UNECE

Good Practices and Lessons Learned in Data-sharing in Transboundary Basins

UNITED NATIONS

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

GOOD PRACTICES AND LESSONS LEARNED IN DATA-SHARING IN TRANSBOUNDARY BASINS

UNITED NATIONS
Geneva, 2024

NOTE

The findings, interpretations and conclusions expressed herein are those of the author(s) and do not necessarily reflect the views of the United Nations or its officials or Member States.

Links contained in the present publication are provided for the convenience of the reader and are correct at the time of issue. The United Nations takes no responsibility for the continued accuracy of that information or for the content of any external website.

The designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This publication is issued in English, French, Russian and Spanish.

Symbols of United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

Photos for this publication were provided by: Erik Aarnos, Water Convention Secretariat, p. vi, Mike Muzurakis, IISD, p. vii, Permanent Secretariat of the Amazon Cooperation Treaty Organization (ACTO), p. 16, the Embassy of Switzerland in Uzbekistan, p. 47, William Hamisi, Water Resources Authority, Kenya, p. 71, Wout de Vries, Rijkswaterstaat (NL)., p. 83, the Permanent Okavango River Basin Water Commission, p. 94 and Adobe Stock (for all other photos featured). The visuals on pages xx, xxiv and 6 were developed by Divya Venkatesh.

Cover photos:
Bottom left: Amazon River basin, shared by Brazil, Bolivia, Colombia, Ecuador, Guyana, Suriname, Peru and Venezuela. Top right: Lake Constance, shared by Austria, Germany and Switzerland. Bottom right: Victoria Falls on the Zambezi River located on the border of Zambia and Zimbabwe.

ECE/MP.WAT/73

UNITED NATIONS PUBLICATION
Sales No.: E.24.II.E.16
ISBN: 978-92-1-003146-2
eISBN: 978-92-1-106424-7

United Nations publication issued by the
United Nations Economic Commission for Europe

FOREWORD

The vast majority of countries around the world rely on shared rivers, lakes and aquifers. Regular collaboration on data- and information-sharing across different sectors and national borders provides a common basis for management, enables forward-looking decision-making and maximizes the benefits of these shared water resources, supporting trust building, stability and peace.

The importance of data-sharing in transboundary basins is highlighted by its inclusion in Sustainable Development Goal (SDG) indicator 6.5.2, which cites the regular exchange of data as one of the four requirements for "operational" arrangements for water cooperation. The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), serviced by the United Nations Economic Commission for Europe (UNECE), provides a unique global legal and intergovernmental framework and platform to support data-sharing in transboundary basins and to facilitate progress towards achieving SDG target 6.5.

Transboundary waters face significant pressures due to population growth, increasing water demand, and the impacts of the triple-planetary crisis of climate change, pollution and biodiversity loss. Natural hazards such as floods and droughts as well as extreme weather events are on the rise worldwide. Results from the third reporting exercise on SDG indicator 6.5.2 (2023) highlight a lack of relevant data and information, resource constraints, and difficulties in data and information exchange as the three main challenges faced by countries in cooperating on transboundary waters. Accordingly, the development of joint data- and information-sharing procedures is fundamental to efficient cooperation, enhanced resilience and emergency preparedness.

Teno River, shared by Finland and Norway.

This publication was developed within the framework of the Water Convention under the leadership of Finland and Senegal as Co-Chairs of the Working Group on Monitoring and Assessment. It presents a collection of lessons learned and supporting case studies from different parts of the world related to different aspects of data- and information-sharing, illustrating real-life examples of challenges and solutions. It provides a comprehensive global overview of related good practices from international, regional, basin-wide, national and local levels. As such, it complements previously developed guidance materials, such as the *Updated Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters* (2023).

The sharing of data and information is essential to the development of transboundary water cooperation. It is needed now more than ever as a cross-cutting enabler for peace, water security and shared prosperity. While several countries and basin organizations have improved their data-sharing procedures, as showcased by the third reporting exercise on SDG indicator 6.5.2, a lot of work remains to be done to ensure the successful achievement of the target and Agenda 2030 more broadly. We hope that this publication will inspire countries and basins to develop and strengthen data- and information-sharing processes, thereby contributing to improved transboundary water cooperation and the achievement of SDG 6 worldwide. The Water Convention stands ready to continue to assist countries, especially Parties, in further improving their monitoring and data-sharing at transboundary level.

Tatiana Molcean

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

Kai Mykkänen

Minister of the Environment and Climate Change, Finland

Cheikh Tidiane Dièye

Minister of Hydraulics and Sanitation, Senegal

Senegal mangroves at the Saloum Delta National Park

The Jet d’Eau fountain in Geneva, Switzerland

PREFACE

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) calls for all Parties to *provide for the widest exchange of information, as early as possible, on issues covered by the provisions of this Convention* (Article 6). Furthermore, the Water Convention calls for Riparian Parties to *establish and implement joint programmes for monitoring the conditions of transboundary waters* (Article 11) and to *exchange reasonably available data within the framework of relevant agreements or other arrangements* (Article 13).

The Working Group on Monitoring and Assessment, established in 2000 as a subsidiary body under the Water Convention, seeks to promote the exchange of data on transboundary waters, support the exchange of experiences and make information on transboundary waters publicly available. Numerous activities have been carried out under the Working Group, such as the development of various guidelines, pilot projects, and two comprehensive regional analyses of transboundary rivers, lakes and groundwaters. In 2006, the Working Group published the *Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters*, with an updated global edition released in 2023. Monitoring and assessment are often integrated into thematic activities or as components in projects on the ground.

At its ninth session (Geneva, 29 September – 1 October 2021), the Meeting of the Parties to the Water Convention entrusted the Working Group on Monitoring and Assessment with the task of collecting good practices and lessons learned in data-sharing in transboundary basins and synthesizing them into a publication.

Ninth session of the Meeting of the Parties to the Water Convention in Geneva, Switzerland

Palais des Nations in Geneva, Switzerland

As Co-Chairs of the Working Group on Monitoring and Assessment, Finland and Senegal led the process of preparing the publication with the support of the Water Convention secretariat. The draft outline of the publication was reviewed at the Expert Meeting on Monitoring, Assessment and Data Exchange (Geneva, 13-14 April 2022). The outline was then approved at the fourth joint meeting of the Working Group on Integrated Water Resources Management and the Working Group on Monitoring and Assessment (Tallinn, 28–30 June 2022). Case studies for the publication were collected following an open call issued by the secretariat in July 2022. In addition, several case studies were developed following two workshops: the Regional Workshop on Monitoring, Assessment and Information-sharing in Transboundary Basins in Central Asia (Astana, 1–2 February 2023), organized by the International Water Assessment Centre (IWAC) and UNECE with the financial support of the German International Development Agency (GIZ) under the Green Central Asia programme; and the Workshop on Strengthening Legal and Institutional Arrangements for Transboundary Water Cooperation and Data Exchange (Beirut, 30–31 May 2023), organized by UNESCWA.

During the Expert Meeting on Good Practices and Lessons Learned in Transboundary Data-Exchange (Geneva, 18–19 April 2023) and the eighteenth meeting of the Working Group on Monitoring and Assessment (Geneva, 17–18 October 2023), participants provided feedback on the structure and text of the draft publication, and subsequently provided additional lessons learned and case studies for integration into the publication. In July 2023, the text was submitted for review to participants of the Expert Meeting and case study authors, and, in December 2023, the revised text was submitted for final review to case study authors. The final draft of the publication, which includes 43 lessons learned, supported by 78 case studies, was reviewed by the fifth joint meeting of the Working Group on Integrated Water Resources Management and the Working Group on Monitoring and Assessment (Geneva, 6–8 May 2024). The secretariat, in cooperation with the lead Parties, then finalized the publication before the 10th session of the Meeting of the Parties to the Water Convention (Ljubljana, 23–25 October 2024).

The publication *Good Practices and Lessons Learned in Data-sharing in Transboundary Basins* will support future activities of the Water Convention specifically under Programme Area 2: Supporting monitoring, assessment and information-sharing in transboundary basins.

ACKNOWLEDGEMENTS

This publication would not have been possible without the generous contributions of many governments, international organizations and individuals.

The Water Convention Secretariat gratefully acknowledges the Co-Chairs of the Working Group on Monitoring and Assessment, Anna-Stiina Heiskanen (Director of the Freshwater Centre, Finnish Environment Institute, Finland) and Niokhor Ndour (Director of Water Resources Management and Planning at the Ministry of Water and Sanitation, Senegal), for their guidance and inputs to the development of this publication.

It also acknowledges the important work carried out by Jos Timmerman (Waterframes, advisor to the Dutch Ministry of Infrastructure and Water Management), who developed the text of this publication based on the case studies and subsequent comments received.

The Secretariat wishes to thank the following individuals and organizations who provided the case studies for *Good Practices and Lessons Learned in Data-sharing in Transboundary Basins*:

Mohamed Abdullahi Abdi, Somali Youth Development Foundation; Tommaso Abrate, World Meteorological Organization (WMO); Dana Agybayeva, Ministry of Ecology and Natural Resources, Kazakhstan; Ajaz Ali, International Centre for Integrated Mountain Development (ICIMOD); Juan Carlos Alurralde, Intergovernmental Coordinating Committee of the Countries of the La Plata Basin; Maria Apostolova, ACTO; Moh'd Arshid, Ministry of Water and Irrigation, Jordan; Rauza Aschanova, Department of Hydrology of the Republican State Enterprise Kazhydromet, Kazakhstan; Macarena Bahamondes Ortiz, Dirección Nacional de Fronteras y Límites del Estado (DIFROL), Ministerio de Relaciones Exteriores, Chile; Iskander Beglov, Scientific Information Center of the Interstate Commission for Water Coordination in Central Asia (SIC-ICWC); Aleš Bizjak, Ministry of Natural Resources and Spatial Planning, Slovenia; Momcilo Blagojevic, International Association of Hydrogeologists (IAH); Hastings Chibuye, Zambezi Watercourse Commission (ZAMCOM); Renaud Corniquet, Ministry of Ecological Transition, France; Dmitry Frank-Kamenetsky, Baltic Marine Environment Protection Commission (HELCOM); Gavril Gilca, Environmental Agency, Moldova; Juuso Haapaniemi, HELCOM; Paul Haener, International Network of Basin Organizations (INBO); Tapio Hakaste, Ministry of Agriculture and Forestry, Finland; Alexander Höbart, International Commission for the Protection of the Danube River (ICPDR); Lasha Inauri, Ministry of Environmental Protection and Agriculture, Georgia; Diego Jara, International Union for Conservation of Nature (IUCN); Heide Jekel, German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection; Loreen Katiyo, Global Water Partnership Southern Africa (GWP-SA); Ziad Khayat, United Nations Economic and Social Commission for West Asia (ESCWA); Kari Kinnunen, Water Convention Implementation Committee; Lamine Konate, Haut-Commissariat de l'Organisation pour la Mise en Valeur du fleuve Gambie (OMVG); Péter Kovács, Ministry of Interior, Hungary; Bo Libert, Independent Expert; Igor Liska, ICPDR; Steven Loiselle, Earthwatch Europe; Hélène Masliah-Gilkarov, ICPDR; Zhanar Mautanova, International Water Assessment Centre (IWAC); Ylber Mirta, Ministry of Environment and Physical Planning, North Macedonia; Felix Ngamlagosi, ZAMCOM; Timea Némethy, Lower Tisza Region Water Management Directorate of Hungary; Salome Oboladze, Ministry of Environmental Protection and Agriculture, Georgia; Washington Otieno, WMO; Jean-Noël Pansera, International Meuse Commission (IMC); Marie-Amélie Pétré, Geological Survey of Finland; Kevin Pietersen, Southern African Development Community Groundwater Management Institute (SADC-GMI); Oleg Podolny, Hydrogeoecological Research and Design Company "KazHYDEC" (Ltd.); Rapule Pule, Orange-Senqu River Commission (ORASECOM); Nina Raasakka, United Nations Environment Programme (UNEP); Riadur Rahman, Joint Rivers Commission, Bangladesh; Biljana Rajić, Ministry of Foreign Trade and Economic Relations, Bosnia and Herzegovina; Valentina Rakhimova, U.M. Akhmedsafin Institute of Hydrogeology and Geoecology, Kazakhstan; Phera Ramoeli, Permanent Okavango River

Water Basin Commission (OKACOM); Ruth Richardson, International Network of Liberal Women; Alfonso Rivera, IAH Transboundary Aquifers Commission; Rosario Sanchez, Texas Water Resources Institute; Mirza Sarac, International Sava River Basin Commission (ISRBC); Gulmira Satymkulova, Secretariat of Chu-Talas Water Management Commission; Andreas Scheidleder, Austria Environmental Agency (UBA); Christian Schilling, Ministry of Environment, Austria; Arnaud Sterckx, International Groundwater Resources Assessment Centre (IGRAC); Tabea Stötter, International Commission for the Protection of the Rhine (ICPR); Przemysław Susek, Chief Inspectorate for Environmental Protection, Poland; László Sütheő, North Transdanubian Water Management Directorate of Hungary; Francisco Taylor, Ministry of Environment, Panama; Jos Timmerman, Dutch Ministry for Infrastructure and Water Management; Karen Villholth, Independent Expert; Tracy Zaarour, ESCWA; Kulpash Zhaken, IWAC; Dinara Ziganshina, SIC-ICWC; and Didier Zinsou, Niger Basin Authority.

While every effort has been made to include all submissions, some inputs have been omitted during the process of development and review of the publication.

The Secretariat also wishes to thank all the participants to the Expert Meeting on Good Practices and Lessons Learned in Transboundary Data Exchange (18–19 April 2023), which reviewed the first draft of the publication:

Tommaso Abrate, WMO; Obinna Anah, African Ministers' Council on Water (AMCOW); Maria Apostolova, ACTO; Iskander Beglov, SIC-ICWC; Dana Maria Bogdan, Organization for Security and Co-operation in Europe (OSCE); John Chilton, Independent Expert; Paul Haener, INBO; Franko Humer, UBA; Nino Imnadze, National Environment Agency (NEA), Georgia; Diego Jara, IUCN; Nana Kitiashvili, NEA, Georgia; Lamine Konate, OMVG; Phera Ramoeli, OKACOM; Davison Saruchera, IUCN; Kristina Schaufler, UBA; Christian Schilling, Federal Ministry of Agriculture, Forestry, Regions and Water Management, Austria; Przemysław Susek, Chief Inspectorate for Environmental Protection, Poland; Mohamedou Sy, Sahara and Sahel Observatory (OSS); Bachir Alkali Tanimoun, Niger Basin Authority; Mariam Tsetskhladze, NEA, Georgia; Karen Villholth, Independent Expert; and Dinara Ziganshina, SIC-ICWC.

In addition, the Secretariat would like to thank all the participants at the Expert Meeting on Monitoring, Assessment and Data Exchange (13–14 April 2022), which supported the development of the outline for *Good Practices and Lessons Learned in Data-sharing in Transboundary Basins*:

Arailym Alimusina, IWAC; Abdoulaye Alio, Lake Chad Basin Commission; Alphonse Ahodègnon Alomasso, Benin; Juan Carlos Alurralde, Intergovernmental Coordinating Committee of the Countries of the La Plata Basin; Maria Apostolova, ACTO; Radmila Bojkovska, North Macedonia; Corina Cosmina Boscornea, Romania; Martina Bussettini, Italy; Fernando Cisneros Arza, ACTO; Kilian Christ, UNEP; George Dzamukashvili, National Water Partnership of Georgia; Melchior Elsler, UNEP; Ikrom Ergashev, Uzbekistan; Samo Grošelj, ISRBC; Amarildo Guri, Albania; Anna-Stiina Heiskanen, Finnish Environment Institute; Paul Haener, INBO; Mohamad Kayyal, UNEP Mediterranean Action Plan; Peter Kovacs, Ministry of Interior, Hungary; Ulugbek Komilov, Uzbekistan; Annukka Lipponen, Ministry of Agriculture and Forestry of Finland; Igor Liska, ICPDR; Elvira Marchidan, Romania; Natalija Matic, Croatia; Zhanar Mautanova, IWAC; Patience Mukuyu, International Water Management Institute (IWMI); Laziz Nazariy, SIC-ICWC; Oleg Podolny, KazHYDEC Ltd.; Juan Carlos Muñoz, Peru; Vesa Puoskari, Finland; José Pérez, Dominican Republic; Anna Rautvuori, Permanent Mission of Finland in Geneva; Edwin Ruiz Ceballos, Dominican Republic; Claudia Ruz Vargas, IGRAC; Kristina Schaufler, UBA; Andreas Scheidleder, UBA; Gvantsa Sivsivadze, Georgia; Arnaud Sterckx, IGRAC; Hassane Tahirou, Lake Chad Basin Commission; and Leyla Tagizadeh, Azerbaijan.

Furthermore, the Secretariat wishes to thank all participants at the 18th meeting of the Working Group on Monitoring and Assessment (Geneva, 17–18 October 2023) and the fifth joint meeting of the Working Groups on Integrated Water Resources Management (IWRM) and on Monitoring and Assessment (Geneva, 6–8 May 2024) for their feedback on the draft of the *Good Practices and Lessons Learned in Data-sharing in Transboundary Basins*.

Lastly, the Secretariat wishes to thank all the experts who provided written comments to the publication until the fifth joint session of the 10th session of the Meeting of the Parties to the Water Convention (Ljubljana, 23-25 October 2024):

Ajaz Ali, ICIMOD; Maria Apostolova, ACTO; Mohd Arshid, Ministry of Water and Irrigation, Jordan; Lamine Baba Sy, OSS; Macarena Bahamondes Ortiz, DIFROL, Ministerio de Relaciones Exteriores, Chile; Aleš Bizjak, Ministry of Natural Resources and Spatial Planning, Slovenia; Hastings Chibuye, ZAMCOM; John Chilton, Independent Expert; Juan Criado, UNESCO; Aurélien Dumont, United Nations Educational, Scientific and Cultural Organization (UNESCO); Dmitry Frank-Kamenetsky, HELCOM; Paul Haener, INBO; Anna-Stiina Heiskanen, Finnish Environment Institute; Nana Kitiashvili, NEA, Georgia; Fanny-Tsilla Koninx, Ministry for Europe and Foreign Affairs, France; Peter Kovács, Ministry of Interior, Hungary; Bo Libert, Independent Expert; Igor Liska, ICPDR; Alberto Manganelli, Regional Centre for Groundwater Management in Latin America and the Caribbean (CeReGAS); Ylber Mirta, Ministry of Environment and Physical Planning, North Macedonia; David Molefha, Ministry of Lands and Water Affairs, Botswana; Ngosa Howard Mpamba, Ministry of Water Development and Sanitation, Zambia; Norest Ndawana, Ministry of Lands, Agriculture, Fisheries, Water and Rural Development of Zimbabwe; Niokhor Ndour, Ministry of Water and Sanitation, Senegal; Viktor Novikov, Zoï Environment Network; Salome Oboladze, Ministry of Environmental Protection and Agriculture, Georgia; Washington Otieno, WMO; Jean-Noël Pansera, IMC; Maria Papaioannou, Hellenic Ministry of Environment and Energy, Greece; Marie-Amélie Pétré, Geological Survey of Finland; Kevin Pietersen, SADC-GMI; Roberto Adolfo Cerón Pineda, Ministry of Environment and Natural Resources, El Salvador; Oleg Podolny, KazHYDEC Ltd.; María Celeste López Quirós, Organization for Tropical Studies; Nina Raasakka, UNEP; Riadur Rahman, Joint Rivers Commission, Bangladesh; Phera Ramoeli, OKACOM; Ruth Richardson, International Network of Liberal Women; Alfonso Rivera, IAH Transboundary Aquifers Commission; Lotta Ruokanen, HELCOM; Annika Sallisalmi, Finnish-Swedish Transboundary River Commission; Mirza Sarač, ISRBC; Kristina Schaufler, UBA; Andreas Scheidleder, UBA; Christian Schilling, Austrian Ministry of Environment; Arnaud Sterckx, IGRAC; Tabea Stötter, ICPR; Claudia Strobl, German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection; Przemysław Susek, Chief Inspectorate for Environmental Protection, Poland; Francisco Taylor, Ministry of Environment, Panama; Sibylle Vermont, Federal Office for the Environment, Switzerland; Karen Villholth, Water Cycle Innovation; Stuart Warner, Global Environment Monitoring System for Water; Claire Williams, Earthwatch Europe; Tracy Zaarour, ESCWA; Kulpash Zhaken, IWAC; and Didier Zinsou, Niger Basin Authority.

At the Secretariat, Erik Aarnos and Iulia Trombitcaia coordinated the preparation of this publication, supported by Sonja Koeppel and Francesca Bernardini. Sara Datturi supported the process of case study collection as part of the Secretariat up until February 2023. John Sasuya and Cammile Marcelo provided administrative support throughout the process.

Finally, this publication would not have been possible without funding from Finland, Germany, the Netherlands, Sweden, Switzerland and the European Union. The secretariat would also like to acknowledge the support provided by all Parties and partners in providing financial and in-kind contributions to the work of the Water Convention.

While every effort has been made to recognize all contributors, the Secretariat offers its regrets to any individual or organization that has been overlooked above.

CONTENTS

LIST OF FIGURES

LIST OF MAPS

LIST OF CASE STUDIES

LIST OF CASE STUDIES

ACRONYMS AND ABBREVIATIONS

ACTO	Amazon Cooperation Treaty Organization
API	Application Programming Interface
BuPuSa	Buzi-Pungwe-Save
DSS	Decision Support System
ETL	Extract Transform Load
EU	European Union
GEF	Global Environment Facility
GIS	Geographical Information Systems
GGRETA	Governance of Groundwater Resources in Transboundary Aquifers
ICPDR	International Commission for the Protection of the Danube River
ICPR	International Commission for the Protection of the Rhine
IGRAC	International Groundwater Resources Assessment Centre
IMC	International Meuse Commission
ISRBC	International Sava River Basin Commission
IUCN	International Union for Conservation of Nature
IWAC	International Water Assessment Centre
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LIMCOM	Limpopo Watercourse Commission
MoU	Memorandum of Understanding
MCCM	Multi-Country Cooperation Mechanism
NGO	Non-governmental organization
NMHS	National Meteorological and Hydrological Service
OiEau	International Office for Water
OKACOM	Permanent Okavango River Basin Water Commission
OMVG	Organization for the Development of the Gambia River
ORASECOM	Orange-Senqu River Commission
RBO	River basin organization
SADC	Southern African Development Community
SADC-GMI	SADC Groundwater Management Institute
SAP	Strategic Action Plan
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
SIC-ICWC	Scientific Information Center of the Interstate Commission for Water Coordination in Central Asia
TNMN	TransNational Monitoring Network
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCWA	United Nations Economic and Social Commission for Western Asia
USAID	United States Agency for International Development
WFD	Water Framework Directive
WHOS	WMO Hydrological Observing System
WMO	World Meteorological Organization
WMS	Web Mapping Services
ZAMCOM	Zambezi Watercourse Commission
ZAMTEC	ZAMCOM Technical Committee Members

Lake Titicaca on the border of Bolivia and Peru

KEY MESSAGES

> *"Data- and information-sharing forms a common basis for transboundary cooperation, enables informed decision-making, builds trust between stakeholders and helps to maximize the benefits of cooperation over shared waters."*

Overview

1. Humanity is facing a triple planetary crisis of climate change, pollution and biodiversity loss. A key approach to mitigating the impacts of this triple crisis is sustainable water management. The foundation of sustainable water management is robust data and information. Data and information play a particularly important role in reducing the impact of extreme events such as floods and droughts, which are becoming more frequent due to climate change. As water flows do not adhere to administrative boundaries and because the elements of the triple planetary crisis are interrelated, sharing of data and information across political, sectoral, environmental and institutional boundaries is essential.

2. Countries worldwide have developed, or are developing, agreements and arrangements governing cooperation on water management for transboundary rivers, lakes and aquifers. Institutions, including joint bodies for transboundary water cooperation, implement these agreements. Under these agreements, countries and institutions develop and maintain data-sharing systems for their transboundary basins. In many cases, the first steps on sharing data and information occur even without formal agreements and lead to the strengthening of cooperation and, with time, the development of legal frameworks and joint institutions. The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) provides a legal framework for monitoring, assessment and exchange of information and data in transboundary basins. It also assists countries and joint bodies in implementing these obligations through its institutional platform.

3. This publication aims to identify, document and learn from various practices and experiences in transboundary basins. The examples presented span multiple regions of the world and address a variety of issues that can arise when working on data- and information-sharing. By illustrating how these difficulties may be overcome, this publication seeks to inspire other countries and basins dealing with similar issues. The following key messages emerge from the good practices and experiences showcased in this publication. For each key message, references are provided to the relevant lessons learned where more detailed information can be found accompanied by supporting case studies.

