the public creates a space in which they can gain a sense of responsibility and understanding of the water-related impacts in transboundary basins and empower them to take action and generate local adaptation strategies, where appropriate.

Case study 2.19 The Drin Memorandum of Understanding and the role of stakeholders

The Drin Basin has a total surface of almost 20,000 km², shared between Albania, Greece, Kosovo (United Nations administered territory under United Nations Security Council resolution 1244), Montenegro and the former Yugoslav Republic of Macedonia. It offers an excellent example of interdependencies between multiple human uses, in a number of interconnected inland water bodies (the Micro and Macro Prespa Lakes, Lake Ohrid, Lake Skadar/Shkoder, the Buna/Bojana River, the Drin River and the Ramsar Wetlands) and the receiving Adriatic Sea. Although the expected impact of climate change on the Drin system has not been thoroughly assessed at the regional level, national communications to UNFCCC from Albania, Montenegro and the former Yugoslav Republic of Macedonia, as well as the report “The State of Water in Kosovo”, conclude that climate change will have serious detrimental impacts on the basin: increases in the heat index; heat waves; deforestation; intense or extreme rain events; floods; droughts; changes of water level in the lakes; and impacts on the production of hydropower.

Until recently, the river was managed mainly at the national level. Despite efforts of the riparian countries to improve their legal and regulatory frameworks in line with EU legislation, there were limitations in institutional frameworks, inadequate governance provisions and capacities, as well as a lack of financial resources for infrastructure and management. Some legally-binding cooperation agreements on water resources and ecosystem management were established between riparians for each of the three international lakes of the Drin system; however, none of them tackled the question of adaptation to climate change and there was no framework for coordinated action at the Drin Basin level.

In December 2009, a multi-stakeholder process for the establishment of a shared vision for the sustainable management of the Drin Basin, the “Drin Dialogue”, was formally initiated. A structured, sophisticated, step-by-step multi-stakeholder dialogue was led by the competent ministries, facilitated actively by GWP Mediterranean and ECE. It comprised targeted assessments and numerous consultation meetings at the national and transboundary levels. It is one of the cases where competent ministries, national agencies, water users, environmental NGOs, academics, the private sector, international institutions and donor countries worked successfully together to ensure that all parties acquired the necessary ownership of the required actions. A series of meetings were organized by the Mediterranean Information Office for Environment, Culture and Sustainable Development to prepare the participation of civil society in the consultations. The Drin Dialogue was completed after two years in 2011, when the five Drin River riparians signed the “Memorandum of Understanding for the Management of the Extended Transboundary Drin River Basin”.

Although in the Memorandum there is no explicit reference to adaptation to climate change, the issue was discussed and is implicitly included. The Drin riparians are committed to “promote joint action for the coordinated integrated management of the shared water resources in the Drin Basin, as a means to safeguard and restore, to the extent possible, the ecosystems and the services they provide, and to promote sustainable development across the Drin Basin”, as well as having a goal to reduce climate change risks, especially through cooperation on flood prevention. The Drin Memorandum of Understanding defines short-, medium- and long-term actions to address the problems identified, including the impact of climate change. The preparation of an Integrated Drin Basin Management Plan is the long-term objective.

In the framework of follow-up actions on adaptation, a German Agency for International Cooperation project was developed to promote specific activities in the period 2012–2018. The target activities include: assisting municipalities in establishing a flood early warning system; drafting national climate change adaptation strategies; formulation and implementation of flood or drought management plans at the communal level; and integration of climate change adaptation strategies in urban planning.

Source: www.drincorda.org.

Lesson 19. Facilitate trust building and collaborative learning

Managing complexity and distrust in relations between riparian countries demands a stepwise and context-specific approach that builds trust and facilitates shared understanding. Build on what is working, for example, largely relying on home-grown governance arrangements, and adjust accordingly. Reach out to epistemic communities and bring together science, law and policy through collaborative learning initiatives and regional projects that enable co-production of knowledge and reflexive learning.

Technical cooperation might demonstrate the practical benefits of better water management and sow the seeds of trust among riparian countries. Joint identification of opportunities between

representatives of riparian countries and scenarios that portray alternative development options make it possible to capitalize on synergies and shared benefits, to address trade-offs and to reconcile different users' preferences. For example, implementation of practical measures — such as joint fish conservation and hydrochemical studies; joint sampling and analysis of water quality; calculation of the basin water balance; and cooperation on development of the legal regulations in water management on the basin level — helped to build trust and substantially improved transboundary dialogue in the Dniester River Basin.

Lesson 20. Apply transparency and openness throughout the process

When working together in a transboundary basin, transparency in methods used, transparency on uncertainties, on interests, planned activities, etc., is needed to ensure the necessary mutual trust. This is especially important in a transboundary context where some of the issues are considered sensitive or related to national security concerns and can therefore not be disclosed. Essential ways to achieve the necessary transparency and openness are through joint collection and exchange of data and information (also see section 3.1); periodic interactions with technical counterparts; development and dissemination of (preferably joint) reports (also see section 3.2); sufficient capacity development (also see section 2.3.2); and intensive communication to overcome formal procedural barriers to collaboration (see section 2.3.3).

Case study 2.20 Colorado River

Managing the Colorado River presents many challenges, as seven Western states in the United States of America share its water with Mexico. The allocation of river water was agreed to in a Colorado River Compact, signed in 1922, and amended several times since to deal with changing water use priorities and circumstances, as well as hydrologic conditions. Despite numerous difficulties and misunderstandings over the history of Colorado River water management, the Compact has served as an effective platform for interaction and dispute resolution. For example, in December 2007, a set of interim guidelines on how to allocate Colorado River water in the event of shortages was signed by the United States Secretary of the Interior, who manages the two key storage reservoirs in the basin, Lake Mead and Lake Powell. The guidelines extend through 2026, and acknowledge the potential for impacts due to climate change and increased hydrologic variability. Similarly, on 20 November 2012, the International Boundary and Water Commission of the United States and Mexico signed an agreement that updated the Colorado Compact provisions to address how the 1.9 cubic kilometres of Colorado River water that Mexico receives every year would be affected by surplus or drought conditions.

One of the many challenges of adapting to climate change is reliable information about short-term impacts in a particular basin. Any set of predictions will be plagued with uncertainty and the need for further research. However, predictions made through a process that combines rigorous scientific review with a broad stakeholder involvement can help galvanize regional leaders to consider concrete adaptation steps. In 2009, the United States Congress authorized the federal Bureau of Reclamation to conduct a series of studies assessing the risks of climate change in the most stressed basins in the western United States.

To take one example, the Colorado River Basin Water Supply and Demand Study (2012), synthesized available model predictions and a wide range of demand and regional growth scenarios in the highly stressed Colorado River Basin. The existing national and international allocation law assumes that the average annual flow is 15 million acre feet; it further assumes that existing carryover storage can supply this amount in low water years. However, the 2012 study warns basin leaders that under conservative future water supply projections, the basin could face a 3.2 million acre foot imbalance by 2060, while admitting that the imbalance could be greater or less.

A wide variety of stakeholders from environmental NGOs to state legislators have accepted the report as a legitimate blueprint for adaptation. The federal Government and the states have not yet taken hard, painful adaptation steps, but the basin states have acknowledged the need for water conservation, supply reallocation and water banking as the best options to live with a decreased water budget. This is an important step towards adapting to a world with an uncertain water supply.

Sources: States of the Rockies Project Research Team, The Colorado River Basin: An Overview, online report available from <https://www.coloradocollege.edu/dotAsset/e57e7c73-2983-477b-a05d-de0ba0b87a00.pdf>.

United States, Department of the Interior, Colorado River Basin Water Supply and Demand Study (Bureau of Reclamation, 2012). Study materials, including final reports, are available online from <http://www.usbr.gov/lc/region/programs/crbstudy.html>.

Lesson 21. Involve decision makers in the adaptation process from the beginning to ensure that the process is integrated with policymaking processes

The direct impact of climate change on the natural and man-made environment will alter existing political, economic, and environmental relationships — sometimes slowly, sometimes quickly. Climate change may simultaneously trigger conflicts and/or induce cooperation between or even within countries. To avoid the former and enhance the latter it is crucial to involve decision makers. Moreover, by involving decision makers from the onset, links with policy processes are assured, relevant policy questions will be better targeted and decision makers have an improved understanding of the adaptation process, the related uncertainties, vulnerabilities and the consequent identification of possible remedial measures.

Ideally, adaptation should be a technical-political conversation that can engage all levels of decision makers from the earliest stages, including authorities at the national, local and transboundary levels. A high-level dialogue can boost the processes and pave the way for dialogue and negotiations at all appropriate operational levels. Influential politicians can serve as leaders and change makers towards enhanced collaboration. Involvement of members of parliamentary bodies elected in the regions of interest has a distinct added value.

Similarly, decision makers should be involved from the beginning in the elaboration of any intervention in order to ensure ownership and political support for the steps to be followed and the results to be achieved. This can be done through the creation of working groups or committees in which all the different stakeholders are represented.

Lesson 22. Ensure stakeholder participation in all steps of the development and implementation of adaptation strategies and measures

A step-by-step approach is necessary in all phases of the process of developing and implementing adaptation strategies and measures, so as to secure stakeholder buy-in, ownership and engagement. This includes several major components: (a) setting clear goals; (b) contextualizing key issues, synthesizing existing knowledge, addressing gaps and acknowledging uncertainty through a situation analysis; and (c) identifying the competent national and transboundary stakeholders, including their roles, stakes, expectations and capacities, through a stakeholders' survey and analysis. It is advisable to use existing consultation and decision-making structures, to address the widest possible audience of stakeholders, to focus on the most willing and the most influential among them, and to screen where there is potential for participants to impact outcomes and where there is not.



Stakeholder participation can be realized by conducting open consultations as well as group discussions, adapting information to the different audiences, elaborating options — including no/low-regret choices — and feasible ways to achieve them, through a participative process and by triggering mutual influence and fostering trust and respect. This yields, among others, increased motivation of the participants and, over time, promotes changes in behaviour. Participation can be sustained by systematizing stakeholder input through the establishment of functioning platforms and planning evaluation from the outset addressing both the process and the outcome.

The engagement of a neutral and/or an all-inclusive facilitator is important to bring the diverse players together.

Case study 2.21 Climate change stakeholder consultations in the transboundary Bugesera Basin shared by Rwanda and Burundi (GWP Eastern Africa)

To kick-start WACDEP in Bugesera (see case study 2.8), the Rwanda and Burundi Water Partnerships organized national consultative meetings of stakeholders in the Bugesera Basin to discuss:

- Adaptation measures to improve the resilience of the local communities to the increasing threat of climate change and variability to water resources, and their capacity to meet these challenges
- The equitable and sustainable use of national and shared water resources in the region, as well as the promotion of integrated management and development
- The modalities of implementing the proposed Bugesera project, as well as the strategic plan and road map for its implementation
- How the project could be integrated with other existing projects in the local area to ensure its ownership and sustainability.

The main results of the project until 2015 include:

- Awareness-raising campaigns on sustainable water resources management and climate change adaptation
- Participatory basin-wide assessments
- Identification of and agreement on priority activities to enhance water security and climate resilience by stakeholders
- Preparation of a draft basin plan for IWRM and climate change adaptation
- Establishment of basin management structures (and broader stakeholder platforms)
- Support for communities in taking local adaptation actions, including:
 - Demarcation and management of part of the buffer zone along the lake shorelines, planting conservation and fruit trees (60 hectares)
 - Establishment of 12 biogas facilities and demonstration campaigns to prove their effectiveness and efficiency as energy sources
 - Extension of water supply systems (for about 3,000 people). Organization of communities into water committees to manage water points. Establishment of small vegetable gardens around the water points using drain water from the water points
 - Introduction of improved cooking stoves (1,000 households), roof water harvesting (12 households) and rehabilitation of upper catchment areas
 - Strengthening of partnerships between local government, local implementing actors and communities.

Lessons learned for scale up or replication:

- Use the basin as a unit for management and cooperation
- Link livelihoods of communities to IWRM. Adaptation options identified in Lake Cyohoha, for example, covered issues related to strengthening livelihoods, enhancing environmental rehabilitation and strengthening local-level structures
- Ensure participation and process ownership by stakeholders and local communities. The processes followed by WACDEP for identifying challenges, problems and adaptation measures, developing appropriate basin management structures and implementing local adaptation actions were all participatory
- Use community structures. Empowerment and ownership of basin management was enhanced by using existing community structures

Case study 2.21 Climate change stakeholder consultations in the transboundary Bugesera Basin shared by Rwanda and Burundi (GWP Eastern Africa) (cont.)

- Use modern (hydrological-climatic) information. Climate change adaptation measures for the Lake Cyohoha area were identified on the basis of scientific and local knowledge
- Ensure political support for programmes. WACDEP gained high political support from the Ministers of Water and Natural Resources of both Burundi and Rwanda.

The promotion of integrated management of the Lake Cyohoha transboundary basin by both Burundi and Rwanda facilitated experience-sharing between the two countries at different levels. WACDEP facilitated several joint activities between the two countries, such as sensitization programmes for stakeholders, awareness-raising programmes, experience-sharing visits and identification of priority actions.

The WACDEP approach supports community-based interventions that empower vulnerable groups of the community, particularly women and children. The expansion of water supply services will ease the burden on women and children to collect water so that children can spend time at school rather than fetching water from the lake; similarly, women will have more time for productive activities.

WACDEP has been involving youth and women in the Lake Cyohoha Basin. Stakeholders agreed to have representation of women and youth in the basin management structure. There were several consultations with women during the situational analysis, both for identification of challenges and on possible actions to address them. The youth group in Rwanda played a key role in producing tree seedlings for the tree planting programme in the buffer zone. WACDEP also organized women groups to be trained and provided improved cooking stoves for distribution to the communities. This was an income benefit for women.

Source: GWP Africa, "WACDEP kicks off with Stakeholder Consultations in the local Bugesera Transboundary Basin shared by Rwanda and Burundi", 4 February 2012. Available from <http://www.gwp.org/en/WACDEP/NEWS-AND-EVENTS/News-Archive/WACDEP-kicks-off-with-Stakeholder-Consultations-in-the-local-Bugesera-Transboundary-Basin-shared-by-Rwanda-and-Burundi/>.

Lesson 23. Ensure stakeholder participation and ownership of adaptation measures at different decision-making levels and spheres of influence

There is a clear need to bring together different levels, sectors, spheres of influence and control and actors when developing and implementing a climate change adaptation strategy on the basin level. Adaptation interventions will conceptually be a relatively new and challenging problem for many individuals and groups, and part of the adaptation strategy should be putting in place a process to develop buy-in in order to be accepted by basin stakeholders, voters, and local authorities. Not all of these actors will be in the public sector or official NGOs; community organizations, corporations, small businesses and professional networks may all be relevant. Some groups may not even have a clear, direct physical presence in the basin itself. In transboundary basins, stakeholder groups from all riparian countries should be involved. Indeed, there is a serious risk that even small adaptation interventions may be perceived as being from "outside" or "above"; these interventions may cause protests and even ultimate rejection if not properly understood and accepted, creating new long-term obstacles and planting the seeds of future conflict. Just as critically, the knowledge and perspective that local stakeholders can bring in may lead to better, locally tailored solutions. Humility and respect are powerful assets for effective stakeholder engagement.

Stakeholder participation in the preparation and adoption of the adaptation measures is essential for there to be real ownership of them by those who will coexist with them daily. In view of the fact that climate change is a complex subject, containing great uncertainties — which favours decision-making deferral and increases the reluctance to act — both formal and informal stakeholders need to be considered for involvement as different entitlements (including cultural) may extend beyond legally binding transboundary water regulations and regimes. Moreover, nature conservation groups and/or researchers working on biophysical processes within the basin should be involved to ensure sufficient consideration of ecosystems and other natural aspects of the water cycle as important "voices" of the environment as a stakeholder.

Case study 2.22 Making space for water in the Bodrog River Basin

The Bodrog River Basin is exposed to severe flooding caused by disorganized urbanization and low connectivity between land (agriculture and forestry), urban and water planning. Management is made more complex by the transboundary nature of the basin. A project was initiated to strengthen cooperative management and to mitigate the consequences of floods through achieving a consistent and holistic management of flood risk in three basin countries.

The activities carried out in the GWP project, facilitated by partners from Hungary, Slovakia and Ukraine, included technical assistance to develop strategic documents for the area (namely, the Strategy for the Mitigation of Floods in the Bodrog River Basin), and concrete investments in pilot areas in each country of the basin.

The project activities considered the maintenance and/or restoration of flood-plains by creating a “space” for water during flood events, as well as measures to prevent and reduce damage to human health, the environment, cultural heritage and economic activities.

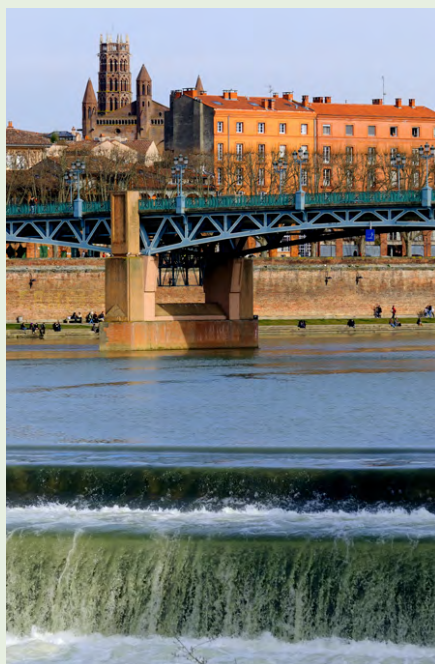
The involvement of municipalities, NGOs, farmers, spatial and urban planning authorities was critical. Practical examples of flood-plain restoration contributed also to improved habitat conditions. In addition, the project partners actively participated in the dissemination of project results providing information for possible replication actions on national levels and to other basins.

Source: GWP, “Transboundary: Making space for water in the Bodrog River Basin (#398)”. Available from <http://www.gwp.org/en/ToolBox/CASE-STUDIES/Europe/Transboundary-Making-space-for-water-in-the-Bodrog-River-Basin-398/>.

In addition to building ownership and ensuring local accountability, stakeholder engagement can also promote learning. Understanding vulnerability and developing appropriate actions will be an exchange among diverse interests. To facilitate a process of iterative learning, it is ideal if the project or programme processes in place encourage developers to build on lessons learned within and — by analogy — beyond the basin in question. However, ensuring access to information can be difficult in practice, especially in contexts where monitoring and evaluation capacities are weak or where all the information may not be available in a digital format (OECD, 2015).

Case study 2.23 Garonne 2050: how to involve stakeholders in the development of adaptation plans

In order to anticipate the impacts of climate change, in 2007 the Adour-Garonne Basin Agency launched a study called “Garonne 2050” to develop different future scenarios as a basis for the formulation of an adaptation strategy for the period 2030–2050. The whole project is based on a participatory approach: the scenarios were elaborated in consultation with local stakeholders, and local stakeholders are also involved in the discussion of possible solutions and adaptation measures.



By 2050, the low flows (summer) will be half of the current flow in the whole basin. From the observations, three scenarios chosen by the water resource managers were elaborated and presented to the basin commission in December 2013.

- Not to intervene and accept greatly reduced flows
- To work to preserve the current situation by compensating the climate change effects
- To limit the vulnerabilities by taking partial action to address the reduction in flow in the low flow (summer) period.

To better involve and inform all stakeholders and reach the general public, a website was created (www.garonne2050.fr) to disseminate information on new developments and the project’s achievements. From this platform, users can access project documents (phase reports, final reports, meetings reports, presentations, study summaries, etc.), as well as three videos explaining the scenarios. Videos are a powerful means of communication, reaching a broad range of audiences (children, illiterates, hearing impaired) and conveying messages in a very immediate way, thanks to the combination of colours, animation and sound. For the Garonne study, the videos use a cartoon style with

Case study 2.23 Garonne 2050: how to involve stakeholders in the development of adaptation plans (cont.)

explanatory soundtracks, which summarize the studies undertaken in a couple of minutes in easy-to-understand language.

Four participatory workshops were held at basin scale: a workshop on the current context; a workshop on micro scenarios (scenarios by theme); a workshop on global (basin-wide) scenarios; and a workshop on the selection of scenarios. The participation was broad, including representatives of agriculture, ecosystems, fishing, economic activities, urbanism and cities, energy and forestry.

In addition, stakeholders are kept up to date about the project's progress through "Information Letters", i.e., newsletters giving an overview of the study and announcing the latest achievements.

Sources: Study website: <http://www.garonne2050.fr/>.
 Adour-Garonne Basin Agency website: <http://www.eau-adour-garonne.fr/fr/index.html>.
 The three videos are available from:
<https://www.youtube.com/watch?v=ZHDmlh8iJQg&feature=youtu.be>
<https://www.youtube.com/watch?v=gZOCX3VNNJ8&feature=youtu.be>
<https://www.youtube.com/watch?v=EOgaj8nEZRE&feature=youtu.be>.

Lesson 24. *Build transboundary teams among scientists, administrative authorities, non-governmental groups and technical experts to enable joint actions, such as assessments*

A joint, transboundary group to harmonize the tools, methods, models and scenarios to be used and to prepare a basin-wide vulnerability assessment is a good way to advance adaptation in general. Such groups should include scientists and administrative authorities of all riparian countries as well as from different regions and sectors of basin-wide relevance. In some cases, external donors or groups with historic long-term interests in the region may also be important to include, as in some former colonial regions or areas with relevant multinational corporate investments. Global governance groups may also be able to support some facilitation roles, such as United Nations agencies. A stakeholder analysis can help to identify the individuals and institutions to be involved.

The group should be mandated to prepare joint assessments and possibly to develop adequate adaptation measures. A proper exchange of information between the countries is imperative for this (also see section 3.1). The representatives in the group should ensure that the relevant information as well as viewpoints from the different countries are included in the assessments.

2.3.2 Capacity development

Capacity development is the process by which individuals, groups and organizations improve their ability to perform their functions and achieve the desired results over time (MacKay and others, 2002). Capacity development is needed to ensure proper understanding of both the process and the content of developing an adaptation strategy. Capacities are needed in water areas, like hydrology and meteorology, but also in non-water areas, such as planning, uncertainty management, forecasting and scenario development. In many cases, insight into particular sectors will be important, such as energy, protected areas, or public health policy for water and sanitation (e.g., malaria, yellow fever, or infant care). If such capacities are not present, a capacity-development plan is needed to fill these gaps. Such a plan includes an honest inventory of the available capacities as well as those that are lacking.

Especially in a transboundary situation, a frank assessment of capacity is of utmost importance. Bridging the unequal capacity among the riparian countries is a crucial requirement, as all riparian actors in the adaptation process should preferably have the same level of knowledge and capacity and a common understanding in order to be able to come to joint decisions. In many cases, they will need to develop this capacity with and through one another. A common understanding will be necessary to facilitate the difficult process of bringing about lasting and significant change.

Lesson 25. Identify the needs for capacity development

Generally, climate change adaptation plan development requires a profound understanding of and capacity development on the three concepts set out below.

- **Understanding climate change:** To know and understand climate change and its impacts on water resources is a clear need in the process towards adaptation. Understanding the scientific aspects is especially important, as it makes it possible to formulate a solid argument to convince decision makers. To acquire this knowledge, the reference to numerous publications and the work of the Intergovernmental Panel on Climate Change (IPCC) is a good initial step. However, this knowledge may be less about specific shifts in air temperature or projections of potential annual precipitation. From a capacity perspective, such knowledge may be most valuable to provide an understanding of how climate and the water cycle interact with social, economic and environmental systems. For instance, knowing that hydropower is an important energy source in upstream portions of the basin, that hydropower dams have been designed primarily as run-of-the-river dams that assume reliable snow-pack storage for dry season generation, and that snow-pack has become much more irregular has important implications for downstream water and energy users. Such integrative, holistic, and non-quantitative insights are critical to communicating needs and priorities across diverse ministries and stakeholders throughout complex basins.
- **Understanding uncertainty:** It is particularly important to understand the uncertainty of climate change, both in order to integrate the adaptation plan preparation work and to argue with decision makers for action, since uncertainties are often an obstacle to decision-making. In this sense, uncertainty is about the limits of knowledge and confidence in decision-making, rather than about having a detailed grasp of standard deviation for projected climate data. Along the same lines as the section above, uncertainty here refers to the ability to articulate that recent trends suggest, for example, that wet season precipitation is becoming more irregular and intense and starting earlier in the year than in decades past, even if the quantitative estimates of future trends show wide variation. Likewise, if projections show little or no clear pattern — high uncertainty — then how should long-term decisions best compensate for such gaps? Should decisions be more robust, covering a wider range of options? Should additional monitoring or data management systems be deployed? Should decisions be re-evaluated more often? Should planning processes focus on shorter increments of time, assuming greater long-term flexibility?
- **Understanding the linkages, potential synergies and conflicts between climate change adaptation and climate change mitigation:** In understanding climate change as a policy issue, there are significant differences and potential trade-offs between adaptation and mitigation. Ideally, possible synergies between the two dimensions should be maximized. For instance, clean energy investments such as biofuels or hydropower should reduce the extent and rate of additional climate change at a global level, but these are also quite consumptive of water resources, and if adaptation and mitigation priorities are not balanced carefully, the opportunities for farmers or cities to adjust to impacts of the infrastructure lifetime of these mitigation investments could inadvertently limit important basin adaptation options. Particularly in transboundary basins with major long-lived infrastructure investments, such decisions can sow the seeds of future conflict.

Identification of capacity-development needs must include the review of the specific needs of public and private sector decision makers, water managers, officials of relevant administrations (local, national, regional), staff working in RBOs, as well as stakeholders, in particular those participating in the basin commissions, sub-basin committees, working groups or thematic groups at basin level.

Case study 2.24 Mekong Climate Change Forum — Adaptation to Climate Change in the Transboundary Context



Home to about 60 million people, the Lower Mekong River Basin has experienced rapid development, urbanization and population growth, which have adverse effects on the resources of the Mekong and the populations who depend on them. Climate change has increasingly placed burdens on the environment and the people. For example, rising temperatures and unpredictable rainfall are bringing drought to some areas and flooding to others. The Mekong Delta is experiencing sea level rise and increasing saltwater intrusion into its ecosystems and farmland. Extreme weather events such as typhoons are increasing in frequency and severity, destroying homes, infrastructure, livestock and crops.

Adaptation measures can help vulnerable communities and governments to better deal with such changing climate conditions and thus reduce the consequences on people's livelihoods, ecosystems and the economy.

From 6 to 8 October 2014, in Siem Reap, Cambodia, the Mekong River Commission held the Second Mekong Climate Change Forum – Adaptation to Climate Change in the Transboundary Context for government officials, academics, experts and representatives from RBOs, the MRC development partners, development agencies, civil society and the private sector to share and exchange their knowledge, experience and progress in undertaking measures to adapt to a changing climate. As particular attention was given to efforts to deal with the transboundary effects of climate change, the Mekong Climate Change Forum provided a good opportunity for stakeholders to exchange ideas on how to scale down regional adaptation strategies and apply them to the national context. Participation was open to those working on climate change in the Mekong region, and 180 people joined the Forum.

The following topics were explored during the 2014 Forum:

- State of knowledge on climate change and its impacts as well as vulnerability of the environment and human well-being in the Lower Mekong Basin
- Climate change adaptation in the Lower Mekong Basin: Policies, strategies and actions on the ground
- Transboundary adaptation needs, approaches and challenges in the Lower Mekong Basin
- Possible synergy between the national and transboundary adaptation strategies.

Selected outcomes of the Forum:

- The exchange of experience on national adaptation strategies and action plans in the Lower Mekong River Basin has identified that the synergy between national and transboundary adaptation efforts can bring benefits. National and transboundary adaptation efforts should be linked to enable successful implementation of adaptation strategies.
- Transboundary cooperation can enhance a broader set of benefits and opportunities than individual country approaches. Transboundary aspects of climate change adaptation should be seen as an integral part of a broader development policy, particularly of a socioeconomic development one.
- The development of a transboundary adaptation strategy needs commitment, efforts and resources. Transboundary adaptation has a clear link to the national policy and, therefore, a long-term interaction with policymakers is a prerequisite for successful implementation.
- The challenges with regards to the uncertainty associated with future impacts from climate change, as well as measuring the costs and benefits of adaptation, should not lead to inaction. Adaptation strategies should focus on no- or low-regret options.

Source: Mekong River Commission, "Second Mekong Climate Change Forum: Adaptation to Climate Change in a Transboundary Context", <http://www.mrcmekong.org/news-and-events/events/second-mekong-climate-change-forum-adaptation-to-climate-change-in-the-transboundary-context/>.

In most basins, investment in the development of additional capacities will be necessary. Indeed, at a global level, there are relatively few experts or educational programmes that provide training in many of the topics that are important for the development and implementation of effective adaptation programmes. As a result, investing in existing staff, networks, and programmes to build and grow “native” and in-basin experts will be an essential strategy. These areas of development are likely to include:

- **Development of scenarios:** The climate change adaptation plan and its actions and measures are closely linked to the quality of climate change scenarios in the region and the basin or sub-basin. Establishing these scenarios requires specific capabilities (methodologies, use of modelling tools, etc.).
- **Management of uncertainties:** A good understanding of the origins of the uncertainty related to climate change and its implications is needed. Moreover, different options to work around gaps in knowledge and a broader vision of how future hydrological conditions may be manifested need to be understood. Such options include, for example, designing no-regret and low-regret measures, the use of so-called real-options means of finance and economic analysis, and the development and application of adaptation pathways methodologies.
- **Integration of data and information:** The team in charge of the elaboration of the adaptation plan has to be able to integrate the data and information related to both global (IPCC outcomes) as well as local or regional climate change into the basin management plan to ensure coherence between the adaptation plan and the basin management plan (or to at least avoid discrepancies). In particular, a basin management plan — which may have a timespan of 5 to 10 years — has to be in line with the content of the adaptation plan, which may be proposing certain measures over much longer timescales (30 to 100 years).
- **Working in interdisciplinary and inter-institutional teams:** Working in diverse teams requires skills like patience, the ability to listen, translation of technical or policy language across other registers, networking, accessing a wide range of information sources (both institutional and private), data analysis (economic and environmental), and the meaningful communication of risk to decision makers.

Lesson 26. Develop a capacity-development plan

The purpose of a capacity-development planning effort is to define a clear and practical assessment, map, schedule and budget to address capacity needs. The plan establishes capacity objectives, indicators, initiatives and the resources required to implement change and measure progress in developing capacities. The plan should be viewed as work in progress rather than a finished blueprint, and including reassessments and clear indicators of progress towards effective capacity-building are critical in this process. The ultimate goal of the plan is to fill the knowledge and process gaps.

The plan contains information on which people will be involved in what types of capacity development. Capacity-development efforts generally include one or more of the following approaches:

- Information dissemination
- Training and learning by doing
- Facilitation and mentoring
- Networking
- Feedback, to promote learning from experience.

Establishing task forces, working groups or joint expert groups at the transboundary level is an efficient way to build a common and solid base of skills among all riparian countries that can include one or more of the above-mentioned approaches.

It is important to ensure that the capacity-development plan is implemented. This encompasses identification and hiring of trainers, developing training material, scheduling participants and organizing workshops, training sessions and other meetings. It also entails evaluating and possibly revising the plan if the evaluation shows that the plan did not succeed in filling the knowledge gaps as initially identified.

Lesson 27. Ensure that investments in information and data-sharing systems target not only technological solutions, but also capacity development and the ability to integrate multidisciplinary information

Implementation of information and data-sharing systems tend to focus on highly technical issues. As a result, many such systems are accessible only for very specialized groups. However, the objective of information and data-sharing systems is to provide relevant information to a wide audience, including decision makers and the public at large (see sections 2.3.1 and 3.1) that can learn from the information and link it to their local situation. As such, these systems are also a tool for capacity development, transparency and stakeholder engagement — providing data and knowledge intended to serve and service effective decision-making. The audience for data should serve as a regular touchstone for these technical discussions and place specific limits on the design of the system.

To make the information and data relevant for a wide audience, the information and data-sharing system has to contain information from various disciplines (see section 3.1). The design of the system should therefore be suitable to accommodate data from various sources, spanning ministries, riparian countries, and public, private and civil society sources. Coupled with that, the information from the database should be relevant to the needs of decision makers and, therefore, to the extent possible, they should be involved in database development.

Developing an interactive website to enable the public at large to access the data will help to make the information accessible and will support the necessary capacity development. Moreover, it will enhance public support for joint activities.

Case study 2.25 Quantifying surface water and groundwater fluxes towards the Dead Sea

In a study conducted within the framework of the multilateral IWRM Sustainable Management of Water in Arid and Semi-arid Regions (SUMAR) project, a scientific quantification of the surface water and groundwater fluxes towards the Dead Sea, shared by Israel, Jordan and Palestine, was performed. Researchers looked not only at how they could determine the actual water balance in the basin — decisive for the sustainable management of the scarce freshwater resources — but also at the resilience of the unique ecosystems along the coastline of the Dead Sea. By managing to integrate various methods — like hydro-geochemical fingerprinting, remote sensing, hydro(geo)logical modelling and setting up the first multilateral gauging station on the Jordan River — the international team of scientists found that climate change may have a bigger impact on water resources in Jordan than in Israel and Palestine. While the groundwater resources currently available in the basin are not sufficient to meet the growing demands, the situation will most likely worsen in the future — with serious social, economic and ecological consequences for the whole region.

Source: Helmholtz Centre for Environmental Research, “New Water Balance Calculation for the Dead Sea”, 22 July 2014. Available from <http://www.ufz.de/index.php?en=33033>.

Lesson 28. Facilitate the exchange of insights and experience between stakeholders on adaptation activities to learn and build capacities

The regular and institutionalized exchange of knowledge and experiences between different stakeholders is a good way of building capacity, as through such processes a common, basin vision of what effective adaptation can and should be achieved should be developed. Organizing the exchange of information and knowledge between stakeholders is therefore an important route for capacity development. This also helps to bring the various stakeholders up to the same level of understanding about the water resources issues affecting their basins.

Basin organizations need to learn from each other, but learning is also possible within basin organizations, i.e. between countries or even between staff members. Networks of basin organizations consequently play a role in capacity development. Twinning or symposiums with two or more basin organizations can facilitate the development of capacities and the sharing of methodologies and tools to address climate change. Other ways to facilitate knowledge and experience exchange are to establish specialized working groups with specific tasks that meet regularly or to organize meetings with stakeholders that are explicitly meant to prepare certain decisions, like prioritizing or choosing among adaptation measures.

Case study 2.26 Exchanges between basin organizations on climate change: First Rhine-Mekong Symposium

The Mekong River Commission and the International Commission for Protection of Rhine held a symposium on "Climate Change and its Influence on Water and Related Sectors". This basin-twinning symposium gathered around 70 participants, including representatives from the International Commission for the Hydrology of the Rhine Basin, ICPR, MRC, government representatives, experts and scientists from the Rhine and Mekong Basins, to share knowledge about and discuss challenges as well as common issues in their different basins and to explore areas for potential cooperation, particularly on climate change-related issues.

During interactive presentations, panels and parallel technical group discussion sessions, specific attention was paid to the development of a climate change adaptation strategy and the assessment of climate change, its influence on the hydrological regimes and impacts on relevant sectors in the basins in a transboundary context.

The symposium participants concluded that, although the two basins are different, they share common challenges that provide a basis for potential cooperation between their RBOs. An outcome document was issued by the symposium, summarizing the meeting's results and outlining areas for further cooperation.

It is hoped that the experience and effective practices presented and discussed at this basin-twinning symposium, as well as its conclusions, can also help other RBOs as they tackle climate change issues in their respective basins.

Sources: Mekong River Commission, "First Rhine-Mekong Symposium", 8 May 2014. Available from, <http://www.mrcmekong.org/news-and-events/events/first-rhine-mekong-symposium/>.

Mekong River Commission and International Commission for the Protection of the Rhine, Report of the 1st Rhine-Mekong Symposium, "Climate Change and its Influence on Water and Related Sectors", 8–9 May 2014, Koblenz, Germany. Available online from http://www.chr-khr.org/sites/default/files/chrredactioneel/report_symposium_89may2014.pdf.

Lesson 29. Ensure the exchange of knowledge between technical specialists and decision makers

The data from monitoring and observation systems often does not satisfy decision makers' needs. The major reason for this is that there is little direct communication between decision makers and technical specialists, such as scientists, economists and engineers. Decision makers from around the world are calling for more useful information that is salient and context-sensitive, credible and legitimate. The credibility of the information can be ensured by implementing quality assurance programmes along with regular evaluation studies, such as round robin tests and data analysis protocols. Legitimacy of the information is, among others, secured by making the production process transparent. This includes publishing the relevant details of the monitoring programme (locations, determinants, frequency) as well as the results.

Case study 2.27 Global network of basins working on climate change adaptation

The ECE Water Convention and its Task Force on Water and Climate, led by the Netherlands and Switzerland, support countries in developing transboundary adaptation strategies through guidance, projects on the ground and the exchange of experience.

In 2013, the Task Force joined forces with INBO to establish a platform for the exchange of experience between pilot projects on climate change adaptation in transboundary basins — the Global Network of Basins Working on Climate Change. The Network currently includes pilot projects in basins of the Amur (“Dauria Going Dry” project), Chu Talas, Congo, Danube, Dniester, Drin, Mekong, Meuse, Neman, Niger, Rhine, Sava and Senegal Rivers and the North-Western Sahara Aquifer System. The pilot teams meet regularly to discuss topics of common concern, such as how to develop transboundary impact and vulnerability assessments and adaptation strategies and how to link national and transboundary adaptation activities. Regular progress reports are prepared and a web platform has been created.



Sources: United Nations Economic Commission for Europe, “Water and Adaptation to Climate Change”, http://www.unece.org/env/water/water_climate_activ.html.

United Nations Economic Commission for Europe, “Transboundary pilot projects on climate change adaptation”, <https://www2.unece.org/ehlm/platform/display/ClimateChange/Welcom>.

To improve the relevance of the information, better communication between information users and scientists is needed, but this may be challenging to realize. Information and knowledge transfer can be achieved through meetings between decision makers and scientists from the riparian countries, including site visits and direct discussions so that technical personnel can understand how their knowledge is both used and acted on (or not, as the case may be). Such meetings should be used to identify the decision makers’ information needs and discuss how to fulfil them, e.g., through the monitoring and observation systems. The meetings will help technical specialists to better understand the knowledge and information needs of the decision makers and how to translate the data and information they hold into practical knowledge that can serve as a basis for decision-making. The meetings will help the decision makers gain an improved understanding and appreciation for the value of the information held by the scientific community.

If decision makers are to be involved in such meetings, the meetings must be well prepared and focused on the problems and gaps encountered in identifying the information needs. Moreover, the input expected from the decision makers must be clear beforehand and the meetings must be targeted and as little time-consuming as possible.

2.3.3 Communication

Communication is often considered a secondary aspect of natural resources management, usually a task to be carried out at the end of projects to advertise outcomes and achievements. On the contrary, exchanging and disseminating information is fundamental not only to share success with the general public when the work is completed, but also to enable cooperation among partners during the development and implementation of the adaptation policy. Indeed, poor communication may be one of the most common sources of failure in achieving consensus and efficacy in adaptation. Given the complexity of adaptation in transboundary basins, smart communication is critical to identifying barriers, overcoming obstacles and catalysing action.

Additionally, designing and putting in place a comprehensive communication strategy fosters dialogue and strengthens relationships among stakeholders, thus furthering transboundary cooperation in general. In fact, new initiatives may be undertaken at the international or regional level in a broader range of fields in the wake of effective projects, taking advantage of the good practice examples offered by previous activities.

Although some rules of communication are valid for any context, some situations require specific guidelines. Transboundary basins belong to these: being a more complex environment, with multiple scales, stakeholders and geographical and historical features, even the most basic communication initiative could turn out to be challenging to apply.

The lessons and case studies in this section examine how to properly position communication in adaptation policies so that it can serve to support the achievement of strategic goals, and not just disseminate information on outcomes.

Case study 2.28 Goals and objectives of the communication strategy for the Permanent Okavango River Basin Water Commission

In 2012 the Permanent Okavango River Basin Water Commission (OKACOM) approved a communication and information strategy entitled "Thinking Transboundary: Information and Communication Strategy for OKACOM". Aligned to the vision and operations of the Commission, which are based on the founding principles of the 1994 OKACOM Agreement, the main communications goal is identified as:

"To promote and support opening of pathways to improved livelihoods in the Cubango-Okavango River Basin through revealing opportunities offered by joint transboundary management and development"

Being aware of the challenges to the realization of its mission, OKACOM established a set of communications objectives aiming to address these potential barriers. Their expected outcomes and impacts are defined one by one, as shown in the following outline:



Case study 2.28 Goals and objectives of the communication strategy for the Permanent Okavango River Basin Water Commission (cont.)



At the end of the list, it is reminded that all specific objectives support the same common end, that is to say, a change in mentality from a cast of mind limited to the national context to one incorporating the entire basin.

Source: Thinking Transboundary: Information and Communication Strategy for OKACOM. (OKACOM Secretariat, Maun, Botswana, 2012). Available from <http://www.okacom.org/site-documents/key-documents/thinking-transboundary-information-and-communication-strategy-for-okacom/view>, www.okacom.org

Lesson 30. Clearly define the strategic objectives of communication in advance

Good communication in any context may have one or more aims: to raise awareness about problems and solutions; to inform partners about progress made, personal initiatives and results; to involve all stakeholders in the decision-making process; to encourage external support; or to fundraise. To succeed, each specific goal requires careful planning regarding the most appropriate means of communication, as well as the timing, scale and location of dissemination. Certainly, this design exercise cannot be properly done if there is no clear view on what to communicate, to whom, how best to reach that audience, and — above all — to what purpose. This is especially true in wide and complex contexts, such as transboundary basins.

Lesson 31. Launch an initial communication plan at the beginning of the project, and update, adjust and revise it progressively

Preparing a communication plan is always useful, but the wider the goals, the more carefully it should be designed. In transboundary water management a poorly planned communication strategy could result in side-lining certain regions, issues, stakeholders, audiences or aspects of the project. Therefore, in such a context a comprehensive communication strategy should present the following characteristics:

- It should be shared and agreed by all the countries, trying to encompass and reconcile their interests and needs.
- It should be included in the project's general strategy, among the basic activities and tools.
- It should be developed at the beginning of the project and cover all its phases (not only the implementation phase, but also the activities preceding and subsequent to it), following a step-by-step approach. For this reason, although a communication strategy represents a long-term plan, it requires the creation of short- and medium-term schemes and programmes (see below).

A good communication plan shows its positive effects immediately, because it fosters the exchange of knowledge and information and strengthens the communication capacities of all parties.

To produce these results, it should comprise the following elements:

- **Objectives:** The objectives should be established according to the project's strategic priorities, but also with regard to the communication needs of the various actors, identified on the basis of the differences in perception, knowledge and level of information.
- **Target audience,** including regional, national and local stakeholders, as well as project partners (see section 2.3.1) and the general public.
- **Short- and medium-term plans,** adding value in terms of efficacy (allowing more precise and detailed choices for each phase, location and recipient) and supervision (i.e., overall view and full control over the entire process).
- **Responsible parties and resources:** to foresee a realistic series of communicational activities, these should be proportionate to the actual human, financial and material assets allocated to the project.
- **A dissemination plan:** Communication plans for outreach purposes should be complemented with a dissemination plan, defining the practical aspects of the delivery of the message to the target audience. The development of a dissemination plan should be composed of three basic steps:
 - Selection of the media and technology (e.g., radio, television, print media and Internet)
 - Creation of the message (selection of information and tone of communication and adaptation to the chosen media and to the target audience)
 - Choice of frequency of communications.
- **Follow-up and evaluation:** Feedback about the reception, understanding and impacts of the messages should be provided and used to adjust, adapt or redirect communication actions throughout the process. In the end, this will determine the effectiveness of the communication plan as a whole.

In transboundary basins, depending on the resources available, it may not always be possible to implement all of the steps suggested above.

Lesson 32. Raise awareness of the importance of acting at a basin-wide scale

Unfortunately, in transboundary basins most adaptation efforts are still focused on and developed at the national level. Therefore a common step to be undertaken through communication is to raise awareness of the importance of shared basin-wide needs.

Case study 2.29 The communications and visibility strategy of the joint EU/UNDP project “Promoting Integrated Water Resources Management (IWRM) and Fostering Transboundary Dialogue in Central Asia”

In the framework of the EU/UNDP project “Promoting Integrated Water Resources Management (IWRM) and Fostering Transboundary Dialogue in Central Asia”, a Communications and Visibility Strategy was developed for the period September 2010–September 2012.

The strategy was the result of joint work between the project team and UNDP and EU outreach units, thus involving all the main partners in the initiative and ensuring that their ideas and priorities were taken into consideration.

The document presents characteristics that make it a good example of comprehensive communication plan in a transboundary context. First of all, the strategy sets out what is defined as an “overall desired outcome”, a general goal that guides the whole communication activity, and a “key message”, consistent with the project aim (i.e., the promotion of IWRM). Moreover, a list of detailed objectives specifies how the overarching goal is going to be achieved.

Once the purposes are set out, the target audiences are identified coherently with the potential beneficiaries of the whole project. Not only are these groups enumerated following the order of importance dictated by the objectives of the strategy, but also the most appropriate channels of communication are outlined for each of them.

Likewise, although the financial resources to implement the communication strategy are not mentioned, responsibilities to put the strategy into effect are distributed among the parties.

Equally relevant is the inclusion of a regular evaluation process, composed of both quantitative and qualitative assessment methods, and the “Visibility Guidelines”, setting a few basic rules to ensure a uniform visual identity.

Finally, a communications plan lists all the planned activities together with the information products to support them, foreseeing possible timeframes or deadlines for their realization. Furthermore, each action is linked to the objectives it is aimed at and the indicators of achievement that will be applied to verify its efficacy.

Source: Communications and Visibility Strategy, September 2010–September 2012, EU-UNDP Project 2009–2012 “Promoting Integrated Water Resources Management (IWRM) and Fostering Transboundary Dialogue in Central Asia”. (Almaty Kazakhstan UNDP, 2010). Available from <http://centralasia.iwlearn.org/publications/projectdocuments/regional/communications-and-visibility-strategy/view>.

Emphasis should be put on the benefits of a comprehensive transboundary strategy, for instance by providing good practice examples from other basins, as well as other examples of successful practices at a basin scale that may have already occurred locally (even if they are not directly relevant to adaptation, water, or climate change per se). Concrete discussions about the adaptation measures and how to implement them practically should be started and fostered throughout the basin, but also outside its borders at the regional and international levels.

Explaining the benefits of a transboundary approach to adaptation is especially difficult in basins without permanent institutions for transboundary cooperation, such as RBOs. In such cases, it can be useful for the project team to have separate meetings with authorities in all the riparian countries to emphasize the benefits of the transboundary approach.

Lesson 33. Tailor messages to your audience, based on its characteristics and needs

Generally speaking, for information to be received as expected, the sender should draft the message looking at it from the point of view of the recipients. The recipients, or audience, are a complex and varied group of individuals and institutions imbued with knowledge, beliefs and opinions that filter and shape the interpretation of facts. As a consequence, adapting the information to the target audience is crucial, not only to make it intelligible, but also to raise interest.

While, usually, the tailoring exercise entails forging language, selecting content and supporting it with the appropriate media according to the public’s capacities, needs and preferences, in the case of transboundary river basins a further effort is required. In consideration of the fact that a transboundary approach aims to develop a basin-wide adaptation plan, special attention should be paid to the following aspects:

Case study 2.30 “Colours of the Dniester”: how to engage children in climate change adaptation

Held for the first time in 2009, the basin-wide competition “Colours of the Dniester” has been conducted since then on an annual basis both in the Republic of Moldova and Ukraine. The art contest aims to call public attention to the beauty of nature and raise awareness about environmental problems and, above all, to involve children and youth in the conservation of the river basin. Usually, more than 400 schoolchildren and students from the two countries participate in the competition, at the end of which around 70 winners are selected and awarded with gifts for their artworks. Each year a brochure with the works of the winners is published and disseminated among the participants, their teachers and the general public. Several categories of works are foreseen in the competition: paintings, photographs, videos and podcasts, events on water resource conservation, stories, poems and popular scientific papers. In 2013 and 2014, the contest was dedicated to the topic of ecosystem restoration as a measure to adapt to climate change.