Key messages

A. Water management needs timely, targeted, sufficient, valid and reliable data

(Lessons 1 and 38–40)

4. Effective and sustainable water governance and water management at all levels need timely, targeted, relevant, sufficient, valid and reliable data and information. This necessity is heightened by the triple planetary crisis of climate change, pollution and biodiversity loss. Sharing data and information is a vital tool in the effective management of transboundary water resources and aquatic ecosystems. It enables assessments of the state of a given basin in its entirety as well as trends over time, including climate change impacts. Such data is essential for developing management strategies tailored to the specifics of each basin.

B. Data-sharing needs an enabling environment

(Lessons 2–9 and 41)

5. An enabling environment for data-sharing, including policy, legal, institutional, informational and financial arrangements, is necessary for the effectiveness and sustainability of data-sharing, and can subsequently significantly enhance transboundary water cooperation. This also includes the existence of adequate and continuous communication and cooperation channels. An open data approach is especially important in this regard. Conversely, inadequate funding often limits the collection and sharing of information. However, new technologies, such as improved remote sensing, drones and sensors, offer cost-effective solutions for riparian countries to collect and share data and information.

C. Groundwater data and information are crucial for effective water management

(Lesson 19)

6. Data and information on groundwater is generally more limited than surface water data, due to constrains in access to technologies for measuring and mathematically modelling this resource. This limitation undermines the role of groundwater in enhancing water security and resilience, especially in a transboundary context. Information is needed particularly on the interaction between surface and groundwater flows, and on the impact of saline intrusion from oceans on surface water and groundwater, especially in drought situations. Such information is also essential for the conjunctive management of surface water and groundwater, including in a transboundary context.

D. Build a common understanding of the functioning of the basin

(Lessons 10, 14, 17–18 and 22–23)

7. Good cooperation and joint management of a basin requires a common conceptual understanding of its functioning. This includes information on location and volume of water, origin of water, flow direction and rate, water quality, aquatic biodiversity, human influences on water quantity and quality, and different water uses. Moreover, information on planned measures and on pressures and sources of pollution (e.g. from industrial, municipal, agricultural or other sectors) is essential to understand potential anthropogenic impacts. The involvement of experts such as hydrologists and hydrogeologists is crucial for data interpretation.

E. Take a pragmatic and focused approach to monitoring

(Lessons 13, 15 and 25)

8. When developing or expanding a monitoring network, it is important to be pragmatic, focused and start with the most important issues and relevant indicators in a given basin. After establishing a routine and gaining experience with monitoring, scope can be expanded, according to staff and budget capacity.

F. Political will is essential

(Lessons 16 and 33–34)

9. A technical approach to the collection and sharing of data and information in transboundary basins is essential but must be accompanied by strong political will at all levels (local, regional, national and transnational). This is necessary for making the necessary policy decisions, concluding agreements and other arrangements for transboundary water cooperation, and establishing protocols for data- and information-sharing and for open access to data, as well as for stability and solidarity among riparian countries. Leadership is crucial to initiate and sustain cooperation, including for data and information-sharing. Basin organizations can support such leadership, by identifying common interests. Political commitment is also needed to secure government support for data and information collection and use in decision-making, including for joint (transboundary) and national strategies and plans. Target 6.5 of the Sustainable Development Goals, supported by indicator 6.5.2 and associated reporting, can help to consolidate political will towards this end.

G. Involve stakeholders

(Lessons 11–12, 35–36 and 42)

10. Water management requires cooperation between different sectors at different levels, from the national (e.g. ministries and research institutes) to the local (e.g. municipalities, farmers, local communities) and civil society. Stakeholders' interests, values, biases, preferences, backgrounds and cultural perspectives can vary significantly, especially in a transboundary cooperation situation. Therefore, all relevant sectors and groups need to be represented in the decision-making process, including when deciding what data and information are relevant. Stakeholders should organize themselves around the issues and be involved in the process of identifying relevant data and information for sustainable integrated water management. Capacity-building around this process is important to ensure all stakeholders have the same level of understanding. In addition, presenting and communicating data and information in an understandable way supports stakeholders' involvement in water management and transboundary water cooperation.

H. Collaborate across different levels and disciplines

(Lessons 20–21, 26–32, 37 and 43)

11. There are different approaches and techniques for collecting, analysing and disseminating data, as well as a range of definitions and standards that need to be harmonized in the context of data- and information-sharing in a transboundary basin. Models can assist in the analysis and evaluation of data and thus in harmonization. International standards, such as the World Meteorological Organization standards for hydrological and meteorological data, can also assist in harmonization. Collaboration at different levels and with different disciplines can help understand the context of results and thus increase the value of the data collected. However, this requires accessibility and comparability of data, as well as regular evaluation of the monitoring system.

I. Develop transboundary early warning mechanisms

(Lesson 24)

12. In order to take timely action, it is important for data and information on potential floods and droughts, as well as accidental pollution, to be shared among neighbouring countries as soon as possible. This will help reduce the risks associated with floods, droughts, water-related diseases, fish kills, and other threats. Developing transboundary early warning mechanisms ensures that the right information reaches the appropriate institutions and people quickly reducing exposure to risks.

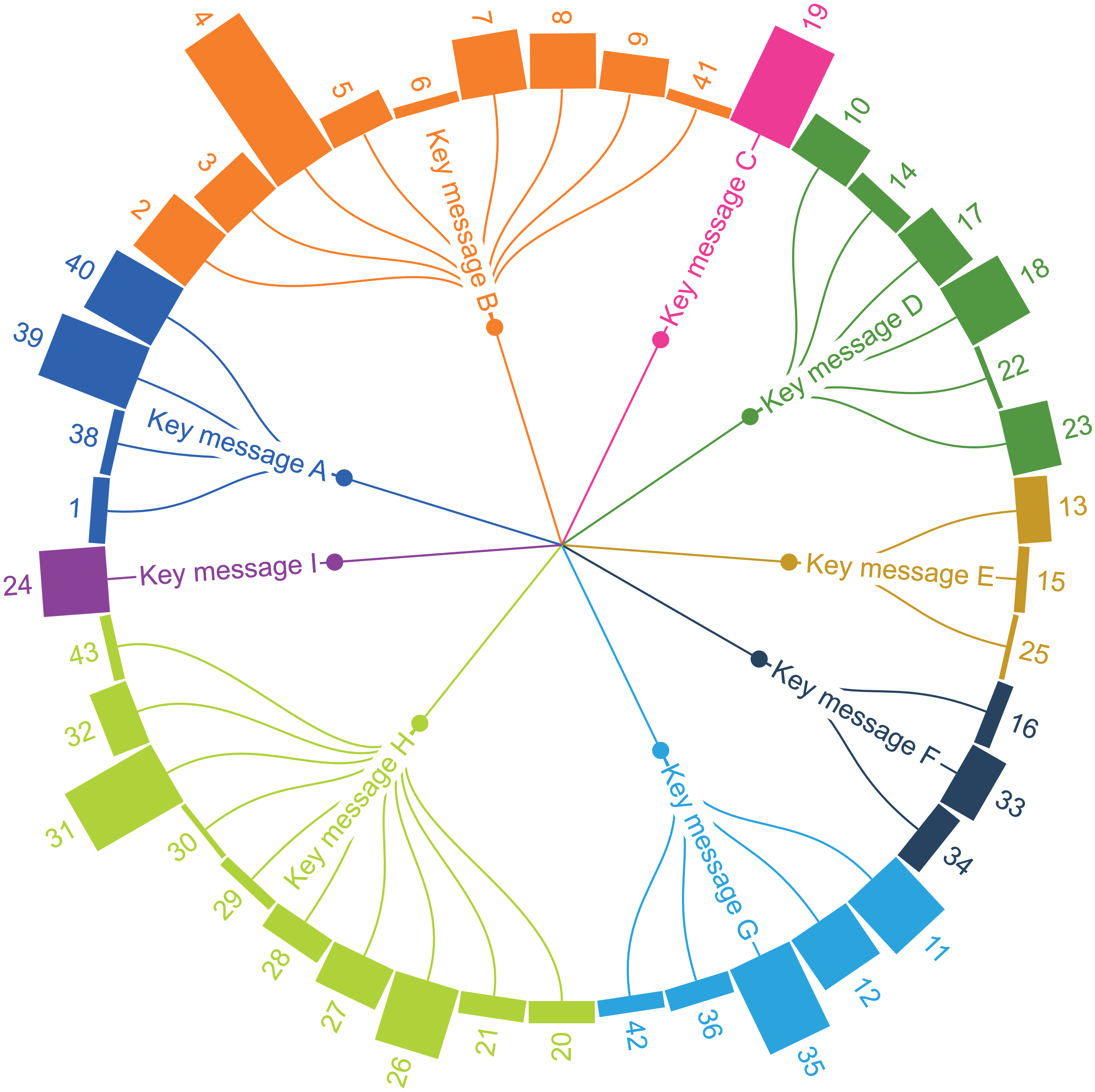
Benefits of regular and planned monitoring and data-sharing in transboundary basins

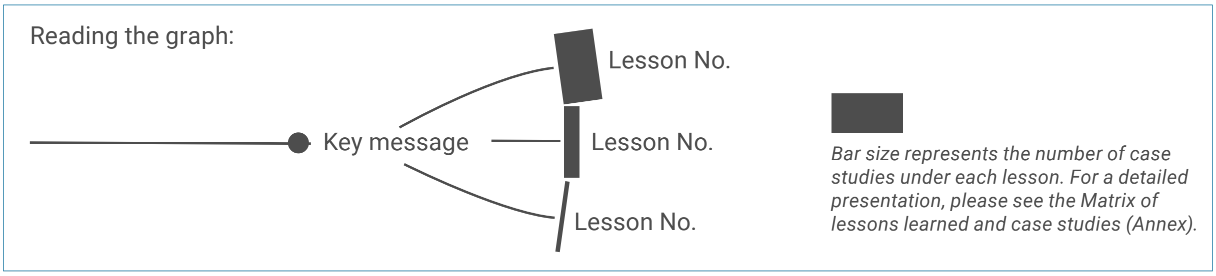
13. Developing and maintaining monitoring systems and sharing data in transboundary basins requires significant effort but yields numerous benefits. Countries featured in the following sections of this publication have identified many such benefits. In particular, monitoring and data-sharing:

- **a)** enable an assessment of the current state of a given basin in its entirety, as well as trends over time, allowing for the development of a management strategy that accounts for the basin's particularities;
- **b)** enable assessment of the impacts of climate change on the basin's water resources and the anthropogenic impacts on biodiversity and ecosystems, both locally and at the basin level;
- **c)** permit identification of current and emerging problems and impacts of human pressures in the basin;
- **d)** allow for an estimation of the flux of substances from transboundary rivers or groundwater to oceans;
- **e)** promote a common understanding among riparian countries of water management issues and allows for the development of water management and other measures that can strengthen efforts to address the various needs of water users, including ecosystems, in the basin;
- **f)** support increased transparency and mutual understanding, facilitating the building of trust among various actors in a transboundary context;
- **g)** strengthen rapid assessment and early warning capabilities for incidents (e.g. flood, drought and chemical spill) affecting transboundary basins;
- **h)** enable informed decision-making for the development and implementation of water management strategies and plans, joint sustainable projects, and evaluation of the effectiveness and efficiency of management and remediation activities.

Hardinge Bridge over the Padma River (Ganges) in Bangladesh

Lessons learned categorised by key message





Key message A: Water management needs timely, targeted, sufficient, valid and reliable data

Lesson 1. *Use basin management planning as a catalyst for developing monitoring and data-sharing systems*

Lesson 38. *Use data and information as the basis for conflict prevention*

Lesson 39. *Enable improved water management through information and data-sharing*

Lesson 40. *Improve awareness and strengthen transboundary cooperation through information and data-sharing*

Key message B: Data-sharing needs an enabling environment

Lesson 2. *Ensure political support for the monitoring and data-sharing system*

Lesson 3. *Embrace an open data approach to water data access*

Lesson 4. *Ensure clear mandates for data-sharing at bilateral or basin level*

Lesson 5. *Informal cooperation can still take place in the absence of a formal agreement*

Lesson 6. *Ensure adequate and continuous financing for monitoring and data-sharing*

Lesson 7. *Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible*

Lesson 8. *Create a specific working group responsible for monitoring as part of a joint commission's institutional framework*

Lesson 9. *Engage with key parties, including civil society, NGOs, and the private sector*

Lesson 41. *Ensure the availability of sufficient resources for information and data-sharing*

Key message C: Groundwater data and information are essential for proper water management

Lesson 19. *Include information on groundwater and other water resources to promote conjunctive water management*

Key message D: Build a common understanding of the functioning of the basin

Lesson 10. *Ensure an integrated and cross-sectoral approach for the monitoring system*

Lesson 14. *Engage with experts in institutional structures in charge of transboundary cooperation*

Lesson 17. *Raise awareness of the importance of acting at a basin-wide scale*

Lesson 18. *Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle*

Lesson 22. *Agree within joint bodies to progressively enlarge the types of data and information collected and shared*

Lesson 23. *Develop procedures for sharing data and information on planned measures*

Key message E: Take a pragmatic and focused approach to monitoring

Lesson 13. *Adopt a step-by-step and iterative approach to monitoring in the transboundary basin*

Lesson 15. *Build on local knowledge*

Lesson 25. *Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies*

Key message F: Political will is essential

Lesson 16. *Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking*

Lesson 33. *Disseminate information to all relevant sectors, ministries and the public*

Lesson 34. *Ensure the sharing of knowledge between technical specialists and decision makers*

Key message G: Involve stakeholders

Lesson 11. *Facilitate trust building and collaborative learning*

Lesson 12. *Support awareness raising and capacity development*

Lesson 35. *Ensure that the collected information serves better management through cooperation*

Lesson 36. *Develop a shared communication plan*

Lesson 42. *Build trust to enable information and data-sharing*

Key message H: Collaborate across different levels and disciplines

Lesson 20. *Support cooperation more flexibly and effectively through inter-agency cooperation programmes*

Lesson 21. *Apply citizen science to support information collection*

Lesson 26. *Harmonize data to facilitate comparability between countries*

Lesson 27. *Ensure regional coordination and technical cooperation*

Lesson 28. *Harmonize and integrate the use of models with measurements*

Lesson 29. *Perform joint monitoring to facilitate data harmonization*

Lesson 30. *Technical cooperation can be a springboard for multidisciplinary cooperation*

Lesson 31. *Build a common data repository, database, or information system*

Lesson 32. *Use models for assessment, interpretation and forecasting*

Lesson 37. *Establish mechanisms for regular review of the monitoring system (no case study available)*

Lesson 43. *Reduce the knowledge gap between countries to enable sharing of data and information*

Key message I: Develop transboundary early warning mechanisms

Lesson 24. *Develop a transboundary early warning system*

Chapter 1

Dniester River, shared by Ukraine and the Republic of Moldova

Introduction

1.1 Background and objectives

Clear and accurate data and information are key to the informed management of water resources. Their importance has been highlighted in the face of increasing climate change, pollution and biodiversity loss, three interlinked threats[1] which are further aggravated by demographic and economic growth. Each of these issues needs to be resolved if humanity is to have a viable future on this planet.

Water resources management can play a crucial role in addressing these issues due to the interlinkages between them: climate change negatively affects society largely through water-related events such as floods and droughts, water pollution limits the availability of freshwater and impacts ecosystems, and poor water management leads to a reduction in habitats and consequent biodiversity loss. Data and information about the water domain are therefore indispensable to confronting these threats.

In its Action Plan, the Water and Climate Coalition states that: "*Data and information are the foundation of climate smart sustainable development. We need data to understand how climate change is affecting our water systems; to understand where, how much, and in what quality water is and will be available. We need information to know where and how our actions can best support our access to the precious resource and protect us from water hazards and disasters.*"[2] This statement holds equally true for pollution and biodiversity issues.

When a basin[3] is shared between two or more countries, comparable and open data and information form the common basis for informed decision-making. Moreover, information and data-sharing play an important role in building trust, thus facilitating cooperation and conflict avoidance. This is recognized in Sustainable Development Goal (SDG) indicator 6.5.2, which includes the regular exchange of information between riparian countries among the operationality criteria for arrangements on water cooperation.

1 www.unfccc.int/news/what-is-the-triple-planetary-crisis, www.ipcc.ch/site/assets/uploads/2021/07/IPBES_IPCC_WR_12_2020.pdf and www.ipcc.ch/report/ar6/wg2/chapter/ccp1

2 www.unfccc.int/news/protect-our-people-and-future-generations-water-and-climate-leaders-call-for-urgent-action

3 In this report, "basin" refers to any body of water, including groundwater bodies, aquifers, lakes and rivers.

There is an urgent need, therefore, for well-organized monitoring programmes that provide relevant data and information enabling accurate assessments of the status of water resources and aquatic ecosystems and evaluations of the magnitude of water quality and quantity problems at the basin and sub-basin levels.

To support the development of monitoring programmes for transboundary basins, in 2006 the Working Group on Monitoring and Assessment under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) developed the Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters. In 2023, an updated version of these Strategies was published (Updated Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters),[4] providing a clear framework and describing the necessary steps for developing a monitoring programme in a transboundary setting.

To support countries in applying the Updated Strategies and establishing the means for data-sharing in transboundary basins, the Working Group on Monitoring and Assessment identified and collected relevant case studies. These examples illustrate the variety of ways in which monitoring programmes can be run and data-sharing introduced and enhanced in transboundary basins in different parts of the world. This collection of lessons learned and good practices focuses specifically on data-sharing between riparian countries.

This publication is based on the concept of **Integrated Water Resources Management (IWRM)**.[5] This concept, among others, implies the sharing of data on all relevant themes around water management (see, *inter alia*, Lesson 10 and Lesson 33) and that managing a basin includes managing both surface water and groundwater (Conjunctive Water Management),[6] while paying attention to the receiving water body (Source-to-Sea approach)[7] (see Lesson 18 and Lesson 19). Any data shared should support this integrated management.

By compiling, analysing and disseminating experiences, this publication identifies and illustrates important steps and lessons learned, as well as good practices, all of which should be considered when developing a monitoring programme for water management in a transboundary context and establishing information and data-sharing in transboundary basins. As the lessons only highlight specific elements, they should be considered in the broader context of the Updated Strategies. It should also be noted that not all lessons are applicable to all situations, as no one solution fits all, and that cultural, legal, institutional, political and other differences exist among countries.

---

4 www.unece.org/sites/default/files/2023-01/ECE_MP.WAT_70_ENG.pdf

5 IWRM is a process that promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (www.gwp.org/globalassets/global/toolbox/publications/background-papers/04-integrated-water-resources-management-2000-english.pdf).

6 Conjunctive Water Management is an approach to water resources management in which surface water, groundwater and other components of the water cycle are considered as one single resource, and therefore are managed in closest possible coordination, in order to maximize the overall benefits from water for the short and the long term (https://unesdoc.unesco.org/ark:/48223/pf0000375026.locale=en).

7 The Source-to-Sea approach recognizes that interventions on land and in rivers, lakes and aquifers can have impacts further downstream, along coasts and in the ocean (www.siwi.org/source-to-sea-platform).

Zelenci Springs, the source of Sava Dolinka River

A total of 78 case studies were collected from around the world and are included in the publication. Of the case studies, 20 cover Africa, 13 cover Asia, 34 cover Europe, 5 cover North America and 9 cover South America.[8] The real-life examples they encompass detail the difficulties and challenges faced by countries and the associated solutions and methods of organization that states and joint bodies have found useful. Several case studies were developed following the Regional Workshop on Monitoring, Assessment and Information Sharing in Transboundary Basins in Central Asia (Astana, 1-2 February 2023), organized by the International Water Assessment Centre (IWAC) in cooperation with GIZ, the main German development agency, and the Water Convention Secretariat. Additionally, several lessons learned were developed following the Workshop on Strengthening Legal and Institutional Arrangements for Transboundary Water Cooperation and Data Exchange (Beirut, 30-31 May 2023), organized by the United Nations Economic and Social Commission for West Asia (UNESCWA) in cooperation with UNECE and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The contents of this publication represent the collaborative efforts of many different actors who provided case studies and comments, as can be seen in the Acknowledgements.

8 Some case studies cover several regions.

1.2 Target audience

The target audience of this publication encompasses all those working on monitoring programmes and the sharing of data and information in transboundary[9] as well as national basins. These include joint bodies such as basin commissions and other institutions for transboundary cooperation as well as the national representatives in such joint bodies; the developers of monitoring strategies, especially in transboundary basins; decision makers; specialists working on monitoring and assessment in ministries; and other authorities, scientists and non-governmental organizations (NGOs).

1.3 Structure

This publication describes selected important lessons from experiences specifically in sharing data and information from monitoring programmes in a transboundary context and illustrates these with examples from all over the world. It is not intended as a handbook as it does not provide detailed instructions related to the development of monitoring programmes or the sharing of data and information. Instead, it aims to provide food for thought and inspire the development of monitoring programmes and the sharing of data and information.

The term **lesson learned** in this publication refers to a recommendation about a certain concept or approach derived from practical experience in a specific situation that has proven to be beneficial or effective. 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 in a particular context. Each case study highlights one or more lessons learned, as indicated in each case study. It should be noted that 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 and may not be valid in all situations. The case studies provide partial information and are illustrations with the purpose to inspire.

The publication is structured according to the logical steps in data-sharing as described in the Updated Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters,[10] starting with the overall monitoring and assessment context. Subsequent sections detail the various elements of developing data-sharing, including: the set up in which data-sharing takes place; the policy, legal and institutional aspects of information and data-sharing; the different types of data and information that are shared; different aspects of harmonization and quality assurance, how data are stored and managed; why and how they are reported; the impacts and benefits of data-sharing; and the main difficulties and challenges encountered during the process.

Annex 1 contains a matrix showcasing the relationship of each case study to the different lessons learned.

---

9 In this publication, "transboundary" refers to crossing national boundaries. Basins can also cross sub-national jurisdictions, such as state boundaries or province boundaries. Sharing of data between jurisdictions is also needed at the national level.

10 www.unece.org/info/publications/pub/375468

Orange River on the border between Namibia and South Africa

Map of case studies

78 case studies grouped according to water body and region, and linked to their corresponding key messages.

RIVERS

Africa

7. *Buzi, Pungwe and Save basins: The BuPuSa Data-sharing Protocol*
11. *Financing of the OKACOM data-sharing procedure*
13. *Extending the mandate of the Organization for the Development of the Gambia River*
21. *Zambezi Watercourse Information System*
22. *Data-sharing in the Buzi, Pungwe and Save basins*
38. *Transboundary citizen science water quality monitoring for SDG 6.3.2 in Kenya and Tanzania*
40. *ZAMCOM procedures for notification of planned measures*
47. *Development of a hydrological cycle observation system in the Nile River basin*
49. *Sharing data in the Niger River basin*
52. *The OKACOM Decision Support System*

Asia

3. *Ganga/Ganges Water Sharing Treaty*
25. *Monitoring cooperation between Tajikistan and Uzbekistan*
27. *Step-by-step development of activities of the Kazakhstan-Uzbekistan Working Group on Environmental Protection and Water Quality in the Syr-Darya River basin*
33. *Basin-wide information from the Upper Indus Basin Network (UIBN)*
36. *Cooperation through inter-agency programmes between hydromets in Central Asia*
39. *Working Group on Environmental Protection in the Chu and Talas River basins*
43. *Development of Early Warning Bulletins in the Amu Darya and Syr Darya River basins*
50. *Cooperation in monitoring of transboundary basins between China and Kazakhstan*
78. *Main challenges to strengthening data-sharing at the regional level in Central Asia*

North America

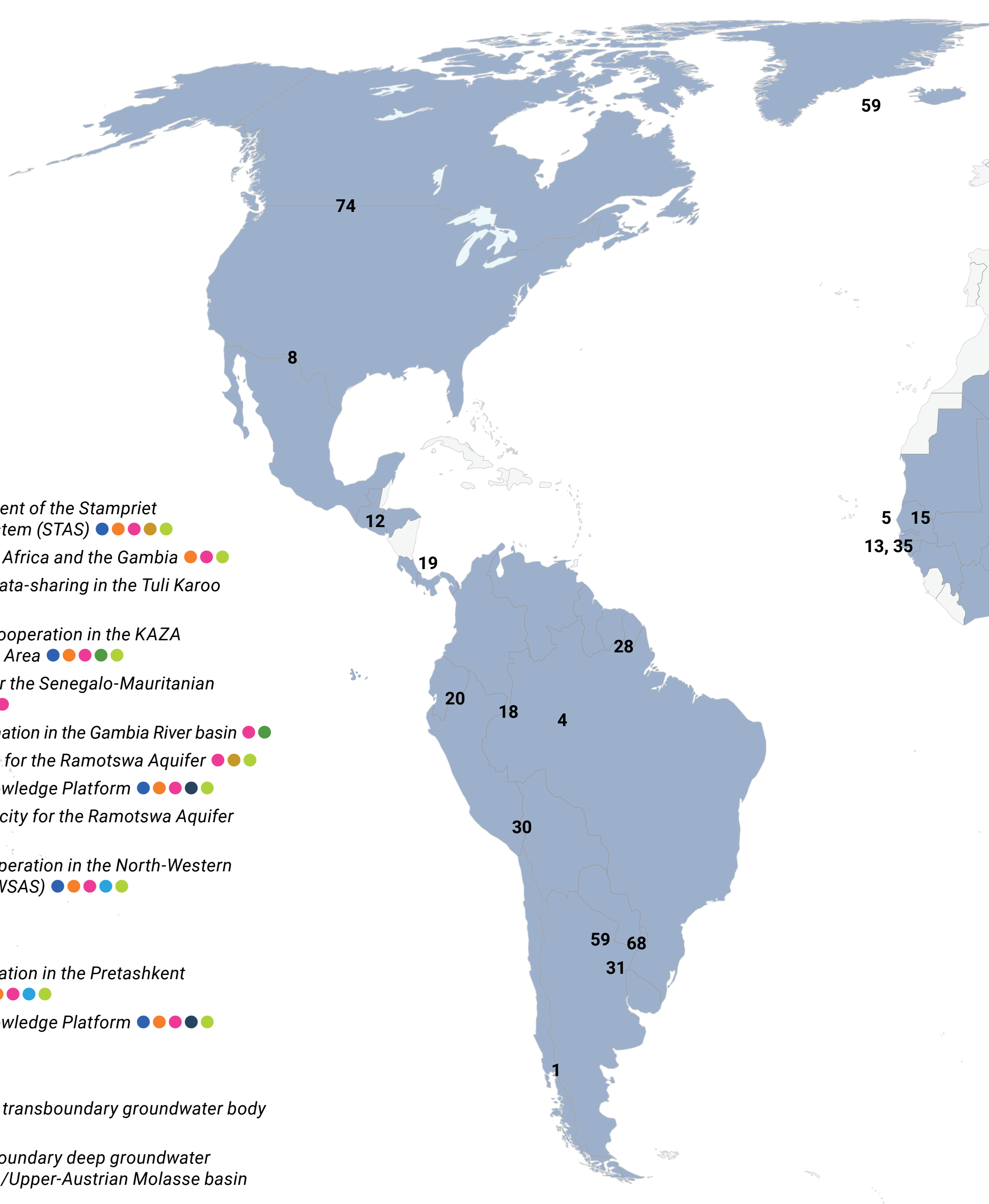
19. *Involving Indigenous populations in the Sixaola basin*
59. *A global portal and framework for international data exchange: the WMO Hydrological Observing system (WHOS)*

South America

1. *Sharing of information between Chile and Argentina*
4. *The Amazon Regional Observatory*
20. *Environmental priorities in recent transboundary water agreements between Ecuador and Peru*
28. *Extension of monitoring in the BIO-PLATEAUX project*
31. *Supporting decision-making in the River Plata basin*
59. *A global portal and framework for international data exchange: the WMO Hydrological Observing system (WHOS)*

Europe

10. *Financing data-sharing in the Sava River basin*
16. *"Hydrology" Working Group of the International Meuse Commission*
17. *Harmonization of data for the International Commission for the Protection of the Rhine (ICPR)*
24. *Building multiple transboundary relationships: the experience of Hungary*
26. *Capacity development by the International Meuse Commission*
34. *Pollution prevention in the Meuse and Scheldt River basins*
37. *Involving citizens in data collection: Drinkable Rivers*
41. *Regular reporting on water quality in German-Polish border waters*
42. *Early warning systems in Georgia*
44. *Emergency pollution notification for transboundary waters shared by the Republic of Moldova and Ukraine*
45. *Flood forecasting in the Meuse River basin*
48. *Coordination on the environmental status assessments of shared transboundary surface waters between Austria and Germany*
51. *Coordination and cooperation in the International Commission for the Protection of the Rhine (ICPR)*
54. *Joint monitoring in the Dniester and Prut River basins by the Republic of Moldova and Ukraine*
55. *Joint Danube Surveys*
57. *The Drin Information Management System*
59. *A global portal and framework for international data exchange: the WMO Hydrological Observing system (WHOS)*
60. *The Rhine Alarm Model*
61. *Integrated information system in the Sava River basin*
62. *Stakeholder participation in the International Commission for the Protection of the Rhine (ICPR)*
64. *Data-sharing for improved water management in the Oder/Odra River basin*
65. *Joint research and monitoring data on fish stocks by Finland and Sweden: the key to sustainable management of migrating salmon in the Torne River*
66. *Pollution load control in the Baltic Sea catchment area*
67. *A shared communication plan for the Danube*
70. *Improved water management in the Rhine River*
71. *Benefits from cooperation in the Sava River basin: the perspective of Bosnia and Herzegovina*
73. *Developing transboundary water quality monitoring of the Teno River*
75. *ICPDR data-sharing in the Danube River basin*



GROUNDWATER

Africa

2. *Governance and management of the Stampriet Transboundary Aquifer System (STAS)*
5. *Open data access in South Africa and the Gambia*
9. *Informal information and data-sharing in the Tuli Karoo Aquifer*
14. *A mechanism for aquifer cooperation in the KAZA Transfrontier Conservation Area*
15. *Regional Working Group for the Senegalo-Mauritanian Aquifer Basin (SMAB)*
35. *Sharing groundwater information in the Gambia River basin*
46. *Machine learning analytics for the Ramotswa Aquifer*
58. *The Arab Groundwater Knowledge Platform*
76. *Limited management capacity for the Ramotswa Aquifer*
77. *Trust-building through cooperation in the North-Western Sahara Aquifer System (NWSAS)*

Asia

56. *Sharing of data and information in the Pretashkent Transboundary Aquifer*
58. *The Arab Groundwater Knowledge Platform*

Europe

23. *Sharing information on the transboundary groundwater body Karavanke*
29. *Management of the transboundary deep groundwater body in the Lower-Bavarian/Upper-Austrian Molasse basin*
69. *Dialogue to address pressing challenges in the Genevese Aquifer*

North America

8. *Informal cooperation on transboundary aquifers along the Mexico-U.S.A. border*
12. *Developing cooperation on the Ocotepeque-Citalá Transboundary Aquifer (OCTA)*
74. *Informal cooperation on hydrogeological assessments of the Milk River Transboundary Aquifer*

South America

18. *Towards binational monitoring of the transboundary aquifer system in Leticia-Tabatinga (Colombia and Brazil)*
68. *Preventive diplomacy on the Guaraní Aquifer System*

LAKES

Asia

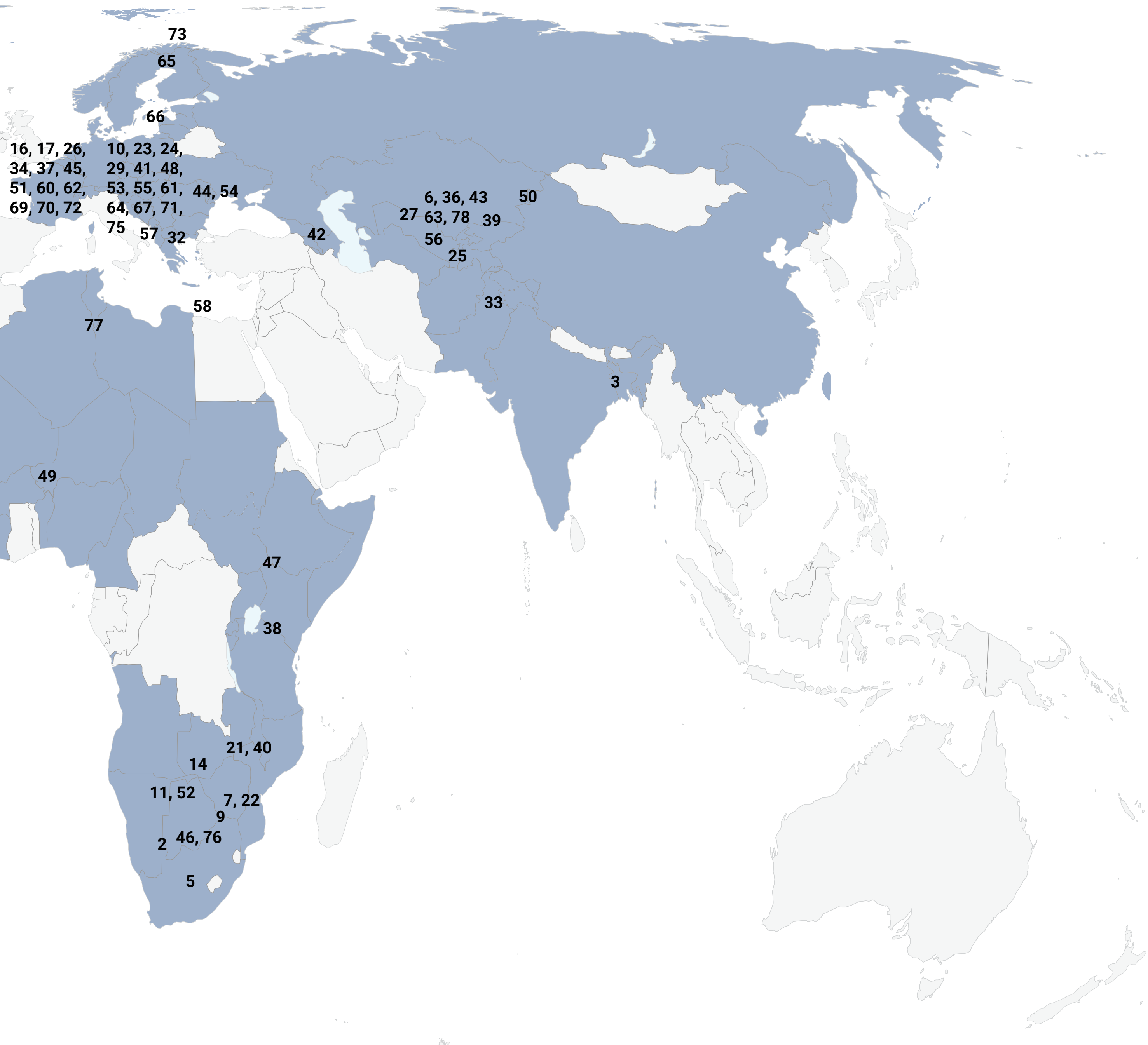
6. *Legal mandates for information and data-sharing in the Aral Sea basin*
63. *Information-sharing in the Aral Sea basin*

Europe

32. *Design and pilot application of a transboundary monitoring scheme for the Prespa Lakes basin*
53. *Reconciling water balance data in Lake Fertő*
72. *International Convention for the Protection of the Waters of Lake Geneva*

South America

30. *Promotion of Indigenous ancestral knowledge to facilitate transboundary water negotiations in Lake Titicaca*



Countries / Areas reflected in the case studies

Key messages

A: Water management needs timely, targeted, sufficient, valid and reliable data ●

B: Data-sharing needs an enabling environment ●

C: Groundwater data and information are crucial for effective water management ●

D: Build a common understanding of the functioning of the basin ●

E: Take a pragmatic and focused approach to monitoring ●

F: Political will is essential ●

G: Involve stakeholders ●

H: Collaborate across different levels and disciplines ●

I: Develop transboundary early warning mechanisms ●

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

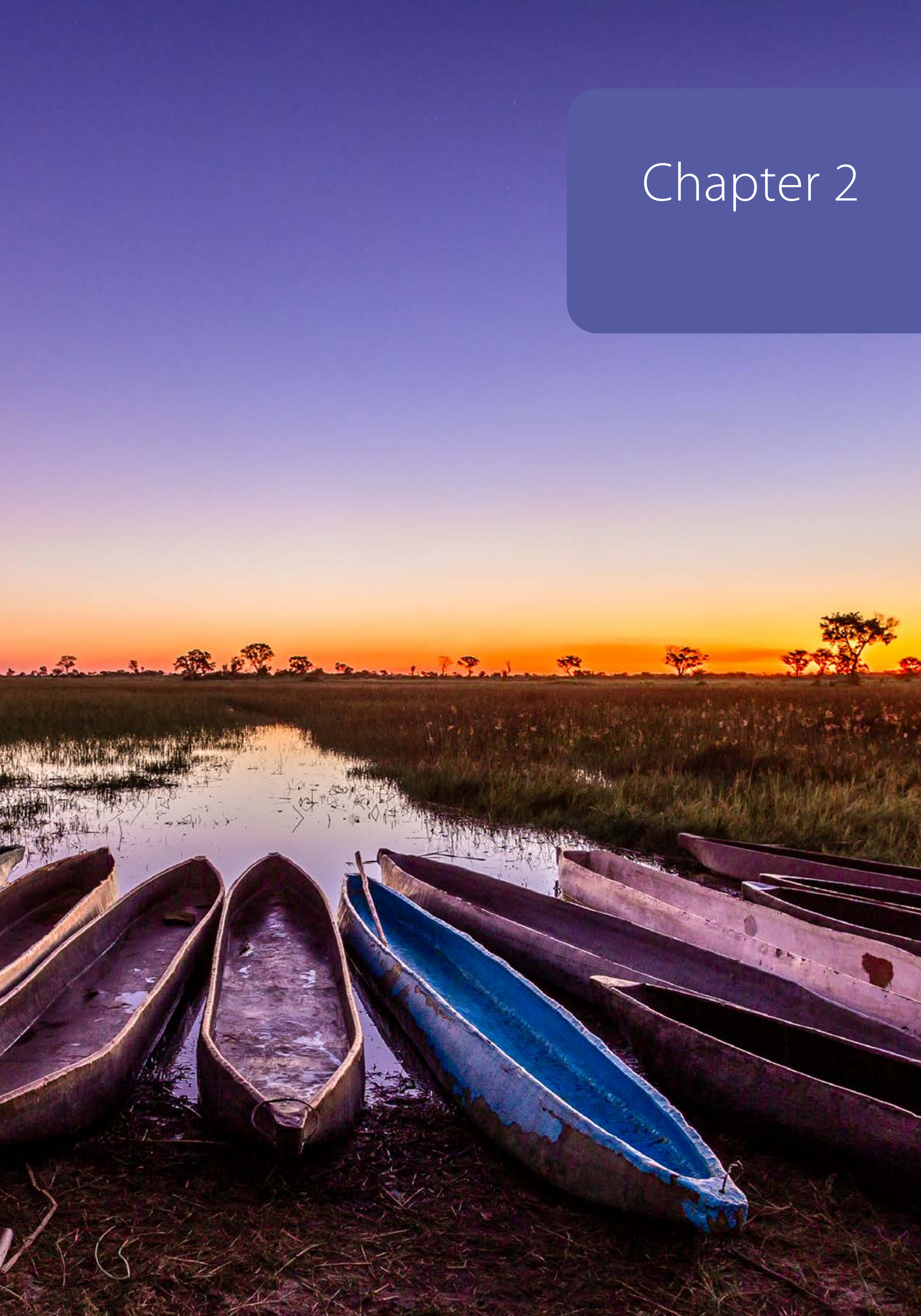
Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

Okavango River in Botswana

Chapter 2



Monitoring and assessment context

Finding common ground and emphasizing similarities instead of differences between institutions and countries is essential to the pursuit of sustainable IWRM. The sharing of information helps to identify this common ground. Political support is also necessary to develop and maintain monitoring systems as well as share the resulting data and information. Such support can be laid down in formal agreements or may take the form of informal support for cooperation.

Mandates for the monitoring and sharing of data should be accompanied by adequate funding. Sustainable financing of monitoring systems is crucial to be able to identify trends and changes over time and, therefore, to single out the effects of policies and measures. A step-by-step approach in developing and extending the monitoring and sharing of information is recommended to enable a process of transparency and trust building. Experiences show that joint study trips, workshops and discussions encourage cooperation among participants within countries as well as across transboundary basins.

The basin forms a natural unit for IWRM in which rivers, lakes and groundwaters interact with each other and with other ecosystems. The whole basin including the receiving water bodies should be considered when developing a monitoring system. A monitoring system should therefore take into account both the Conjunctive Water Management[11] approach and the Source-to-Sea approach.[12]

Groundwater monitoring is often more complex than surface water monitoring. Groundwater systems are three-dimensional, usually complex environments, with limited observation points (springs, wells), whose assessment usually requires expensive and long-term efforts. Relevant experts, like hydrogeologists, should therefore be engaged on a permanent basis within the structures responsible for transboundary cooperation (e.g., river basin organizations, joint bodies).

11 www.iwlearn.net/gwcwmhub

12 www.siwi.org/source-to-sea-platform

Lesson 1 Use basin management planning as a catalyst for developing monitoring and data-sharing systems

Countries developing cooperation agreements for basin management planning often face the problem of a weak data and information base. Establishing such agreements can therefore involve developing monitoring and data-sharing systems. Basin management planning can function as a catalyst for developing monitoring and data-sharing. Conversely, data-sharing can help improve cooperation by building trust.

Case studies that cover this lesson: Case study 1, Case study 2, Case study 12 and Case study 61.

Case study 1 Sharing of information between Chile and Argentina

Lessons learned covered in this case study: Lesson 1, Lesson 10 and Lesson 18.

Within the framework of the Protocol on Shared Water Resources, Argentina and Chile share information on three transboundary basins: Río Valdivia, Río Puelo and Río Baker. In 1991, the two countries signed the "Environmental Treaty and the Additional Specific Protocol on Shared Water Resources". The Protocol establishes a Working Group within the framework of the Environment Subcommittee, a body that in turn forms part of the Chilean-Argentine Binational Commission (Art. 12 of the 1984 Peace and Friendship Treaty).

Article III of the Treaty, on "Means", encompasses the "Sharing of technical-scientific information, documentation and joint research".

Article 8 of the Protocol indicates that: "the execution of the actions and programs referred to in this Protocol will be carried out, mainly, through:

a) Sharing of legal, institutional, technical-scientific information, documentation and research.

b) Organization of seminars, symposiums and bilateral meetings of scientists, technicians and experts."

Article 5 of the Protocol establishes that General Utilization Plans are the management instrument agreed between the countries for the shared and integrated management of water resources.

In 2019, both countries shared spatial information related to the above-mentioned basins including: national political-administrative limits, basin hydrography, the location of glaciers and protected natural areas, in addition to the location of meteorological, fluviometric, water quality and glaciological stations.

This information is intended to build a shared atlas of the basins, and to ensure the availability of fundamental and basic information to reach an agreement on a General Utilization Plan for each prioritized basin.

Source: Case study provided by Macarena Bahamondes, National Department of State Borders and Boundaries of Chile (DIFROL), 2022.

Lake General Carrera, shared by Argentina and Chile

Case study 2 Governance and management of the Stampriet Transboundary Aquifer System (STAS)

Lessons learned covered in this case study: Lesson 1, Lesson 8, Lesson 13, Lesson 19 and Lesson 31.

The Stampriet Transboundary Aquifer System (STAS) is located entirely within the Orange-Senqu River basin, in an area shared by Botswana, Namibia and South Africa. The Orange-Senqu River Commission (ORASECOM) is the institution responsible for managing the resources of the river basin. The governments of Botswana, Lesotho, Namibia and South Africa formalized ORASECOM by signing the Agreement for the Establishment of the Orange-Senqu River Commission on 3 November 2000 in Windhoek, Namibia. The 2000 Agreement states, "The Parties shall exchange available information and data on the hydrological, hydrogeological, water quality, meteorological and environmental status of the river system (Article 7.4)". The Convention also states that, "The Council of Commissioners shall take all necessary measures to make recommendations or to advise the Parties on matters such as the standardized form of collection, processing and dissemination of data or information relating to any aspect of the river system (Article 5.2.5)". Each Party is responsible for monitoring activities on its territory. Riparian states are also responsible for installing, operating and maintaining all monitoring and recording equipment on their territory.

In 2017, the riparian countries sharing the STAS agreed to establish a Multi-Country Cooperation Mechanism (MCCM) for the joint governance and management of the aquifer and nest it within the existing ORASECOM structure. The STAS MCCM was created within the framework of the project "Governance of Groundwater Resources in Transboundary Aquifers (GGRETA)" and implemented by UNESCO's Intergovernmental Hydrological Programme (UNESCO-IHP), in close partnership with national counterparts and with the support of the Swiss Agency for Development and Cooperation (SDC). The MCCM comprises three National Focal Points per riparian country: one hydrogeology/model focal point, one legal/institutional focal point and one gender focal point. The focal points assist and report to ORASECOM's Groundwater Hydrology Committee (GWHC), which oversees and advises the Technical Task Team of ORASECOM on issues related to developing and managing the water resources of the Orange-Senqu River basin, including groundwater. The hosting of MCCM within the GWHC illustrates the feasibility and importance of African river basin organizations (RBOs) as institutions providing an enabling institutional structure to guide cooperation on shared groundwater resources management. The STAS model has since become a catalyst for establishing additional transboundary aquifer coordination mechanisms in southern Africa.

The long-term vision of Botswana, Namibia and South Africa is to achieve permanent institutionalized cooperation whereby the principal function of the MCCM, through ORASECOM, is to advise countries and engage in joint strategizing on the management of aquifer resources in the region. To facilitate this, the GGRETA project supported the co-development of a "STAS Wide Strategic Action Plan (SAP)" in 2021. The SAP proposes projects and management actions to address identified priority problems and achieve sustainability goals for the aquifer. Priority activities within the SAP include setting up a groundwater level monitoring network to assess the aquifer's status and enhance groundwater data-sharing by the member states. The plan also identifies priority monitoring sites and suggests a set of objectives for transboundary monitoring of groundwater levels and groundwater quality. The shared data feed into the existing ORASECOM Water Information System (WIS)[13] and also form part of the GGRETA Information Management System.[14] A comprehensive document on the rules and procedures for sharing data on transboundary aquifers and other types of data and information, including those provided in the 2000 Agreement, is being prepared.

The GGRETA project has also performed an assessment to support the improvement of data-sharing and monitoring frameworks in ORASECOM, with a focus on the STAS. The assessment includes a report on the status and trends of groundwater resources in the aquifer, updating the inventory of groundwater data available as of 2022.[15] Furthermore, the assessment provides a baseline and a template for future annual reporting periods by the GWHC, identifying gaps to be filled to improve monitoring. The following national governmental institutions acted as focal points during GGRETA and continue to be key stakeholders in leading the efforts in data-sharing and monitoring: the Ministry of Land Management; Water and Sanitation Services of Botswana; the Ministry of Agriculture, Water and Land Reform of Namibia; and the Department of Water and Sanitation of South Africa.

Source: Case study prepared by Karen Villholth, Water Cycle Innovation; Kevin Pietersen, SADC-GMI; and Rapule Pule, ORASECOM, 2023.

13 www.wis.orasecom.org

14 www.un-igrac.org/resource/ggreta-information-management-system-ims

15 https://unesdoc.unesco.org/ark:/48223/pf0000375026.locale=en

Lesson 2 Ensure political support for the monitoring and data-sharing system

Political will is an important prerequisite for cooperation and can be fostered by incorporating water as an element of regional cooperation and integration. Political support is important for a monitoring system due to the longer-term commitment required. Involving policymakers in guiding the establishment of the system and articulating the benefits and common interests of data and information at the basin level, will help build political support. A policy for information and data-sharing, and a resulting monitoring system that generates sound information, will provide a solid basis for negotiations among riparian countries, including options for upstream-downstream trading and compensation mechanisms.

Case studies that cover this lesson: Case study 3, Case study 6, Case study 7, Case study 15, Case study 24, Case study 25, Case study 27, Case study 38, Case study 61, Case study 66, Case study 70 and Case study 77.

Case study 3 Ganga/Ganges Water Sharing Treaty

Lessons learned covered in this case study: Lesson 2, Lesson 35 and Lesson 39.

The Ganga/Ganges River is shared between Bangladesh and India. In Bangladesh, the Joint Rivers Commission is responsible for data-sharing; in India, the Central Water Commission is the responsible institution. The governments of both countries signed the "Ganges Water Sharing Treaty, 1996"[16] on 12 December 1996 for a period of 30 years. The treaty addresses the sharing of water during the dry season, between 1 January and 31 May, thus providing support to the respective commissions in both countries.

The Joint Rivers Commission in Bangladesh is responsible for the monitoring and sharing of the Ganga/Ganges Waters at the Farakka Barrage in India. Monitoring takes place at the Hardinge Bridge in Bangladesh. All expenses related to information and data-sharing are borne by the respective governments. The data shared include total observed flow, flow released to Bangladesh, flow released to India and water level.