Surugiu Eugenia, 18 years old, Moldova

The art contest has been supported by the projects implemented by ECE, OSCE and UNEP in the Dniester River Basin within the Environment and Security (ENVSEC) Initiative and funded by the Austrian Development Cooperation, the European Union Instrument for Stability (IJS), Finland, Sweden and Switzerland. The local coordinators include the Lviv Province Department of the State Agency of Water Resources and the NGO Mama-86-Odessa in Ukraine and the International Environmental Association of River Keepers (Eco-TIRAS) in the Republic of Moldova.

Source: Hanna Plotnykova, OSCE, personal communication (2014).

- Messages should be differentiated more depending on the present living conditions of the population (directly versus indirectly affected communities, rural versus urban populations) than on national criteria. So, instead of having communication sub-plans by country, it would be worth having the dissemination materials and initiatives differentiated by the various target populations.
- The choice of language is as important as it is delicate: although it would be advisable to select a unique idiom for the whole basin to convey a message of unity and uniformity, intelligibility by the target audience is the decisive criterion.
- While tailoring communications to the various recipients, the overall coherence of the message has to be guaranteed at a basin level.

Lesson 34. Handle internal communication between project partners with the same care as external outreach

Adaptation strategies in transboundary basins generally involve not only the riparian countries, but also an international team. Here are some suggestions to create a functioning internal communication structure among partners:

- **Create a coordination mechanism** to ensure that the information provided is not conflicting, late, or overlapping (for instance, establishing a system of sequential transmission points following a priority order for receivers; creating different lists of recipients for each subject, level of urgency and area; and identifying an inventory of verified sources of information).
- **Clearly define roles and responsibilities** to guarantee a faster and better exchange of information among project coordinators and from them to local stakeholders. The organizational structure so created will facilitate the overall implementation of the project, since it will apply to other phases and activities, and support the strengthening of a network of relations among partners.

Case study 2.31 Gathering project partners around the same table in the Dniester River Basin

On 27–28 May 2013, Zoï Environment Network organized a workshop in Lviv, Ukraine, with all the partners of the project “Reducing vulnerability to extreme floods and climate change in the Dniester River Basin”, jointly managed by ECE, OSCE and UNEP.

The purpose of the workshop was to bring together the different actors involved in the project — from local and national institutions to international partners — to exchange views about issues and solutions related to flood communication in the basin, an issues that had later to be included in the implementation plan of the project.

The event was attended by over 60 people, including representatives of local authorities and key organizations from the Republic of Moldova and Ukraine (professionals from hydrometeorological institutions, water administrations, nature protection agencies and rescue and emergency department at the national, basin, provincial and local levels), as well as specialists from other Western and Central European countries and international organizations.

Besides representing a good example of stakeholder involvement, this case is illustrative of one of the many possible ways to carry out and improve internal communication between partners in a transboundary initiative. An additional important objective of the workshop organizers was to ensure that all stakeholders were well aware of the project accomplishments. The distribution to the participants of the “Study of the institutional capacities and practices for the communication of flood risks in the Dniester river basin”, conducted by Zoï Environment Network, helped in this regard. The workshop was also intended to facilitate new steps in the development of the project in collaboration with local partners, so as to include perspectives both from the national and the regional scales and to strengthen channels of cooperation and the exchange of information.

In confirmation of the importance of internal dialogue among partners, a recurrent gap identified in the management of flood-related communication in the Dniester River Basin was the absence (or incomplete or untimely execution) of clear interaction schemes between responsible organizations, partly due to the centralization of the exchange of information in the hands of high-level decision-makers.

Source: Zoï Environment Network, “Reducing vulnerability to extreme floods and climate change in the Dniester river basin”, report of the workshop on the institutional capacities and practices for the communication of flood risks in the Dniester River Basin, Lviv, Ukraine, 27–28 May 2013. Online report available from <http://www.zoinet.org/web/publications>.

- **Establish a standard format for information exchange** to simplify transmission, understanding and response. Simple expedients, like the use of agreed graphic forms, a shared glossary and harmonized location references and denominations, could prove to be very useful in this sense. Likewise, to avoid mistakes in translation, a language common to all the riparian countries should be chosen, if possible.
- **Be precise.** Each article of news or information should be accompanied by detailed and clear explanations, to avoid misunderstandings among countries.

Lesson 35. Implement and model communication about adaptation for key audiences on the most appropriate scale, which may be the local or sub-basin scale rather than the whole-basin level

In many cases, information about climate change has been disseminated by international organizations, like IPCC, or national Governments using a top-down approach. However, the subsequent development of the socioeconomic scenarios and the assessment of the vulnerabilities at the basin scale require a strong involvement of the local actors, especially at the sub-basin and riparian country levels.

This entails, first of all, the launching of comprehensive communications with the stakeholders to inform them about the overall policy goals, including those specifically targeted at the natural environment; scenarios; impacts and vulnerabilities; adaptation options, including issues like compensation for property loss; participatory opportunities and their weaknesses; and policy limitations.

Secondly, after raising awareness and educating the local actors, communication should aim at their involvement in all the steps of the adaptation project.

Case study 2.32 Communicating at basin and local levels in the Mekong River Basin

The Mekong River Commission has recognized for many years the necessity of implementing a communication strategy at all scales, from the basin level to the local level. Attention to both recurs throughout the “Communication Strategy and Disclosure Policy” published in 2009. This communication strategy “seeks to promote the MRC as a world class river basin organization that serves the peoples of its Member States in their need to sustainably develop the water resources of the Mekong River Basin, so as to reduce poverty while maintaining essential environmental services”.

First and foremost, the communication strategy focuses on the responsiveness of MRC to its member States, partners and stakeholders, especially with regard to their involvement in transboundary activities. The strategy aims to develop a two-way exchange of information with national and local actors, informing them of the Commission’s initiatives and incorporating their opinions into dissemination activities towards external audiences. At the same time, the strategy aims to extend to the transboundary level, by including suggestions and proposals from relevant regional and international organizations and media.

Second, the communication strategy’s guiding principles have provisions for addressing communication needs at different scales. On the one hand, they state the need to “Reinforce the Member States’ ownership of the MRC and 1995 Agreement, and promote knowledge of the roles of the Council and Joint Committee”, acknowledging the lack of awareness among many stakeholders of how the river basin is managed at a systemic level. As a consequence, the Commission commits itself to enable fast and accurate communication of joint decisions and initiatives of the member States. On the other hand, it is recognized that actors at the local level need to have access to data and analyses collected by MRC in the course of the past 50 years. Therefore, MRC assumes an open engagement to “make as much material as freely available as possible through web downloads”, striving to “be responsive to demand by quickly publishing information in the public domain”. Moreover, to answer to the local needs, MRC pledges to “improve local accessibility of materials through more translation”.

Third, the multilevel nature of the communication strategy is confirmed in the identification of the target audiences: it encompasses decision-makers at the regional, national and local scales, the general public (local, regional and international), affected groups, community groups, civil society and NGOs (especially those relevant to regional water resources development and watershed management associations), media (national and international news agencies; Internet-based news services, like VietNamNet; national and provincial newspapers in local languages plus in English, French and Chinese, including website editions; national and regional magazines; regional newspapers; national radio networks; international radio networks with a presence in the basin; national, regional and international television networks) and youth.

Furthermore, an attempt to give an overview of the basin management led by MRC and to explain the character and purpose of the organization, while tailoring communication to specific questions by stakeholders, resulted in the formulation of a series of “Key Messages” and “Frequently Asked Questions”. Among these, particularly interesting is the section about “MRC as an Organization”, which tries to highlight the importance of basin-wide management.

Besides content, the communication strategy dedicates great attention to the question of linguistic differences among riparian countries. To ensure that the message reaches all recipients at every level, the translation of communications into the four languages spoken in the basin, as well as a few *linguae francae*, is reiterated at several points: two sections are dedicated to “Language and Accessibility” and “Translation”; and translation is also explicitly indicated for almost every communication tool listed (website, press releases, policy briefings, video, etc.).

Finally, MRC addresses the issue of the physical reach of the public in the remotest areas at the provincial and district levels. Among new possible channels for the distribution of hard copies to stakeholders, the strategy points to local government offices and NGO networks, along with some dissemination occasions, such as news conferences and news releases.

Source: MRC, *Communication Strategy and Disclosure Policy* (Vientiane, 2009). Available from <http://www.mrcmekong.org/publications/strategy-and-work-programmes/?start=10>.

Lesson 36. *Select appropriate instruments to communicate about climate change impacts on water resources and adaptation options*

It is important to seize and create as many opportunities as possible to disseminate information about adaptation to climate change in transboundary basins, keeping in mind that appropriate means of communication have to be identified for each occasion. Where the level of awareness is low or sensitivity is high, testing and evaluating a number of different communication approaches may be useful to ensure you are meeting your communication goals and promoting the types of dialogues and interactions intended. Launching a campaign too quickly with partial or ineffective outreach can have negative long-term consequences and damage or limit opportunities to achieve consensus and positive action.

The most interactive way of communicating is through the organization of events requiring the physical (or remote) presence of the recipients, like conferences, workshops and site visits. Today, many international events are focusing on new approaches to address climate change: national dialogues to discuss the development of national adaptation plans, meetings about building or updating basin management plans, etc. With a narrower focus, regional conferences at basin or sub-basin scale attempt to raise awareness and promote reflection and discussion on adaptation in specific areas. Additionally, workshops, especially those involving non-water experts (e.g., sociologists, agronomists, energy professionals and health specialists), require the active participation of those attending and thereby foster dialogue and the generation of new ideas.

A totally different channel of communication consists of tools based on a one-way flow of information, such as written documents (flyers, brochures or newsletters), visual and audiovisual materials (e.g., posters, infographics and films) and other instruments combining the two (such as websites). In transboundary basins, such material should — ideally — be developed for the entire basin.

Indirect, but more engaging means of communication are via media that demand the dynamic involvement of the user, like games and videogames. In recent years, serious gaming, simulations of real-world events or processes designed for the purpose of solving a problem have proven to be innovative means of reaching particular audiences.

Case study 2.33 “Multiple tools multiple times!” Dissemination tools in the AMICE communication plan

In the framework of the project “Adaptation of the Meuse River to the Impacts of Climate Evolutions (AMICE)”, a communication plan was developed with the aim not only of sharing information between partners, but also of disseminating the project results among all stakeholders and increasing awareness of the general public about climate change and its effects on the environment. To achieve this, the communication plan included a broad range of tools:

- International, regional and local events: meetings with the local community; meetings with small groups of local policy-makers; training workshops; field visits, open to the population; exhibition stands
- Website
- Written and audio-visual material: brochures and publications; posters; press releases; articles, drafted together with journalists; newsletters; interactive documentary.

Targeted at the general public of the Meuse River Basin, the interactive documentary proved to be the most effective communication tool, also due to the fact that it was published on the project website and linked to all partners’ websites. It was composed of several one-minute filmed sequences of the river, its tributaries, infrastructure, etc., each translated into the three languages of the basin. Because of budgetary constraints, the documentary was not translated into English, an important omission recognized by the partners at the end of the project.

Sources: Martine Lejeune, “The AMICE Communication Plan”, version January 2011. Online report available from http://www.amice-project.eu/docs/pa1_pr4_1302196426_AMICE_COMMUNICATION_PLAN_in_text.pdf. Additional materials are available from <http://www.amice-film.eu/> and <http://www.amice-project.eu/en/>.

Lesson 37. Use targeted approaches to raise awareness on the need for adaptation

There is a need to raise the awareness of the public at large about the need for adaptation and the requirements in terms of capacity. However, the “public at large” is not a uniform group, and even single groups may require more than one means of engagement and outreach. At a local level (such as a sub-basin), this can be done by using a variety of communication tools to inform the public about successful local interventions to address climate change (see case studies 2.30 and 2.31 and section 2.3.1).

A special target group are children and youth in school, who can be reached relatively easily through their teachers, who may nonetheless need training. They can also serve as multipliers of information, spreading awareness among their families.



“Colours of the Dniester” competition, Teslyuk Evelina, 10 years old, Ukraine



“Colours of the Dniester” competition, Kutelmah Yaryna, 10 years old, Ukraine



“Colours of the Dniester” competition, Kubitka Alina, 17 years old, Moldova

Case study 2.34 Using games for capacity development

During the “Fifth workshop on water and adaptation to climate change in transboundary basins”, held in Geneva on 14–15 October 2014, at the initiative of UNECE, a serious game was played by participants to develop negotiation capacities for discussions on climate change adaptation in transboundary basins.

The game, called “Shariva Roleplay,” has been developed by the UNESCO-IHE Institute for Water Education. The role play provides insights into interlinkages and interdependencies at a basin scale. The role play helped participants understand different issues and players involved in transboundary river basin management and adaptation to climate change and floods.

The participants were divided in two teams (officials representing the relevant ministries), representing the two countries sharing the same river basin (upstream and downstream). The teams had to find a way of negotiating trade-offs between different sectoral and country interests.

The participants in the game can learn about the methods of negotiation and the difficulties of building a common strategy, including the difficulties of compromise inside one country among the various users, in the context of additional pressures such as climate change or economic growth.

Source: Daniel Valensuela, International Network of Basin Organizations, personal communication (2015). Presentation on the game available from <http://www.unece.org/index.php?id=34431#/>

An aerial photograph of a river valley. The river is braided, with multiple channels and large areas of light-colored sand and gravel bars. The valley is surrounded by dense green forests. In the center, there is a small village with red-roofed houses. To the right, there are large green fields and a road. The overall scene is a mix of natural and human-made elements.

Chapter 3

An aerial photograph of a river basin, showing a winding river through a green landscape. In the lower-left corner, there is a small settlement with several buildings and roads. The top of the image is a solid red banner containing the title text.

Vulnerability and impact assessment in transboundary river basins

The vulnerability of a system includes both an external dimension, represented by its exposure to climate change and variability, and an internal dimension, represented by the system's sensitivity to direct and indirect impacts and the system's capacity to buffer, ignore, resist and even transcend impacts. A highly vulnerable system is one that is very sensitive to modest changes in climate, where the sensitivity includes the potential for substantial harmful effects and for which the ability to cope is limited. In a transboundary basin, the vulnerability may be different for different riparian countries, even if the climatic impacts are similar, as the sensitivity, exposure and adaptive capacity may differ.

3.1 Data collection, exchange and storage

For many basins, a shared understanding of vulnerability can be negotiated through the use of common indicators, data products and performance markers of climatic and eco-hydrological information. Data sharing and information processing are significant precursors for effective collaboration on model and scenario harmonization (see section 3.2.2). In most cases, permanent data-sharing mechanisms should be created at the transboundary level so that basin institutions can function coherently.

Almost all aspects of water resources management must be informed by data, even if the data is qualitative, incomplete, or flawed. Even the knowledge that information is missing can inform decision-making processes. Transboundary water management has many special problems not always found at smaller scales, particularly with the transmission, alignment, resolution and integration of information. For instance, collected data should be stored in a way that will allow easy retrieval, which may entail specific agreements in a transboundary setting. Climate change adaptation also has special concerns, given that clear, tangible, precise and accurate information may be available for the past, while knowledge about the future lacks all of those qualities. All basins, countries and water management decisions have at least some gaps in information, particularly under holistic approaches that include hydrological, environmental and socioeconomic data. Knowledge is inherently imperfect. Instead of trying to describe perfect data, this chapter will focus on assessing, gathering, compiling and exchanging "good enough" information to enable effective transboundary climate change adaptation decisions. This chapter discusses the various aspects of data and information sharing.

Lesson 38. Identify information needs and processes for assessing, gathering, compiling and exchanging information

Information and data help identify the vulnerabilities in a basin. Meaningful, accurate, and sufficiently precise data are critical to ensure that vulnerability assessments are grounded in actual biophysical and socioeconomic processes and can inform evidence-based decision-making. Indeed, the sharing of data itself can build confidence and ensure that concerns and objections about creating common data and water management platforms are aired (and resolved) early. However, raw data is not “information” in itself. Data must be processed and often contextualized in order to become information, which can in turn then be used to inform decisions.

Information can cover a range of issues from hydrometeorology to socioeconomic concerns. Good information can improve decision-making and must be exchanged between riparian countries. Such information can include “virtual data,” such as the outcomes of model runs and scenario development. It is also important that information is presented in a way that is understandable for decision makers and the public at large.

Lesson 39. Ensure collection and sharing of the appropriate and necessary data, information and models for the entire basin and across the water cycle

The collection of the necessary data and information for climate change adaptation includes: quantitative and qualitative local knowledge; palaeoclimatic records; surface water and groundwater monitoring records; projected information (e.g., global climate model data); extreme event records; water supply, demand or usage estimates; data to inform climate, socioeconomic and environmental scenarios; and the elaboration of a knowledge base about potential future changes. Such data are needed at the national and international levels, even more so if they concern an international basin. To ensure data availability on the international level, sharing of data is imperative. Joint monitoring systems can help in this regard.

Information access differs considerably across countries, regions and disciplines. In virtually all cases, not all information and data that are needed (as described above) is available; uncertainty is a systemic problem for both water resources management and long-term climate adaptation more generally. Nevertheless, assessments can be made on the basis of the best available information, and uncertainty per se is not normally a reason for inaction. Indeed, one key response to insufficient knowledge is to reconsider the types of decisions that are possible.

Next to the information from riparian countries, use can be made of existing international sources of information, such as the United Nations Global Environment Monitoring System (GEMS), the Information System on Water and Agriculture of the United Nations Food and Agricultural Organization (FAO AQUASTAT), the World Meteorological Organization’s Hydrological Information Referral Service (WMO INFOHYDRO), the International Groundwater Assessment Centre (IGRAC) for groundwater, the Global Runoff Data Centre (GRDC) for surface water and World Data Centres, etc. Low availability and poor quality of data and information unfortunately add to the uncertainty in the projections.

In some regions, the private sector may hold significant pools of data. For instance, companies that focus on energy production, mining, petrochemical extraction or manufacturing, beverages, commercial agriculture or commercial transportation may have established networks to gather, monitor and analyse information that could be deeply relevant to climate change impacts and adaptation.

Remote sensing tools are rapidly increasing in sophistication and can serve as a supplement to bridge monitoring and data gaps — especially when information is withheld or retained due to political sensitivities — as well as a means of promoting transparency and trust between political institutions and stakeholders (indeed, in some basins the most challenging barriers to sharing data may be intra-national rather than international). In basins with limited hydrological records, remote sensing may also serve to create a common data baseline for comparison with projected

conditions, though remote sensing information should be calibrated and ground truthed as global data sets commonly have systematic or regional distortions and biases. Consistency in how data is collected, packaged, modelled and interpreted, through the development of socioeconomic, environmental and climate scenarios, is important for reaching coherence in comprehensive assessments of impacts and vulnerability.

To enable sharing of data, a common, integrated, accessible database is the ideal goal. Such a joint database was created for the Dniester Basin,² and illustrated that such a database needs a joint administrator and a mechanism through which data can be continuously updated (e.g., the Basin Commission); otherwise the information becomes outdated and cannot be used for decision-making.

The exchange of data through databases housed in separate institutions is an alternative to creating a single, interoperable and jointly managed database. In many cases, sharing data evolves over time, as trust, need and political investment develop.

Interoperability of data — that is, the ability to blend and merge data on particular topics into a common format and resolution — will drive the transition of data into information that can be effectively deployed. Interoperable data on water quality, for instance, may span divergent regulatory frameworks, categories and spatial and temporal scales. The shortage of interoperable data is almost universal in the beginning of joint transboundary water management. As a result, explicit agreement should be made to harmonize data sets, while minimizing the loss of information and resolution that can come from the harmonization process. Data sets need to be harmonized for scale, resolution and focus, as well as be comparable in terms of measuring method and quality. Reaching such comparability entails close cooperation between the relevant institutions and procedures like round-robin testing.

Case study 3.1 Development of geoportal for the Dniester basin

Geoportal (dniester.grida.no) was developed to enhance information collection, sharing and use within the project “Transboundary cooperation and sustainable management in the Dniester River basin: phase III – Implementation of the Action Programme (DNIESTER-III)”. Shared data are visualized on the basis of a geoinformation system built on ArcGISServer 10.2. The portal provides the possibility to download, update and display social, economic and geophysical data, to locate hydrological stations and to access monitoring data. The software features made it possible to use satellite images to analyse land cover (Truemarble Image, Geocover Image). To ensure the confidentiality of certain information the portal gives users restricted access (with passwords). One of the layers of the geoportal contains a dynamic map of the Water Quality Index, which was developed in cooperation with the project “Capacity Building in Data Administration for Assessing Transboundary Water Resources in the countries in Eastern Europe, Caucasus and Central Asia”. Water authorities and hydrometeorological services, with the support of international organizations, are looking for resources to further develop the portal.



Source: Hanna Plotnykova, OSCE, personal communication (2015).

The data included in the common database need to be processed for verification, ground-truthing, accuracy and precision and degree of uncertainty. A common data assessment protocol can be helpful to develop a common database. In situations where not all data are available, incomplete data, alternative sources (such as remote sensing or satellite data) or expert opinions can be used instead.

² See Geoportal of the Dniester River Basin, available from dniester.grida.no/en/.

Even in politically tense basins, information and data-sharing projects can constitute an important way of building trust between riparians. Data and information sharing can be done on a technical level. This exchange of information and the process of cooperation itself leads to a better mutual understanding, which in turn builds trust. For example, in the Dniester Basin national and local public health authorities were involved in joint sampling and analysis of water quality at transboundary points in the Republic of Moldova and Ukraine. The samples were taken at the same time and were analysed in the laboratories of organizations involved. This exercise helped to improve communication and cooperation among the relevant authorities and to reduce discrepancies, which were frequently considerable at the beginning of the joint sampling.

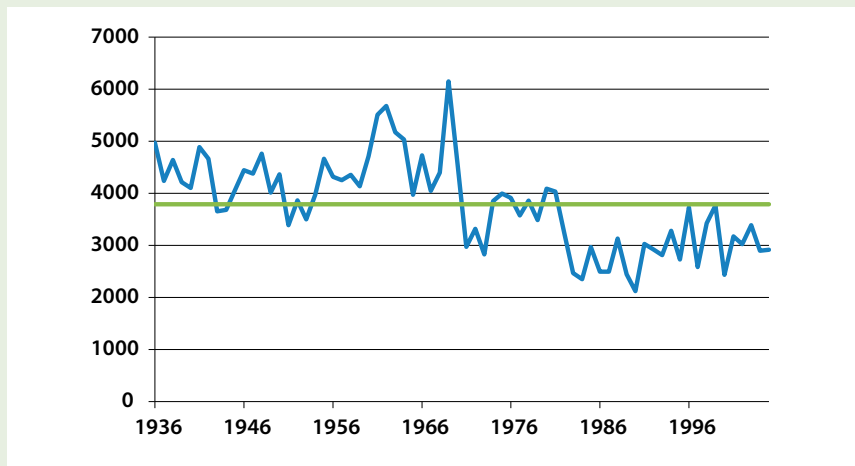
Case study 3.2 Prediction of water levels of the Ubangi River

From its source to 100 kilometres below Bangui, the capital of the Central African Republic, the Ubangi River defines the boundary between the Central African Republic and the Democratic Republic of Congo. Thereafter, the Ubangi forms the boundary between the Democratic Republic of Congo and the Republic of Congo until it flows into the Congo River. Together with the Congo River, the Ubangi provides an important transport artery for river boats between Bangui and Kinshasa/Brazzaville (which face each other across the Congo River). The Congo Basin spans 3,822,000 km². The average flow of the Congo River is about 41,000 cubic metres per second in Kinshasa/Brazzaville. The Ubangi has a length of 2,300 km and an average flow of 4,000 cubic metres per second.



The navigation conditions downstream of Bangui have deteriorated over the past decades, with only 4 days per year without navigation in the 1930s, but over 200 days annually over the past decade. According to the Common Service for Maintenance of Waterways (*Groupement d'Intérêt Économique — Service commun d'entretien des voies navigables*), this decrease in both rainfall and discharge is due to climate change, as there are no water withdrawals in this sector. The same climate tendency can be observed since the 1970s in West Africa (Sahel) and the Lake Chad region.