Data are collected by a joint observation team consisting of team members from both countries. Data are shared every year in the form of a report.

In Bangladesh, the data are stored at the Joint Rivers Commission Office and can be accessed by the public via a website,[17] with an annual report prepared each year. Decision makers are informed about the recommendations of the report.

Source: Case study provided by Md. Riadur Rahman, Joint Rivers Commission, Bangladesh, 2022.

16 www.ssvk.org/koshi/reports/treaty_on_farakka_india_bangladesh_4_ganga_river_water.pdf

17 www.jrcb.gov.bd

Lesson 3 Embrace an open data approach to water data access

"Open data is data that is openly accessible, exploitable, editable and shared by anyone for any purpose".[18] Open data can facilitate transparency, accountability and public participation. International experience shows that the more "open" data are, the more economic and social benefit is created. It is therefore recommended to consider an open data approach when establishing access arrangements for water data.[19]

Case studies that cover this lesson: Case study 4, Case study 5, Case study 25, Case study 28, Case study 58, Case study 59, Case study 61, Case study 74 and Case study 75.

Case study 4 The Amazon Regional Observatory

Lessons learned covered in this case study: Lesson 3, Lesson 23, Lesson 24 and Lesson 31.

The Amazon River basin is the largest basin in the world, covering more than 6 million km², and is shared between Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela. The eight Amazon countries are members of the Amazon Cooperation Treaty Organization[20] (ACTO), which was created in 1998 as a permanent forum for cooperation, exchange and information, based on the Amazon Cooperation Treaty, signed in 1978. Since 2002, the organization has a Permanent Secretariat located in Brasilia, Brazil. A Strategic Action Programme (SAP) for the Integrated Management of Water Resources in the Amazon basin was developed and adopted by the riparian states in 2017.

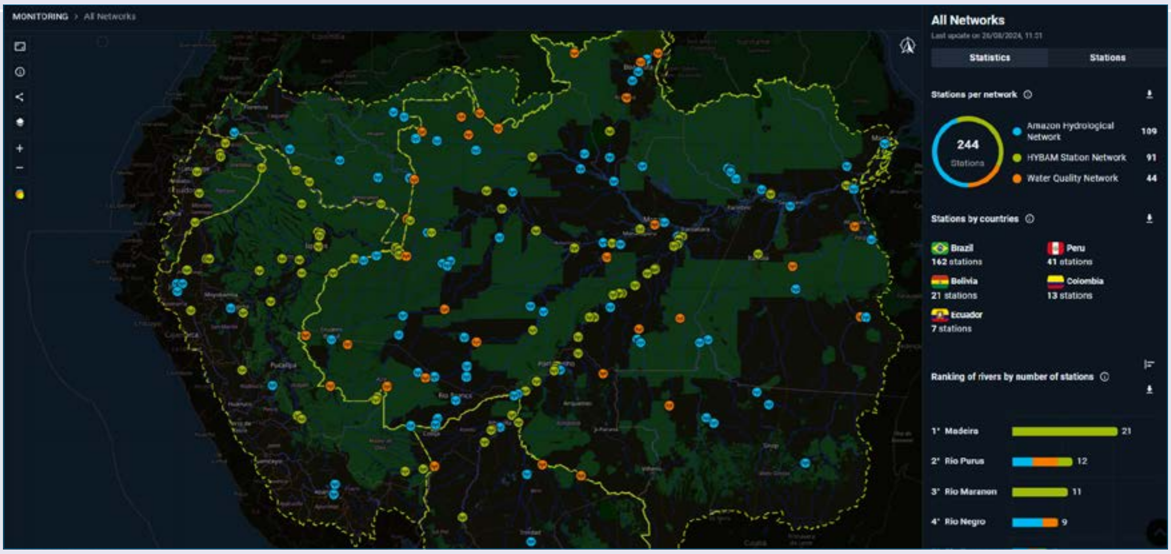
The SAP recommended the establishment of regional monitoring networks incorporating hydro-meteorological, water quality, ETA (Erosion, Transport and Sedimentation) and groundwater elements as well as an Integrated Water Resources Information System, a strengthening information exchange mechanism between the national institutions responsible for the management of water resources. In 2021, consistent with its broad vision of regional integration of information, ACTO inaugurated the Amazon Regional Observatory (ORA), an information reference centre and permanent virtual forum that facilitates the flow and exchange of information on the Amazon (see *Figure 4.1*). The Observatory hosts the Amazon Hydrological Network, which monitors the water balance and exchange of water between the countries based on 343 monitoring stations, and the Regional Network for Water Quality Monitoring, for which the eight countries have agreed to exchange information on water quality parameters defined in relation to SDG indicator 6.3.2.

18 www.euarenas-toolbox.eu/glossary-term/open-data/

19 www.en.unesco.org/science-sustainable-future/open-science/recommendation and www.wmo.int/wmo-unified-data-policyresolution-res1

20 www.otca.org/en

Figure 4.1 Monitoring stations in the Amazon Hydrological Network



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: Permanent Secretariat of the Amazon Cooperation Treaty Organization (PS-ACTO), accessed in August 2024.

Currently, data-sharing in the Amazon draws on the budget of the Permanent Secretariat of the Amazon Cooperation Treaty Organization (PS-ACTO) and the resources of the "Amazon Project – regional action in the area of water resources", an example of cooperation between the National Agency for Water and Basic Sanitation of Brazil (ANA) and the Brazilian Cooperation Agency (ABC). Data shared include hydrometeorological monitoring of river levels and flows, water quality monitoring and critical situations (floods and droughts). Collection of data is undertaken by the hydrological and water quality monitoring networks of the eight countries. A diagnosis of the hydrological and water quality monitoring protocols in riparian countries has been conducted and a proposal for a standardized protocol for the Amazon basin was prepared and submitted to the states.

The data are shared via online access to the information systems of the riparian countries and the joint database of the Amazon Regional Observatory of the PS-ACTO, which is publicly accessible via the website of the Amazon Regional Observatory.[21] Hydrological data are shared every hour and water quality data every seven days. The data can be downloaded by API (Application Programming Interface) in Excel, JPEG and CSV formats.

A Water Resources Situation Room has been created within the PS-ACTO (see *photo*) and will develop drought and flood early warning bulletins and reports for decision makers and the public. This regional Situation Room will be connected to a network of National Water Situation Rooms, to be established under the ongoing Amazon SAP Implementation Project (ACTO/UNEP/GEF).

21 www.oraotca.org

Water Resources Situation Room within the PS-ACTO

Photo credit: Permanent Secretariat of the Amazon Cooperation Treaty Organization (PS-ACTO), 2023.

The first *Water Quality Report of the Amazon Basin* was launched by ACTO during a side event of the United Nations Water Conference in March 2023.[22] The report highlights the main pollution sources and their impact on water bodies.

The operation and expansion of the hydrological and water quality monitoring networks depends on the institutional strengthening of national monitoring and information systems, and on long-term financial support, taking into consideration the costs of monitoring and the countries' budget constraints.

Source: Case study provided by Maria Apostolova, Amazon Cooperation Treaty Organization (ACTO), 2023.

22 www.unesco.org/en/articles/enhancing-cooperation-and-integrated-water-management-amazon-river-basin

Case study 5 Open data access in South Africa and the Gambia

Lessons learned covered in this case study: Lesson 3, Lesson 19 and Lesson 31.

South Africa is a water-stressed country where groundwater contributes significantly to rural and urban water supply, as well as irrigation. An estimated 80,000 to 100,000 boreholes are drilled each year. The Department of Water and Sanitation collects a large amount of data of various types, such as borehole data and groundwater monitoring data. The groundwater level monitoring network comprises approximately 1,800 observation wells that are monitored on different monitoring frequencies.

Since June 2010, groundwater data have been available for download from the National Groundwater Archive (NGA).[23] The NGA is an online, centralized database where everyone can register, for free, to access groundwater data. The NGA is a main component of the National Groundwater Information System, a responsibility of the Department of Water and Sanitation, as set forth by the "National Water Act", established in 1998.

The database currently comprises more than 293,000 information points, such as boreholes, dug wells, seepage ponds, springs and so on. Data can be captured and edited from the regional offices of the Department of Water Sanitation and several registered partner institutions. Several filters are available to browse through the desired datasets, and data linked to monitoring water levels can be visualized in chart form.

Currently, an average of 500 users consult the NGA every month, with that number trending upwards. Data are used for a broad range of applications in water management and environmental protection by public institutions as well as the private sector. They are particularly useful for siting new wells. Data have also proved instrumental for the assessment of river basins and aquifers shared with neighbouring countries. The management of these transboundary resources requires groundwater and other water data to be shared between riparian states. The NGA has proved particularly helpful in this regard and may inspire similar initiatives in neighbouring countries.

The Gambia is a small West African country of 10,700 km^2, with an estimated population of 2.6 million. The country is surrounded by Senegal. As its name indicates, it is located on the lower stretch of the Gambia River, which is located at sea level, making it vulnerable to seawater intrusion. Water is saline up to 250 km from the mouth of the river, which corresponds to the western half of the country, where most of the people live.

The salinity of surface water makes the Gambia particularly dependent on fresh groundwater, which is found at shallow depths throughout the country. Sustainable groundwater management is therefore a priority, and active measures are required to prevent anthropogenic contamination, over-abstraction or seawater intrusion into the aquifers.

Since 2014, the Department of Water Resources of the Gambia has operated a groundwater monitoring network of about 35–40 observation boreholes, most of which are equipped with automatic data loggers. Nearly half of the monitoring boreholes are concentrated in the capital city area, where population density and industrial activity are highest, while the rest are equally distributed eastward at intervals of 35 km throughout the north and south bank of the country.

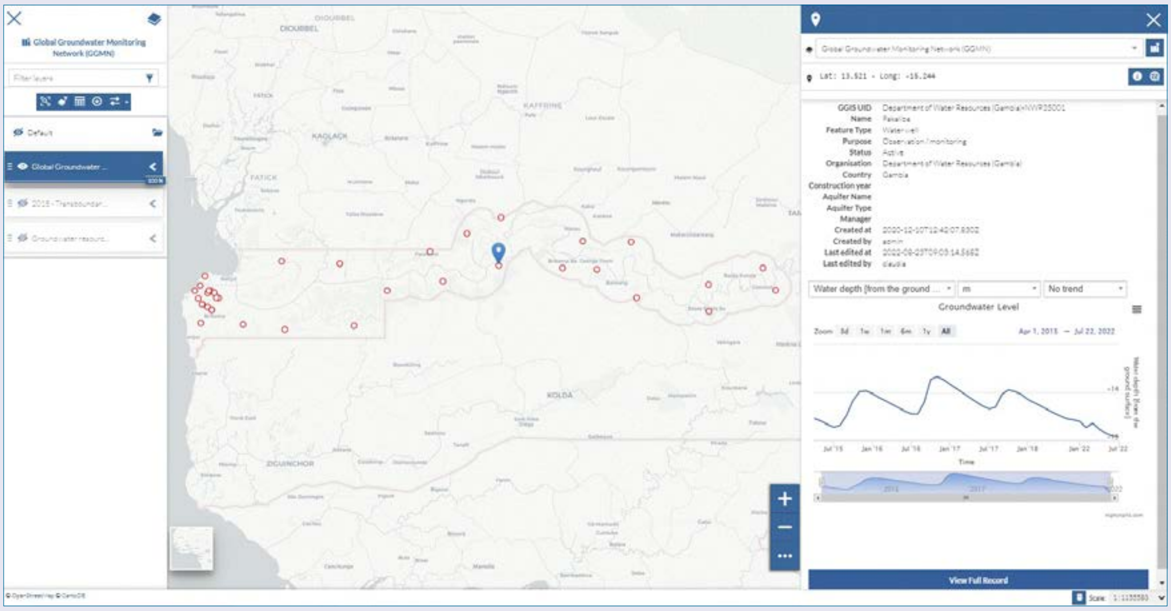
---

23 www.dws.gov.za/NGANet

Groundwater level data, groundwater quality data and borehole data are collected and managed by different units, across different ministries. The same holds for surface water data and meteorological data. Data-sharing is therefore necessary to ensure efficient water management. However, the plan to set up a national information system has not yet materialized, and data-sharing remains a challenge.

To move forward, the division in charge of the groundwater monitoring network decided to share the available data via the Global Groundwater Information System (GGIS),[24] an online platform operated by the International Groundwater Resources Assessment Centre (IGRAC), where hydrogeological maps, borehole data and groundwater monitoring data can be shared and made accessible to all, for free (see *Figure 5.1*). Groundwater monitoring data from the Gambia has been accessible since 2018.

Figure 5.1 **Overview of the Gambia in the Global Groundwater Information System**



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: www.un-igrac.org/special-project/ggmn-global-groundwater-monitoring-network, accessed in April 2024.

Source: Case study provided by Arnaud Sterckx, International Groundwater Resources Assessment Centre (IGRAC), 2023.

24 www.ggis.un-igrac.org

Lesson 4 Ensure clear mandates for data-sharing at bilateral or basin level

Many basins lack agreements and legal frameworks for the sharing of data and information. This absence of a formal structure makes it difficult to share data and information. The basic obligation of riparian countries to share data and information needs to be stipulated in intergovernmental agreements on transboundary water cooperation at bilateral and/or basin level, in order to provide the mandate for national institutions to share information and for joint bodies to collect, process and disseminate such information. Data- and information-sharing may be further specified in other technical documents such as monitoring programmes, technical regulations on information or data-sharing, and statutes and regulations of joint bodies or their working groups. Agreements should be developed in such a way that they can be supplemented by more detailed technical documents or protocols. Furthermore, agreements should not be a limiting factor to the level of cooperation.

Case studies that cover this lesson: Case study 6, Case study 7, Case study 10, Case study 12, Case study 13, Case study 16, Case study 19, Case study 20, Case study 22, Case study 23, Case study 24, Case study 27, Case study 28, Case study 30, Case study 31, Case study 36, Case study 40, Case study 41, Case study 44, Case study 49, Case study 50, Case study 52, Case study 53, Case study 54, Case study 61, Case study 64, Case study 65, Case study 66, Case study 71 and Case study 73.

Case study 6 Legal mandates for information and data-sharing in the Aral Sea basin

Lessons learned covered in this case study: Lesson 2, Lesson 4 and Lesson 13.

For over 30 years, five Central Asian states of the Aral Sea basin (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) have cooperated within the framework of a regional organization, the International Fund for Saving the Aral Sea, and its institutions the Interstate Commission for Water Coordination of Central Asia (ICWC) and the Interstate Commission for Sustainable Development of Central Asia (ICSD). The main institutions for data-sharing are the Basin Water Management Organizations for Amu Darya and Syr Darya, and the Scientific and Information Center of ICWC (SIC ICWC).[25]

Provisions on information sharing have been included in the constituent documents of regional organizations such as the Intergovernmental Agreement on Cooperation in the Field of Joint Management on Utilization and Protection of Water Resources from Interstate Sources (1992), relating to both surface- and groundwater, and the Statute of the ICWC (1992, revised in 2008), both signed by the five states. They were further detailed in decisions of the ICWC.

In 2005, the ICWC adopted the "Temporary Rules for the Use of the Regional Information System on Water and Land Resources of the Aral Sea Basin". In 2014, the ICWC approved the "Concept Document on the Development of an Information Network on Water Management in Central Asia". The latter describes a step-by-step approach to developing databases and information systems at the national, basin and regional levels, while relying on existing resources and infrastructure.

Source: Case study provided by Dinara Ziganshina, Scientific Information Center of the Interstate Commission for Water Coordination in Central Asia (SIC-ICWC), 2022.

25 www.icwc-aral.uz

Save River in Mozambique

Case study 7 Buzi, Pungwe and Save basins: The BuPuSa Data-sharing Protocol

Lessons learned covered in this case study: Lesson 2 and Lesson 4.

The Mozambique-Zimbabwe Joint Water Commission is mandated to arrange the sharing of data and information on water resources between the two countries. However, the frequency and type as well as quality of data to be shared is not well defined in the Joint Water Commission Agreement. Accordingly, the two countries have signed water-sharing agreements for the Pungwe (2016), the Buzi River (2019) and the Save (2023). All these agreements contain an annex on Data-sharing. The two countries, with support from the Buzi-Pungwe-Save (BuPuSa) project of the Global Environment Facility (GEF), have developed a Data-sharing protocol entitled "Rules and Procedures between the Republic of Zimbabwe and the Republic of Mozambique on the Sharing of Data and Information Related to the Development and Management of the Buzi, Pungwe and Save Watercourses". The Data-sharing Protocol has been approved by the Joint Water Commission and will come into force once it has been signed by the Ministers responsible for water from both countries.

The responsible institution for the BuPuSa Data-sharing Protocol is the Mozambique-Zimbabwe Joint Water Commission, with support from the Regional Administration of Southern Waters (ARA Sul, Administração Regional de Águas do Sul) and the Zimbabwe National Water Authority.

Currently, the responsibility for financing data collection lies with the member states. In Zimbabwe, the cost of data collection is recovered by selling data to the public as well as other institutions. This approach, however, is not applicable where data are shared by riparian countries. In Mozambique, a Memorandum of Understanding (MoU) has been signed between water institutions and meteorological institutions allowing free access to hydrological/water quality data.

In July 2023, the Buzi, Pungwe, and Save Watercourses Commission (BUPUSACOM) was launched and tasked with planning, development, and management of the water resources within the three river basins.

Source: Case study provided by Loreen Katiyo, Global Water Partnership Southern Africa (GWPSA), 2023.

Lesson 5 Informal cooperation can still take place in the absence of a formal agreement

Cooperation is necessary for proper management but does not always require a formal agreement. For example, experts and academia from riparian countries can take steps to share data and information. However, a formal agreement provides better guarantees for data-sharing than informal relationships between experts.

Case studies that cover this lesson: Case study 8, Case study 9, Case study 14, Case study 33, Case study 74 and Case study 76.

Case study 8 Informal cooperation on transboundary aquifers along the Mexico-U.S.A. border

Lessons learned covered in this case study: Lesson 5, Lesson 7, Lesson 10, Lesson 19, Lesson 31 and Lesson 34.

Several aquifers have been identified along the border between Mexico and the United States of America. However, only limited data are available to verify how many of them are transboundary.

The Binational Groundwater Task Force (BGTF)[26] is part of the Permanent Forum of Binational Waters between Mexico and the United States of America and is composed of experts and academics from both countries. In the absence of a formal agreement, mandate or committed funds, this informal arrangement enables members of the BGTF to discuss issues and agree matters on a voluntary basis, with potential interest from projects and funding possibly arriving later. On average, the BGTF meets virtually once a month.

Initially, data are shared by direct exchange only among members of the BGTF network. Data and existing information are then standardized, and inconsistencies removed. The information and knowledge generated with this framework will then be published as white papers, scientific papers and synthetic plain language reports, addressing mainly decision makers. There is no protocol on timing; the sharing is based on activities assigned or required by the members and the expected outcomes. Data are stored in the database of the Permanent Forum of Binational Waters by members of the BGTF network.

This cooperative endeavour is intended mainly to provide a consistent quantitative framework for identifying transboundary groundwater issues based on shared indicators, a factual set of baseline conditions and a clear set of objectives that are accepted by all major stakeholders, governmental and non-governmental entities along the Mexico-U.S.A. border, with a view to guiding diplomatic discussions. The BGTF believes that enabling information and data-sharing will build trust.

26 www.binationalwaters.org/programs-and-initiatives/binational-waters-task-force

Data and information include:

- monitoring data of water quantity and quality of transboundary groundwater;
- information on best available technology;
- results of relevant research and development;
- national regulations;
- hydrogeological characteristics of transboundary aquifers (TBAs);
- identification of potential common TBA issues such as:
  - main aquifer stressors, and/or transboundary effects, driven by demographic growth, economic integration, hydro-social conflicts, differences in governance regimes and climate change
  - intensive use, unsustainable water-use practices and overexploitation of groundwater in the Mexico/United States of America TBAs
  - different water-management and governance approaches
  - increasing water threats and conditions for water conflicts
- design of specific metrics to identify the common TBA issues listed above.

The BGTF plans to provide all analyses produced with processed data and generated information to the members of the Permanent Forum of Binational Waters, the International Boundary Waters Commission (IBWC), the Comisión Internacional de Limites y Agua (CILA), and states and federal governments as policy briefs, data production reports, joint publications and so on. Information is made publicly available once it is integrated and reported properly.

Source: Case study provided by Alfonso Rivera, International Association of Hydrogeologists' Transboundary Aquifers Commission and Rosario Sanchez, Texas Water Resources Institute, 2022.

Case study 9 Informal information and data-sharing in the Tuli Karoo Aquifer

Lessons learned covered in this case study: Lesson 5, Lesson 7, Lesson 19 and Lesson 39.

The Tuli Karoo Aquifer is shared between Botswana, South Africa and Zimbabwe. The institutions responsible for monitoring and data-sharing are the Department of Water and Sanitation (Botswana), the Department of Water and Sanitation (South Africa) and the Zimbabwe National Water Authority. There is no joint body overseeing cooperation and management associated with the aquifer, although the Groundwater Committee of the Limpopo Watercourse Commission (LIMCOM) plays a significant role in coordinating activities on transboundary aquifers in the Limpopo River basin at large supported by the Southern African Development Community Groundwater Management Institute (SADC-GMI). Three transboundary aquifers have been identified in the basin: the Ramotswa Aquifer (Case study 76), the Tuli Karoo and the Limpopo Aquifer basin.

The area is semi-arid and water availability, particularly surface water, is variable and scarce. Groundwater is thus a primary source of water for domestic and agricultural use by the largely rural communities. With growing climate impacts, such as protracted droughts, use of groundwater will increase, requiring more concerted management across borders. Adequate data that inform decision makers on water availability are an important prerequisite for the sustainable management of shared aquifers. An extensive study on the shared aquifer was therefore undertaken, bringing together water officials from the three countries to discuss the potential of the aquifer to provide water and food security for the approximately 2 million people who depend on this resource.[27]

There is currently no formal agreement in place between the countries on data-sharing. However, within the scope of the project "Conjunctive Surface-Groundwater Management of SADC's Shared Waters: Generating Principles through Fit-for-Purpose Practice", funded by the United States Agency for International Development (USAID) and led by the International Water Management Institute (IWMI), a consensus was reached to pilot the installation of sensors and data loggers (for measuring and storing data on electrical conductivity, water level and groundwater temperature) and to informally share data groundwater data, in particular on water levels, among the countries.[28] The equipment was provided by UIT GmbH (Dresden, Germany), a private sector specialist in monitoring and telemetry. The online system and data loggers were purchased through project finance.

Equipment was installed and data were collected through existing borehole infrastructure (monitoring boreholes). A study on designing a strategic transboundary aquifer monitoring network of wells (giving the optimal number and location of monitoring boreholes) was conducted by IWMI, and it was found that 58 monitoring boreholes would ideally be needed to produce meaningful information across the aquifer. In 2020, a total of four existing boreholes in Botswana and South Africa were equipped with sensors and data loggers (CTD-GPRS system), where pressure is automatically converted to water level.[29] Wireless data transmission in real time (daily, with half hour frequency) uses cloud-based telemetry, with data accessible via a web browser on a computer or smartphone.[30] Access is limited to government officials, and the data are not publicly available.

Currently, the system is not in use, but there is potential for it to be revitalized and expanded according to specifications. It would require a financial and technical commitment on the part of the three countries to sustain the system and generate the required data in response to specific needs. As the pilot was project-funded, there was no financial obligation on the countries. More concrete cooperative arrangements will therefore need to be agreed to support the viability of the monitoring system, which would include the maintenance of the monitoring boreholes and joint data analysis. Arrangements should also be made to migrate the system to existing LIMCOM or SADC-GMI data/information platforms.

Source: Case study provided by Karen Villholth, Water Cycle Innovation, based on reports by IWMI, 2023.

27 www.conjunctivecooperation.iwmi.org/wp-content/uploads/sites/38/2021/06/TuliKarooTDA-compressed.pdf

28 www.conjunctivecooperation.iwmi.org/wp-content/uploads/sites/38/2022/02/Groundwater-monitoring-in-the-Tuli-Karoo-Transboundary-Aquifer-Area.pdf

29 www.conjunctivecooperation.iwmi.org/wp-content/uploads/sites/38/2021/03/GroundwaterMonitoringTuliKarooFINAL.pdf

30 www.agrilinks.org/post/achieving-sustainable-resource-use-measuring-what-you-manage-groundwater-monitoring-shared-tuli

Lesson 6 Ensure adequate and continuous financing for monitoring and data-sharing

Regular and long-term monitoring is important for trend analysis, climate change assessment, biodiversity change assessment and aquifer monitoring. Monitoring therefore requires long-term commitment and funding in order to develop a good, common understanding of the water situation and to identify trends. One approach is to develop a joint monitoring system including data-sharing, with funding from various sources including riparian states and donors. In particular, improvement of a monitoring system and the development of new methods or hardware can be supported by external sources. The overall operation of the monitoring system is most secure if it is funded from domestic sources. Instead of a joint monitoring system, data from the respective national monitoring systems can be shared.