Evolution of Ubangi mean discharge (cubic metres per second) in Bangui from 1936 to 2005 (CICOS)



Within the EU-funded "African Monitoring of Environment for Sustainable Development Programme" a model for predicting the water levels was developed at the pinch-point for navigation: the Zinga Rapids. The model combines hydrological data from the navigation services of the Central African Republic, the Republic of Congo and the Democratic Republic of Congo. To improve data quality, these data are combined with data obtained by satellite. The model provides forecasts for 5, 10 and 15 days. Sailors can thus decide whether to delay or speed up their departure or to change their cargo.

Experience has shown that the quality of available data is a major concern for a reliable modelling. The expected water levels as forecasted are not very accurate for over 5 days of forecasting. These uncertainties must be carefully communicated to managers and end users.

Source: CICOS, 2015

Lesson 40. Evaluate thematic, spatial and temporal areas of data coverage and gaps

Accurate assessment of the situation in a basin and the potential impacts and vulnerabilities needs to be based on a common understanding and, consequently, common information from the basin. A first step is to assess data needs, and then to collect and exchange that data. Evaluating the results from that search allows for identification of differences in temporal, spatial and thematic coverage, quality and gaps that had not been identified earlier.

The result is an overview of the information needs as well as the available data and information on the basin level, including gaps in the available information. Such an overview allows for the development of a joint monitoring and observation system, exchange of knowledge and experience in information collection and arrangements for filling gaps. In developing these information needs, potential future information needs should also be considered.

Case study 3.3 Joint database for the Neman River Basin

The Neman River Basin includes parts of the territory of Belarus, Lithuania, the Russian Federation (Kaliningrad Province), Poland and Latvia. The total river length is 914 km and the basin area is 98,200 km². In the average year, Belarus and Lithuania together account for approximately 94 per cent of the total Neman River runoff. The climate in the basin is moderately continental. The Atlantic Ocean is the major factor affecting the climate.

Hydrometeorological network in the Neman River Basin

The main environmental problems in the basin are due to the discharge of pollutants to water bodies from point and non-point sources of pollution.

In the Neman River Basin there is a network of 23 meteorological (8 in Belarus and 15 in Lithuania) and 25 hydrological stations (12 in Belarus and 13 in Lithuania) (see the figure). Monthly data include air temperature, precipitation and runoff. Within the framework of an ECE/ UNDP/ ENVSEC pilot project, the exchange of data and commonly agreed climate scenarios between the countries took place and a common data base was used. An Internet-based common information platform was developed and installed, containing meteorological and hydrological data and thematic maps with future climate and runoff scenarios.

However, since the database is only linked to the project its sustainability in the long-term cannot be ensured.

Source: ECE/UNDP/ENVSEC project "River Basin Management and Climate Change Adaptation", <http://www.cricuwr.by/neman/>.



Lesson 41. Build a common repository of the information to be communicated

A lot of information already exists about climate change and water. One of the first steps of the communication strategy should be the creation of a reference knowledge base of the relevant existing documentation from both global and regional or basin data-resolution scales. A range of different kinds of information is essential for proper communication: first, data on climatic and eco-hydrological conditions; second, scenarios and projections or forecasts, including explanations of the models used to elaborate them; and, third, descriptions of ongoing projects and their results. It is better if the collection and selection of information is managed by a single entity acting at a basin level. Once such a repository is produced and shared among partners, preparation of messages for dissemination can commence. Certainly, to reach this objective, the removal of political and technical barriers to the exchange of information and data is indispensable.

Case study 3.4 The Nile Information System

The Nile Information System is an online open platform providing access to information about the Nile River Basin. Created in the framework of the Nile Basin Initiative (NBI) with the aim of developing a knowledge system on the entire basin, the Nile Information System is intended to “support the systematic storage, retrieval, exchange and analysis of relevant information (e.g. documents, data, maps, etc.) on water, environment and socioeconomic aspects of the Nile Basin”. To this end, users, ranging from key NBI stakeholders to the general public, can obtain and at the same time contribute material to the System.

Information can be browsed by:

- NBI Centres, i.e. by the local offices where knowledge was generated during the implementation of projects in the basin
- Thematic areas, specifically water resources, land resources, social and economic environment and climate change
- NBI networks, i.e. various institutions and organizations (ministries, universities, professional networks) operating in the field of transboundary water management
- Policies and Guidelines, a range of strategic and operational documents guiding NBI activities to ensure their conformity to the principles of IWRM
- Datasets containing hydrology, climate, environment and socioeconomic data.

The Nile Information System complements the existing knowledge tools, such as the digital library and archives, and constitutes a common repository that partners can use for the development of communication activities.

Source: <http://nileis.nilebasin.org/>.

3.2 Assessing vulnerabilities, opportunities and synergies

Vulnerability assessments are inherently imperfect. As a result, vulnerability assessments should be viewed as an iterative, ongoing process (see more on uncertainty in section 2.1.2 above). To view the process of vulnerability assessment as a purely technical exercise or a one-off report will consume limited resources, reduce credibility with decision makers and stakeholders, and will underestimate the inevitable information gaps around future impacts of climate change. Indeed, vulnerability assessments are communication and engagement tools to mobilize stakeholders and create effective adaptation plans and actions.

Vulnerability assessments provide particular, pre-identified decision makers with information that guides choices on where, when and how to intervene. Vulnerability assessments should be undertaken by interdisciplinary teams representing natural, social and economic sciences, other relevant technical expertise, such as spatial planning and engineering, and (potentially) stakeholders capable of articulating special needs, such as giving voice to particular ecosystems, species and biophysical processes.

Different methodologies are available for vulnerability assessments. Some of them are described in the *ECE Guidance on Water and Adaptation to Climate Change*, though thousands of tools, methodologies and approaches to assessing vulnerability have been developed since that publication's release in 2009. This rate of development is expected to continue to accelerate and diversify in the coming years. As a result, this chapter does not try to provide a comprehensive overview of methodologies and approaches, but rather to describe some of the lessons learned about vulnerability assessment relevant in a transboundary context, as well as some of the ideal qualities and roles that effective vulnerability assessments should possess.

3.2.1 Vulnerability assessment at the basin and sub-basin level

The drivers of climate change are planetary, but the consequences of climate change are hydrologically expressed at both basin and local scales.

Lesson 42. Develop a common understanding of the concepts of vulnerability, opportunity, impacts and uncertainty related to climate change

Vulnerability and impact assessments are tools designed to inform decisions on, planning for and actions to address observed and potential climate impacts. Effective assessments have a clear focus (what is being assessed?) and a clear audience (who will use the assessment?). However, the language around climate change can become a source of misunderstanding and potentially an obstacle to both assessment and implementation, particularly in a transboundary context with potentially conflicting interests and visions, governance frameworks, focuses and audiences. A common language, targets, audiences and set of references as well as a common methodology should be established early in the process of assessing impacts and vulnerability, preferably in writing, so that stakeholders and decision makers can build on an explicit, solid and clear foundation.

There are many definitions for climate change vulnerability, but probably the closest to a consensus standard is the sensitivity of an object or system of interest to climate change relative to its response capacity (IPCC, 2014). The risk of negative effects arises from the interaction of climate-related hazards, including hazardous events and trends, with the vulnerability and exposure of human and natural systems. Comprehensive assessments will span all of these variables in a way that should be actionable for end-users.

At least four other conditions should be considered near the outset of an assessment, as set out below.

1. Methodologies for vulnerability assessment have been evolving extremely rapidly in recent years. This evolution is often driven by attempts to reduce or constrain quantitative uncertainties and/or make use of emerging knowledge from specific applications (such as water resources management) or particular disciplines (such as engineering, ecology, or economics) or for particular types of decision makers (protected area managers, hydropower operators). The development of quantitative, bottom-up approaches to vulnerability assessment, for instance, dates only to about 2008, while top-down "downscaling" methodologies have been used over a decade longer. An explicit and open exploration of recent methodologies is highly recommended, and the application of more than one methodology may be the most useful and effective way to inform a wide variety of decisions. In a transboundary context, spatial scales will often be quite large, which can enable the use of many kinds of relevant data. Methodologies that tend to limit major sources of data (for instance, excluding particular climate models or climate scenarios or palaeo data) may not fully describe the uncertainty, which could lead to a sense of false confidence (see item 4 below). As a result, methodology selection will require negotiation among key riparian parties.
2. The sensitivity and exposure of governance and stakeholder institutions, regulatory frameworks and relevant social systems should be included in the assessment next to the primary focus of climatic and biophysical impacts. For transboundary basins in particular, the interaction between governance levels can have a significant influence on adaptation actions, and identifying governance gaps and synergies can be an important component of an assessment.

3. The process should explore emerging potential opportunities that may result from realized or potential climate impacts in addition to negative impacts. High-latitude regions, for instance, may see an expansion of suitable agricultural zones.
4. The tolerance for end-user or stakeholder uncertainty about future impacts should be an important part of the assessment process; the temporal and spatial scope of decisions should be calibrated to the data and information available and its level of confidence. “Uncertainty tolerance” is not a widespread term for vulnerability assessments, but it is an issue that is important for stakeholders and decision makers to consider, and early enquiries into tolerance for the relative lack of precision and accuracy can enable more directed and audience-appropriate reports. Vulnerability assessments that limit major data sets a priori will not fully represent the uncertainty inherent in a system, such as excluding particular climate models or climate scenarios. The uncertainty tolerance for the design of new water infrastructure, for instance, will be quite different than an examination of regulatory frameworks — for the former, a more quantitative determination of potential impacts may be most important, while for the latter a qualitative trend analysis may be sufficient. Likewise, there may be significant gaps in uncertainty tolerance across relevant governance institutions in a transboundary basin. If technical decision makers are uncomfortable with the confidence of projected data for future hydrological conditions in the design and operation of water infrastructure, then they and other types of decision makers may need to re-evaluate the set of options available. For instance, should the project be evaluated against a broader set of potential futures? Should safety margins be increased? Should the project be designed for more flexible operations across a wider range of conditions? Should the project be deferred to a later date? Should additional measures be developed in case of service failures? The level of uncertainty tolerance is particularly important for projects that will span long timescales, such as creating regulatory frameworks or designing hard infrastructure.

Lesson 43. Consider the whole basin and all steps of the water cycle in the vulnerability assessment

The characteristics of water strongly suggest that vulnerability be assessed across the whole water cycle. Water is both a local and global management priority, while climate change is impacting different spatial and temporary aspects and steps in the water cycle unevenly. Therefore, focusing on a single aspect of the water cycle — particularly just “visible” and local surface water — may miss important impacts that are relevant for local stakeholders. Evaporation, precipitation, snow-pack and glaciers, surface flows and run-off patterns, and groundwater storage and recharge processes can potentially be influenced by shifts in land-use patterns, climate change and consumption patterns. Moreover, uncertainties (and the tolerance for uncertainties) differ between these steps of the water cycle.

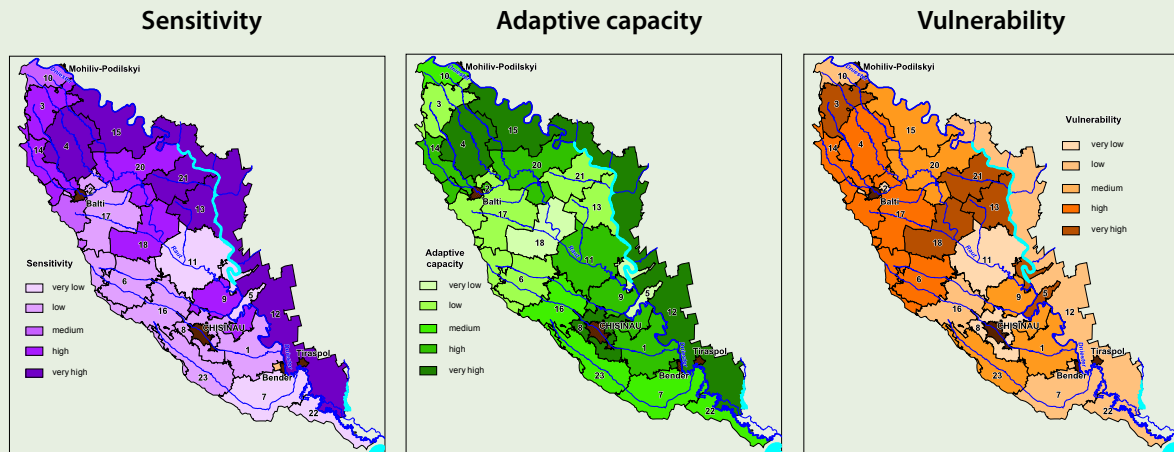
Case study 3.5 Classifying the climate vulnerability of the Moldovan part of the Dniester River Basin

The vulnerability of the Dniester River Basin — a transboundary river between the Republic of Moldova and Ukraine — was assessed as a function of the sensitivity of its natural and socioeconomic systems to climate change impacts and of its adaptive capacity to confront them. The sensitivity assessment included the description of a number of specific indicators characterizing the physiographic and socioeconomic situation in the basin. The adaptive capacity was assessed against general economic, primary agricultural indicators, taking into consideration health and housing conditions. Additionally, to assess the spatial distribution of the vulnerability of the Moldovan part of the Dniester Basin, a specific approach was developed.

The Dniester basin occupies about 59 per cent of the Republic of Moldova’s territory and plays an important role in the country’s economy. Given the state of its economic development, the Republic of Moldova must choose its adaptation options carefully, based on identification of its most vulnerable administrative-territorial units (ATU), in order to prioritize and plan adaptation actions. As a main research tool, a ranking approach was selected in which each ATU was assessed according to its “place” in the ranked sequence of two components of

Case study 3.5 Classifying the climate vulnerability of the Moldovan part of the Dniester River Basin (cont.)

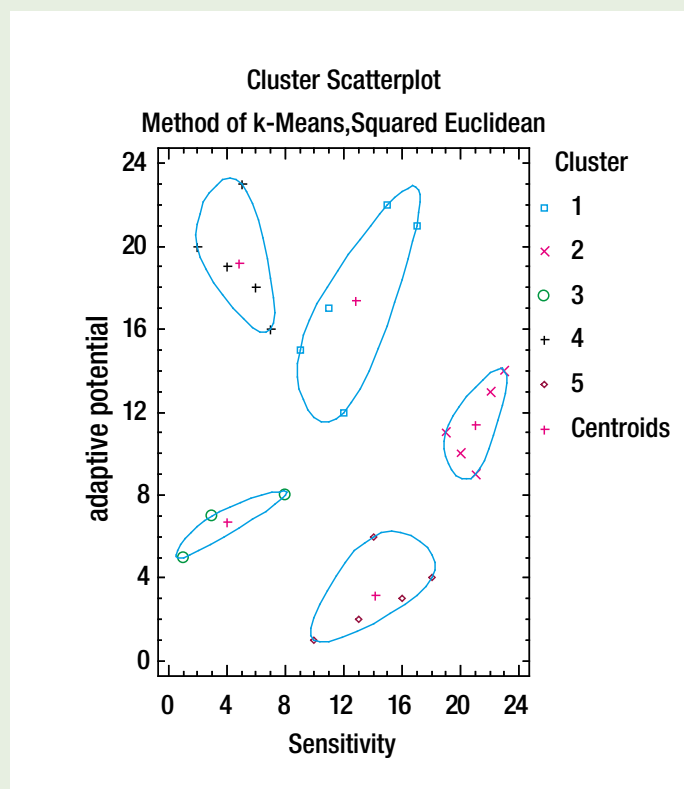
Figure 1. Ranking the vulnerability to climate change of the Republic of Moldova's ATUs in the Dniester River basin as a function of their sensitivity and adaptive capacity.



vulnerability: sensitivity and adaptive capacity. Each component was defined as the sum of ranks of indicators and proxies describing its different physiographic and socioeconomic characteristics. The total relative vulnerability of each ATU was calculated by combining its sensitivity and adaptive capacity ranks (Figure 1).

The ATUs' vulnerability was also visualized by clustering them, using sensitivity and adaptive capacity as axes (Figure 2). Clustering showed the relative needs of each ATU grouped in five clusters, each of which brings together ATUs with similar levels of sensitivity and adaptive capacity.

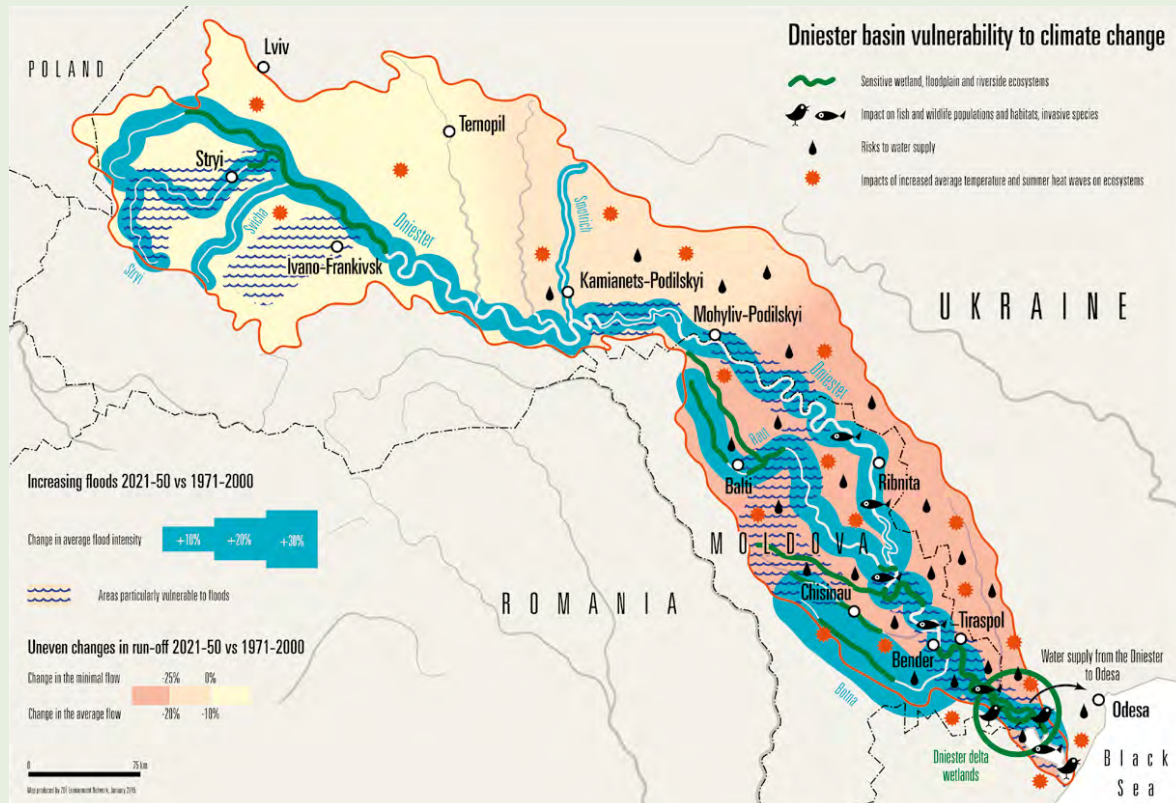
Figure 2. Distribution of Moldova's ATU in the Dniester basin by their vulnerability, depending on their relative sensitivity and adaptive potential



Case study 3.5 Classifying the climate vulnerability of the Moldovan part of the Dniester River Basin (cont.)

In addition to the detailed vulnerability assessment for the Moldovan part of the Dniester, a basin-wide vulnerability assessment was carried out, including also the Ukrainian part (Figure 3).

Figure 3: Basin-wide vulnerability of the Dniester basin



Zoi Environment Network, 2015.

Source: Roman Corobov and others, Climate change vulnerability: Moldavian part of the Dniester River basin (Chisinau, Eco-Tiras, 2014). Available in Russian from <http://www.eco-tiras.org/docs/ecotirasFinal-small.pdf>.

Lesson 44. Assess vulnerability at both the basin and sub-basin levels

Most policy and operational trade-offs are not made at the basin scale. For transboundary basins, a whole-basin assessment is critical to capture biophysical trends holistically, often revealing governance gaps and conflicts when political, management and governance boundaries differ from hydrological basins, while vulnerability assessment on a sub-basin level can identify and prioritize local adaptation targets. This is the level where many concrete adaptation measures are actually taken (see Case study 3.5).

In arid regions, relying on groundwater resources often shared with other riparian countries, assessments should be carried out for all major aquifers, if possible (see Case study 3.6).

Case study 3.6 The vulnerability of the lullemeden–Taoudeni–Tanezrouft Aquifer System

The transboundary aquifer system of the lullemeden–Taoudeni–Tanezrouft aquifers, shared by Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger and Nigeria, covers an area of 2.5 million km² and is composed of the lullemeden aquifer in the east and the Taouedeni-Tanezrouft aquifer in the west. The two aquifers are connected through a small sediment corridor, also known as the fosse de Gao, corresponding to a stretch of the Niger river in the Gao region in Mali. In some areas the Niger River constitutes an important source of recharge, whereas in other areas the Niger River drains the aquifer system. Recharge and drainage differ according to seasonal and climate variability. Knowledge of the relationships between aquifers and between aquifers and the inland delta of the Niger River is fundamental for analysing their vulnerability to the impacts of climate change. In this regard, meeting the increased demand for water and improving the management of the hydraulic system, including the exploitation of surface and groundwater resources, constitute important challenges.

It is estimated that over 80 per cent of the water used in West Africa comes from groundwater. The availability, accessibility, supply of and demand for water in Africa will be mainly influenced by population growth and urbanization. Water demand will quadruple with the doubling of the West African population in the coming decades. According to IPCC (2008), groundwater recharge is expected to decrease with reduced rainfall and runoff, resulting in increased water stress.

In the context of the “Joint and Integrated Water Resources Management of the lullemeden–Taoudeni-Tanezrouft Aquifer Systems and the Niger River” project, OSS undertook a vulnerability analysis of the system. An information system was built based on the SIRIS method (System of Integration of Risk with Interaction of Scores). The studies integrated the physical characteristics of the aquifer systems and their environment (recharge, permeability, water depth, free or captive) as well as anthropogenic stresses (population, demand for water, well density).

The analysis identified areas with a particular groundwater exploitation potential. The potential was due to either strong linkages with surface water, which ensures a steady supply supporting water resources even during periods of rainfall deficit due to climatic variations, or permeability, which allows for large water reserves, entailing the possibility of high flow rates in the basin.

The analysis also helped to identify areas that are highly vulnerable to the risk of a declining groundwater level (see map below). In general, the upper level of groundwater in the aquifer system varies between 50 and 300 metres below the land surface, but the lower groundwater levels can go as deep as 1,000 metres. The most vulnerable zones are found specifically in the large plains upstream of the Niger River (Mali) and in the central region of the Niger River Basin (Niger and Nigeria). In these areas the declining level of groundwater tables could hinder access to water for irrigation and disrupt agricultural production. The Nigerian part of the aquifer is also prone to a future increased precipitation deficit, which may lead to an increased demand for groundwater.



Sources: Sahara and Sahel Observatory, “Rapport 18 du projet GICRESAIT, Modélisation et vulnérabilité”, Project report, 2013.

Guillaume Favreau and others, “Groundwater resources increase in the lullemeden Basin, West Africa”, in *Climate Change Effects on Groundwater Resources: A Global Synthesis of Findings and Recommendations*, Treidel H, Martin-Bordes JL and Gurdak JJ, eds. (Boca Raton, Taylor & Francis, 2011).

Lesson 45. Link the vulnerability assessment with capacity-building for decision makers and stakeholders

Vulnerability assessments should — ideally — be tools designed to directly inform decisions, planning and actions. Involving stakeholders and decision makers in the preparation and development of a vulnerability assessment should ground the assessment process so that outcomes are useful and meaningful to end users. In many cases, the process of assessment is also an opportunity to build the adaptive capacity of stakeholders and decision makers. A powerful means of engaging decision makers is to collaborate on the scenario development process so that the assessment team and decision makers both construct a clear and common understanding of the tolerance for uncertainty for specific types of decisions. In many cases, the assessment team may decide to describe impacts in qualitative rather than quantitative terms, since numerical and statistical measures of uncertainty often provide a false sense of security about the level of confidence in projected trends.

In most basins, local or national efforts to adjust to emerging or projected climate conditions are already under way, and the vulnerability assessment can be an effective means of evaluating these organic efforts and, if they have been effective, promoting them throughout other parts of the basin.

The vulnerability assessment team can also work closely with decision makers to test the utility of alternative approaches to mitigating climate impacts, making the vulnerability assessment a means for hypothesis testing. Would increasing the number of flood barriers reduce vulnerability throughout the basin, or just in the immediate area of the barriers? Can green infrastructure be used as a supplement for local irrigation needs? One useful strategy in developing such actions is to categorize them by the level of “decision commitment”, long-term flexibility, or path dependency implied by these actions. For example, so-called low- or no-regret measures, such as improved monitoring, cross-sectoral coordination approaches like IWRM and early warning networks for floods, may have only indirect connections to climate vulnerability and adaptation and would constitute best practices under a stationary climate or a wide range of possible climate futures. In contrast, building new or modifying infrastructure, investing in new capacity, restoring ecological or hydrological systems, or modifying governance agreements may be associated with selecting a subset of projected climate futures at the expense of other possible futures.

3.2.2 Use and integration of scenarios and models

The technical analysis of interactions between biophysical and socioeconomic systems is generally conducted via the development of models, which are normally interpreted through alternate scenarios of future events or “storylines” that can express potential risks, impacts and vulnerabilities. Models are approximations of natural and human processes, often with deep uncertainties and many simplifications. While they are essential for estimating trends and projected impacts, they are also an approximate and limited description of reality. Most modellers and scenario builders are very aware that these models are tools designed to inform, but not determine, decisions.

Decision makers are often confronted with difficult choices about when to act and how much to anticipate, and they have a strong desire to avoid reacting too soon (or too late) and spending too much (or too little). As such, models and scenarios can help demonstrate the operating space for decision makers — what kinds of decisions are irreversible and might commit them (or future decision makers) to particular pathways. Untangling impacts is challenging for anyone, but decision makers often face difficulties exploring interactions between climate change and other human and natural system responses, hence the importance of credible models and storylines.

Lesson 46. Harmonize and integrate the use of climate, environmental and socioeconomic models and scenarios

At transboundary scales, credibility may need to be built or accrued through the conjoined efforts of technical and policy teams to co-define climate, environmental and socioeconomic models and scenarios. In cases where individual national actors have already created models and scenarios, a

negotiated process of harmonization should be undertaken. Technical concerns often focus on the use of quantitative data, such as reconciling spatial or temporal scales. As a prerequisite for holistic assessment and effective adaptation planning, climatic, socioeconomic and environmental models and scenarios should be harmonized at the same or very similar scales and resolutions. Interoperability is an important element in finding synergies that move between, for instance, eco-hydrological changes in fisheries or flood frequency and magnitude, economic impacts and responses. Ideally, models should span full-basin scales rather than political, administrative, or other types of non-hydrologic boundaries alone. If a basin-scale approach is not possible, data comparison and harmonization should at least be done at the borders (as happened in the AMICE project, case study 2.33). Policy implications, particularly around economic assumptions, are critical to address early in the process of harmonizing future development scenarios. Ideally, models and scenarios are not just developed as one-off products with national partners, but are maintained, updated and revised as conditions and priorities evolve and change over time.

Indeed, ensuring that all scenarios and models are credible and evidence-based will support difficult trade-offs between political boundaries, governance levels, sectors and stakeholders by policymakers seeking defensible long-term and sustainable solutions. However, it is important to note that sharing data (see section 3.1) and model and scenario harmonization and collaboration will not by themselves produce political cooperation. Data, scenarios and models inform decisions but do not determine them, particularly at transboundary levels.

Case study 3.7 Neman River Basin data and model harmonization

The Neman River basin covers parts of Lithuania, Latvia, Poland, Belarus and the Russian Federation. The river plays an important role for industry, cities and agriculture, but climate variability and change have created difficulties in forecasting the available water resources across the basin. Decision makers started to realize that part of the challenge in forecasting at a basin scale was due to problems with reconciling spatial and temporal scales for different types of climatic and hydrological information. When developing integrated climate and hydrological forecasting models for the Neman River Basin, there has been a strong emphasis on data and modelling harmonization. The countries within the basin provide a compelling example of transboundary data exchange.

Several challenges arose for harmonization, including developing a common methodology. The Lithuania-Belarus joint assessment of the current status of climate change for 1961–2010 addressed this issue by using a common information platform and database when estimating annual average air temperature and precipitation increases.

Basin countries agreed to employ the long-term climate change forecasts (35–50 years) for the Neman River Basin using the output data of the ECHAM5 global climate model and the SRES A1B and B1 scenarios (IPCC 2007) and CMIP5 multi-model ensemble (IPCC 2013). These data were incorporated into models projecting annual average air temperature and precipitation changes.



Source: Vladimir Korneev, Central Research Institute for Complex Use of Water Resources of Belarus, "Collection of lessons learned and good practices on climate change adaptation in transboundary basins", e-mail to Sonja Koeppel and others, 13 October 2014.

Case study 3.8 **Caucasus vulnerability assessment through capacity building and sharing data, models and expertise**

In the framework of preparing the Second National Communications to UNFCCC, Armenia, Azerbaijan and Georgia carried out vulnerability assessments and identified priority adaptation measures in the sub-basins of the Kura River. However, projections of impacts varied from country to country. Thus, a need was identified to improve the assessments through better data exchange and cooperation between the countries, to improve the application of assessment models and to identify common concerns, particularly those related to water resources.

Under the UNDP/ENVSEC project “Regional Climate Change Impacts Study for the South Caucasus Region” (2009–2011), the leading national experts from the three countries undertook technical discussions and exchanged data to decrease the uncertainties and to develop concerted adaptation measures. Data sets related to climatic risks, climatology, hydrology, morphology and socioeconomic aspects were compiled in a common database.

The exchange of data and expertise has improved vulnerability analyses, especially of socioeconomic aspects, as well as the prioritization and development of adaptation measures. The improved data and modelling approaches have enabled countries to develop more effective assessments based on four Global Circulation Models that were selected as the most appropriate for the South Caucasus, based on historical observations. Using these four models, projections of changes in precipitation and air temperature were adjusted. The exchange of information, data and expertise has also greatly helped the countries in their work on their Third National Communications. The regular update of the National Communications ensures also the regular update of the vulnerability assessments.

Source: Vahagn Tonoyan, “Collection of lessons learned and good practices on climate change adaptation in transboundary basins”, e-mail to Sonja Koeppel and others, 2 September 2014

Lesson 47. *Involve stakeholders in vulnerability assessments*

Resources and/or data are not always available for a full-fledged vulnerability assessment. Stakeholders and experts have knowledge that can and should be used in addition to what can be collected from observations and inventories. Therefore, they should be involved in the vulnerability assessment to identify the most vulnerable regions of the basin, the most vulnerable sectors and possible adaptation measures. This is done by discussing with them what the expected future climate developments are and the expected impacts in the basin. Furthermore, stakeholders and experts can help to reduce uncertainty associated with model downscaling and to ground-truth models, improving the quality of vulnerability assessment.

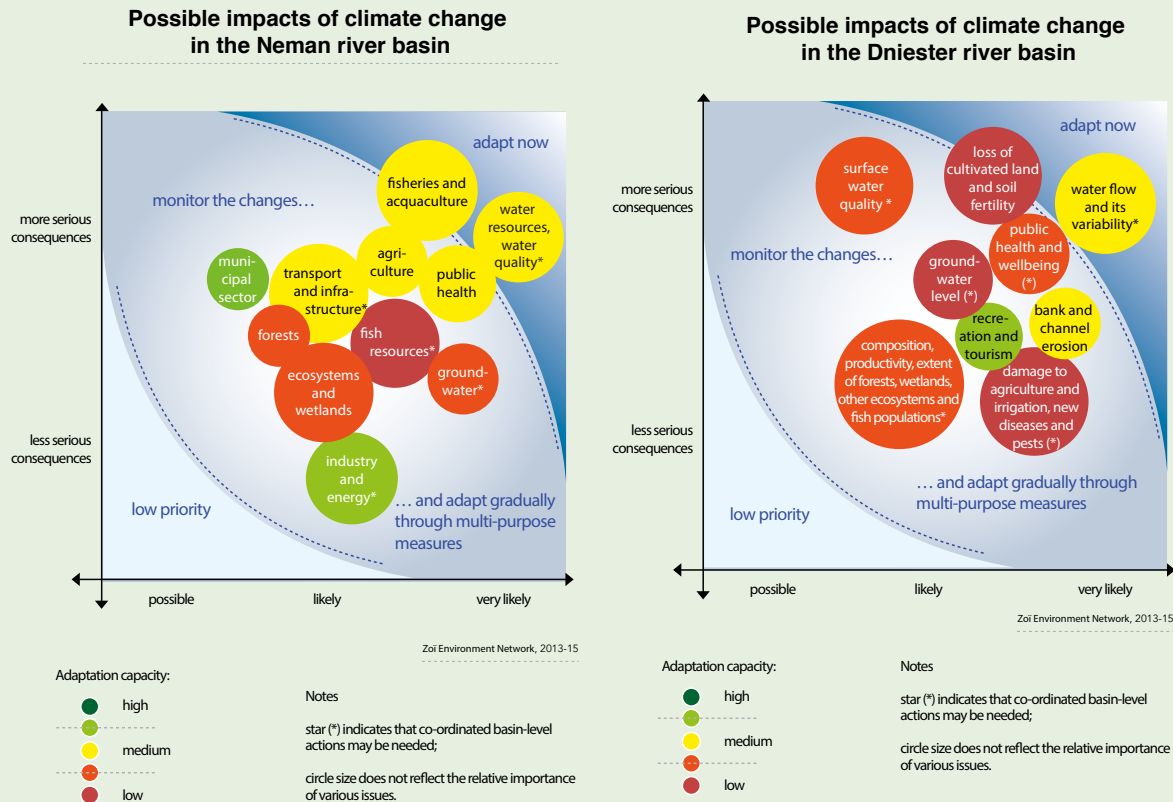
Case study 3.9 **Participatory analysis of the vulnerability of the Neman and Dniester River Basins to climate change according to severity and probability of its consequences**

The experience of vulnerability assessments for two Eastern European rivers, the Dniester and Neman, has demonstrated the importance of wide public participation in testing the assessments’ findings in public. During a facilitated discussion at specially organized workshops the representatives of local authorities, sectoral ministries and agencies, academic and non-governmental organizations reviewed the findings from regional or sectoral perspectives and suggested priority adaptation measures to reduce likely climate-driven risks. They also discussed which of the proposed measures could be taken on the country level or locally and which of them required cross-border cooperation and coordination with the neighbours. On the whole, these exercises, based on short textual and graphical summaries describing the main identified risks, their probability and urgency, promoted the communication of the vulnerability assessment outputs to a broad and diverse audience, confirmed them (or not, as the case may be) from a largely non-academic perspective and provided a platform for brainstorming on specific options for adaptation. Participants in the workshops were happy not only to move ‘bubbles’ on the graphs (as illustrated below) or to change their colours from the viewpoint of the impact intensity and probability, but eventually were able to discuss the issues in-depth and much better understand their content, context and interdependence.

Case study 3.9 Participatory analysis of the vulnerability of the Neman and Dniester River Basins to climate change according to severity and probability of its consequences (cont.)

As the figure shows, the specificity of each basin determines its inherent sets of climate change impacts, which eventually results in different sets of adaptation responses.

Graphical presentation of the Neman (*left*) and Dniester (*right*) River basins adaptive capacities on the background of climate change impacts, their intensity and probability



Zoi Environment Network, 2015

Sources: Roman Corobov and others "Assessment of Climate Change Vulnerability at the Local Level: A Case Study on the Dniester River Basin (Moldova)". *The Scientific World Journal*, vol. 2013, Article ID 173794 (2013). Available from <http://dx.doi.org/10.1155/2013/173794>.

Roman Corobov and others, *Climate change vulnerability: Moldavian part of the Dniester River basin* (Chisinau, Eco-Tiras, 2014). Available in Russian from <http://www.eco-tiras.org/docs/ecotirasFinal-small.pdf>.

Vladimir Korneev, Central Research Institute for Complex Use of Water Resources of Belarus, "Collection of lessons learned and good practices on climate change adaptation in transboundary basins", e-mail to Sonja Koeppel and others, 13 October 2014.

Chapter 4





Developing adaptation measures

Adaptation measures can vary greatly and are usually a mix of, among other things, structural and non-structural, regulatory and economic instruments, and education and awareness-raising measures. As with vulnerability assessment, adaptation should probably never be thought of as “finished”: adaptation is a process, and one that will be with us for the foreseeable future.

Measures developed under an adaptation strategy in general focus on mitigating the direct and indirect effects of climate change. However, the process of developing the adaptation strategy can also reveal weaknesses and inconsistencies in the policy, legal and institutional frameworks, as well the implementation of these frameworks, so that adaptation will often include measures to improve the policy, legal or institutional settings, and/or the implementation thereof. This may include, for instance, the establishment of a joint body, the development of a joint monitoring system or renegotiation of basin agreements. Although such measures may not directly target climate change adaptation, they provide the necessary (enabling) environment to be able to adapt in an effective and more efficient way. Information measures are also included in this chapter, as such measures are fundamental to developing an adaptation strategy and are often lacking in basin cooperation.

4.1 Adaptation measures in the transboundary context

Adaptation measures should be developed on the basis of the results of vulnerability assessments, as well as on development objectives, stakeholder considerations and the resources available. Identified measures should cover all the broad, generalized steps of an adaptation cycle: prevention, improving resilience, preparation, reaction and recovery. Measures for prevention and improving resilience are related both to the effects of shifts in broad aspects of climate, such as the seasonality of precipitation, and to extreme events, such as droughts and floods.

Measures with basin-wide impacts mainly include structural measures or those related to managing such infrastructure, for example the construction of or revision of operating rules of water infrastructure, or ecosystem-based adaptation measures such as restoration of hydrological connectivity or reforestation of riparian forests. In addition, monitoring, data exchange platforms and early warning systems are often included in transboundary adaptation strategies. Table 1 provides an overview of possible adaptation measures for different climate change impacts.

Table 1. Examples of water-related adaptation measures

		Indirect						
Impacts		Quality	Timing	Ecosystems	Energy	Agriculture	Cities	
Direct		Quantity	Quality	Timing	Ecosystems	Energy	Cities	
Extreme Events	Floods / droughts intense precipitation tropical cyclones	Hypoxia High water temperatures	Increase in intra-annual variability	Shifts in the composition of ecological communities	Increased consumptive water use	Increased need for irrigation Increased agricultural runoff	Shifts in water treatment Increased water consumption Increased pluvial flooding	
	Drought frequency / severity Flood frequency / severity	Seawater intrusion Cold-season eutrophication events Groundwater salinity Shift from snowpack accumulation to winter rain	Onset / timing of seasonal monsoon Length of wet / dry season					
Shifts in average or "normal" climate								
Adaptation options		Quantity	Quality	Timing	Ecosystems	Energy	Agriculture	Cities
Hard interventions	Measures aiming at maintaining dam safety, afforestation and other structural measures to avoid mudflows Construction of dykes Land-use management Increased water efficiency Early warning systems Metered water systems Ecosystem-based adaptation	Agricultural runoff holding ponds to capture sediment, nutrients Prevention of and cleaning up of dump sites in flood risk zones Wastewater treatment Ecosystem-based adaptation	Flood retention areas Increased storage capacity for dry season flows Enlarging the availability of water (e.g. increase of reservoir capacity) Rainwater harvesting Scheduled water releases to match historic flood regime	Creation of migratory corridors, fish ladders Ecosystem-based adaptation/ green infrastructure Restoration of wetlands	High-efficiency turbines	High-efficiency irrigation Shift to saline-resistant rice varieties	Leakage repairs	
	Soft interventions	Introduction or strengthening of a sustainable groundwater management strategy Water pricing Farmer's flood insurance compensation program Drought priority use program Aquifer storage	Joint commission to coordinate storage operating regime Common water quality regulatory framework	Environmental flows evaluation Operating regime IWRM with integrated climate "renormalization" process	Designation of wetland protected areas	Policy shift away from thermal energy sources Basin-wide operating regimes	Elimination of subsidies for water services Migration of people away from high-risk areas Restriction of urban development in flood risk zones Cost-recovery system Quantity-based charges	

4.1.1 Structural and non-structural measures

Water management decisions are often loosely divided into structural or “hard” approaches (such as designing, building, or modifying physical infrastructure) and non-structural or “soft” approaches (such as creating information and control systems, operating regimes, regulatory approaches, or governance, pricing and allocation schemes). Some of the most significant actions for implementing climate adaptation can involve soft interventions that do not involve the construction or modification of infrastructure, such as re-evaluating an existing infrastructure operating regime for new or projected hydrological conditions, developing regulatory mechanisms that account for emerging trends in climate impacts, capacity-building to ensure flexible decision-making or reforming land-use management or land-tenure systems to prioritize sensitive hydrological zones. Soft interventions are often particularly useful for creating the enabling conditions for more effective and resilient management decisions. In a transboundary context, soft interventions may in many cases be the main instrument for joint collaboration, such as the creation of an early warning network for emergency flooding across a basin, but structural measures also often require collaboration.

Lesson 48. Develop a mix of structural and non-structural measures

In most basins, a mixture of hard and soft approaches is necessary and warranted. Hard interventions are often associated with more risk for regret since they more generally represent a commitment to a particular set of climate futures, such as building new infrastructure that may be sensitive to additional or unpredicted shifts in the climate. In many cases, this set of futures may not be explicitly stated in advance, which is often a symptom of vulnerability in itself.

Technical methods for designing robust infrastructure are still emerging and evolving. Clearly, hard interventions are very often necessary for economic development (such as exploiting hydropower potential or building urban water treatment facilities). But climate change is also fostering broader discussions about using hard interventions designed to buffer impacts from climate change, such as increasing water storage capacity in regions with increasing climate variability or declining precipitation trends, the development of efficient storm-water systems to reduce urban flooding and transitioning from rain-fed to irrigated agriculture. Hard interventions can also include so-called green or natural infrastructure, which uses geophysical and/or biophysical systems to provide services comparable to traditional built infrastructure. Green infrastructure is most often employed when ecological co-benefits are highly valued (also see section 2.1.3).



Connecting infrastructure investments to climate change impacts (i.e., “because annual precipitation is declining, we should build more water storage”) is likely to become more common as the fingerprints of climate change become more visible. Local pressure to implement highly-visible engineered solutions can be very great and place stress on transboundary relationships. However, new ways of thinking about climate change adaptation may provide alternatives to building or expanding infrastructure. For instance, instead of creating new flood defences, creating regional flood insurance programmes, relocating activities or structures away from expanding flood-plains, or giving land “back” to the river to restore natural flow and meander dynamics may prove more durable, flexible and cost-effective for some types of climate impacts. Indeed, in the case of increased storage capacity, climate conditions may evolve in such a way that precipitation and runoffs patterns shift beyond the design limits of the infrastructure, which appears to be the case now in the United States for the Hoover Dam and it’s growing “bathtub” ring of declining water quantities in the Colorado River basin. Similar impacts could occur for unanticipated floods or major shifts in the timing of precipitation. Often, alternative and non-traditional approaches require more stakeholder buy-in and decision maker capacity-building than “traditional” hard interventions, but they may also function to reduce conflicts at a basin or sub-basin level.

While infrastructure is often seen as a solution to realized or projected climate impacts, once built, that infrastructure will also increasingly need adaptation interventions to maintain or secure the services it was designed to provide. Traditional design and operation methodologies have assumed a single possible future (or at least a narrow range of possible futures), and many pieces of infrastructure more than a few decades old are seeing infrastructure-climate mismatches. In contrast to infrastructure for adaptation, the adaptation of infrastructure often requires a significant reconsideration of the limits of the adaptive capacity. Will hydropower continue to be a realistic service? Are alternative sources of service available? Can demand reductions or efficiency processes allow for a longer period of transition? Can the operating regime be modified or shifted? Would the removal of the infrastructure be a less painful approach in the long term?



Case study 4.1 Structural interventions in the Senegal River Basin

The Senegal River Basin is characterized by high inter- and intra-annual spatial and temporal variability in rainfall and runoff. Climate change has been identified as a significant driver exacerbating this variability. Severe drought struck the region in the 1970s, with major economic consequences. The Senegal River Basin Development Organization was created in March 1972 following the drought. The construction of new jointly financed and owned water infrastructure was identified as a major approach to addressing climate impacts.

The Basin Development Organization has built dams in Manantali and in Diama. Manantali Dam is a multi-purpose hydroelectric dam with a reservoir that aids in flow regulation. The Diama Dam creates a large reservoir for water management in its environs. Combined, the two dams allow for irrigation of 375,000 ha and generate 800 gigawatt-hours per year of hydroelectric power. Recently the run-of-the-river dam was completed and construction of another dam of the same type in Gouina has begun. Several other reservoir dams are being considered by the Basin Development Organization for their benefits to river flow and water management during seasonal scarcity or droughts.

Dams have been Senegal's first major adaption measures. However, it has become increasingly difficult to fill reservoirs to produce hydroelectric power or sufficient water for irrigation. The Basin Development Organization is attempting to address this issue in the midst of financial losses as electricity purchasers shift to more reliable sources of energy. This shows the limitations of reservoirs and dams as adaptation measures and the need for considering their suitability in the light of climate change and associated uncertainties. Additional infrastructure by itself — especially large, inflexible infrastructure — is not likely to be an effective long-term approach to climate adaptation.

Source: Senegal River Basin Development Organization.

4.1.2 Basin-wide monitoring and observation system

Many effects of climate change occur at long timescales and will be better understood as more information becomes available. To be able to observe such changes, especially in the longer timescales, a proper information system on the basin scale is a prerequisite. As such an information system is often lacking, this section will discuss some elements of an information system that can support adaptive water management.

Lesson 49. Develop a common monitoring system

To ensure that the proper information is collected and is credible from the viewpoint of all riparian countries, a common monitoring system should be developed. The purpose of such a system may range from a mere exchange of experiences to a full-fledged joint monitoring programme. When exchanging experiences, improved understanding may grow between the riparian countries. This will advance confidence in each other's national monitoring programmes. A joint monitoring programme can help to reduce costs as the programme can be attuned to the river basin instead of the administrative borders and is built upon a common understanding of requirements and methodologies.



A vast amount of literature on developing monitoring systems is available. Specific issues to cover in building a transboundary monitoring system are discussed in the publication, *Strategies for monitoring and assessment of transboundary rivers, lakes and groundwaters* (ECE, 2006).

Lesson 50. Ensure that monitoring and observation systems are capable of adjusting to the possible changes in information needs

Monitoring and observation systems are usually developed and designed for long-term operations and are not expected to substantially change over time. The uncertainties connected with climate change, however, require such systems to be flexible to remain relevant and be able to effectively support decision-making.

To achieve such flexibility, a basic requirement is to be able to provide timely identification and warning of emerging environmental problems and effective feedback on the adequacy of policies and programmes. This information is needed for all riparian countries in a basin. At the same time, monitoring and observation systems have to be able to provide information also in data-poor areas, which requires integrating different sources of information. Moreover, these systems need to be regularly reviewed and revised.

Developing a flexible monitoring and observation system, as a result, necessitates proper and regular specification of information needs. Regular reviewing ensures that the monitoring and observation system can account for changes, both in the legal and institutional set-up, and in changes in hydrological and meteorological conditions. Information needs should be determined in close cooperation between decision makers and scientists, while close communication with the stakeholders should also be ensured (see section 2.3.1).

Case study 4.2 The TransNational Monitoring Network

The TransNational Monitoring Network is an important tool under the Danube River Protection Convention, whose Contracting Parties are committed to cooperate in the field of monitoring and assessment. Formally launched in 1996 by the ICPDR, the network aims to provide an overall view of pollution and long-term trends in water quality and pollution loads in the major rivers in the Danube River Basin.