Case studies that cover this lesson: Case study 10 and Case study 11.

Case study 10 Financing data-sharing in the Sava River basin

Lessons learned covered in this case study: Lesson 4, Lesson 6 and Lesson 24.

The Sava River basin is shared between Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, and a small part of northern Albania. Cooperation between these countries has been established on the basis of the Framework Agreement on the Sava River Basin (FASRB),[31] with implementation coordinated by the International Sava River Basin Commission (ISRBC),[32] whose permanent secretariat serves as the executive body. The Parties to the FASRB are Bosnia and Herzegovina, Croatia, Serbia and Slovenia. Montenegro cooperates with the ISRBC based on a Memorandum of Understanding (MoU). The ISRBC meets at least twice a year, and the Parties to the FASRB congregate in principle every two years at the Meeting of the Parties, reporting to all relevant sectors, ministries and the public on a regular basis.

The mandate for cooperation in data-sharing at the basin level is described in a number of legal frameworks, notably the "Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin",[33] the "Policy on the Exchange and Use of Sava GIS Data and Information",[34] and the "Memorandum of Understanding on Cooperation Concerning Regular Functioning and Maintenance of the Flood Forecasting and Warning System in the Sava River Basin".[35]

31 www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/fasrb.pdf

32 www.savacommission.org/sava-commision/structure-and-functioning/sava-commission/239

33 www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/dataexchangepolicy_en.pdf

34 www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/savagis_datapolicy_v1.0_and_annexes_final.pdf

35 www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/memo_of_understanding_on_savaffws.pdf

The general financing of ISRBC activities follows established financial rules. ISBRC expenditures linked to regular activities are covered by the General Fund, which is derived from mandatory annual contributions by the Parties, established on an equal basis from miscellaneous income. The expenditures include salaries and allowances for Secretariat staff, current costs, travel expenses, operational costs and equipment. Funds required to maintain the budget balance draw on the *Reserve Fund*. Finally, the *Special and Trust Fund* receive grants from a variety of organizations and make payments for projects not covered by the regular budget.

The Special and Trust Fund also receives annual contributions to ensure regular maintenance and controlled performance of the joint Flood Forecasting and Warning System in the Sava River Basin (Sava FFWS).[36] The contributions are paid on an equal basis by signatories to the Sava FFWS MoU, with the exception of Montenegro, which contributes half of the annual contribution paid by each of the countries.

Data-sharing activities are funded by the Special and Trust Fund, among others, and linked to project-based funding. Monitoring and data-sharing, modelling and forecasting activities are financed mainly through grants from the European Commission and the Western Balkans Investment Framework, as well as from funding the US Government and other organizations.

As the operational integrated information system (Sava GIS, Sava HIS, Sava FFWS) (Case study 61) requires continuous and regular maintenance and support, the financing of these activities also benefits the Special Fund.

Long-term plans to improve data-sharing, modelling and forecasting, as well as to install new software and hardware, are supported through financing by the World Bank, GEF and the Special Climate Change Fund under the Integrated Development Programme for the Sava and Drina River Corridors.

Source: Case study provided by Mirza Sarač, International Sava River Basin Commission (ISRBC), 2024.

Case study 11 Financing of the OKACOM data-sharing procedure

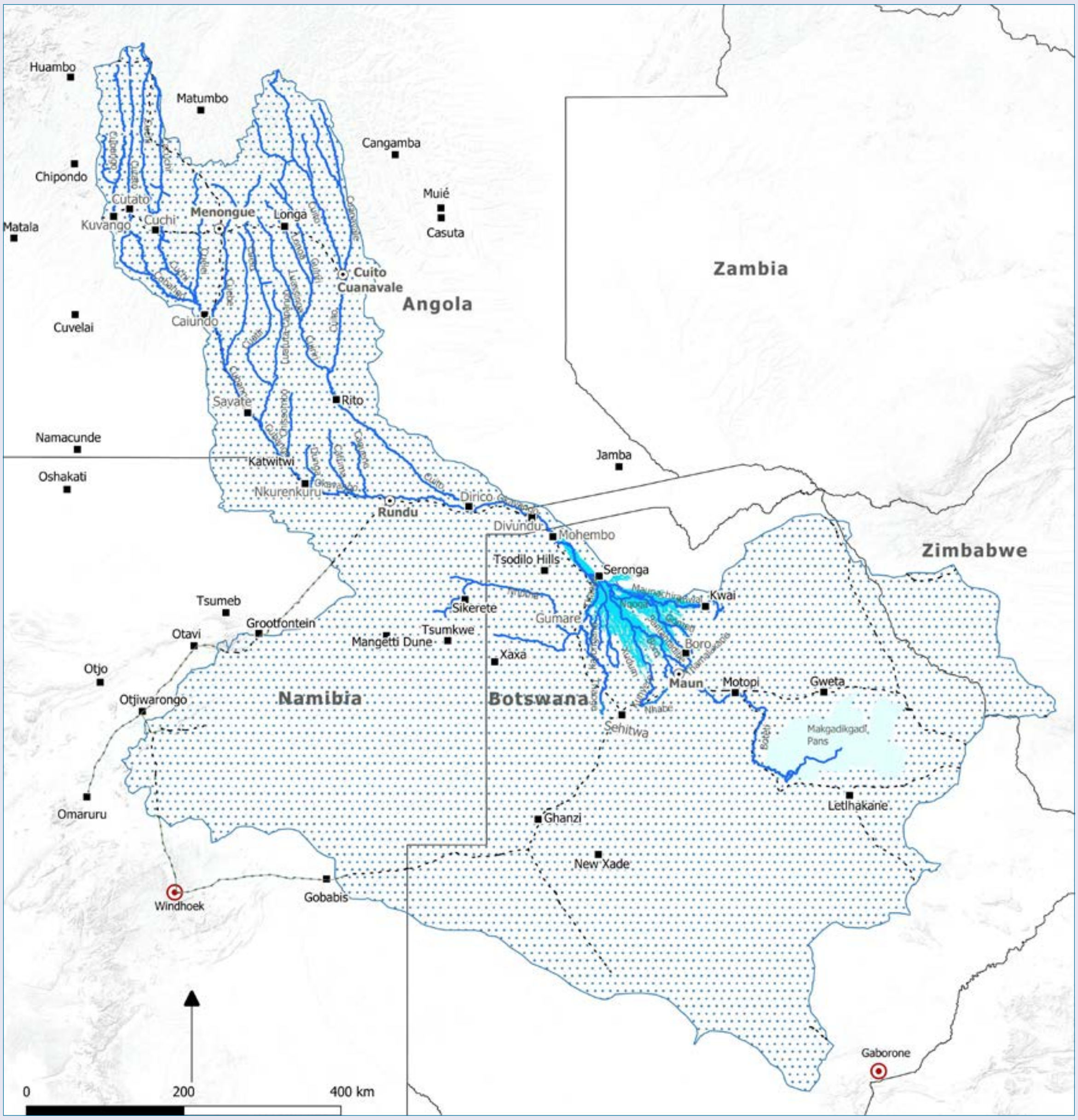
Lessons learned covered in this case study: Lesson 6 and Lesson 26.

The Cubango-Okavango River basin is shared between Angola, Botswana and Namibia (see *Map 11.1*). Cooperation and shared basin resources management are facilitated through the Permanent Okavango River Basin Water Commission (OKACOM).[37] Statistical agencies in the member countries are the primary national institutions mandated with documenting, storing and distributing national data. The responsible institutions for water resources/basin data in the three countries are the Office for the Administration of the Cunene, Cubango and Cuvelai Watersheds (*Gabinete para Administracão das Bacias Hidrográficas do Cunene, Cubango e Cuvelai*) in Angola; the Department of Water and Sanitation in Botswana; and the Department of Water Affairs in Namibia.

36 www.savacommission.org/flood-forecasting-and-warning-system/579

37 www.okacom.org

Map 11.1 The Cubango-Okavango River basin



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: Mukendoyi Mutelo, 2021. Available at: www.okacom.org/cubango-okavango-river-basin-corb.

Each member state finances data collection activities as part of usual departmental activities. From time to time, International Cooperative Partners (ICP) also support joint data collection and basin-wide monitoring field excursions, contributing significantly to data availability, especially on ungauged streams.

Source: Case study provided by Phera Ramoeli, Permanent Okavango River Basin Water Commission (OKACOM), 2022.

Lesson 7 Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible

Where a mechanism for cooperation exists, either formalized or informal, and is focused either on a basin or on water resources cooperation in general, such a mechanism can be used to extend and improve cooperation on data-sharing. An RBO is an obvious example of such a mechanism, but other arrangements can also serve transboundary cooperation.

Case studies that cover this lesson: Case study 8, Case study 9, Case study 12, Case study 13, Case study 14, Case study 15, Case study 38, Case study 43, Case study 56, Case study 68 and Case study 76.

Case study 12 Developing cooperation on the Ocotepeque-Citalá Transboundary Aquifer (OCTA)

Lessons learned covered in this case study: Lesson 1, Lesson 4, Lesson 7, Lesson 9, Lesson 10, Lesson 17, Lesson 19, Lesson 31, Lesson 35 and Lesson 40.

The Ocotepeque-Citalá Transboundary Aquifer (OCTA) is shared between El Salvador and Honduras and is located in the upper part of the Lempa River basin, within the larger Trifinio Region, shared between El Salvador, Guatemala and Honduras. Between 2013 and 2022, the General Directorate of Water Resources of Honduras and the Ministry of Environment and Natural Resources of El Salvador collaborated on the OCTA within the framework of the GGRETA project, implemented by UNESCO-IHP in close partnership with the International Union for Conservation of Nature (IUCN), IGRAC and national counterparts, with the support of the SDC.

National government institutions actively engaged in this process, especially in the areas of capacity strengthening, awareness raising and knowledge generation. They shared data about the OCTA, including for a multidisciplinary assessment aimed at understanding the aquifers' hydrology, hydrogeology, stakeholder interests, pollution issues, and legal and institutional frameworks.[38] These data became part of the OCTA database, which will serve as a basis for future transboundary monitoring in the OCTA. The data also form part of the GGRETA Information Management System.[39]

The above activities strengthened dialogue on the OCTA among a variety of stakeholders in the region, leading to a consensus that challenges related to groundwater quantity and quality in the aquifer need to be addressed with a basin-wide and participatory approach. While the OCTA is shared between the two states of El Salvador and Honduras, transboundary groundwater exchange may still occur among all three states through connected surface water (the Lempa River),[40] illustrating the critical need for conjunctive assessment and management of surface water and groundwater in transboundary settings.

38 www.unesdoc.unesco.org/ark:/48223/pf0000245263

39 www.un-igrac.org/resource/ggreta-information-management-system-ims

40 www.groundwatercop.iwlearn.net/gefgwportfolio/ggreta/trifinio

In 2019, a Statement of Intent[41] was signed by representatives of the OCTA stakeholders: the governments of El Salvador and Honduras, the Trinational Commission of Plan Trifinio (CTPT),[42] municipalities located in the OCTA area of both countries, water boards and the association of municipalities (Mancomunidades) of the Trifinio Region. The Statement represents their commitment to create a joint governance structure tasked with cooperation on the sustainable management of shared water resources associated with the OCTA. This emphasizes the collection of data and the compilation of information necessary for the management of water resources in the OCTA, and the sharing of information among all stakeholders.

Building upon the Statement of Intent, the stakeholders co-developed a policy instrument (a joint roadmap) in 2022 to aid materialization of the objectives, identifying key actions to guide the binational management of the OCTA. The roadmap includes a strategic line focusing on the generation, dissemination and use of hydrogeological knowledge for participatory management of the aquifer. Activities include setting up a monitoring network to fill important knowledge gaps necessary to achieve integrated management of groundwater and surface water. The roadmap also proposes to integrate its strategic lines and activities within a programme, or projects in the CTPC. As a trinational cooperation mechanism for El Salvador, Guatemala and Honduras, OCTA stakeholders agreed that the CTPT could provide a stable legal and institutional overarching structure for the implementation of coordinated actions across the three countries, as well as a platform to seek financial support, as needed. While not a formal legal instrument, the Statement of Intent, supported by the roadmap, constitutes a significant building block towards formalized cooperation on shared aquifers between the two countries.

Source: Case study provided by Karen Villholth, Water Cycle Innovation based on reports by UNESCO-IHP, 2023.

Case study 13 Extending the mandate of the Organization for the Development of the Gambia River

Lessons learned covered in this case study: Lesson 4 and Lesson 7.

The Organization for the Development of the Gambia River (OMVG) is a regional organization comprising four member countries: the Gambia, Guinea, Guinea-Bissau and Senegal. It was created on 30 June 1978 by the Gambia and Senegal to develop the resources of the Gambia River. The Republic of Guinea and the Republic of Guinea-Bissau joined the organization in 1981 and 1983, respectively. In 1987, the purview of the OMVG was extended to the watersheds of the Kayanga/Géba and Koliba/Corubal Rivers and the existing basin organization was used to extend cooperation in this new geographical area.

41 www.internationalwaterlaw.org/blog/2019/11/01/the-ocotepeque-citala-statement-of-intent-a-first-step-towards-transboundary-aquifer-cooperation-in-central-america/

42 The CTPT is a regional organization that forms part of the Central American Integration System (SICA). In 1997, a treaty was signed between the Republics of El Salvador, Guatemala and Honduras for the execution of the Trifinio Plan, as a model of integration and conservation, aimed at managing the territory to improve the living conditions of local communities.

The OMVG High Commission is the implementing body for the integrated development programmes of the four member countries and aims to achieve the rational and harmonious exploitation of the shared resources of the Gambia, Kayanga-Géba and Koliba-Corubal river basins. To this end, the High Commission is responsible for providing capacity-building support to the national technical services in charge of collecting basic data on the three rivers under its jurisdiction within the territory of the member states.

The Technical Ministries responsible for monitoring and managing water resources and the supervisory ministries of the member states, through the OMVG national units, have signed an MoU to monitor and share data relating to water knowledge and management in the watersheds under the jurisdiction of the OMVG.

The tripartite agreement signed between the High Commission and the member states for the sharing of water data defines the obligations of each of the signatories:

- The Technical Ministries are responsible for monitoring and managing water resources, i.e. diagnosing and rehabilitating the network of hydrometric stations, collecting and updating data, and carrying out associated analyses.
- The OMVG National Unit within the supervisory Ministry is responsible for coordinating activities and acts as an interface between the OMVG and the national technical services responsible for monitoring the measurement networks, collecting data, processing and updating databases related to the watersheds under OMVG's jurisdiction.
- The OMVG High Commission is responsible for the administrative coordination of activities and makes financial resources available to the technical ministries via the OMVG National Units of the supervisory ministries.

Source: Case study provided by the Haut-Commissariat of the Organization for the Development of the Gambia River (OMVG), 2024.

Case study 14 A mechanism for aquifer cooperation in the KAZA Transfrontier Conservation Area

Lessons learned covered in this case study: Lesson 5, Lesson 7, Lesson 17, Lesson 19, Lesson 20, Lesson 39 and Lesson 40.

The Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA) is shared between Angola, Botswana, Namibia, Zambia and Zimbabwe, and is the world's largest transboundary conservation area, covering 520,000 km^2. The SADC region encompasses 18 established TFCAs.[43] Cooperation between the five states is formalized through the KAZA TFCA Treaty, signed in 2011. This agreement lays the foundation for joint and international cooperation around the protection and management of significant ecosystems and ecoregions that cut across two or more of the five member states.

43 www.sadc.int/sites/default/files/2022-07/SADC_TFCA_Brochure.pdf

The KAZA TFCA is not, *per se*, defined by hydrological boundaries, but rather by the conglomeration of an array of interconnected protected areas that are under current threat from population growth, land use change, economic development and climate change. The aim of the cooperation mechanism is to enhance the protection and management of significant ecosystems and ecozones through joint legal frameworks and planned measures; for example, by establishing corridors and buffer zones to facilitate the natural migration routes of wildlife and to protect biodiversity. The KAZA TFCA includes the iconic Okavango Delta, Victoria Falls, and many other often wetland-connected systems that straddle two or more of the five states. Hence, cooperation on water resources is essential to achieving the goals of the KAZA TFCA Treaty.

Many of the surface water and wetland systems are sustained by transboundary aquifers of which five are mapped in the KAZA TFCA. Management of these aquifers, along with the surface water systems, is increasingly facilitated through cooperation on groundwater across the KAZA TFCA.[44] Generally, data collection, and hence knowledge of transboundary aquifers linked to TFCAs in Africa, is limited, as priority for monitoring is given to surface water. This is in part due to lack of recognition of the role aquifers play in supporting wetlands, and more broadly terrestrial and aquatic ecosystems – so-called groundwater-dependent ecosystems.

For the KAZA TFCA, incipient groundwater data collection and sharing are associated with the transboundary Kwando River basin – a key tributary to the Okavango Delta – as well as a number of transboundary aquifers, such as the Nata Karoo Sub-basin[45] and the Eastern Kalahari Karoo Basin Aquifer system.[46] This knowledge base provides a critical baseline for understanding these integrated systems, including delineation of the underground geological formations and aquifers and their connection with surface water systems. This work forms an important foundation for the identification of knowledge gaps and critical management issues associated with water resources and contributes to the better design of joint monitoring networks and programmes, data-sharing and information systems.

The KAZA TFCA partly overlaps with two major river basins: the Cubango-Okavango River basin and the Zambezi River basin. Accordingly, the need for integrated management of water resources and linked ecosystems is becoming increasingly apparent and acknowledged by TFCA and river basin organizations (Figure 14.1).[47] Significant progress and synergy on cooperation related to shared water resources and ecosystems in the KAZA TFCA hinges on the close cooperation between OKACOM and ZAMCOM, separately, as well as within the framework of the KAZA TFCA Treaty. To facilitate this, an MoU has been signed between OKACOM and the KAZA TFCA Secretariat, and one is pending between ZAMCOM and the KAZA TFCA.

Source: Case study provided by Karen Villholth, Water Cycle Innovation based on IWMI/Water Cycle Innovation report, 2022.[48]

44 www.kaza-grow.iwmi.org

45 www.link.springer.com/article/10.1007/s10040-018-1896-x

46 www.sadc-gmi.org/publications/#Eastern-Kalahari-Karoo-Basin-Aquifer-System

47 www.unesdoc.unesco.org/ark:/48223/pf0000383775

48 www.watercycleinnovation.com

Lake Kariba, reservoir on the Zambezi River shared by Zambia and Zimbabwe

Lesson 8 Create a specific working group responsible for monitoring as part of a joint commission's institutional framework

A dedicated monitoring working group or similar organizational unit with the necessary technical skills can make the necessary specific technical arrangements, thereby reducing the need for extensive political discussions. Agreement needs to be reached on the data to be collected – an iterative process that needs to be conducted on a regular basis – and a working group set up to decide what data to collect and from which locations. The proposed data collection process can then be agreed upon by decision makers. Agreement must also be reached on the comparability of data and information. Harmonization can be achieved by using the same methods and data formats, or by ensuring that the data produced by different methods are comparable (see Lesson 26). However, the working group needs an appropriate mandate to carry out its tasks.

Case studies that cover this lesson: Case study 2, Case study 15, Case study 16, Case study 17, Case study 27, Case study 29, Case study 41, Case study 48, Case study 50 and Case study 64.

Case study 15 Regional Working Group for the Senegalo-Mauritanian Aquifer Basin (SMAB)

Lessons learned covered in this case study: Lesson 2, Lesson 7, Lesson 8, Lesson 19 and Lesson 40.

The Senegalo-Mauritanian Aquifer Basin (SMAB) is shared between the Gambia, Guinea Bissau, Mauritania and Senegal. As part of its accession process to the Water Convention, Senegal requested support to develop a cooperation initiative for the aquifer and deepen its knowledge of the aquifer. In April 2020, the Regional Working Group for Transboundary Cooperation on the SMAB was established with support from the Water Convention Secretariat, bringing together four governments, OMVG and the Organization for the Development of the Senegal River (OMVS).[49]

Data- and information-sharingg is the responsibility of the Department of Water Resources (DWR) in the Gambia, the General Directorate of Water Resources (Direção Geral de Recursos Hídricos, DGRH) in Guinea-Bissau, the National Centre of Water Resources (Centre National des Ressources en Eau, CNRE) in Mauritania, and the Directorate of Water Resources Management and Planning (Direction de Gestion et de Planification des Ressources en Eau, DGPRE) in Senegal. Focal persons from these four institutions form part of the Regional Working Group, a body mandated to sharing data and advance cooperation in groundwater management among the four countries of the SMAB.

49 www.unece.org/media/press/360381

Cooperation through the Regional Working Group strengthened understanding of the aquifer's characteristics and led to the development of a joint vision. In September 2021, ministers in charge of water in the four states signed a declaration committing the countries to establish a legal and institutional framework for cooperation on sustainable management of the SMAB. They also charged the Regional Working Group with enabling the sharing of data on the SMAB. The two transboundary basin organizations (OMVS and OMVG) will jointly provide the Secretariat for the Regional Working Group, which will elaborate the future intergovernmental mechanism for concerted management of the SMAB. External funding is being sought to finance activities planned by the Regional Working Group, including the sharing of data.

Source: Case study provided by Arnaud Sterckx, International Groundwater Resources Assessment Centre (IGRAC), 2022.

Case study 16 "Hydrology" Working Group of the International Meuse Commission

Lessons learned covered in this case study: Lesson 4, Lesson 8, Lesson 24 and Lesson 35.

The Meuse River basin is shared between Belgium, France, Germany, Luxembourg and the Netherlands. The "International Agreement of the River Meuse", signed in 2002, states that the contracting Parties shall cooperate "in coordinating the implementation of the requirements of the Water Framework Directive (WFD) to achieve the environmental objectives it sets out and, in particular, in coordinating all programs of measures for the International River Basin District Meuse … in part by means of preventive measures – to reduce the impact of floods and droughts". Parties shall also cooperate "in consulting each other and then coordinating preventive and protective measures against floods, giving consideration to ecological aspects, regional planning, landscape conservation and other fields such as agriculture, forestry and urban development".

In accordance with Article 4 of the Agreement,

"3. The implementation of the requirements of the Water Framework Directive shall be coordinated multilaterally within the International Meuse Commission [through its working group "WFD"].

In particular, this shall involve the coordination of:

a) the analysis of the characteristics of the International River Basin District Meuse;
b) the investigation of the impact of human activities on the status of surface waters and groundwater in the International River Basin District Meuse;
c) the economic analysis of water use;
d) monitoring programs"

In addition, the Commission undertakes to ensure "the exchange of information between operational centres."

Concerning flooding, an agreement on data-sharing and flood forecasting within the Meuse International River Basin District was signed on 9 December 2016 entailing the mutual and continuous sharing of hydrological data and forecasts (water levels, flows) between the services (see *Case study 45*). There is no charge for the sharing and no additional costs for the services. The IMC "Hydrology" Working Group is responsible for monitoring and updating this agreement.

Concerning low water flows, a way to calculate average discharge over a seven-day period was discussed and validated by the "Hydrology" Working Group of the IMC. The country delegations also agreed on the most relevant stations to be included in the low water notice, and the text, tables and maps to be incorporated in the document.

The secretariat oversees the collection of data each Monday, updating the low water notice and publishing it on the IMC website. Each delegation uses its own data to evaluate low water levels in its respective part of the basin, allowing public authorities and decision makers to take appropriate measures concerning water usage, as necessary. The IMC's low water notice also provides an overview of the situation in the whole basin, enabling downstream countries to make adequate preparations in view of the situation upstream.

Finally, concerning water quality, the country delegations agreed to monitor 55 parameters within the Homogeneous Measurement Network, which consists of 39 stations, at the same frequency and employing the same analytical method and standards. The monitoring and evaluation of the Homogeneous Measurement Network is carried out by the IMC "Monitoring" Working Group.[50]

Source: Case study provided by Jean-Noël Pansera, International Meuse Commission (IMC), 2023.

Case study 17 Harmonization of data for the International Commission for the Protection of the Rhine (ICPR)

Lessons learned covered in this case study: Lesson 8 and Lesson 39.

The International Commission for the Protection of the Rhine (ICPR) was founded in 1950 to analyse pollution, recommend water protection measures, harmonize monitoring and analysis methods and exchange monitoring data on the Rhine. To this end, member states of the ICPR (France, Germany, Luxembourg, the Netherlands, Switzerland and the European Commission) successfully cooperate with Austria, Liechtenstein and the Belgian region of Wallonia, as well as Italy, to ensure the health of the Rhine and all waters running into the river.

An international expert group dedicated to regular chemical monitoring meets twice a year. Requirements for monitoring have been discussed and defined within the group, including a list of mandatory and optional parameters for all monitoring sites along the Rhine, which is updated every six years. In addition, a list of substances relevant to the Rhine is updated every three years.

50 www.meuse-maas.be/Accueil/La-commission-internationale-de-la-Meuse.aspx?lang=en-US

Data are collected annually and published online. The data also form the basis of reports on water quality in the Rhine written by the expert group and published online every two (now every three) years.[51]

Additionally, since 2015 an expert group has produced non-target and target analyses of polar, persistent, mobile and toxic substances that cannot be detected by routine analytical methods. The goal is to make the analytical results comparable for substances for which no standardized methods exist.

Source: Case study provided by Tabea Stötter, International Commission for the Protection of the Rhine (ICPR), 2023.

Lesson 9 Engage with key parties, including civil society, NGOs and the private sector

A variety of parties ranging from civil society and NGOs to private parties such as farmers or hydropower operators have an interest in water resources and require information about them. These parties both gather and have an interest in accessing additional information. Joining forces to collect data and information can be mutually beneficial.

Case studies that cover this lesson: Case study 12, Case study 18, Case study 19, Case study 37, Case study 38, Case study 62 and Case study 67.

Case study 18 Towards binational monitoring of the transboundary aquifer system in Leticia-Tabatinga (Colombia and Brazil)

Lessons learned covered in this case study: Lesson 9, Lesson 18, Lesson 19 and Lesson 35.

As well as benefiting from cultural, economic and social exchange, the twin Amazon cities of Leticia in Colombia and Tabatinga in Brazil rely on groundwater from a shared transboundary aquifer system.

In 2015, ACTO made the first assessment of the transboundary aquifer in Leticia-Tabatinga to collect information and promote the sustainable management of these resources in the region. Over the period 2022–2023, the two countries carried out a hydrogeological, vulnerability and risk assessment for the development of groundwater use and protection policies in the transboundary region of Leticia (Colombia) and Tabatinga (Brazil), within the framework of the Amazon SAP Implementation Project (ACTO/UNEP/GEF). The study area comprised the urban area and part of the suburban area of Leticia and the urban area of Tabatinga, located on the left bank of the Amazon River, on the border between Colombia, Brazil and Peru.

51 www.iksr.org/en/topics/pollution/priority-substances

This binational initiative updated the baseline of groundwater demand, assessed the aquifer's vulnerability and potential sources of contamination, and designed a groundwater quality and level monitoring network, oriented to define policies and technical guidelines for the use and protection of groundwater sources, as well as a strategy for mitigating contamination risks in the region.

The study assessment was completed under the supervision of a Binational Technical Group integrating senior professionals from the National Water Agency of Brazil and the Ministry of Environment and Sustainable Development of Colombia. The progress and main results were shared and discussed with the relevant national, state/department and municipal stakeholders, academia, users and social actors at two Binational Workshops held in Leticia (September 2022) and Tabatinga (June 2023).

Among the main results, the assessment included:

- an updated inventory of groundwater points (121 points in Tabatinga and 226 in Leticia), including 68 additional points (39 in Leticia and 29 in Tabatinga), indicating that groundwater is used mainly for domestic purposes and to a lesser extent for public supply (consumption), industrial, recreational and livestock uses;
- a sanitary diagnosis of the catchments, which found that close to 70 per cent of points inventoried comply with the sanitary infrastructure conditions for point source pollution protection (see *photos*);
- assessment of intrinsic vulnerability to aquifer contamination evaluated by two different methods (GOD and DRASTIC), showing in both cases a predominance of areas with moderate vulnerability (70 per cent and 76 per cent, respectively) followed by high vulnerability (21 per cent and 23 per cent, respectively), in this case associated with the presence of shallow aquifers, and in smaller proportion areas with low vulnerability to contamination (1 per cent and 9 per cent, respectively);
- inventory and analysis of activities with potential to become sources of groundwater contamination, such as deficient sewerage in urban areas, inadequate solid waste disposal, presence of effluent lagoons, inadequate storage or distribution of fuels, clay exploitation, presence of industries, cemeteries and slaughter plants;
- cross-referenced intrinsic vulnerability maps and maps of potential sources of contamination, which demonstrated that approximately 45 per cent of the study area, located mainly south of Leticia and in the urban area of Tabatinga, corresponds to areas of high and very high risk;
- the design of a groundwater monitoring network, which includes 60 points – 35 in Leticia and 25 in Tabatinga. The results of the first laboratory analyses in this network identified a difference between the groundwater of both municipalities, with higher values for electrical conductivity, dissolved solids, nitrates and chlorides, and a higher degree of mineralization in the wells of Tabatinga compared to those of Leticia. The results also indicate that the groundwater is characterized by constant interaction with rain and surface water.

To ensure the sustainability of the binational groundwater monitoring network, at the 2nd Binational Workshop (2023), the local governments made a commitment to add implementation of the automatic groundwater monitoring network to the agenda of the Brazil-Colombia Binational Integration and Neighbourhood Commission, and to dedicate technical teams and equipment to monitor both surface and groundwater.

The next steps include the definition and agreement of policies and technical guidelines for the use, monitoring and protection of groundwater sources and a strategy for mitigating contamination risks in the region.

Source: Case study provided by Maria Apostolova, Amazon Cooperation Treaty Organization (ACTO), 2023.

Case study 19 Involving Indigenous populations in the Sixaola basin

Lessons learned covered in this case study: Lesson 4, Lesson 9, Lesson 33 and Lesson 40.

The Sixaola River basin, shared by Costa Rica and Panama, is an important biodiversity hotspot on which more than 33,000 people depend for their livelihoods. The basin is home to diverse rural, Indigenous and Afro-descendant communities that face environmental challenges common to both Costa Rica and Panama. Most of the inhabitants of the Sixaola basin are Indigenous.

The "Costa Rica-Panama Border Development Cooperation Agreement" *(El Convenio sobre Cooperación para el Desarrollo Fronterizo Costa Rica-Panamá*), signed in 1992, facilitates water cooperation through a basin-wide approach and IWRM practices. Data-sharing is defined by the Binational Commission, which meets twice a year to review the status of the basin. The Agreement identified the need to promote and participate in binational projects in the basin, which led to the creation of the Binational Commission of the Sixaola River basin (*Comisión Binacional de la Cuenca del Río Sixaola, CBCRS*), in 2007.[52] The objectives of the CBCRS are to:

- coordinate and develop actions necessary for the integrated management of the basin;
- ensure the conservation of natural resources and biodiversity;
- promote sustainable production;
- strengthen binational institutions.

Currently, the Commission is composed of representatives from 35 organizations, including both governments, the private sector and representatives from the seven Indigenous territories of the basin.

52 www.sixaola.org/index.php

The "Integrated Water Resources Management (IWRM) Project for the Transboundary Sixaola River Basin" (*El Proyecto Hacia la Gestión Integrada de los Recursos Hídricos (GIRH) transfronterizos de la Cuenca del Río Sixaola*) aims to strengthen governance and increase the capacity of the CBCRS and local communities to manage the basin sustainably. The project has four components: governance, pilot projects, early warning systems and knowledge management.[53]

Knowledge management and information sharing is handled by the project's implementation unit. The knowledge management component of the project states that information and knowledge must serve the communities in the basin. All results, such as a transboundary analysis of the Sixaola River basin (carried out in 2023), are published on the project website.[54] The project has the following information sharing objectives:

- All technical information generated by the project in any of its areas will be presented to the public in accessible formats (both digital and physical).
- Information will be written in a way that is easy to understand and encourages people to learn from it and apply the knowledge in their communities.
- Information will be translated into the Indigenous languages spoken in the basin (Bribri, Cabécar, Ngäbey Naso) in printed and audio formats that are most used and useful to the population.
- A virtual platform will be developed with vital information on climate, hydrology, risks and threats to the basin that will support residents and decision makers.

In the initial phase of the project, the Indigenous Peoples Participation Framework and the Indigenous Peoples Commission were assembled with representatives from each territory. The functions of the Commission include:

- participating in the development of the project plan and reviewing which activities are needed;
- acting as an Indigenous social audit;
- evaluating compliance with Indigenous rights;
- communicating with the communities;
- ensuring intercultural perspectives and women's participation.

The project aims to reduce the gender gap by enhancing the participation of women in basin management; emphasizing their role in governance and decision-making; collecting data on the challenges faced by Indigenous women and women working in the agricultural sector; and strengthening their capacity for restoration, sustainable management and early warning systems.[55]

53 www.sixaola.org/proyecto.php

54 www.sixaola.org/documentos.php

55 www.sixaola.org/genero.php

In 2022, the project opened a dialogue with the main governance mechanisms of the seven territories proposing the Commission as a forum for exchange. Each authority designated two people – one woman and one man – as representatives. With the support of the project, two sub-basin committees were created in the Sixaola basin: the Risco River Sub-basin Committee and the Sibube Creek Sub-basin Committee. Both committees are composed of members of the Indigenous communities in the area and provide a platform for information exchange with government institutions. Certain activities, such as the installation of infrastructure for the development of the early warning system, will be carried out in Indigenous territory. The Commission will be consulted in advance on these activities to ensure that the system respects ancestral practices in Indigenous territories.[56]

At the request of the Binational Commission, the project gathers data and information on fish species in the basin, including on species diversity, abundance, external health of individuals, degree of tolerance to pollution, feeding habits and relationship to habitat. The information is presented at the meetings of the Binational Commission and is used by communities, organizations and institutions to prioritize actions for restoration, reforestation, prevention of livestock access to water and promotion of efficient waste management, among others.

Together with the National Association of Equality Agents (*La Asociación Nacional de Agentes de Igualdad, ANAI*), the project promotes participatory biomonitoring of rivers in the basin. In 2023, ANAI carried out 17 participatory biomonitoring days at 13 sites in Costa Rica, 3 in Panama and 1 on the border. The sites were selected and monitored in coordination with Costa Rican and Panamanian authorities, Indigenous territories, local organizations and companies.

The project is funded by GEF and implemented by the United Nations Development Programme (UNDP) with the Organization for Tropical Studies *(Organización para Estudios Tropicales, OET)* as implementing partner. The main institutional partners are the Ministry of Planning and Political Economy (MIDEPLAN) and the Ministry of Environment and Energy (MINAE) through its regional office of the Amistad Caribe Conservation Area (ACLAC) in Costa Rica, and the Ministry of Economy and Finance (MEF) and the Ministry of Environment (MIAMBIENTE) in Panama. MIDEPLAN and MEF host the Executive Secretariats of the 1992 Cooperation Agreement.

Source: Case study provided by Francisco Taylor, Ministry of Environment (MIAMBIENTE) in Panama, 2024.

56 www.sixaola.org/comunidades.php

Lesson 10 Ensure an integrated and cross-sectoral approach for the monitoring system

Supporting IWRM also necessitates an integrated approach to data and information collection. While such an approach will incorporate water use and other sectoral aspects, it should also take into account environmental considerations in order to avoid ecological degradation, which will ultimately have a negative impact on socioeconomic conditions. Among other things, informed decision-making requires data and information on the causes of problems and the effectiveness of associated measures.

The Driving force – Pressure – State – Impact – Response (DPSIR) framework provides an integrated and cross-sectoral approach for the collection and sharing of data and information. Information from different sectors is essential for monitoring purposes, including data on water abstraction for irrigation or industrial production, and information on the use of pesticides and fertilizers. Such information relates both to surface water and groundwater and the possible interactions between them and can be combined with other monitoring system data to identify sources of problems or potential issues, such as water scarcity.

Case studies that cover this lesson: Case study 1, Case study 8, Case study 12, Case study 20, Case study 21, Case study 22, Case study 23 and Case study 68.

Case study 20 Environmental priorities in recent transboundary water agreements between Ecuador and Peru

Lessons learned covered in this case study: Lesson 4, Lesson 10, Lesson 24 and Lesson 39.

Recent transboundary water agreements are progressively adopting provisions on sustainable development, ecosystem-based approaches and climate change adaptation.

Ecuador and Peru share nine transboundary river basins. Two flow into the Pacific Ocean (Zarumilla and Puyango-Tumbes) and seven flow into the Amazon River (Catamayo-Chira, Mayo-Chinchipe, Santiago, Morona, Pastaza, Conambo-Tigre and Napo). In 2017, the Governments of Ecuador and Peru adopted an "Agreement that Establishes the Binational Commission for the Integrated Water Resources Management of the Transboundary Basins between Peru and Ecuador". This Agreement is the latest in a series of transboundary water agreements in South America and the first in the region to provide a framework for regulating all transboundary river basins shared between two countries.

The Agreement also consolidates bilateral cooperation to enhance the use and management of shared waters. One of the main functions of the Binational Commission, created through the Agreement, is to propose climate change adaptation and mitigation measures based on data and information exchange that will guide early warning systems and the overall response to extreme climate events.

Ecuador and Peru are currently drafting the "Rules of Procedure of the Binational Commission" which will guide specific functions and activities at the transboundary level, as well as at the local level in each of the nine river basins. Considering the unique characteristics and challenges of each one of these transboundary river basins, it is likely that Ecuador and Peru will draft various basin instruments in specific areas such as data and information exchange, which can guide other states in negotiating framework and basin-level agreements.

Source: Case study provided by Diego Jara, International Union for Conservation of Nature (IUCN), 2023.

Case study 21 Zambezi Watercourse Information System

Lessons learned covered in this case study: Lesson 10, Lesson 11, Lesson 12 and Lesson 39.

The Zambezi River basin is shared between Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. The Zambezi Water Information System (ZAMWIS), a common repository, has been established under the Zambezi Watercourse Commission (ZAMCOM), with the Zambezi Watercourse Secretariat (ZAMSEC) appointed as the responsible institution.

ZAMWIS was established through the "Rules and Procedures for Sharing Data and Information Related to the Management and Development of the Zambezi Watercourse", adopted on 25 February 2016 by the Council of Ministers. The system is financed by contributions from members states and development partners. Available information shared through ZAMWIS covers topics including hydrology, meteorology, water quality, socioeconomics, the environment and planning instruments (e.g. policies, legal instruments, strategies, master plans, etc.). Several knowledge products on the Zambezi basin are also available as well as studies and publications from NGOs and civil society organizations, among others.

Data shared by focal institutions are uploaded to the ZAMWIS database by ZAMSEC, and then exchanged according to the schedule established in the Rules & Procedures protocol. However, the riparian states remain the owners of the data and information. The database is open to the public.

The following documents are produced for the ZAMCOM Technical Committee Members (ZAMTEC): spreadsheets and time series updated as information is added to the database, progress and review reports, and work plans and budgets.

The shared database has led to:

- confidence in the notification process because the information is readily available;
- regional mobilization of funds (among others, the Climate Investment Funds (CIF) finance nature-based solutions to the climate crisis in the Zambezi River basin, cutting across Zambia, Malawi, Mozambique, Namibia and Tanzania);
- capacity enhancement of National Focal persons;
- alignment of vision asymmetries of member states through the Zambezi Strategic Plan (ZSP);
- regional economic development (the Programme for Integrated Development and Adaptation to Climate Change in the Zambezi Watercourse (PIDACC) is an investment programme that contributes to implementation of the Zambezi Strategic Plan for the Watercourse (ZSP 2018–2040));
- alleviation of national security concerns (the ZAMWIS Decision Support System (DSS) helps inform decision-making participating in planning processes for the Zambezi basin to the benefit of cooperative human and economic development).

Source: Case study provided by Felix Ngamlagosi and Kudakwashe Kayirasora, Zambezi Watercourse Commission (ZAMCOM), 2022.

Zambezi River in Zimbabwe

Case study 22 Data-sharing in the Buzi, Pungwe and Save basins

Lessons learned covered in this case study: Lesson 4, Lesson 10, Lesson 18, Lesson 31 and Lesson 33.

The Buzi, Pungwe and Save Transboundary River basins are shared by Mozambique and Zimbabwe. The mandate for Data-sharing is held by the Mozambique-Zimbabwe Joint Water Commission, as laid down in the Data-sharing Protocol (see *Case study 7*). The data shared cover the topics of hydrology, hydrogeology, climatology, meteorology, water quality, socioeconomics the environment and planning instruments.

Under the Data-sharing Protocol, the two countries agreed to share information on the best available technologies as well as the results of relevant research and development. Emission data relating to pollutants and wastewater is limited to water quality and pollution threats.

Potential planned measures have been identified and are included in the signed water sharing agreements, which require member states to notify each other of new planned measures well in advance. The Protocol also requires states to share national regulations relating to water sharing as well as data related to critical situations such as emerging floods or droughts, and accidental spills.

The Data-sharing Protocol promotes the harmonization of data collection, processing and storage. Each country has its own database, but plans have been made to establish a central repository of information – the Buzi Pungwe, Save Water Resources Information System (BuPuSaWIS). Both countries have agreed on different levels of access to data.

Currently, data are shared through weekly e-bulletins shared by email. Information is also shared daily through the BuPuSa WhatsApp group, particularly during the rainy season due to the high risk of flooding. Some key hydrological stations on the three transboundary rivers in both countries are being upgraded to transmit data in real time, with Data-sharing frequency ranging from 15 min to 1-hour intervals. Decision makers also receive weekly reports. In addition, relevant information is published on the websites of the water authorities – a weekly bulletin in Mozambique and dam levels in Zimbabwe. In both countries, information is also shared via TV and radio.

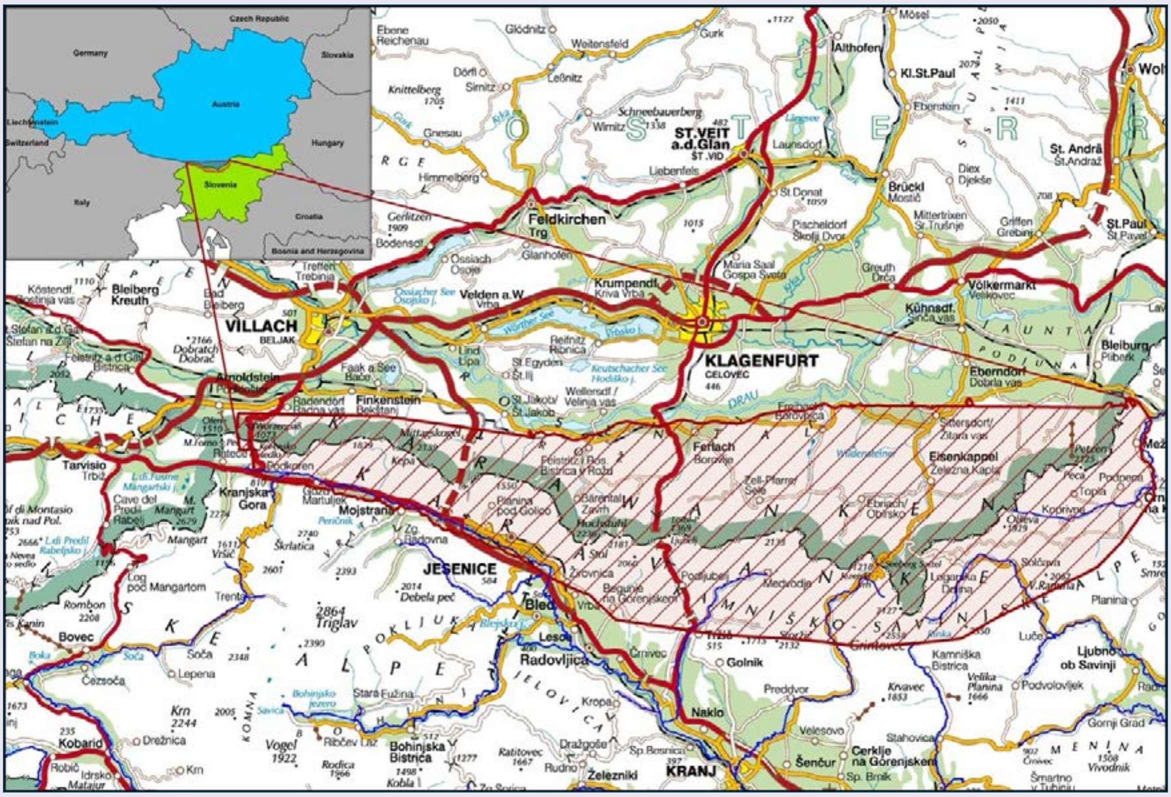
Source: Case study provided by Loreen Katiyo, Global Water Partnership Southern Africa (GWPSA), 2022.

Case study 23 Sharing information on the transboundary groundwater body Karavanke

Lessons learned covered in this case study: Lesson 4, Lesson 10, Lesson 23 and Lesson 35.

The Transboundary Groundwater Body Karavanke is shared between Austria and Slovenia (see *Map 23.1*). Data-sharing related to Karavanke occurs within the bilateral working group “Reserves of Drinking Water Karavanke”, which operates within the framework of the Permanent Slovenian-Austrian Commission for the Drava River, led by the Ministry of Natural Resources and Spatial Planning of the Republic of Slovenia and the Federal Ministry of Agriculture, Forestry, Regions and Water Management of the Republic of Austria.

Map 23.1 Political map of the Karavanke Transboundary Aquifer



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: Brenčič, M. and W. Poltnig (2008). *Podzemne vode Karavank: skrito bogastvo = Grundwasser der Karawanken: versteckter Schatz*. Ljubljana: Geološki zavod Slovenije; Graz: Joanneum Research Forschungsgesellschaft.

The creation of the Permanent Slovenian-Austrian Commission for the Drava River is based on the “Agreement between the Government of the Republic of Slovenia and the Federal Government of the Republic of Austria on the further validity of the appointed Yugoslav-Austrian Contracts in the relations between the Republic of Slovenia and the Republic of Austria” (1993) and the subsequent Law ratifying the Agreement.

Data- and information-sharing activities are both financed and consist of in-kind contributions provided by experts to the bilateral working group, a component necessary for the functioning of the Permanent Commission.

The data and information are shared as required according to the agenda of the bilateral working group. Examples of such information and data shared between the parties include the following:

a) Environmental conditions of transboundary waters monitored – these include information on groundwater (quantity and quality) monitoring locations together with monitoring specifics, (e.g., measured parameters, frequency, etc. and data). The quantitative and qualitative status of the common groundwater body is regularly updated.

b) Results of relevant research and development – regularly discussed data include national hydrogeological findings such as unexpected groundwater data, the results of recent tracing experiments, new findings linked to the determination of drinking water resources, hydrogeological specifics gained via common actions (e.g., tunnel excavation across national borders) and progress on relevant international and national projects, etc.

c) Measures taken and planned – discussions have taken place on the new concept presented for water supply in municipalities within the common groundwater body.

d) National regulations – national legislations are discussed and translated with the aim of ensuring the common protection of groundwater resources flowing across the border (delineation of water protection zones).

e) Permits – information on recently granted water rights is regularly updated.

The parties adhere to ISO standards for prescribed data quality control at the national level. Data are disseminated mostly via online transfer and tools ensuring fast and adequate provision of information. The working group meets annually, and data are shared according to the issues addressed in the working group meeting agenda, with reports shared usually after the meeting. As most of the groundwater monitoring data are publicly available online, additional transfer of data is only rarely needed. The data are stored in national databases, most of which are accessible and open for public use.

The long-term cooperation between the parties of the working group enables the production of joint monographs and expert reports published every few years. The parties are also engaged in common international projects with the aim of maintaining the good status of the common groundwater body.

Regular reports detailing the progress of the working group are presented at annual sessions of the Permanent Slovenian-Austrian Commission for the Drava River. The official minutes of the sessions are available to the public.[57]

Source: Case study provided by Aleš Bizjak, Ministry of the Environment and Spatial Planning of the Republic of Slovenia, 2022.

57 www.evode.gov.si/index.php?id=92

Lesson 11 Facilitate trust building and collaborative learning

Sharing of data and information helps to build trust between riparian countries. Transparency and openness throughout the monitoring process not only promotes trust building (see e.g. Lesson 3), it also supports mutual learning. Joint monitoring (Lesson 29), meetings, workshops and other activities that bring together representatives of riparian countries can help to build better mutual understanding and collaborative learning and thus improve trust.

Case studies that cover this lesson: Case study 21, Case study 24, Case study 25, Case study 38, Case study 45, Case study 51, Case study 55, Case study 56, Case study 62, Case study 70, Case study 71, Case study 73 and Case study 76.