The network utilizes nationally assessed monitoring data and is based on the provisions of the Danube River Protection Convention, which requires:

- The harmonization of monitoring and assessment methods, particularly concerning water quality in rivers
- The development of coordinated or joint monitoring systems applying stationary or mobile measurement devices and shared communications and data processing facilities
- The elaboration and implementation of joint programmes for monitoring riverine conditions in the Danube Basin, including flow rates, water quality, sediments and riverine ecosystems, as a basis for the assessment of transboundary impacts.

The network is based on national surface water monitoring networks and includes monitoring locations across the Danube and its main tributaries. An interim water quality classification scheme has been specially developed to evaluate the data collected by the network.

In 2006, the TransNational Monitoring Network was revised to ensure full compliance with the provisions of the EU Water Framework Directive.

Source: ICPDR, "TNMN - TransNational Monitoring Network", <http://www.icpdr.org/main/activities-projects/tnmn-transnational-monitoring-network>.

Lesson 51. Develop a transboundary early warning system

Especially in case of floods and pollution disasters, it is important to have a transboundary system in place to warn the downstream countries so that they can take timely and appropriate action. The "early warning" or "warning and alarm" system encompasses flood forecasting systems, including hydrological models to be able to calculate when and where potential floods may occur, but also how fast a pollution plume travels downstream. Such systems should cover the entire basin, not

only individual national reaches of the basin. Moreover, the system should include a procedure defining who is to be contacted in various defined situations. The procedure should be laid down in a protocol that is approved by all riparian countries.

The procedure should also contain necessary response times. Different levels of warning and alarm can be distinguished, ranging from “be alert” to “immediate response needed”. The latter will require a very short response time.

As usually flood control divisions and pollution control divisions work separately, or may even be part of different institutions, there is a need to ensure the early warning system is set up so that the appropriate authorities are alerted for any given scenario; depending on the type of warning, different divisions or institutions should receive the alarm.

The early warning system should be able to deal with floods, but also with pollution crises. In many cases, measures can be taken to alleviate the effects of floods or pollution plumes. Also, drought forecasting systems are useful. As weather forecasting systems are improving, predictions on the longer term (up to weeks and months) are becoming more reliable. If a potential drought period is detected, early measures can be taken to prepare for dryer periods, like staged or multi-level water-use limitations. Such drought response measures should be negotiated and elaborated before crisis conditions develop and may require separate vulnerability assessment in order to prioritize basin users.

Institutions involved in issuing or receiving alerts must be prepared for this task. Especially for floods and disaster warning systems, round-the-clock availability is needed to be able to respond in time to any incident. Also each institution has to be aware of their specific role in the system and the necessary actions they have to take.

Regular testing of the early warning system is needed. Testing is done by creating a virtual incident. An alert has to be issued and the responses have to be assessed to identify possible gaps in the system. Generally, failures in the system relate to minor issues that can have huge consequences, like contact details (telephone number, e-mail address, fax number, employee names) that are outdated or responsible people who are temporarily not available. Such issues are solved, among others, by assigning contact details to roles, not to people.



Case study 4.3 **The GEF/UNEP/ACTO project on integrated and sustainable management of transboundary water resources in the Amazon river basin considering climate variability and change: Adapting to Climate Change in the Transboundary MAP Region: Madre de Dios (Peru), Acre (Brazil) and Pando (Bolivia)**

The Acre River Basin is located in the South-Western Amazon Basin at the border of the transboundary MAP region, with an area of approximately 36,000 km², with 88 per cent in Brazil, 7 per cent in Peru and 6 per cent in Bolivia. Over the past decades the Acre River Basin faced extreme weather events such as floods and droughts. It also suffered the impacts of intense anthropogenic pressure, including deforestation, use of large areas for agro-livestock and artisanal gold mining, which have significantly affected the aquatic ecosystems, vegetation, soils, air and, consequently, the health and economies of local populations.

With the support of the three countries' government representatives, from technical to national institutions, the civil defence organizations, as well as local stakeholders, the "Adapting to Climate Change in the Transboundary MAP Region: Madre de Dios (Peru), Acre (Brazil) and Pando (Bolivia)" project collected the required data to establish a georeferenced database, thus generating a statistical analysis on climate change and its effects on ecosystem functions in the MAP region. At the same time, a diagnosis of areas affected by severe droughts, floods, landslides and erosion was carried out. Based on these data, a tri-national early warning system was developed and implemented in the Department of Pando (Bolivia) with the Pando Departmental Centre for Emergency Operations; in the Department of Madre de Dios (Peru) with the National Water Authority; and in the State of Acre (Brazil) with the Secretariat of Environment. Responsible staff members from relevant local institutions were trained to operate the early warning system, based on the technology of Terra MA2 Platform. To support the warning system, a new radio communication system was installed.

Solid joint efforts and cooperation of national, regional and local governments and the essential civil actors are the basic conditions to guarantee the sustainability of the tri-national early warning system.

Source: Global Environment Facility (GEF) Amazon project "Integrated and sustainable management of trans boundary water resources in the Amazon river basin considering Climate variability and change" implemented by the United Nations Environment Programme and executed by the Amazon Cooperation Treaty Organization with funding from the GEF.

4.2 Prioritization of measures and their location

A wide range of adaptation measures may be developed and/or identified. Not all measures may be highly relevant for the situation at hand or can be implemented given limited budgets; therefore, prioritization of measures is usually required.

Lesson 52. Assess the economic, environmental and social costs and benefits of different adaptation options on a basin scale

Climate change does not fit easily into a single sectoral or institutional "box", and the actions necessary to respond to realized or emerging impacts may likewise have unintended consequences. The potential for sowing conflict may be greater in transboundary settings, since stakeholder engagement processes are more easily restricted within national boundaries that do not match hydrological borders; solutions that work in some river basins in a single country may be more challenging in others, especially in downstream countries. Flood risk reduction actions in one region, for instance, may increase flood risks in downstream countries, while national adaptation plans should span ministries and sectors that may be able to identify gaps and synergies. The risks for unintended consequences may be higher if significant differences in risk exist across political boundaries, such as variations in environmental, economic and social or livelihood values.

In the same way that vulnerability assessments are an important tool to visualize climate impacts, a broad preliminary assessment of adaptation options that includes the transboundary implications of those options for all stakeholders can reduce or eliminate the potential for future conflict. Such an assessment should include the economic, environmental and social costs and benefits of the different adaptation options. A formal and highly credible transboundary consulting mechanism such as a river basin commission is needed in order to promote balanced and sustainable decisions

for all riparian countries. Finally, it is important that all documents and plans be viewed as living, evolving documents, which include mechanisms to evaluate efficacy, to adjust course and to incorporate new thinking and lessons. Environmental indicators based on a Pressure-Impact-Response methodology are very useful for such monitoring purposes.

Planning and prioritizing adaptation measures from a basin perspective provides an opportunity to select also measures and their location that are useful from a basin perspective.

Lesson 53. When selecting adaptation measures consider their impact on mitigation

Adaptation measures can influence other policies, like climate change mitigation. Adaptation measures may hinder mitigation, e.g., desalinization or pumping of (ground) water for drinking water and irrigation purposes requires energy, possibly generated from fossil fuels. Increasing water use as a result of climate change leads to aggravating droughts that can trigger forest fires or wetland destruction leading to loss of stored carbon. Moreover, it may increase the demand for water, leading to a negative feedback of aggravating drought. Improved water management, in contrast, can improve agricultural practice, help to store carbon through forestation, maintain wetlands and reduce heat spells.

On the other hand, mitigation measures may hinder adaptation. For instance, biofuels need vast amounts of water and hydropower infrastructure stores vast quantities of water, water that is no longer available for other purposes or available at the wrong moments. Therefore, especially as water management is an important linking factor between adaptation and mitigation, it is imperative to take mitigation aspects into account when developing adaptation measures.

Lesson 54. Establish a transparent, participatory and explicit prioritization process

The process of prioritizing adaptation measures is often critical to effective implementation and typically should be made with a mixture of both technical and policy-oriented decision makers. Common methods of prioritizing include cost-benefit assessments conducted based on a vulnerability assessment, the potential “durability” or longevity/efficacy of the range of solutions and the degree of flexibility versus the level of commitment to a particular path dependency. Engineers, scientists and other specialist decision makers have a tendency to develop technically “optimal” adaptation measures, but policymakers are likely to use other standards that may seem technically sub-optimal, which often results in conflicts between technical and policy teams. In practice, high-level decision makers will undergo a “satisficing” or arbitrage process balancing multiple prioritization methods. When possible, prioritization methods should be made explicit and through a transparent process. In that regard, public participation is mandatory not only to reveal the most appropriate measures. but also to contribute to a project’s social acceptance.

The prioritization process may be guided by various methods, ranging from systematic qualitative analysis, to semi-quantitative analysis in order to compare different attributes or parameters, to a full quantitative analysis of risks, costs and benefits. Examples of tools to perform such analyses include cost-benefit analysis, cost-effectiveness analysis, multi-criteria analysis and expert judgement. Often several approaches are combined in the prioritization process.

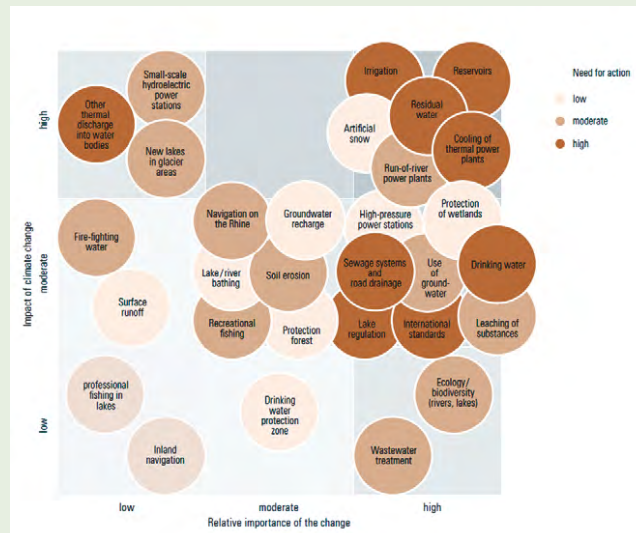
For example, strategic environmental assessment is a decision support tool with a legal basis in a growing number of countries that aims to identify and evaluate options in a participatory way and executes a comparative evaluation of those options from a cross-sectoral perspective. SEA can therefore give support in selecting adaptation measures.

Public participation can be used to define criteria for prioritizing measures such as sustainability, effectiveness, side effects, efficiency, legitimacy, feasibility, priority and urgency, etc. Such criteria can be weighted and all proposed measures may be assessed against these criteria.

Case study 4.4 Methods used for prioritizing adaptation measures in national and transboundary adaptation strategies

Different adaptation strategies have been developed using different methods for prioritizing measures. In Switzerland, for example, when developing the Federal Council's Adaptation Strategy, priority sectors were defined, including water management, followed by goals and fields of action. Subsequently, these fields of action were prioritized with respect to the impact of climate change, the relative importance of the climate-related change, and the need for action (see graph below).

Adaptation to climate change in Switzerland: Goals, challenges and fields of action



Similar methods were used in the Dniester and Neman basins (see case study 3.9) when developing basin adaptation strategies.

In the Netherlands, when developing the National Adaptation Strategy, potential adaptation measures were collected and then selected after hydrological analysis according to pre-defined criteria such as effectiveness, costs and benefits, impacts on the environment and impacts on other sectors. In addition, the robustness of the measures against several different futures was assessed, using, for example, the tipping point approach.

The table below summarizes criteria for selection of adaptation interventions used at the first meeting of the ECE/INBO Global Network of Basins Working on Climate Change Adaptation (February 2013).

Criterion	Indicators/sub-criteria	Questions to be asked
Effectiveness of adaptation	Adaptation function	Does the measure provide adaptation in terms of reducing impacts, reducing exposure, enhancing resilience or enhancing opportunities?
	Robustness to uncertainty	Is the measure effective under different climate scenarios and different socioeconomic scenarios?
	Flexibility	Can adjustments be made later if conditions change again or if changes are different from those expected today?
Side-effects	No regret	Does the measure contribute to more sustainable water management and bring benefits in terms of also alleviating already existing problems?
	Win-win (or win-lose)	Does the measure entail side-benefits for other social, environmental or economic objectives? For example, does it: <ul style="list-style-type: none"> – Contribute to closing the gap between water availability and demand? – Affect the delivery of other water management objectives (e.g., river flow)? – Create synergies with mitigation (e.g., by leading to decreased greenhouse gas emissions)?
	Spill-over effects	Does the measure affect other sectors or agents in terms of their adaptive capacity? Does the measure cause or exacerbate other environmental pressures? Does the measure contribute to mitigation?
	Transboundary effects	Does the measure have potential negative impacts on other riparian countries?

Case study 4.4 Methods used for prioritizing adaptation measures in national and transboundary adaptation strategies (cont.)

Criterion	Indicators/ sub-criteria	Questions to be asked
Efficiency/ costs and benefits	Efficiency	Are the overall benefits of the measure high compared to the costs?
	Transboundary aspects	Is the measure beneficial for the basin as a whole? Is this measure taken at an effective and efficient location considering the entire basin?
Framework conditions for decision- making	Equity and legitimacy	Is anybody negatively affected by this measure? Does it take into account the needs of vulnerable groups? Are decision-making procedures accepted by those affected and do they involve stakeholders?
	Feasibility of implementation	Is implementation feasible in the time available? Are any technical, social (number of stakeholders, diversity of values and interests, level of resistance), political or institutional (conflicts between regulations, degree of cooperation, necessary changes to current administrative arrangements) barriers expected?
	Alternatives	Are there alternatives to the envisaged adaptation measure that would, e.g., be less costly or would have fewer negative side-effects?
	Transboundary aspects	Has the measure been consulted with other riparian countries? Is the measure consistent with national adaptation strategies, existing transboundary agreements, etc.?
	Priority and urgency	Does the adaptation measure address severe and relatively certain climate change impacts in the river basin? Is the addressed impact expected to occur in the near future? Is action needed now?

Sources: United Nations Economic Commission for Europe (2009). Guidance on water and adaptation to climate change. Geneva and New York. Available from <http://www.unece.org/env/water/publications/pub.html>.

Switzerland, Federal Office for the Environment FOEN, Adaptation to Climate Change in Switzerland: Goals, challenges and fields of action, Number UD-1055-E (Bern, 2012). Available from <http://www.bafu.admin.ch/publikationen/publikation/01673/index.html?lang=en>

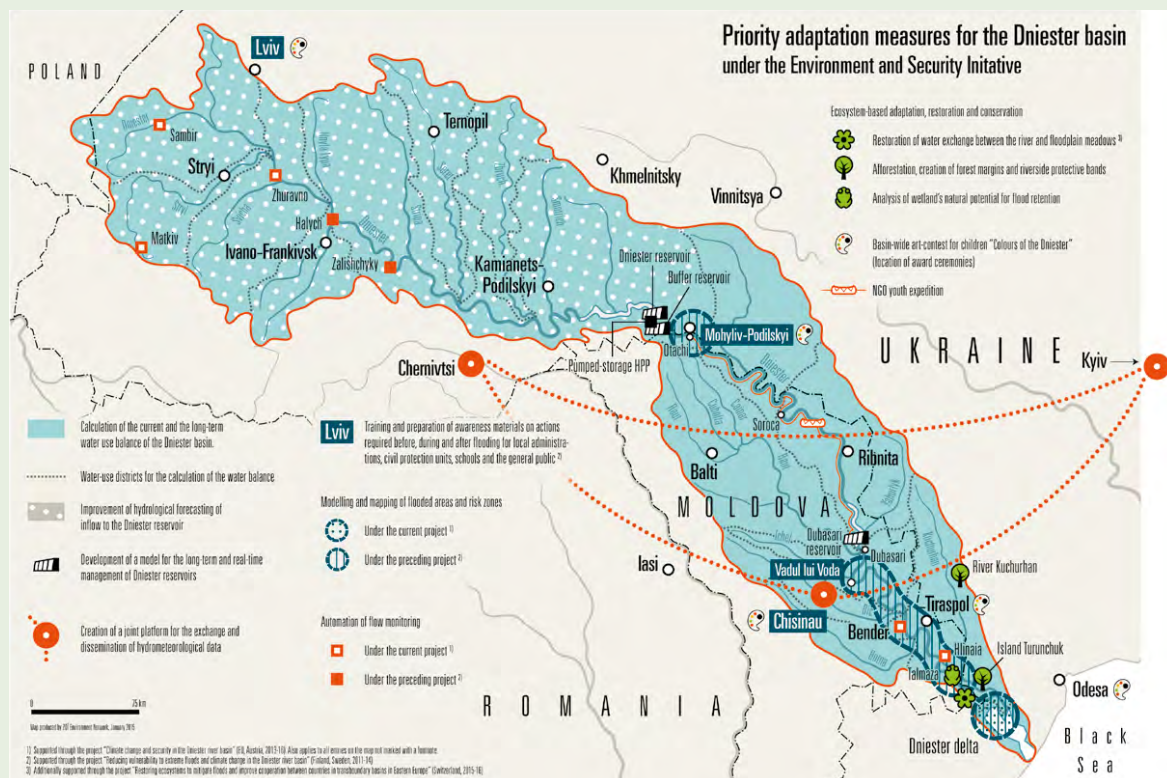
Lesson 55. Locate adaptation measures at the most beneficial location in a transboundary basin and consider sharing the costs and benefits

Adaptation measures should be located, when possible, at the most beneficial location in the basin to ensure optimal effects (Dinar, 2006 and Qaddumi, 2008). For example, natural water retention measures for floods are often more effective when located upstream. However, political considerations also need to be taken into account, making it sometimes difficult to undertake certain measures at a particular location in the basin. Developing and discussing a transboundary adaptation strategy can be an opportunity for such a discussion so that national borders can be as much as possible disregarded in the planning of measures.

Case study 4.5 Prioritizing measures and their location in the Dniester River Basin

The ECE-OSCE project "Climate Change and Security in the Dniester River Basin" implemented under the ENVSEC project "Climate Change and Security in Eastern Europe, Central Asia and the Southern Caucasus" supported development of a Strategic Adaptation Framework for the Dniester River Basin, which includes prioritized adaptation measures. Criteria for a participatory prioritization process of adaptation measures included the transboundary dimension, climate change adaptation benefits and potential and dependence on water resources. During two national workshops in the Republic of Moldova and in Ukraine stakeholders discussed the location of vulnerable areas within the basin and potential adaptation measures using a basin-wide map without national borders. A few pilot adaptation measures focusing on improving information base for adaptation, ecosystem restoration and public awareness will be implemented by the Climate Change and Security in the Dniester River Basin project.

Case study 4.5 Prioritizing measures and their location in the Dniester River Basin (cont.)



Source: Zoi Environment Network, 2014.

But how can such measures then be implemented? This can be realized through the principle of cost and benefit sharing. There are several options to agree upon cost and benefit sharing between riparian countries:

- **Link issues:** Make a link between upstream-downstream concerns and downstream-upstream concerns. These can include issues within the water domain (e.g., ensure upstream to downstream minimal discharge versus downstream to upstream navigation possibilities) or outside the water domain (e.g., ensure upstream to downstream minimal discharge versus downstream to upstream energy provision).
- **Reciprocity (good relations):** Accept an agreement that may perhaps have less favourable terms in order to keep good relations and to create a "reservoir of goodwill" with other riparian countries.
- **Enlarge the geographical scope:** Extend the scope of a basin agreement to cover additional basins on which linking of issues (see above) is possible (e.g. linking negotiations over the Colorado and the Rio Grande Rivers between Mexico and the United States of America).
- **Side payments:** Provide financial compensation in return for a concession (e.g., an agreement between Finland and the Russian Federation for compensation of energy production loss to ensure flood protection).

There are a number of adaptation projects and programmes ongoing in transboundary basins. In Europe, the Danube Strategy is a macro-regional strategy for transnational territorial cooperation in the Danube region. Adaptation is a cross-cutting topic relevant for several of the thematic priorities. For the Baltic Sea, the Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region project (www.baltcica.org) uses climate change scenarios to discuss and develop adaptation measures with relevant planning authorities and stakeholders. The project also assesses the costs and benefits of adaptation. Project results contribute to supporting transnational approaches in the Baltic Sea region.

Case study 4.6 Making a link between upstream and downstream issues in the Dniester River Basin

The basin-wide approach to the selection of the location of adaptation measures could be illustrated by two measures implemented in the Dniester Basin. One of them focused on improving flood prevention by installing automatic water level monitoring stations in the Upper Dniester in Ukraine so that the information is quickly available to the relevant agencies downstream in the Republic of Moldova and Ukraine to make the right flood protection decisions on time.

The second measure comprised activities aimed to protect fish diversity that were conducted in the Lower Dniester, where there are a lot of wintering holes and wintering and nursery grounds that are important for the survival of the fish (including migratory species) from the entire basin. Fish conservation activities included research investigating the condition of fish and identifying the most valuable areas that provide the vital needs of fish and the purchase of a motorboat to fight the poaching of fish.

Source: Hanna Plotnykova, OSCE, personal communication (2015).

Case study 4.7 The Columbia River Treaty

The Columbia River is approximately 2,000 km long and drops 820 km from its headwaters in Columbia Lake. In general, the rivers flow from Canada into the United States of America. However, the Kootenay River flows south from Canada into the United States and then north returning to Canada, where it joins the main stem of the Columbia River. While the main stem of the Columbia and Kootenay river systems in Canada are less than 15 per cent of the entire Columbia basin, they supply approximately 35 per cent of the water flowing through the river at Portland, and as much as 50 per cent at flood levels. The Canadian portion of the basin directly feeds into Lake Roosevelt, the reservoir behind Grand Coulee Dam, thus greatly influencing power production at Grand Coulee, the biggest power producer on the river. The upper Columbia and Kootenay systems experience great variability in seasonal flows with high season flow (in June), as much as 40 times greater than low season flow (in January). Furthermore, the inter-annual flow volumes vary by as much as a factor of four.



The focus of the Columbia River Treaty, which was negotiated between 1961 and 1964, is largely on flood control and power generation of the Canadian portion of the Columbia River Basin, and on the four 'Treaty Dams' that are the subject of inter-basin regulation. Under the terms of the agreement, Canada provided 15.5 million acre-feet of reservoir storage while the United States of America paid USD 64.4 million to Canada for half of the expected avoided flood damages for 60 years (until 2024) under "assured annual flood control plans". The United States can request Canada to provide additional on-call flood control, subject to proving the need and providing additional compensation to Canada but this has not been requested to date.

The United States and Canada share equally in the computed power benefits in the United States associated with the regulation of flow from Canada's Columbia River Treaty projects. Increased power benefits are calculated based on projected optimal operation, not actual operation. Therefore, regardless of how the United States chooses to operate its dams in real-life, Canada will receive 50 per cent of the projected agreed amounts of energy and capacity. The United States must deliver to Canada half of its estimated power benefits from the operation of the Canadian Treaty storage, currently worth about USD 250-350 million annually.

The Treaty also permitted the United States of America to build the Libby Dam, which it did in 1973, with the Kooconusa reservoir extending 67 km into British Columbia (Canada). No direct compensation was given to Canada, but Canada benefits from regulated flow from Libby for its power generating facilities on the lower Kootenay River in British Columbia and for flood control benefits on the Kootenay and Columbia rivers.

Source: GEF Transboundary Freshwater and Marine Legal and Institutional Frameworks Project, "In Depth Case Study of the Columbia River Basin". Available online from http://www.unece.org/fileadmin/DAM/env/documents/2014/WAT/05May_22-23_Geneva/case_studies/4.4.R.Paisley_ColumbiaRiver_case_study.pdf

Lesson 56. Consider using economic analysis to build the case for action and to inform the selection of adaptation options

Economic analysis can contribute to the decision-making process for adaptation. These studies can quantify the expected costs and benefits (often in the form of avoided damage) of adaptation to help build the case for action, especially when done on a basin-wide level.

In transboundary basins, the costs and benefits may be unevenly distributed between the countries. In such cases, compensation mechanisms may be developed, like direct payments or linkage with economic sectors, like energy. However, in general, economic assessments of the costs of adapting to climate change for water systems remain sparse; many existing studies typically focus on cost estimates and do not quantify benefits. Further, they tend to focus on hard interventions, such as building structural flood protection or storage, rather than soft solutions, such as policy shifts or behaviour change, like reducing water demand. These soft solutions are often less-costly interventions than structural alternatives, but they are often more difficult to quantify, especially in terms of benefits. In addition, environmental impacts are often very difficult to quantify and may be challenging to incorporate, particularly in traditional non-holistic approaches to cost-benefit analysis. Despite their limitations, economic assessments that help to demonstrate the cost of inaction (or not adapting) can contribute to building the case for action. An example from Armenia provides an illustration (case study 4.8).

Case study 4.8 Assessing the socioeconomic costs of climate change to spur adaptation action in Armenia

A major study to assess the socioeconomic impacts of climate change in Armenia helped to encourage decision makers to take action on adaptation. The study documented a wide range of social and economic impacts such as an increased incidence of illness due to heat waves; water shortages and increases in electricity tariffs and food prices; and an increase in the incidence of dangerous landslides, mudflows and floods. Moreover, business revenues, jobs, household income and consumption might all fall. The study estimated that losses from diminishing agricultural productivity could exceed eight per cent of Armenian GDP by 2100. Overall, the study highlights that while the potential for economic growth in Armenia is large, the absence of significant measures to adapt to climate change could easily impede that growth.

The study concludes that many of the best climate adaptation measures are also important steps for economic development; measures that will improve economic and social outcomes regardless of climate change. These are “no-regret” adaptation measures – no extra cost is imposed by climate change. The measures recommended include infrastructure improvement, promotion of water efficiency, disaster risk reduction, improved building designs and materials that help structures withstand the existing cold winters and hot summers in a cost-efficient way, public education programmes and support of research.

Source: Stanton, E.A., Ackerman, F. and Resende, F., *The Socio-Economic Impact of Climate Change in Armenia*. (UNDP Armenia, Stockholm Environment Institute, Yerevan, 2009). Online report available from http://www.am.undp.org/content/armenia/en/home/library/environment_energy/the-socio-economic-impact-of-climate-change-in-armenia.html.

4.3 Financing the implementation of adaptation measures

4.3.1 Mix of public and private funds

A recent review of adaptation efforts in OECD countries has shown that financing for adaptation has yet to be adequately addressed in many of them (OECD, 2014)³. For those countries that have specified financing approaches to support their adaptation plans, several approaches have been taken. A few countries have dedicated funding for general climate change adaptation, some of which is apportioned to water issues. Other countries are mainstreaming adaptation into existing budgetary arrangements. Water-related adaptation may also figure in specific water programmes and projects. Finally, certain countries are tapping into international funding mechanisms for adaptation. In many cases labelling funding that contributes to adaptation objectives as “adaptation financing” is not necessary or practical, given the difficulties with attribution.

³ This chapter draws significantly on the work of OECD (2013) and the OECD country profiles on Water and Climate Change Adaptation available for download at: www.oecd.org/env/resources/waterandclimatechangeadaptation.htm

Lesson 57. Ensure adequate financing for adaptation through a mix of public and private funds

Financing for adaptation needs involvement of the private sector (OECD, 2015, World Economic Forum, 2014). The public sector has to work synergistically with the private sector to create projects that generate a return on investment. Many of the benefits of adaptation are local and private, which can provide a powerful incentive for private investors to invest in adaptation measures. The public sector plays the leading role, addressing key market failures and externalities as well as delivery of public goods. For instance, public financing can be used as a (time-bound) catalyst to leverage private investments, e.g., through removing subsidies for fossil fuel and establishing subsidies for green infrastructure. Cost-effective activities that are unlikely to attract private funding, such as capacity-building, education and training, remain largely publicly funded.

In a transboundary situation, cost and benefit sharing may be instrumental to enable investments (see section 2.1.1 and case study 4.7). In some cases, the economic situation in the riparian countries may be substantially different. Especially in such cases, investments can be made by the wealthier country while future benefits are shared in a way to compensate for the investments.

Case study 4.9 Australian Water for the Future Programme

The Australian Government is investing AUD 14 billion over 12 years to facilitate climate change adaptation and as a response to increasing water scarcity. Specific measures include:

- Sustainable Rural Water Use and Infrastructure Programme: AUD 5.8 billion has been committed to increase water use efficiency in rural Australia.
- Restoring the Balance in the Murray-Darling Basin Programme: AUD 3.1 billion has been committed to facilitate water buy backs to protect and restore the environmental health of the Murray-Darling Basin.
- Urban water programmes to secure and diversify urban water supplies: over AUD 250 million has been committed to fund practical projects that reduce water losses in cities and towns. Over AUD 680 million has been allocated to investment in desalination plants, water recycling schemes, storm-water harvesting and reuse projects.
- Improving Water Information Programme: AUD 450 million over 10 years has been provided to the Bureau of Meteorology to revolutionise the way water information is measured, accounted for, reported, forecast and analysed.

Source: Organization for Economic Cooperation and Development (2013), Country Profiles on Water and Climate Change Adaptation. Paris. Available from: <http://www.oecd.org/env/resources/waterandclimatechange.htm>.

While experience with financing adaptation for water is still preliminary in most countries, several countries are exploring innovative financing mechanisms. A few examples are summarized in case study 4.10.

Case study 4.10 Exploring innovative financing mechanisms

Several countries are exploring innovative approaches to financing adaptation for water systems. Illustrations include:

- Denmark: preparing new legislation to increase the possibilities for Danish water and sewer companies to finance more intelligent and socioeconomically optimal climate change adaptation measures. For example, the proposal could make it possible for sewer companies to co-finance improvements to roads and waterways to keep rainwater out of the sewer system.
- Germany: examining the possibility of including aspects of climate adaptation in Federal funding programmes and joint funding instruments financed by the Federal Government, the Regions (Länder) and the EU.
- Mexico: since 2006, Mexico has been selling catastrophe bonds (“cat bonds”) as an innovative form of risk financing. If a disaster occurs during a bond’s lifetime, the Government uses the money borrowed to pay for repairs. If no disaster occurs, the Government pays the money back with interest.

Source: Organization for Economic Cooperation and Development (2013). *Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters*, OECD Studies on Water. Paris. Available from <http://www.oecd.org/env/resources/waterandclimatechange.htm>.

4.3.2 Mainstream basin adaptation in development policies and programmes

Climate change adaptation should be integrated in the development of planning, programmes and budgeting across a broad range of economic sectors, through mainstreaming and the establishment of effective and stable adaptation policy frameworks. Such a coordinated, integrated approach to adaptation is needed to address the scale, complexity and urgency of addressing climate change impacts.

Lesson 58. Mainstream adaptation costs into the overall costs of water management

The cost of adapting to climate change will likely add to the already substantial financing gap for water systems. Adaptation costs for water could be substantial, especially for flood protection (see case study 4.11). Many of the investments needed for adaptation could take place within normal investment replacement cycles or could be added on top of planned investments. It is difficult and often not practical to attempt to separate out the marginal additional costs related to adaptation from those due to a broader range of pressures on water systems resulting from a wide range of drivers.

Case study 4.11 Illustrations of adaptation costs for the water sector

A review of economic assessments of adaptation in Europe was undertaken in 2011. The review found relatively low to medium coverage for economic assessments of the water sector compared to other sectors. However, several recent national level studies indicated potentially significant adaptation costs, in particular for flood protection. In the United Kingdom, a study estimated the total adaptation investment for a portfolio of responses to address flooding (coastal, river and intra-urban) over the next 80 years at between USD 33 billion and USD 115 billion (depending on the scenario) implying average annual costs of up to EUR 1 billion. Similarly, in the Netherlands, a recent assessment of flood protection and flood risk management estimated the cost of implementing a comprehensive set of adaptation measures at EUR 1.2–1.6 billion per year up to 2050 and EUR 0.9–1.5 billion per year thereafter (up to 2100).

Source: Paul Watkiss and Alistair Hunt, "The Costs and Benefits of Adaptation Policy in Europe: Review Summary and Synthesis", ClimateCost Policy Brief, 2011. Online report available from <http://www.climatecost.cc/reportsandpublications.html>.

Lesson 59. Use economic instruments for water management to reduce baseline stress and provide flexibility to changing conditions

A range of policy instruments can be drawn on to promote effective and timely adaptation. These include regulatory instruments (standards, permits, regulations), economic instruments (charges, subsidies, payments for ecosystem services, insurance schemes, markets) and information-based instruments (planning tools, voluntary agreements, awareness-raising and information provision). Economic instruments, in particular, can be useful to improve incentives for managing risk and dealing with greater uncertainty.

Economic instruments include taxes and charges (water tariffs, environmental taxes and charges); subsidies (on products and practices); market mechanisms for environmental goods (tradable permits for pollution or water abstraction, compensation mechanisms); and voluntary agreements. Care should be taken in the design and application of each instrument, so as to avoid unwanted effects. Moreover, in a transboundary context, such instruments need to be coordinated between the riparian countries to avoid unwanted effects from unilateral actions.

Water pricing instruments are usually used to contribute to financing water services and infrastructure, but can also be used as demand management instruments. Water taxes and charges can also be used to apply the "user pays" and "polluter pays" principles to water management. Other market mechanisms include tradable water entitlements, such as those in place in the Murray-Darling Basin in Australia.

A specific category of economic instruments are risk-sharing and management tools, such as catastrophe bonds and insurance. Catastrophe bonds securitize risks associated with natural hazards. One innovative example of pooling risk can be found in the Caribbean (see case study 4.12).

Case study 4.12 Pooling catastrophe risk due to excessive rainfall events in the Caribbean

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is a unique and innovative approach to pooling climate-related risk. It is a regional catastrophe fund, providing coverage to Caribbean governments, which is designed to limit the financial impact of disasters. It is the first and currently only multi-country parametric risk pool in the world. Risk pooling offers the advantage of diversifying risk, which greatly reduces the cost of reinsurance compared to the price each government would have paid individually.

CCRIF was established in response to the severe damage caused by Hurricane Ivan in 2004, which caused billions of dollars in losses across the Caribbean. For both Grenada and the Cayman Islands the losses were close to 200 per cent of GDP.

The Facility offers parametric insurance, which disburses funds based on the occurrence of a pre-defined level of hazard and impact, as opposed to indemnity-based insurance, which covers the policyholder against the loss of a specific asset. In May 2012, CCRIF introduced a product for excessive rainfall. Several features of the offerings help to maintain governments' incentives to invest in risk reduction. Premiums are based on an analysis of actual risk and potential compensation does not cover all potential damages, thus maintaining the incentives to engage in loss-reducing measures.

Sources: Caribbean Catastrophe Risk Insurance Facility, "Understanding CCRIF's Hurricane and Earthquake Policies", Technical Paper Series #1, 2012. Available from www.ccrif.org/sites/default/files/publications/TechnicalPaper1-HurricaneEarthquakePoliciesAugust2012.pdf.

Intergovernmental Panel on Climate Change, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. (Cambridge University Press, Cambridge, United Kingdom and New York, 2012).

In addition to insurance schemes, other economic instruments, when well designed, can reduce inefficient water use and improve the flexibility of water allocation to respond to changing conditions. In the OECD survey of *Water and Climate Change Adaptation* (OECD, 2013), several countries, along with the European Commission, identified economic instruments to cope with water quantity issues, including water pricing, abstraction charges, water-related taxes and water trading as part of their adaptation response. France, for example, recently developed an innovative tax to improve incentives for the management of urban rainwater (see case study 4.13).

Case study 4.13 Incentives for managing urban rainwater: the "Rain Tax" in France

In France, a growing number of municipalities are confronted by the challenge of increasing storm-water runoff. This puts pressure on their current water treatment systems. First introduced by the Law on Water and Aquatic Ecosystems, the new "Rain Tax" is designed to promote the sustainable management of rainwater, control pollution and prevent the risk of floods. In addition, the tax provides extra revenue to contribute to the financing of urban rainwater management. Municipalities have the choice of whether to implement the tax.

The tax applies to land and road owners (both public and private) in urban areas. It is determined according to the impermeable land surface (imposed on surfaces of a minimum of 600 square metres, with the maximum tariff of EUR 1 per square metre). However, a tax reduction of between 20 and 100 per cent can be offered if the land or road owner plans to create or improve the rainwater management system with the objective of limiting or stopping storm-water runoff.

The revenue from the tax is exclusively dedicated to the public management of urban rainwater. This includes the creation, operation, renewal and extension of infrastructure installation and maintenance.

Source: Ministry of Ecology, Sustainable Development and Energy, "Taxe pour la gestion des eaux pluviales urbaines", Fiche No. 3, Paris, 2006. Available in French from http://www.developpement-durable.gouv.fr/IMG/pdf/Gestion_des_eaux_pluviales_urbaines.pdf.

Chapter 5



Monitoring and evaluation of adaptation actions

When implementing adaptation initiatives in transboundary basins, it is important to ensure that the allocated resources lead to the intended objectives in a cost-effective and timely manner. Monitoring facilitates an ongoing assessment of progress made in implementing planned initiatives. The closely linked, but essentially separate, process of evaluation provides an independent assessment of how effective initiatives are in achieving set objectives. This can guide mid-course adjustments that may be needed and inform the allocation of scarce resources to activities known to deliver. Moreover, the adaptive water management approach requires regular evaluation and updating of the adaptation strategy.

To achieve the level of information needed, it may be necessary to carry out evaluations during the implementation of the initiative (interim or mid-term evaluation), when the implementation of the initiatives has been completed (final evaluation) and some years after its completion (ex-post evaluation). However, the format used will to a large extent depend on the nature of the initiative. For example, approaches used to evaluate focused pilot projects will differ from those used to evaluate large, long-term programmes. Similarly, the financing mechanisms used (e.g., joint financing by riparian States as compared with financial support from bilateral or multilateral agencies) may also affect the preferred approach.

The evaluation framework and the evaluating indicators for adaptation measures should be designed at the planning stage. Then, the iterative process makes it possible to improve the efficiency of the evaluation framework⁴.

5.1 Build a basin-wide evaluation system

A basin-wide assessment is necessary to be able to implement a basin-wide adaptation strategy. In order to do this, a range of tools is available, from which the most suitable should be chosen. This choice should also be based on a theoretical approach to what determines the changes in the basin.

⁴ The present chapter draws heavily on the work of OECD (2015).

Lesson 60. *Develop a theory of change*

At the project and programme level, a theory of change developed at the outset can help map the multiple pathways to the identified objectives, determine which pathway to choose and decide the relationship between the different components and the reported outcomes. In a dynamic context, like that of transboundary basins, a theory of change enables managers and evaluators to situate the local adaptation initiative within the global scale of climate change. Further, it recognizes that reported outcomes cannot be solely attributed to individual initiatives, but rather reflect changes brought about by a diverse portfolio of initiatives and socioeconomic change.

Case study 5.1 **Establishing a theory of change**

To establish a theory of change, six tasks should be considered:

Task 1 – Conduct a context analysis: At the basin level, a climate risk and vulnerability assessment can identify priority climate-related impacts to be addressed.

Task 2 – Identify the long-term outcome: To ensure that all stakeholders involved in an initiative work towards the same objectives, there must be a shared understanding from the outset of what the objectives are.

Task 3 – Develop a pathway of change: To inform the development and implementation of an initiative and to guide the subsequent evaluation of its efficiency and effectiveness, a “pathway of change” analysis can help identify causal linkages and map the direct and indirect results the intervention aims to achieve.

Task 4 – Operationalize outcomes: For each objective, it must be clear who the target population is, what the baseline is, how success will be measured, within what timescale results are expected and what evidence will be used to monitor and evaluate outcomes.

Task 5 – Define interventions: Once agreement has been reached on the intended outcomes, a strategy must be developed that outlines the measures through which the identified objectives will be achieved, differentiating between those that are within the control of the initiative and those that are not.

Task 6 – Articulate assumptions: A set of assumptions will determine how the set objectives are pursued. To adequately reflect these assumptions in the evaluation, they must be outlined in the theory of change.

Sources: Andrea Anderson, “The Community Builder’s Approach to Theory of Change: A Practical Guide to Theory Development”, The Aspen Institute Roundtable on Community Change, New York, 2005. Available from http://www.dochas.ie/Shared/Files/4/TOC_fac_guide.pdf

Dennis Bours, Colleen McGinn and Patrick Pringle, *The Theory of Change approach to climate change adaptation programming: Guidance note 3* (SEA Change CoP, Phnom Penh and UKCIP, Oxford, February 2014). Available from <http://www.seachangecop.org/node/2933>

Ayesha Dinshaw and others. “Monitoring and Evaluation of Climate Change Adaptation: Methodological Approaches”. OECD Environment Working Papers, No. 74. (Paris, OECD Publishing, 2014). Available from <http://dx.doi.org/10.1787/5jxrclr0ntjd-en>.

Lesson 61. *Use a portfolio of monitoring and evaluation tools and be cautious in attributing impacts to climate shifts*

Across scales and approaches, attributing changes observed on the ground to specific initiatives is not easy. At the global and regional level, confidence in climate projections is relatively high, at least for a few climate variables such as air temperature at an annual resolution. However, the level of certainty decreases at the regional, national and local levels, when looking at scales smaller than roughly the size of the Danube Basin in Europe, and at temporal scales less than one year, around questions of shifts in the frequency and severity of extreme events, and when analysing trends related to the water cycle (e.g., precipitation patterns). Although statistical techniques are available to downscale climate projections, applying these requires technical capacity and a large range of reliable data and information not easily available in all countries, and downscaling capacity does not imply capacity in the ability to interpret or consume those data products. Additional factors contributing to uncertainty around the effectiveness of adaptation initiatives include:

- The challenge of discerning the attribution of an adaptation intervention to changes brought about by other interventions as well as broader socioeconomic trends.

- The difficulty in establishing baselines and setting targets against which impact can be measured in a relatively uncertain climate context.
- The challenge of evaluating the outcomes of adaptation initiatives that may only become apparent over a long time horizon within relatively short evaluation cycles.

To overcome these challenges, a portfolio of monitoring and evaluation tools is needed. Each individual tool may only capture a component of the climate risks and vulnerabilities, but combined they can provide a better overview of the larger picture. Table 2 summarises a few of these different tools.



Table 2. Examples of monitoring and evaluation tools, methods and approaches

Tool	Application	Advantages	Disadvantages
<p>Performance indicators: Measures of inputs, processes, outputs, outcomes and impacts.</p>	<ul style="list-style-type: none"> ● Help set performance targets and assess progress made in achieving them. ● Help identify problems to allow for corrective action. ● Indicate whether an in-depth evaluation or review is needed. 	<ul style="list-style-type: none"> ● Effective means to measure progress towards objectives. ● Facilitate benchmarking comparisons between different organizational units, districts, and over time. 	<ul style="list-style-type: none"> ● Too many indicators, or indicators without accessible data sources, can result in the system being costly, impractical and not sufficiently used. ● Possible trade-offs between the optimal indicator set and indicators that can be measured using existing data.
<p>The logical framework approach: A tool that clarifies the results chain of an initiative (inputs, processes, outputs, outcomes and impacts).</p>	<ul style="list-style-type: none"> ● Assists in the preparation of detailed operational plans by specifying the objectives, complementary milestones and targets of an initiative, and outlines the assumptions and possible risks. ● Provides a basis for activity review, monitoring and evaluation. 	<ul style="list-style-type: none"> ● Ensures that decision makers ask fundamental questions and analyse assumptions and risks. ● Engages stakeholders and, when used dynamically, is an effective management tool to guide implementation, monitoring and evaluation. 	<ul style="list-style-type: none"> ● If managed rigidly, stifles creativity and innovation. ● If not updated during implementation, can be a static tool that does not reflect changing conditions.
<p>Theory-of-change evaluation: An in-depth understanding of the broader context and the contribution of an initiative to reported change.</p>	<ul style="list-style-type: none"> ● Maps the design of complex activities. ● Improves planning and management. 	<ul style="list-style-type: none"> ● Provides early feedback about what is or is not working and why, and helps to identify possible unintended side effects. ● Provides a basis for assessing the likely impacts of initiatives and helps to prioritize issues to be investigated in greater depth. 	<ul style="list-style-type: none"> ● Can become very complex if the scale of an initiative is large or if an exhaustive list of factors and assumptions is assembled. ● Stakeholders might disagree on the determining factors. Such disagreements can be time-consuming to resolve.
<p>Formal surveys: A tool to collect standardized information from a carefully selected sample of people or households.</p>	<ul style="list-style-type: none"> ● Provide baseline data against which the performance of the initiative can be assessed and input for a formal evaluation. ● Facilitate comparison of different groups at a given point in time or of changes over time in the same group. 	<ul style="list-style-type: none"> ● Provide valuable information about the sample group and more generally about the population as a whole. ● Quantitative estimates can be made for the size and distribution of impacts. 	<ul style="list-style-type: none"> ● The processing and analysis of data are very time-consuming and living-standards and household surveys are also expensive. ● Some information is difficult to obtain through formal interviews.

Tool	Application	Advantages	Disadvantages
<p>Rapid appraisal methods: A quick and low-cost approach to gathering the views and feedback of beneficiaries and other stakeholders.</p>	<ul style="list-style-type: none"> ● Provide rapid information for management decision-making. ● Provide information on socioeconomic changes, interactive social situations, and people's values, motivations and reactions. 	<ul style="list-style-type: none"> ● Low cost. ● Can be conducted quickly. ● Provide flexibility to explore new ideas. 	<ul style="list-style-type: none"> ● Findings usually relate to specific communities or localities and thus it is difficult to generalize from findings (i.e., for basin-wide action). ● Less valid, reliable and credible than formal surveys.
<p>Participatory methods: Provide active involvement in decision-making for those with a stake in the initiative.</p>	<ul style="list-style-type: none"> ● Contribute to learning about local people's perspectives and priorities that can inform sustainable interventions. ● Identify problems during implementation. This can also inform the evaluation of the initiative. 	<ul style="list-style-type: none"> ● Examine relevant issues by involving key players in the design process. This also creates partnerships and local ownership and contributes to enhanced local learning, management capacity and skills. ● Provide timely, reliable information for management decision-making. 	<ul style="list-style-type: none"> ● Time-consuming if key stakeholders are involved in a meaningful way. ● Potential for domination and misuse by some stakeholders to further their own interests.
<p>Public expenditure surveys: Track the flow of public funds and determine if resources reach target groups.</p>	<ul style="list-style-type: none"> ● Diagnose problems in service delivery quantitatively. ● Gather evidence with regard to delays, "leakage" and corruption. 	<ul style="list-style-type: none"> ● Support the pursuit of accountability when little financial information is available. ● Improve management by pinpointing bureaucratic bottlenecks in the flow of funds for service delivery. 	<ul style="list-style-type: none"> ● Government agencies may be reluctant to open their accounting books. ● Cost is substantial.
<p>Cost-benefit/cost-effectiveness analysis: Assess if the costs of an activity can be justified by outcomes and impacts.</p>	<ul style="list-style-type: none"> ● Informs decisions about the most efficient allocation of resources. ● Identifies initiatives that offer the highest rate of return on investment. 	<ul style="list-style-type: none"> ● Makes explicit the economic assumptions that might otherwise remain implicit or overlooked at the design stage. ● Useful for convincing policymakers and funders that the benefits justify the activity. 	<ul style="list-style-type: none"> ● Fairly technical, requiring adequate financial and human resources. ● Requisite data may not be available, and projected results may be highly dependent on assumptions made.
<p>Impact evaluation: Systematic identification of the effects on individual households, institutions and the environment caused by an initiative.</p>	<ul style="list-style-type: none"> ● Measures outcomes and impacts of an activity and distinguishes them from the influence of other, external factors. ● Informs decisions on whether to expand, modify or eliminate projects, programmes or policies. 	<ul style="list-style-type: none"> ● Provides estimates of the magnitude of outcomes and impacts for different demographic groups or regions or over time. ● Examines the extent to which the initiative is making a difference: What are some of the results? How can they be improved? 	<ul style="list-style-type: none"> ● Can be expensive and time-consuming, although faster and more economical approaches are available. ● Difficulties in identifying an appropriate counterfactual.

Source: Adapted from World Bank (2004).

In order to bring together the insights from the different approaches, honest and open coordination between producers and users of the various sources of information is critical (also see sections 2.3.1 and 3.1). The nature of such a coordination mechanism will often depend on the systems already in place. At the basin level, this may include institutional mechanisms that have been created to manage the overall planning and implementation of the adaptation initiative. Alternatively, mechanisms in place to monitor and evaluate the broader development objectives that the adaptation initiative contributes to, can be used. The United Kingdom has taken a third approach to evaluating its National Adaptation Programme and established an independent body to coordinate the evaluation process.