Case study 24 Building multiple transboundary relationships: the experience of Hungary

Lessons learned covered in this case study: Lesson 2, Lesson 4, Lesson 11, Lesson 18, Lesson 23, Lesson 36, Lesson 40 and Lesson 41.

Hungary has established transboundary water management commissions with all seven of its neighbouring countries (Austria, Croatia, Romania, Serbia, Slovak Republic, Slovenia and Ukraine). While the objectives of these commissions are identical, the structures vary as do the types of data shared and their form and frequency. The exchange of data between countries is regulated by Bilateral Water Management Committees. Minutes from the annual Committee meetings define the work schedule for the following year and are forwarded to the Hungarian Ministry of the Interior and the Ministry of Foreign Affairs and Trade. In addition, technical terms used in technical documentation are agreed upon. Watercourses and facilities of common interest are often visited by the two riparian countries together.

Longstanding cooperation has led to the development of strong professional relationships between the hydrological specialists of the riparian countries. This enables them to communicate outside official data reconciliation processes, thereby facilitating joint work.

The case of the Mureș River basin shared between Hungary and Romania provides a good example of the activities involved.

The Hungarian-Romanian Water Quality Protection Subcommittee is responsible for chemical, biological and radiological analysis, monitoring, assessment, as well as collection and exchange of data on water quality, in accordance with its respective rules of operation. The body operates under the chairmanship of the Lower Tisza District Water Directorate (ATIVIZIG) in the Mureș River basin. The Subcommittee also monitors and evaluates the results of water quality analyses and measures taken in response to specific pollution incidents with transboundary impact. Sampling and measurement tasks are carried out by the laboratories of the competent county government offices, with which daily contact is maintained.

The framework for international cooperation has been laid down in bilateral water agreements, with the designated organizations carrying out their tasks in a defined hierarchical system. The Committee and Subcommittees carry out their tasks based on their rules of operation.

The financial resources for transboundary operations are included in the budget of each institution. The respective costs of information and data-sharing, as defined in the rules, are financed by the parties themselves.

Data are shared about the relevant environmental status of transboundary waters, about national regulations in the event of changes to the national legal environment and meteorological standards, and about critical situations. In the event of a major calamity, immediate informal and formal written notifications are circulated through bilateral or multilateral cooperation frameworks (e.g. the Danube Accidental Emergency Warning System), taking into consideration the nature and extent of the event.

Each year, the nationally accredited laboratories participating in the work of the transboundary water quality subcommittees take part in international comparative measurements, known as intercomparison measurements, that guarantee the reliability of the test results. In addition, joint and regular water discharge measurements are carried out according to an annual schedule, and the results are evaluated with partner institutions in both countries. The Parties mutually inform each other of national measurement and data processing standards, in compliance with recommendations of the World Meteorological Organization (WMO).

Daily meteorological and hydrological data communication takes place in the form of data files attached to emails and hosted on FTP servers. The verified and processed hydrological time series are exchanged by the Parties on paper and electronically prior to the annual meeting of experts of the subcommittees. At the meetings, experts discuss and evaluate the results which then form the subject of a joint report prepared in two languages and shared between the Parties. The annexes of the minutes contain the results of the measurements, as well as their evaluation based on the appropriate methodology laid down in the rules. The reports are submitted to both the managing body (General Directorate of Water Management), and the Ministry of the Interior. Documents prepared on the activities of the Water Committee are not made public.

Another example of building multiple transboundary relationships is the Danube Hydrologic Information System (HIS) of the International Commission for the Protection of the Danube River (ICPDR). The Danube HIS was created based on previous experiences with the Sava HIS. The long-term sustainability of system outputs could enable future transnational flood and ice forecasting activities and early warning developments for flood risk management or any water-related scientific activities in the river basin.

Led by Hungary, a common platform has been created to provide water level and discharge, water temperature and precipitation data for the Danube and its major tributaries. The possibility to join the data platform is available to all Danube countries.

Source: Case study provided by Timea Némethy, Lower Tisza Region Water Management Directorate, and Peter Kovacs, Ministry of Interior, Hungary, 2022.

Case study 25 Monitoring cooperation between Tajikistan and Uzbekistan

Lessons learned covered in this case study: Lesson 2, Lesson 3 and Lesson 11.

The Northern Fergana Canal and the Big Fergana Canal receive water from the upper part of the Syr Darya River and deliver irrigation water to Uzbekistan and then to Tajikistan. The water flow was measured by hydroposts located on both sides of the borders; however, the measurement results differed between the two sides and the equipment was in need of rehabilitation.

To address this issue, the two countries agreed to replace the two hydroposts on the same canal with a joint automated hydropost per canal – one situated on the Big Fergana Canal (BFC) and one on the Northern Fergana Canal (NFC). Both stations are located on the territory of Tajikistan.

Within the framework of Switzerland's National Water Resources Management Programme in Tajikistan, and on the request of the Ministry of Energy and Water Resources of Tajikistan, technical feasibility studies were conducted to assess different technological options for measuring water flow in the BFC and NFC, and an appropriate solution was selected.

Within the framework of its Blue Peace Programme, the Swiss Development Cooperation (SDC) mandated HELVETAS Swiss Intercooperation to support the procurement and installation of the selected equipment on condition that an effective governance framework was in place to manage the joint operation and maintenance of the equipment and the exchange and use of the data produced.

On 10 May 2023, a protocol outlining the principles of joint water monitoring was signed between Tajikistan and Uzbekistan with procurement and installation of the equipment foreseen for autumn later the same year. During this process, capacity was enhanced at the local and national level to facilitate cooperation for the project.

Two hydroposts were installed at the two canals at the end of 2023 and were inaugurated in the presence of ministers from Tajikistan and Uzbekistan in February 2024 (see *photo*).

Inauguration of Northern Fergana Canal hydroposts

Photo credit: Embassy of Switzerland in Uzbekistan, 2024.

Source: Case study provided by Bo Libert based on reports from the SDC project "Support to the rehabilitation of two transboundary hydroposts on the Big Fergana Canal and the Northern Fergana Canal, Tajikistan", 2023.


Meuse River in Dinant, Belgium

Lesson 12 Support awareness raising and capacity development

Awareness of the importance of basin-wide data and information and the ways in which they can be used at all levels (from the local to the international) is essential to sustaining a meaningful monitoring system. Identifying capacity development needs at different levels is therefore necessary and it may be useful to develop and implement a capacity-development plan.

Case studies that cover this lesson: Case study 21, Case study 26, Case study 30, Case study 42, Case study 45, Case study 47, Case study 55, Case study 56, Case study 61, Case study 71 and Case study 76.

Case study 26 Capacity development by the International Meuse Commission

Lessons learned covered in this case study: Lesson 12.

In response to the catastrophic floods of July 2021 (see *Case study 45*) and to strengthen international coordination at the scale of the Meuse basin (shared between Belgium, France and The Netherlands), the International Meuse Commission organized seminars for the flood forecasting services of the seven states and regions of the basin. The seminars took place in September 2021 and September 2022, and allowed for an analysis of climatic and hydrological events and exchanges on the difficulties of forecasting these extreme events.

The International Meuse Commission also organized a training course on the European Flood Awareness System (EFAS) for flood forecasting services[58] in April 2023, to improve coordination and transboundary cooperation within the International Meuse basin.

Source: Case study provided by Jean-Noël Pansera, International Meuse Commission (IMC), 2023.

58 www.efas.eu/en

Lesson 13 Adopt a step-by-step and iterative approach to monitoring in the transboundary basin

Developing and maintaining a monitoring system is an iterative process of evaluation and improvement, as illustrated by the "Monitoring and Assessment Cycle" in the *Updated Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters*.[59] Therefore, it is not necessary to implement a fully developed monitoring system at once. Instead, a step-by-step approach can help develop a system and improve it over time. Such a project can form the basis for more regular cooperation and sharing of data and information. Pilot projects can also be useful instruments for a step-by-step approach.

Case studies that cover this lesson: Case study 2, Case study 6, Case study 27, Case study 28, Case study 32 and Case study 78.

Case study 27 Step-by-step development of activities of the Kazakhstan-Uzbekistan Working Group on Environmental Protection and Water Quality in the Syr Darya River basin

Lessons learned covered in this case study: Lesson 2, Lesson 4, Lesson 8, Lesson 13, Lesson 24, Lesson 27 and Lesson 43.

In 1997, the governments of Kazakhstan and Uzbekistan signed a cooperation agreement on environmental protection and the sustainable environmental management of water. In 2017, the governments published the Strategy for Economic Cooperation for 2017–2019, which included the creation of "a joint commission for cooperation on environmental protection" and activities "ensuring joint water sampling, analysis, and sharing of water quality data and regulations". In 2018, the Joint Working Group on Environmental Protection and Water Quality in the Syr Darya River basin was established.

59 www.unece.org/info/publications/pub/375468

The Working Group has held meetings, visited relevant laboratories, studied regulatory and technical documentation, made decisions on monitoring and reviewed the activities of stakeholders. In 2019, the Working Group approved a list of indicators to be measured, sites for joint water sampling, and the analysis and sharing of results. In 2020, Kazakhstan and Uzbekistan agreed to review and determine the timing of sampling, taking into account the time for water to travel between sampling points. In 2021, the Parties agreed to promptly notify each other of emergency situations, to perform joint analysis of water samples, and to share experiences related to the joint analysis and capacity building.

In 2022, Kazakhstan and Uzbekistan invited representatives from Kyrgyzstan and Tajikistan to participate in the Working Group meeting as observers, as these two countries also share the Syr Darya River basin. Kazakhstan proposed the creation of a joint four-party working group to address water quality in the Syr Darya basin, and an interim report on implementation of the project "Development of Joint Measures to Prevent and Respond to Pollution of the Syr Darya River in Emergency Situations" was presented. The meeting also considered a draft Programme of Measures for the conservation and restoration of the ecosystem of the transboundary Syr Darya River for 2023–2025, which included activities to identify and eliminate sources of pollution.

Since the establishment of the Working Group, Kazakhstan and Uzbekistan have made progress in the implementation of measures aimed at improving the ecosystem of the Syr Darya River basin. However, some challenges remain such as disparities in national regulations and standards as well as variations among the physical facilities of monitoring services, as water quality monitoring involves a variety of agencies within each country who use different sampling sites and monitoring frequencies. The Working Group is planning to implement a comprehensive environmental survey of the Syr Darya River basin with the involvement of international organizations. The inclusion of Kyrgyzstan and Tajikistan in these activities would represent an important step forward for the water quality of the Syr Darya River basin.

Source: Case study based on a presentation by Dana Agybayeva, Ministry of Ecology and Natural Resources of the Republic of Kazakhstan, 2023.

Syr Darya River in Tajikistan

Case study 28 Extension of monitoring in the BIO-PLATEAUX project

Lessons learned covered in this case study: Lesson 3, Lesson 4, Lesson 13, Lesson 23 and Lesson 26.

A transboundary water and aquatic biodiversity Observatory is currently under development for two transboundary watersheds: the Maroni (French Guiana and Suriname) and the Oyapock (Brazil and French Guiana). The Observatory forms part of the BIO-PLATEAUX project, with joint activities coordinated by the International Office for Water (OiEau) coordinates, which also runs the project.[60] The focal points are the French Guiana Water Office (OEG), Anton de Kom University of Suriname (AdeKUS) and the Secretariat of State for International Relations and Foreign Trade of the State of Amapa (SECRICOMEX).

Rather than having a centralized system with a single organization responsible for the production and sharing of data, the three countries have a wide variety of bodies producing and sharing data on water and aquatic environments. In French Guiana, key players include the Guiana Territorial Collectivity (Collectivité Territoriale de Guyane, CTG), the Directorate General for Territories and the Sea (Direction Générale des Territoires et de la Mer, DGTM) and the French Guiana Water Office (Office de l'Eau de Guyane, OEG). In Brazil, relevant organizations include the National Water Agency at federal level and the Secretary of State for the Environment (Secretaria de Estado do Meio Ambiente do Amazonas, SEMA) at Amapa State level. In Suriname, notable bodies include the ministries of Natural Resources, Public Works, and Environment or Regional Development.

In the presence of their respective national and territorial authorities, the focal points of the BIO-PLATEAUX project signed two statements promoting data-sharing and designated responsibilities under the process. In November 2019, a Declaration signed at the end of the Conference of Cayenne initiated a long-term joint initiative to improve cooperation, better understand the water resources and raise awareness of issues facing the Maroni and Oyapock watersheds. A Declaration signed by the partners at the end of Phase 1 of the project in April 2022 announced a preliminary version of the transboundary Observatory in the second phase.

The project is supported by the European Union through the INTERREG Amazonia Cooperation Programme, the CTG, the DGTM, the OEG, the National Centre for Space Studies (CNES), and the French Office for Biodiversity (OFB).

The shared information includes environmental status monitoring data on the quantity/quality of surface water and groundwater in transboundary basins, volumes withdrawn, drinking water and sanitation indicators, and metadata of existing data sets. The partners also share documents and studies in a dedicated space.

Comparability and data quality are ensured through the establishment of national level benchmarks. The production of metadata for the various data sets draws on national metadata catalogues. The metadata catalogues are the responsibility of the data producers and include quality control procedures. Data harmonization is often impromptu, carried out during automatic import-export procedures using Extract Transform Load (ETL) tools. The process for integration of the data into the transboundary platform of the Observatory also allows for additional quality control through the possibility of cross-analysis between different data sets.

60 www.bio-plateaux.org

Franco-Brazilian Binational Bridge over the Oyapock River

Data-sharing occurs mainly via Application Programming Interfaces (API) and Web Mapping Services (WMS), with the aim of strengthening open data protocols and ensuring the interoperability of information systems. Regular updating of data from the information systems of national producers (and/or the national information system on water) on the Observatory platform is then automatized via interoperability processes. Various applications set up at the national level also enable the downloading of data sets. The sharing of reference data and "historical" data is done gradually, subject by subject. These processes make it possible to consume and harvest the data according to need, based on agreements, with frequency varying from real time to daily/ten-day/monthly/annual intervals.

The data are stored primarily in the information systems of the data producers, and the establishment of a national (or regional, as the case may be) platform allows for the integration and cross-valorisation of the data, which remain the responsibility of the data producers. Depending on needs and authorizations, data can then be integrated into the framework of the transboundary Observatory platform. Most of the visualization products produced at the transboundary level are available online, accessible and can be downloaded by the public. In specific cases, the data and products generated have different levels of access (public, private, restricted by password).

From the moment the data are integrated into the transboundary platform, they can be used to produce reports, maps, bulletins and online visualization products such as interactive maps and dashboards. In addition, an interactive catalogue of metadata, available online, should allow consumers to access descriptive elements relating to traceability and production and quality control procedures, enabling them to verify whether the available data sets are likely to meet their needs.

Source: Case study provided by Paul Haener and Rémi Boyer, Office International de l'Eau (OiEau), 2022.

Lesson 14 Engage with experts in institutional structures in charge of transboundary cooperation

Relevant experts, such as hydrogeologists in aquifers or hydrologists in river basins, should be involved in the joint bodies responsible for transboundary cooperation on a permanent basis. This is necessary to ensure that the right knowledge and information is used in water management decisions at both national and transboundary levels. In addition, as many countries lack a strategy or the capacity to collect water data consistently, experts are needed to improve the consistency of the monitoring system and to properly assess the transboundary water system based on the data collected. This is even more important for groundwater, given the greater complexity of underground systems.

Case studies that cover this lesson: Case study 29, Case study 63, Case study 65 and Case study 72.

Case study 29 Management of the transboundary deep groundwater body in the Lower-Bavarian / Upper-Austrian Molasse basin

Lessons learned covered in this case study: Lesson 8, Lesson 14, Lesson 19, Lesson 27, Lesson 35 and Lesson 39.

The transboundary deep groundwater body in the Lower-Bavarian / Upper-Austrian Molasse basin is shared between Austria and Germany. To ensure sustainable geothermal use of the groundwater, Germany (Bavaria) and Austria jointly developed a strategy for the use and protection of the deep transboundary groundwater body. Details of the strategy are outlined in the *Principles of geothermal use of deep groundwater body in the Lower-Bavarian-/Upper-Austrian Molasse basin*.[61]

A bilateral Expert Group on "Thermal Water" was established within the legal framework of the Regensburg Treaty (1987) on Water Management Cooperation in the Danube River basin, consisting of representatives of the key authorities from the German federal state (Land) of Bavaria and Austria. The Expert Group developed the scientific knowledge base and a combined and balanced monitoring programme with regular data-sharing and appropriated tools, notably a numerical groundwater model, to support transboundary management of the groundwater body.

Data are shared at least once per year within the framework of regular expert group meetings. Each Party is responsible for covering its own costs. If needed, data can also be shared between the responsible institutions on demand (e.g. via email). The collected data are stored in national databases.

Source: Case study provided by Andreas Scheidleder, Environment Agency Austria, and Christian Schilling, Austrian Federal Ministry for Agriculture, Forestry, Regions and Water Management, 2022.

61 www.land-oberoesterreich.gv.at/files/publikationen/gtw_grundsatzpapier2012.pdf

Lesson 15 Build on local knowledge

Substantial knowledge and information about water management situations and possible interventions is often found at the local level. Building on this knowledge can lead to innovative and efficient measures, as well as improved local support and ownership, increasing the effectiveness of activities.

Case studies that cover this lesson: Case study 30 and Case study 37.

Case study 30 Promotion of Indigenous ancestral knowledge to facilitate transboundary water negotiations in Lake Titicaca

Lessons learned covered in this case study: Lesson 4, Lesson 12, Lesson 15, Lesson 21 and Lesson 26.

The active participation of Indigenous communities in transboundary water negotiations can be essential to improve the management and governance of shared waters.

The Lake Titicaca basin shared between Bolivia and Peru is home to nearly 3 million people in primarily rural communities. Indigenous peoples including the Quechuas, Aymaras and Uros have lived and flourished for centuries in this region, developing their traditional farming, fishing and trade systems. The ancestral knowledge accumulated over generations by these peoples is fundamental to ensure adequate protection of the Lake Titicaca basin.

In 1996, the Governments of Bolivia and Peru adopted an agreement to establish the Lake Titicaca Authority (ALT), the main objective of which is to promote and conduct actions, programmes and projects for the management, control and protection of Lake Titicaca and the greater *Sistema Titicaca-Desaguadero-Poopó y Salar de Coipasa (TDPS)*. The Statute creating the ALT stipulates that one of the main functions of this Authority is to secure the maintenance, continuity and use of information systems and mathematic models for the joint management of the TDPS.

After nearly 30 years since the creation of the ALT, the environmental challenges facing Lake Titicaca have increased and become more complex. Pollution from mining activities, untreated wastewater and agricultural runoff, as well as the effects of climate change, require more holistic approaches to incorporate best practices to manage the lake. Here, indigenous ancestral knowledge combined with the use of new technologies is fundamental to ensure active participation in solutions to address the multiple challenges affecting Lake Titicaca.

In 2016, Indigenous women living in the region of Lake Titicaca, with the support of local and international organizations including *Agua Sustentable* and IUCN, formed the group *Mujeres Unidas en Defensa del Agua* (Women United in Defence of Water). The group functions as a platform for dialogue and sharing lessons, experiences and best practices to protect their sacred lake. The Indigenous women use drones and measuring devices to monitor the quality of water in Lake Titicaca and share the data to inform decision-making. These practices contribute to a better overall understanding of the conditions of the lake and foster the active and informed participation of non-state actors in transboundary water negotiations.

Source: Case study provided by Diego Jara, International Union for the Conservation of Nature (IUCN), 2023.

Further reading

Ramsar Convention (2005). *An Integrated Framework for Wetland Inventory, Assessment and Monitoring (IF-WIAM)*. Kampala. Available at www.ramsar.org/document/an-integrated-framework-for-wetland-inventory-assessment-and-monitoring-if-wiam

Rozemarijn ter Horst and others (2023). Special issue: Exploring the use of data and models in transboundary water governance. *Water International*, vol. 48, no. 8, pp. 909–1080. Available at: www.doi.org/10.1080/02508060.2024.2304975

United Nations Convention to Combat Desertification (2023). *Drought Toolbox: Monitoring and Early Warning*. Bonn, Germany. Available at www.unccd.int/land-and-life/drought/toolbox/monitoring-and-early-warning

United Nations Economic Commission for Europe (2006). *Good Practice for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters*. Geneva. Available at www.unece.org/info/publications/pub/21680

___________ (2018). *Principles for Effective Joint Bodies for Transboundary Water Cooperation*. Geneva. Available at www.unece.org/info/publications/pub/21755

___________ (2018). *Financing Climate Change Adaptation in Transboundary Basins*. Geneva. Available at www.unece.org/info/publications/pub/21764

___________ (2021). *Funding and Financing of Transboundary Water Cooperation and Basin Development*. Geneva. Available at www.unece.org/info/publications/pub/359843

___________ (2021). *Agreements for Transboundary Water Cooperation: A Practical Guide*. Geneva. Available at www.unece.org/info/publications/pub/361821

___________ (2023). *Updated Strategies for Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters*. Geneva. Available at www.unece.org/info/publications/pub/375468

World Meteorological Organization (2021). *Technical Regulations (WMO No. 49), Volume III: Hydrology*. Geneva. Available at www.library.wmo.int/index.php?lvl=notice_display&id=10700

___________ (2021). *Guide to Instruments and Methods of Observation (WMO No. 8)*. Geneva. Available at www.library.wmo.int/index.php?lvl=notice_display&id=12407

Chapter 3

Confluence of the Indus and Zanskar Rivers

Setting up data-sharing

The first step in sharing data is to determine which data and information need to be shared. First, it is important to know which data and information are of relevance to the respective institutions responsible for collecting and disseminating information at the basin level and other levels. Second, it is important to understand which data and information are relevant to policymaking processes. Third, it is important that the countries involved agree on the data and information that are to be shared.

To this end, it is essential to identify issues and priorities related to the use and protection of the relevant transboundary river, lake, groundwater or transitional water, their interactions and ecosystems, as well as the receiving water bodies. This includes looking at the uses and functions of the basin, the associated pressures and pollution sources, the available (and accessible) information, relevant criteria and targets (such as water quality classes and e-flows), and the water and environmental legislation in the riparian countries.

Once this information is known, the next stage is to determine the most practical way of gathering data from the different sources. These include the monitoring system, expert judgements, statistical publications, open data sources, remote sensing, citizen science, Indigenous and local knowledge, and the document libraries of institutions.

As most data used for transboundary water resources management (both quality and quantity) is provided by national organizations, ideally the data-sharing system should be designed to draw on national information systems with (direct) access to data sets made available by national partners. This implies the reinforcement of national capacities in data management and the development of capacities to share comparable data and ensure interoperability with the information systems of partners, using a common language and common procedures.

Lesson 16 Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking

To ensure that decisions in water management and water-using sectors are based on relevant information, decision makers need to be involved in the process from the earliest stages. This will ensure that information produced by the monitoring system and shared with partners is relevant to policymaking and facilitates informed decisions.

Case studies that cover this lesson: Case study 31, Case study 58 and Case study 70.

Case study 31 Supporting decision-making in the River Plata basin

Lessons learned covered in this case study: Lesson 4, Lesson 16, Lesson 24, Lesson 31 and Lesson 32.

The River Plata basin, shared between Argentina, Bolivia, Brazil, Paraguay and Uruguay, is the second largest river basin in South America. Cooperation between the countries is based on the La Plata Basin Treaty of 1969 and effected through the Intergovernmental Coordinating Committee of the La Plata Basin Countries (CIC CdP) in accordance with an agreement between the governments,[62] updated in 2001.[63] The Internal Regulations define the governance and operating rules of the organization and were updated in 2002.[64]

The sharing of data is carried out voluntarily by the institutions responsible for information related to the waters of each country. Additionally, the CIC CdP is implementing a Decision Support System (DSS) that allows for the visualization and processing of information from different countries through a single interoperable platform (Delft-FEWS). This initiative forms part of the broader project framework for implementation of the CIC Strategic Action Plan,[65] which is financed by GEF. CIC CdP operations are financed with contributions from the five countries. In addition, the countries have agreed to implement Hydrometeorological Forecasting and Early Warnings System in the La Plata Basin (PROHMSAT) to enhance the capacities of regional National Meteorological and Hydrological Services (NMHSs) to provide flood forecasting, thereby decreasing the vulnerability of the surrounding communities to flood impacts.[66]

62 https://cicplata.org/es/documentos/#1481142093532-099e3504-55cd

63 https://cicplata.org/es/documentos/#1481159972214-a3dab81d-4760

64 https://cicplata.org/es/documentos/#1481159970877-815b56d0-d69f

65 "Preparando las bases para la implementación del Programa de Acción Estratégica (PAE) de la Cuenca del Plata." https://cicplata.org/es/proyecto-implementacion-pae/

66 www.wmo.int/projects/hydrometeorological-forecasting-and-early-warning-system-la-plata-basin

Paraná River on the border of Brazil and Paraguay

The data are made available by country institutions and are automatically integrated into a common online database on the configured Delft-FEWS platform. The same institutions oversee the operation of the monitoring stations, while the CIC CdP that hosts the system, oversees its maintenance and coordinates operations as well as possible new developments, training and knowledge transfer.