While the application of existing institutional mechanisms can reduce costs, the creation of an independent body can signal the importance attributed to good monitoring and evaluation of adaptation and help to ensure a degree of autonomy. Whatever the approach taken, it is important that the coordinating mechanism has access to the relevant information (across sectors and levels of decision-making) and the capacity to use the information to assess progress made and to identify remaining gaps and challenges.

5.2 Regularly update assessments

The adaptation strategy needs to fulfil its objectives. Assessments are needed to evaluate if the adaptation measures as implemented are effective in leading to the desired outcomes. Alongside this, models and scenarios should be reconsidered on a regular, iterative basis, as new information from climatic and eco-hydrological monitoring becomes available and economic and development strategies evolve over time. Moreover, adaptive management requires the regular review of the vulnerability assessments (also see section 3.2).

Lesson 62. Evaluate the effectiveness of adaptation measures

To evaluate the effectiveness of adaptation measures, regular reporting of indicators is a valuable source of information. Depending on the nature of the intervention, the indicators may be directly aligned with project or programme components. Alternatively, they may be more broadly aligned with the overarching objectives of the initiative, focusing on socioeconomic indicators that in different ways contribute to exposure and vulnerability to climate change. In practice, data availability and monitoring and evaluation capacity determine to a large extent what aspects of an initiative can be monitored (OECD, 2015). For example, while it is relatively easy to monitor water availability and quality, it is much harder to assess if cooperation among riparian States has improved, or if the communities in the water basin have become more resilient to the effects of climate change. To overcome this challenge, it is useful to draw on a mix of qualitative outcome indicators and quantitative process indicators that, when combined, provide an overview of progress made in adapting to climate change in the given context (Lamhauge, Lanzi and Agrawala, 2012). However, indicators on their own can only signal if change has occurred. To understand how that change came about, they must be combined with the information generated by some of the other tools listed in table 2.

Table 3 outlines a few questions that may be considered when developing indicators for adaptation initiatives. Case study 5.2 summarizes the approach used by the Global Environment Facility (GEF) to monitor and evaluate transboundary basin initiatives, focusing on process indicators, stress reduction indicators and environmental status indicators.

Table 3. Questions to guide indicator development for adaptation initiatives

Question	YES	NO	If NO:
Is there consensus among stakeholders on what successful adaptation will look like?	<input type="checkbox"/>	<input type="checkbox"/>	Seek consensus with stakeholders (beneficiaries, local staff and other actors) so there is shared ownership of the outcomes of the project.
Did relevant stakeholders participate in the planning process?	<input type="checkbox"/>	<input type="checkbox"/>	Participation should be mainstreamed into planning from the outset. If it is not, explore whether and how to revise current plans and to enact institutional policies to ensure better participation in the future.
Do the indicators follow a specific set of indicator development criteria (i.e., SMART, ADAPT, CREAM or SPICED)?	<input type="checkbox"/>	<input type="checkbox"/>	Choose the most appropriate criteria for the intervention and make sure that the indicators reflect them.
Will the indicators contribute to an understanding of whether the objectives have been achieved? Do the indicators take into account the assumptions that have been made towards the intervention and its enabling environment?	<input type="checkbox"/>	<input type="checkbox"/>	Revisit the theory of change and its assumptions, and assess how to make the indicators more relevant towards the logic underpinning the intervention, taking into account the context and enabling environment.
Have indicators been included that measure the context or enabling environment in which the intervention is operating?	<input type="checkbox"/>	<input type="checkbox"/>	Develop indicators that track the enabling environment. This should be done as part of the baseline.
Is the number of indicators selected manageable, given the expected time frame for reporting and resources available for indicator data collection and analysis?	<input type="checkbox"/>	<input type="checkbox"/>	Review whether all the indicators selected are relevant, or if it is possible to exclude some without compromising the integrity of the overall data set.
Based on the intervention as well as the objective of the monitoring and evaluation, is there an appropriate balance between process and outcome indicators? And between qualitative and quantitative indicators?	<input type="checkbox"/>	<input type="checkbox"/>	Can the mix of indicators clearly assess the results of the intervention and provide the information needed for learning and decision-making? Is there a need to change the indicator mix?
Will data availability change during the course of the project or after the project has been completed?	<input type="checkbox"/>	<input type="checkbox"/>	Develop a data collection contingency plan if data availability and sources might change, and include the contingency plan in the monitoring and evaluation framework.
Do the indicators provide data that can easily be converted into information and knowledge that will be useful for the recipients of the evaluation? Will the information be useful for decision-making, accountability and adaptive learning?	<input type="checkbox"/>	<input type="checkbox"/>	Engage with the beneficiaries of the project and end users of the information to discuss the types of questions they seek to answer and the type of information or knowledge needed to answer them.

¹Abbreviations: ADAPT (adaptive, dynamic, active, participatory, thorough); CREAM (clear, relevant, economic, adequate, monitorable); SMART (specific, measurable, attainable, realistic, timely); SPICED (subjective, participatory, interpreted, cross-checked, empowering, diverse).

Source: Leagnar and Bours (forthcoming).

Several evaluation systems have already been developed for basin management and can be adapted and used in the evaluation of adaptation measures at the transboundary basin scale. The GEF approach for evaluating water initiatives (case study 5.2) is a relevant tool. The Network of Asian Basin Organizations (NARBO) has also introduced a set of "Indicators for RBO Performance Benchmarking" and INBO and the African Network of Basin Organisations (ANBO) have developed Key Performance Indicators for Transboundary Basins Management in the framework of the EU Water Facility.

Lesson 63. Establish mechanisms for regularly reviewing the assessments in order to ensure flexible adaptation

Decision makers have found that scheduling reviews and updates of the adaptation strategy on a fixed schedule is a useful means of ensuring its long-term flexibility. Technical progress, as well as the implications of emerging data, can lead to reconsideration of goals, progress and policy. For instance, as the rapid development of new remote-sensing data products or research into emerging climatic trends (or even new insights into regional palaeo-climatic history) may show previously unresolved patterns. The identification of new regulatory or stakeholder priorities can also be a significant prompt, such as new energy sources, a serious flood or drought, or increased interest in endangered species. Political processes, however, may benefit by having fixed-term reassessments of vulnerability (and the processes of evaluating vulnerability), which can then explicitly inform transboundary institutions, such as the reallocation of water resources, the planning of new infrastructure, or the operating regime of existing infrastructure to match shifting conditions and changing needs.



Case study 5.2 The approach by the Global Environment Facility in evaluating water initiatives

The Global Environment Facility (GEF) has traditionally played an important role in supporting developing countries in undertaking joint action to protect and develop shared waters. Given the complex and politically sensitive nature of transboundary basin initiatives, the GEF has focused its monitoring and evaluation framework on the multi-country collaborative processes and institutional arrangements. Recognizing that many objectives may take years or decades to materialize, the GEF has developed a set of interim indicators for assessing if the transboundary basin initiatives are on track or if corrective measures are needed. The indicators fall into three broad categories:

- **Process indicators** that track if agreed processes and the related policy, legal, regulatory and institutional reforms needed to achieve set objectives are in place
- **Stress-reduction indicators** that focus on the implementation of measures that reduce the stress on the environment and that are linked to socioeconomic improvements
- **Environmental status indicators** that measure the improved quality of the ecosystem, results that usually take a long time to mature and often not within the evaluation cycle of individual initiatives.

Examples of indicators in two GEF-funded international waters projects

Indicator type	Water and environmental management in the Aral Sea Basin	Lake Victoria environmental management project
Process indicators	<ul style="list-style-type: none"> ● Adoption of a regional water and salt management policy ● Agreement among participating nations on interstate water use and environmental sustainability ● Adoption by each government of national policy, strategy and action programmes to reduce salinity and irrigation water use by 15% 	<ul style="list-style-type: none"> ● Harmonizing among the three countries the legislation addressing the management of fisheries and environmental variables important to the lake basin and improved enforcement of this legislation ● Establishing sustainable long-term capacity for management and control of water hyacinth and other invasive weeds ● Establishing a lake-wide water quality and rainfall monitoring system to generate information on eutrophication management and pollution control
Stress reduction indicators	<ul style="list-style-type: none"> ● Reduction of irrigation water use by 15%, which increases effective water flow to delta wetlands by some 15% ● Reduction in soil salinity in line with targets ● Achievement of sustainable levels of investment in the effective management of water resources and salinity from private and public sources 	<ul style="list-style-type: none"> ● Reduction in the nutrient and faecal coliform counts from towns bordering the lake ● Reduction in sediment and phosphorus loading in rivers flowing into the lake ● Reduction by at least 50% over 5 years in significant industrial pollutants entering the lake
Environmental status indicators	<ul style="list-style-type: none"> ● River salinity in line with targets ● Decreased salinity levels of delta lake ● Increased dissolved oxygen levels in delta lake ● Increased flows to delta lake ● Increased number of migratory birds ● Income of local population rises 	<ul style="list-style-type: none"> ● Stabilizing the Nile perch catch at least at current levels and increasing recovery of other species ● Measurable reduction in the infestation of water hyacinth ● Stabilization of areas retained as wetlands

Source: Juha I.Uitto, "Multi-country cooperation around shared waters: role of monitoring and evaluation", Global Environmental Change, Vol. 14, (28 March 2004). Available from <http://dx.doi.org/10.1016/j.gloenvcha.2003.11.006>.



Annexes



ANNEX 1

LIST OF PILOT PROJECTS AND BASINS MEMBERS OF THE GLOBAL NETWORK OF BASINS WORKING ON CLIMATE CHANGE ADAPTATION

Pilot projects

The following pilot projects are or were supported directly by the ECE secretariat in the framework of ENVSEC and in cooperation with other ENVSEC partners, such as UNDP, OSCE and UNEP:

1. Pilot project on the Chu Talas Basin, shared by Kazakhstan and Kyrgyzstan, implemented by UNDP and ECE, in cooperation with OSCE.
2. Pilot project on the Dniester Basin, shared by the Republic of Moldova and Ukraine, implemented by UNEP, ECE and OSCE.
3. Pilot project on the Neman River Basin, shared by Belarus, Lithuania and the Russian Federation, implemented by UNDP and ECE.
4. Pilot project on the Sava River Basin, shared by Bosnia and Herzegovina, Croatia, Serbia and Slovenia, implemented by the Sava River Basin Commission and ECE.
5. The project "Dauria Going Dry" on the Amur/Argun/Daursky Biosphere reserve, shared by the Russian Federation, Mongolia and China, and implemented by the Daursky Biosphere Reserve (representing the Dauria International Protected Area), the World Wildlife Fund Russian Federation and Rivers without Boundaries International Coalition and partially supported by ECE.

Basins and organizations members of the global network of basins working on climate change adaptation

1. Amur/Argun/Daursky Biosphere Reserve, shared by the Russian Federation, Mongolia and China.
2. Chu Talas Basin, shared by Kazakhstan and Kyrgyzstan.
3. International Commission of Congo-Oubangui-Sangha in the Congo Basin, shared by Cameroon, the Central African Republic, the Democratic Republic of the Congo, the Republic of the Congo, Equatorial Guinea and Gabon.
4. International Commission for the Protection of the Danube River in Danube Basin, with the following contracting Parties: Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Montenegro, the Republic of Moldova, Romania, Serbia, Slovenia, Slovakia and Ukraine.
5. Dniester Basin, shared by the Republic of Moldova and Ukraine.
6. Drin Basin, shared by Albania, Greece, Kosovo (UN administered territory under UN Security Council resolution 1244), Montenegro and the former Yugoslav Republic of Macedonia.
7. MRC-CCAI on the Lower Mekong River, shared by Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam.
8. Meuse Basin, shared by Belgium, France, Germany, Luxembourg and the Netherlands (Project AMICE implemented by the Etablissement Public d'Aménagement de la Meuse (EPAMA)).
9. Neman River Basin, shared by Belarus, Lithuania and the Russian Federation.
10. Niger Basin Authority in Niger Basin, shared by Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria.

11. International Commission for Protection of Rhine in the Rhine Basin, shared by Austria, Belgium, France, Germany, Italy, Liechtenstein, Luxembourg, the Netherlands and Switzerland.
12. Sahara and Sahel Observatory/NSWAS Consultation Mechanism, shared by Algeria, Libya and Tunisia.
13. International Sava River Basin Commission in the Sava River Basin, with the following contracting Parties: Bosnia and Herzegovina, Croatia, Serbia and Slovenia.
14. Senegal River Basin Development Authority in the Senegal Basin, shared by Guinea, Mali, Mauritania and Senegal.

See the web page of the Water Convention devoted to pilot projects on climate change adaptation for more information (<https://www2.ECE.org/ehlplatform/display/ClimateChange/Welcome>).

ANNEX 2

REFERENCES

- Canada-United States (2012). Great Lakes Water Quality Protocol. Available from http://www.ijc.org/en/_/Great_Lakes_Water_Quality.
- Dinar, Shlomi (2006). "Assessing side-payment and cost-sharing patterns in international water agreements: The geographic and economic connection". *Political Geography*, vol. 25, No. 4 (May), pp. 412-437.
- Dinshaw, Ayesha and others (2014). "Monitoring and Evaluation of Climate Change Adaptation: Methodological Approaches". OECD Environment Working Papers, No. 74. Paris: OECD Publishing. Available from <http://dx.doi.org/10.1787/5jxrclr0ntjd-en>.
- Doswald, Nathalie and Matea Osti (2011). "Ecosystem-based approaches to adaptation and mitigation — good practice examples and lessons learned in Europe". Federal Agency for Nature Conservation report No. 306. Bonn, Germany: German Federal Agency for Nature Conservation.
- European Commission (2013). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An EU strategy on adaptation to climate change (COM/2013/0216 final). Available from <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52013DC0216>.
- European Union (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. O.J. (L 327), pp. 1–73.
- European Union (2007). Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. O.J. (L 288), pp. 27–34.
- Drieschova, A., Giordano, M., Fischhendler, I. (2008). Governance mechanisms to address flow variability in water treaties. *Global Environmental Change*, vol. 18, No. 2, pp. 285-295.
- Fischhendler, Itay (2004). "Legal and institutional adaptation to climate uncertainty: a study of international rivers". *Water Policy*, vol. 6, pp. 281–302. Available from <http://www.iwaponline.com/wp/00604/wp006040281.htm>.
- García, L. E. and others (2014). *Beyond Downscaling: A Bottom-Up Approach to Climate Adaptation for Water Resources Management*. Alliance for Global Water Adaptation (AGWA) Report 01. Washington, D.C.: World Bank Group. Available from http://alliance4water.org/resources/AGWA_Beyond_Downscaling.pdf.
- Germany, Federal Ministry for Economic Cooperation and Development (2013). *Monitoring and Evaluating Adaptation at Aggregated Levels: A Comparative Analysis of Ten Systems*. Bonn and Eschborn, Germany: German Agency for International Cooperation. Available from https://gc21.giz.de/ibt/var/app/wp342deP/1443/wp-content/uploads/filebase/me/me-guides-manuals-reports/GIZ_2013-M+E_of_Adaptation_Comparative_analysis.pdf.
- Haasnoot, M. and others (2012). Exploring pathways for sustainable water management in river deltas in a changing environment. *Climatic Change*, vol. 115, No. 3-4 (December), pp. 795-819.
- Intergovernmental Panel on Climate Change (2007). *Climate Change 2007: Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, United Kingdom, and New York: Cambridge University Press. Available from: https://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html
- _____ (2013). *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Available from: <http://www.climatechange2013.org/report/>

- _____ (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part A, Global and Sectoral Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom, and New York: Cambridge University Press. Available from <http://ipcc-wg2.gov/AR5/report/>.
- International Law Association (2004). Report of the Seventy-First Conference 3 (2004); 71 ILA 337, 385 (2004). The draft version of the Berlin Rules on Water Resources, as submitted to the Conference, is available from [http://www.internationalwaterlaw.org/documents/intldocs/#International Law Association Documents](http://www.internationalwaterlaw.org/documents/intldocs/#International_Law_Association_Documents).
- International Network of Basin Organizations and others (2012). *The Handbook for Integrated Water Resources Management in Transboundary Basins of Rivers, Lakes and Aquifers*. Online handbook available from www.inbo-news.org, www.gwp.org and www.iowater.org.
- International Sava River Basin Commission (2002). Framework Agreement for the Sava River Basin. Available from http://www.savacommission.org/basic_docs.
- Jones, Holly P., David G. Hole and Erika S. Zavaleta (2012). "Harnessing nature to help people adapt to climate change". *Nature Climate Change*, vol. 2, No. 7 (July), pp. 504–509. Available from http://people.ucsc.edu/~zavaleta/pubs/Jones_NatureClimate_2012.pdf.
- Lamhauge, Nicolina, Elisa Lanzi and Shardul Agrawala (2012). "Monitoring and Evaluation for Adaptation: Lessons from Development Co-operation Agencies". OECD Environment Working Papers, No. 38. Paris: OECD Publishing. Available from <http://dx.doi.org/10.1787/5kg20mj6c2bw-en>.
- Leagnavar, Punjanit and Bours, Dennis (forthcoming), "Good Practice Study on Principles for Indicator Development, Selection and Use in Climate Change Adaptation M&E", *Climate-Eval*. Available from <https://www.climate-eval.org/sites/default/files/studies/Good-Practice-Study.pdf>
- MacKay, Ronald and Douglas Horton (2002). "Capacity development in planning, monitoring, and evaluation: results of an evaluation". Briefing Paper 51, July. The Hague: International Service for National Agricultural Research. Available from <http://www.ifpri.org/sites/default/files/pubs/isnararchive/publicat/bp-51.pdf>.
- Munang, Richard and others (2013). "Climate change and ecosystem-based adaptation: a new pragmatic approach to buffering climate change impacts". *Current Opinion in Environmental Sustainability*, vol. 5, No. 1 (March), pp. 67–71.
- Naumann, Sandra and others (2011). *Assessment of the potential of ecosystem-based approaches to climate change adaptation and mitigation in Europe*. Final report to the European Commission, Directorate General for Environment. Berlin: Ecologic Institute; United Kingdom: Environmental Change Institute of the Oxford University Centre for the Environment. Available from http://ec.europa.eu/environment/nature/climatechange/pdf/EbA_EBM_CC_FinalReport.pdf.
- Organization for Economic Cooperation and Development (2013). *Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters*, OECD Studies on Water. Paris. Available from <http://www.oecd.org/publications/water-and-climate-change-adaptation-9789264200449-en.htm>.
- _____ (2014). *Financing Climate Change Action, Policy Perspectives*. Online report, available from <https://www.scribd.com/doc/239900170/Financing-Climate-Change-2014-Policy-Perspective#download>.
- _____ (2015). *National Climate Change Adaptation: Emerging Practices in Monitoring and Evaluation*. Paris. Available from <http://dx.doi.org/10.1787/9789264229679-en>.
- Qaddumi, Halla (2008). *Practical approaches to transboundary water benefit sharing*. Working Paper No. 292. London: Overseas Development Institute. Available from <http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/2576.pdf>.
- Sanchez, Juan Carlos and Joshua Roberts, eds. (2014). *Transboundary Water Governance: Adaptation to Climate Change*. IUCN Environmental Policy and Law Papers No. 75. Gland, Switzerland: International Union for Conservation of Nature. Available from https://www.iucn.org/about/work/programmes/environmental_law/elp_resources/elp_res_publications/?uPubsID=5009.

- Timmerman, Jos (2014). *Information Needs for Water Management*. Boca Raton, Florida: Taylor & Francis Group. Available from <http://www.crcpress.com/product/isbn/9781466594746>.
- Timmerman, Jos and others (2011). Developing transboundary river basin monitoring programmes using the DPSIR indicator framework. *Journal of Environmental Monitoring*, Vol. 13, No. 10, 2808-2818.
- United Kingdom (2011). *Adapting to climate change in the UK: Measuring progress*. Adaptation Subcommittee Progress Report 2011. Online report, available from <http://www.theccc.org.uk/publication/adapting-to-climate-change-in-the-uk-measuring-progress-2nd-progress-report-2011/>.
- United Nations (1997). Convention on the Law of the Non-Navigational Uses of International Watercourses. Available from: http://legal.un.org/ilc/texts/instruments/english/conventions/8_3_1997.pdf.
- United Nations (2013), *Water cooperation in action: approaches, tools and processes*, report of the International Annual UN-Water Zaragoza Conference, Spain, 8–10 January 2013. Available from http://www.zaragoza.es/ciudad/medioambiente/onu/en/detallePer_Onu?id=710.
- United Nations Economic Commission for Europe (1992). *Convention on the Protection and Use of Transboundary Watercourses and International Lakes*. Available online at: www.unece.org/env/water
- _____ (2006). *Strategies for monitoring and assessment of transboundary rivers, lakes and groundwaters*. Geneva and New York. Available from <http://www.unece.org/env/water/publications/pub.html>.
- _____ (2009). *Guidance on Water and Adaptation to Climate Change*. Sales No. 09.II.E.14. Available from : <http://www.unece.org/env/water/publications/pub.html>.
- United Nations Environment Programme-DHI Partnership and others (2014). *Green Infrastructure Guide for Water Management, Ecosystem-based Management Approaches for Water-Related Infrastructure Projects*. Online publication, available from <http://stormwater.wef.org/2014/09/unep-releases-green-infrastructure-guide/>.
- Wertz-Kanounnikoff, Sheila and others (2011). Ecosystem-based adaptation to climate change: What scope for payments for environmental services? *Climate and Development*, vol. 3, No. 2 (June), pp. 143–158.
- World Bank (2004). *Monitoring and Evaluation: Some Tools, Methods and Approaches*. Washington, D.C.: The World Bank Operations Evaluation Department, Knowledge Programs and Evaluation Capacity Development Group. Available from <http://ieg.worldbankgroup.org/>.
- _____ (2009). *Convenient solutions to an inconvenient truth: Ecosystem-based approaches to climate change*. Washington D.C. Available online from http://siteresources.worldbank.org/ENVIRONMENT/Resources/ESW_EcosystemBasedApp.pdf.
- World Economic Forum (2014). *Climate Adaptation: Seizing the Challenge*. Geneva. Available from http://www3.weforum.org/docs/GAC/2014/WEF_GAC_ClimateChange_AdaptationSeizingChallenge_Report_2014.pdf.

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Water and Climate Change Adaptation in Transboundary Basins: Lessons Learned and Good Practices

As 60 per cent of global freshwater flows cross national boundaries, transboundary cooperation in adaptation is necessary to prevent possible negative impacts of unilateral adaptation measures on other riparian countries and to support the coordination of adaptation measures at the river/lake-basin or aquifer level. Cooperation can enable joint development of more cost-effective solutions, which offer benefits to all or several riparian Parties. For example, uncertainty can be reduced through the exchange of information and combining the impact assessments and model results throughout the basin and thus increasing the reliability of modelling results. Transboundary cooperation in adaptation also helps to locate measures, such as flood protection infrastructure, in the basin where they have the optimum effect, which may be in another riparian country. Transboundary cooperation thus helps to share costs and benefits of adaptation and to increase the overall efficiency and effectiveness of adaptation in a basin.

The publication intends to compile, analyse and disseminate experiences, and thereby to demonstrate and illustrate important steps and lessons learned as well as good practices to take into account when developing a climate change adaptation strategy for water management in the basin or transboundary context. It includes lessons learned and good practices mainly from the programme of pilot projects under the United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes implemented since 2010 in cooperation with partner organizations such as the Organization for Security and Cooperation in Europe and the United Nations Development Programme in the framework of the Environment and Security Initiative. It also includes lessons and examples from the ECE/INBO global network of basins and numerous other organizations working on water and climate change in transboundary basins, such as the International Union for Conservation of Nature, the Global Water Partnership and many others.

The publication serves as a complement to the Guidance on Water and Adaptation to Climate Change as well as to the previous handbooks of the International Network of Basin Organizations.

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Palais des Nations
CH - 1211 Geneva 10, Switzerland
Telephone: +41(0)22 917 44 44
Fax: +41(0)22 917 05 05
E-mail: info.ece@unece.org
Website: <http://www.unece.org>

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