The frequency of system updates depends on the individual country and may vary. Hydrometeorological data are updated frequently, varying between one hour and one day, depending on the country. Water quality data are updated at monthly intervals.

Once data stored in national databases are centralized in the common DSS database, they are accessible to the public, and are easy to find and interoperable, but are not yet available for download or reuse. At present, no joint reports have been published, although periodic reports are expected in the medium term.

The DSS aims to support decision-making by involving decision makers from each country in its configuration. At this stage, the system is geared mainly towards expert technical users who, depending on the communication and decision-making strategy of their country, can use the DSS as an input for decision-making.

Free access to interoperable data-sharing was further improved in 2018 through a project supported by WMO and its partners. During this period, the WMO Hydrological Observing System (WHOS)[67] was implemented, offering benefits including mapping the different metadata used by different countries, creating interoperability between different data formats through the WHOS DAB (Discover and access Broker), and making data freely downloadable through Water Data Explorer (WDE). The data shared by the different data providers in the La Plata basin are accessible, discoverable and downloadable through this portal.[68] WHOS is operated and maintained at a regional centre in Brazil established by the data providers in the La Plata River basin.

Source: Case study provided by Juan Carlos Alurralde, Comité Intergubernamental Coordinador (CIC) de los Países de la Cuenca del Plata, 2022, and Washington Otieno, World Meteorological Organization (WMO), 2023.

67 www.community.wmo.int/en/activity-areas/wmo-hydrological-observing-system-whos

68 www.tethys.inmet.gov.br/apps/water-data-explorer

Lesson 17 Raise awareness of the importance of acting at a basin-wide scale

As water knows no boundaries, water management works best when the entire basin is considered. Any action should consider the impact on the entire basin, so that actions can be taken at the most effective location and scale.

Case studies that cover this lesson: Case study 12, Case study 14, Case study 32, Case study 33, Case study 57, Case study 68, Case study 74 and Case study 76.

Case study 32 Design and pilot application of a transboundary monitoring scheme for the Prespa Lakes basin

Lessons learned covered in this case study: Lesson 13, Lesson 17, Lesson 35 and Lesson 39.

The transboundary Prespa Lakes basin is shared between Albania, Greece and North Macedonia, and is renowned for its global ecological importance. The basin comprises two main lakes, Great Prespa and Lesser Prespa. These water bodies face particular challenges in the form of unsustainable human practices that have deteriorated the water resources, a situation further aggravated by climate change. Successful protection and management of the freshwater resources and valuable ecosystems of the Prespa Lakes requires transboundary collaboration to meet both the ecological and human needs across the basin.

Over the past two decades, trilateral cooperation initiated by a prime ministerial declaration in 2000 and consolidated with the international "Agreement on the Protection and Sustainable Development of the Prespa Park Area", signed 10 years later by the three countries and the European Union, has strengthened and evolved. Since the entry into force of the Prespa Park Agreement in May 2019, important steps have been taken to promote data-sharing and harmonization of the respective systems and methodologies applied in the different countries, which all comply with or approximate the requirements of the European Union Water Framework Directive (EU WFD).

A good knowledge and common understanding of the status of water resources and challenges at basin level is the most fundamental step for the development of appropriate water management policies. Establishing a transboundary monitoring scheme to provide valid scientific information at basin level is therefore a prerequisite to wise water management planning in the Prespa Lakes basin.

To this end, a concept note for a pilot project for a transboundary monitoring scheme was presented during the first meeting of the Working Group for Water Management (WGWM) in June 2022.

The objectives of the pilot project are:

- improvement of transboundary water dialogue and exchange of information in the Prespa Lakes basin;
- enhancement of scientific knowledge and understanding of the status of surface water resources and main threats across the basin;
- harmonization of water monitoring across the transboundary Prespa Lakes basin and the establishment of a scientific basis for the assessment of status and the best planning of appropriate management measures;
- promotion of EU water policy implementation in the Prespa Lakes basin, which extends beyond the boundaries of the European Community.

Prespa Lake shared by Albania, Greece and North Macedonia

The second meeting of the WGWM in January 2023 progressed with an agreement on the roadmap for implementing joint priorities for water management, including, ultimately, the development of a joint River Basin Management Plan. To this end, a technical Task Group, under the WGWM, was set up (in February 2023) to oversee the implementation of these joint priority actions and to facilitate data-sharing based on unified templates and methodologies (compatible with those of the EU WFD).[69]

Source: Case study provided by Ylber Mirta, Ministry of Environment and Physical Planning, North Macedonia, 2023.

69 See also the UN Water case study *What Progress Looks Like: Albania, Greece And North Macedonia (Prespa Lakes) – Transboundary Cooperation (SDG target 6.5)* www.unwater.org/sites/default/files/2023-03/sdg6_acceleration_snapshot_652_albania_greece_north_macedonia_feb_2023a.pdf

Lesson 18 Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle

Where water management is carried out at the basin level, data and information are needed that cover the entire basin to the extent possible, including the receiving water body.[70] In addition, the data and information collected should cover the entire water cycle, ranging from meteorological data, soil moisture and groundwater to run-off and evapotranspiration.

The monitoring system should provide information enabling all riparian countries to take action. This includes identifying the most indicative indicators of common concern, monitoring sites for bilateral data-sharing, and common templates/rules for data-sharing and harmonization of data. A dedicated working group (Lesson 8) and expert involvement (Lesson 14) can provide substantive support for such decisions. Specifying the needs of information production should support transboundary basin and aquifer systems management. In addition, the strategy for access to data production and information production/dissemination should match these needs.

The temporal and spatial scale for monitoring and data collection needs to reflect the issues at hand. For instance, for large basins and aquifers, it may be rational to focus monitoring and data-sharing on areas that are particularly vulnerable under high stress or critical from a transboundary viewpoint, as well as hotspot areas such as industrial zones or areas featuring intensive agricultural activities.

Case studies that cover this lesson: Case study 1, Case study 18, Case study 22, Case study 24, Case study 33, Case study 34, Case study 35, Case study 44, Case study 47, Case study 51, Case study 60 and Case study 61.

Case study 33 Basin-wide information from the Upper Indus Basin Network (UIBN)

Lessons learned covered in this case study: Lesson 5, Lesson 17, Lesson 18, Lesson 33 and Lesson 42.

The International Centre for Integrated Mountain Development (ICIMOD) is an inter-governmental knowledge centre working in the Hindukush Himalayan (HKH) region shared by eight member countries (Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan).

ICIMOD has established the Upper Indus Basin Network (UIBN), a voluntary and neutral knowledge and research network of key stakeholders in riparian countries of the Indus basin, including Afghanistan, China, India and Pakistan. The network aims to bring together relevant government institutions, policy champions, development organizations, researchers and academic institutions to collaborate and share new knowledge, experiences, challenges and solutions related to climate, cryosphere, water, hazards and vulnerability, and adaptation data. Given the geopolitical sensitivities in the region, data-sharing processes are not yet active; however, the network maintains a focus on knowledge, experience and information-sharing.

70 Source-to-Sea approach www.siwi.org/source-to-sea-platform

The network has country chapters in all the riparian countries who meet periodically at the national and regional level. The chapters unite diverse institutional members working in the upper Indus basin and are headed by representatives of relevant government institutions including: the Afghanistan National Water and Environment Research Centre (ANWERC); Yunnan University, China; the Indian Institute of Geomagnetism, Mumbai; and the Pakistan Council of Research in Water Resources (PCRWR). Among the many other institutions involved in the network and contributing to information and knowledge-sharing are the Ministry of Energy and Water, Afghanistan; the Chinese Academy of Sciences; the Institute of Tibetan Plateau Research; Jawaharlal Nehru University, India; the Pakistan Metrological Department' the Water and Power Development Authority, Pakistan; and many others. The members from these organizations are nominated by their respective institutions, who work together on joint interventions.

Since the knowledge and research network is voluntary and entirely neutral, no formal signed agreement exists among the engaged Parties. However, a forum has been established by the members with mutual consensus. The members have also agreed on the scope of the network defining 10 guiding questions, based on which the countries generate and share knowledge. In addition, the network has developed and endorsed a governance framework, defining the purpose of the network, governance structure, scope, roles and responsibilities, meeting intervals and reporting mechanisms.[71]

At this stage, ICIMOD is coordinating and supporting the network with resources including finance to arrange meetings at the regional level, while the country chapters organize their own periodic meetings. International researchers working in the region, providing valuable contributions on knowledge and information-sharing, cover their own expenses to participate in meetings. Relevant country chapters are also expected to mobilize resources for any collaborative research interventions with other country chapters. The country chapters are also discussing opportunities for joint funding proposals to support knowledge development catering to regional knowledge gaps. In addition, ICIMOD is providing some funds for a few collaborative research interventions in India and Pakistan. The study reports and research papers generated from these studies are published jointly by both the country chapters and ICIMOD.[72]

Information and knowledge-sharing takes place twice a year during the network's periodic meetings. In addition, experience and knowledge-sharing among country chapters at the national level occurs on a more frequent basis, once every few months. For specific collaborative or joint research interventions, the frequency may differ depending upon the nature of the research and the associated duration.

71 www.lib.icimod.org/record/34478

72 Tuladhar, Sabarnee and other authors. 2022. Climate change, water and agriculture linkages in the Upper Indus Basin: A field study from Gilgit-Baltistan and Leh-Ladakh. *Frontiers in Sustainable Food Systems*, vol. 6. www.doi.org/10.3389/fsufs.2022.1012363 and Shrestha, Aryn Bhakta (2021) Developing a science-based policy network over the Upper Indus Basin. *Science of the Total Environment*, vol. 784 www.sciencedirect.com/science/article/pii/S0048969721021379

Meeting proceedings are shared on ICIMOD's web portal and may be accessed by the public. The data sets generated from the Sustain Indus Initiative are hosted on the Indus Knowledge Partnership Platform (IKPP), which is also open access.[73] Collaborative research studies are published in the form of assessment reports and open access journal articles[74],[75] and disseminated to wider audiences.

Source: Case study provided by Ajaz Ali, International Centre for Integrated Mountain Development (ICIMOD), 2022.

Case study 34 Pollution prevention in the Meuse and Scheldt River basins

Lessons learned covered in this case study: Lesson 18, Lesson 24 and Lesson 35.

In 1999, the International Scheldt Commission (ISC) and the International Meuse Commission (IMC) decided to develop a tool for their respective river basin districts to ensure effective communication between the different states or regions in the event of a pollution incident with transboundary risks. The Warning and Alert System (WAS) is common to the two river basin districts of the Meuse and the Scheldt, both shared between Belgium, France and the Netherlands, with the Meuse district also extending to Germany and Luxembourg.[76]

In practice, each state or region of the basins concerned has designated a Main Alert Centre (MAC), which functions as the main actor ensuring all communications at the international level in the event of a water pollution incident with potential transboundary impact. In such cases, the MAC concerned uses the computerized warning and alert system tool to notify and communicate all relevant data to the MAC(s) of countries or regions potentially affected by the pollution wave, following a strict procedure, with a copy to the International Commissions.

Whenever a sudden transboundary deterioration in the quality of the surface waters of the Meuse or Scheldt River basin district threatens its use and/or could threaten people, flora, fauna or the environment, the Warning and Alert System is triggered. A report on these alerts is drawn up each year by the IMC or ISC, showing the evolution of accidental pollution in each basin and its associated characteristics (*Figure 34.1*).

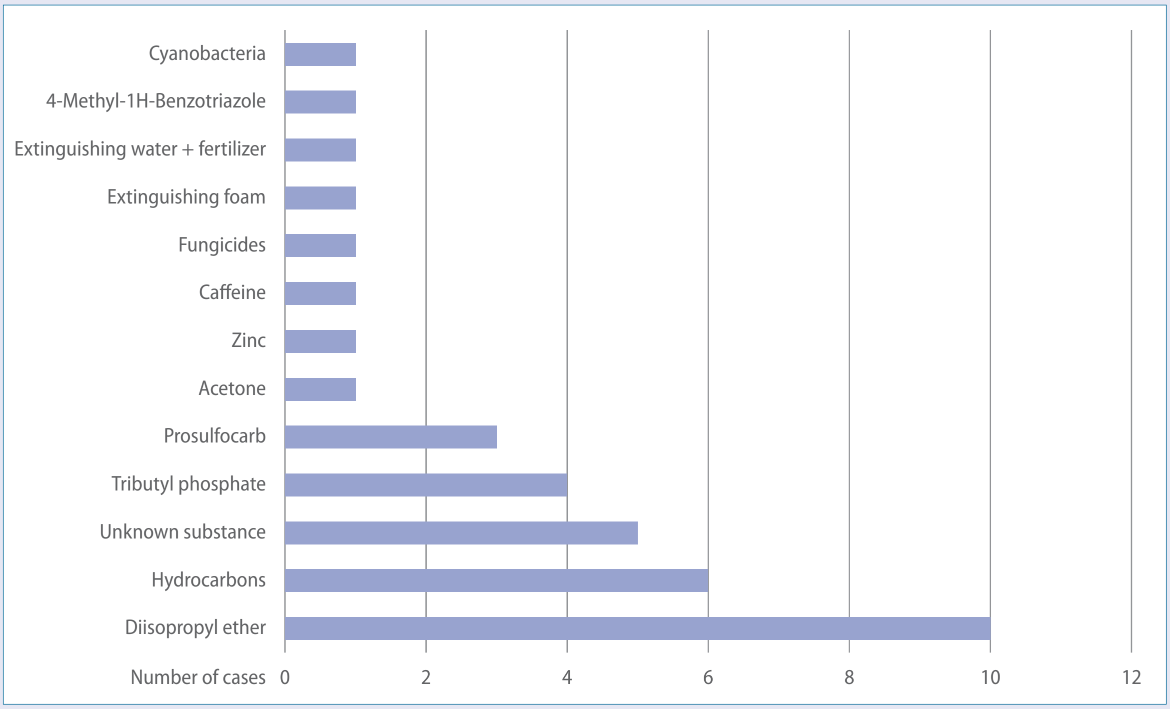
73 www.icimod.org/initiative/indus-knowledge-partnership-platform

74 www.sciencedirect.com/science/article/pii/S0048969721021379

75 www.researchgate.net/publication/341195860_Promoting_Science-Based_Diplomacy_in_the_Upper_Indus_Basin_through_a_Research_Network

76 www.saameuseescaut-wasmaasschelde.be

Figure 34.1 **Overview of the causes (pollutant types) of Warning and Alert System notifications between 2021 and 2022 in the Meuse basin**



Source: International Meuse Commission, 2023.

The WAS Meuse and WAS Scheldt are both activated between 20 and 40 times each year, mainly for requests for information from a downstream country about a substance exceeding the set standards.

Once per year, the IMC and ISC organize an alert exercise on a fictitious pollution, to allow the MACs to use the tool and prepare themselves for a real pollution incident.

Source: Case study provided by Jean-Noël Pansera, International Meuse Commission (IMC), 2023.

River Scheldt in Antwerp, Belgium

Lesson 19 Include information on groundwater and other water resources to promote conjunctive water management

Conjunctive water management, where surface water, groundwater and other components of the water cycle are managed as a hydraulically connected system, helps to highlight possible interrelationships between the different components. Groundwater in particular is often overlooked in water management, partly due to its lack of visibility and the associated difficulties with its monitoring and management. Nevertheless, groundwater plays an important role in many countries, for example as a source of drinking water and as water for agriculture. Groundwater can also affect the availability and quality of surface water, and vice versa. It is therefore essential to collect information on groundwater.

Case studies that cover this lesson: Case study 2, Case study 5, Case study 8, Case study 9, Case study 12, Case study 14, Case study 15, Case study 18, Case study 29, Case study 35, Case study 42, Case study 46, Case study 55, Case study 56, Case study 58, Case study 68, Case study 69, Case study 76 and Case study 77.

Case study 35 Sharing groundwater information in the Gambia River basin

Lessons learned covered in this case study: Lesson 18 and Lesson 19.

Data sets identified and prioritized by the Organization for the Development of the Gambia River (OMVG) and member states target the following themes: hydrology, groundwater and aquatic biodiversity. An important tool in this process is the OMVG's data visualization portal[77] produced with the support of OiEau. The following data are available on the portal:

- monitoring stations (village wells, boreholes, piezometers, limnimeters and virtual stations);
- hydrological data;
- piezometric data;
- hydrological data on virtual stations and uncertainties;
- surface water quality data;
- groundwater works;
- indicators by infrastructure and/or basin;
- land use;
- networks (roads, railways, high voltage lines);
- environmental DNA measurement points in the Corubal basin.

In the absence of common repositories set up between the riparian countries, the harmonization of data is undertaken as needed during automatic import-export procedures such as ETL. Data quality control remains the responsibility of the data producers, the latter being invited to specify the quality control procedures in their metadata sheets describing the data sets made available. The process for integration of the data into the OMVG transboundary platform also allows for additional quality controls through the possibility of cross-analysis between different data sets.

77 www.aquacoope.org/gwh/fr

To the extent possible, regular updating and sharing of data is accomplished via automated interoperability processes (ETL, API, Web Service) between the information systems of the national producers (and/or the national information system on the water) and the OMVG platform. These processes make it possible to consume and harvest the data according to need, based on agreements, and to automate access to data with frequency varying from real time to daily/ten-day/monthly/annual intervals.

The data are stored primarily in the databases of the data producers who remain responsible for their data, then possibly in the national information systems. Depending on needs and authorizations, the data can then be integrated into the framework of the OMVG platform. The data and products generated have different levels of access (public, private, restricted by password) depending on the case. With the exception of specific cases where a producer requests that the confidentiality of the data be respected, the majority of data visualization products created at the transboundary level are available online and can be accessed and downloaded by the public.

The establishment of a shared information system based on the individual information systems of national partners assumes a requisite level of awareness and training on the procedures of shared management. Moreover, as the water and environmental information systems of the countries concerned are at varying levels of development, it is important to build management capacities at the national level.

Source: Case study provided by Paul Haener, Office International de l'Eau (OiEau), 2022.

The Gambia River mangroves

Lesson 20 Support cooperation more flexibly and effectively through inter-agency cooperation programmes

The development of inter-agency cooperation programmes in support of intergovernmental agreements, or even in the absence of such agreements, can provide flexible tools for cooperation. Such programmes can be concluded for shorter periods and allow for adjustments when extended or revised for a new period.

Case studies that cover this lesson: Case study 14, Case study 36, Case study 39 and Case study 63.

Case study 36 Cooperation through inter-agency programmes between hydromets in Central Asia

Lessons learned covered in this case study: Lesson 4 and Lesson 20.

In the region of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), bilateral cooperation programmes between hydrometeorological services are typically concluded for a period of three years and renewed afterwards. These bilateral programmes define the type, timing, frequency and method of transfer of information. This information encompasses the exchange of actual meteorological, hydrological and agrometeorological data and the exchange of information products such as weather forecasts, water and reservoir volumes forecasts, warnings of extreme hydrometeorological situations, and the exchange of bulletins and reports.

In addition to the regular exchange of data and forecasts, such programmes may also cover cooperation in research and development. For example, the programme of cooperation between Kazhydromet in Kazakhstan) and Uzhydromet in Uzbekistan, which is renewed every three years, enables these agencies to exchange hydrological information on 23 observation points in the territory of Uzbekistan and 12 in the territory of Kazakhstan. This daily exchange covers water level and water flow, ice phenomena on rivers, and data on water inflows, discharges and volumes of reservoirs. Every three months, Uzhydromet provides Kazhydromet with the forecasts of water flow in the Amu Darya and Syr Darya river basins for a month and a quarter.

Similar programmes exist between Kazhydromet and Kyrgyzhydromet in Kyrgyzstan, and Kazhydromet and Tajikhydromet in Tajikistan. In addition, Kazhydromet participates in a three-year bilateral programme with Roshydromet in the Russian Federation, enabling the daily exchange of hydrological data on transboundary rivers and reservoir volumes as well as hydrological forecasts.

The exchange of data on water quality is developing gradually in the region, especially between Kazakhstan and Uzbekistan in the Syrdarya River basin (since September 2018) and between Kazakhstan and Kyrgyzstan in the Chu and Talas river basins. Monitoring and data-sharing is also carried out on a regular basis in basins shared between Kazakhstan and the Russian Federation. These basins are (Kazakh name, followed by Russian name) Ertis/Irtysh, Yesil/Ishim, Toyl/Tobol, Zhaiyk/Ural, Karaozen/Bolshoy Uzen, Saryozen/Maly Uzen and Kigash/Kigach.

Source: Case study based on a presentation by Rauza Aschanova, Department of Hydrology of the Republican State Enterprise Kazhydromet, 2023.

Lesson 21 Apply citizen science to support information collection

The public at large can be mobilized to support data collection and analysis. This process is referred to as "citizen science". Volunteers can be provided with the necessary tools and knowledge to perform monitoring activities, and the data collected can make a substantial contribution to monitoring networks at relatively low cost. Through these activities, volunteers become more engaged and increase their awareness of key issues and needs, thus improving their capacity to participate in decision-making. This topic also has links with Lesson 9 on engaging civil society and Lesson 15 on building local knowledge.

Case studies that cover this lesson: Case study 30, Case study 37, Case study 38 and Case study 65.

Case study 37 Involving citizens in data collection: Drinkable Rivers

Lessons learned covered in this case study: Lesson 9, Lesson 15, Lesson 21 and Lesson 36.

Drinkable Rivers is a global movement founded by Li An Phoa to involve people in monitoring the health of their rivers. The creation of the programme was catalysed by her realization that the Rupert River in Canada had become undrinkable within a period of three years due to the construction of dams and mining. Rivers are only drinkable when all actions in an entire watershed contribute to their health. As such, drinkable rivers are an indicator of healthy living and are vital for all life on Earth.[78]

The ambitious and all-round citizen science programme run by Drinkable Rivers not only enables people to monitor the health of rivers, but it also helps track progress towards the goal of a world with drinkable rivers. There are currently 50 citizen science hubs in 18 countries run by enthusiastic people who mobilize volunteers around them. Most hubs are part of local environmental organizations, schools, visitor centres or companies. Each hub is provided with:

- a professional, standardized measurement kit;
- an introductory workshop and videos for ongoing support;
- manuals and instruction videos;
- a platform for data-sharing and mutual learning.

Drinkable Rivers also mobilizes communities to act, led by inspired citizens who are often water professionals, environmental activists, artists, businesspeople and politicians.[79] Drinkable Rivers encourages and assists them in this process and develops tools (action guides, courses, films) to enable concrete action towards achieving drinkable rivers.

Drinkable Rivers also initiates river walks with local community members to engage with them and encourage them to care for rivers. The guiding question used to gauge the usefulness of a community intervention is: "Does this behaviour, this measure or this innovation contribute to drinkable rivers?"

Source: Case study provided by Jos Timmerman on behalf of the Dutch Ministry for Infrastructure and Water Management, 2023.

78 See www.drinkablerivers.org

79 See, for instance, www.drinkablerivers.org/mayors-for-drinkable-rivers

Case study 38 Transboundary citizen science water quality monitoring for SDG 6.3.2 in Kenya and Tanzania

Lessons learned covered in this case study: Lesson 2, Lesson 7, Lesson 9, Lesson 11, Lesson 21 and Lesson 40.

This first transboundary citizen science approach to river monitoring addresses the need to scale up citizen science-based water quality data collection to support national SDG 6.3.2 reporting in Kenya and Tanzania and is supported by the World Water Quality Alliance (WWQA). The work undertaken in Kenya and Tanzania – and more specifically in the Mara River basin in Kenya, which then flows into Tanzania and Lake Victoria– evaluates key components of a citizen science/regulatory water quality design process in both countries in relation to SDG indicator 6.3.2 reporting and explores the challenges and opportunities of a community-based approach. The approach will then be used as a template for transnational river monitoring across Africa.

The transnational project focused on engaging communities through local Water Resource User Associations (WRUAs) in Kenya and local Water User Associations (WUAs) in Tanzania, in their ongoing efforts to improve their understanding of the drivers of water quality degradation. To achieve this goal, the associations employed Freshwater Watch, a citizen science methodology developed by Earthwatch Europe. Both WRUAs and WUAs are recognized by national governments as local partners. The information acquired through river monitoring is proving to be important in the ongoing management of river water quality in both Tanzania and Kenya. The ongoing success of the project is due to the clear knowledge-sharing approach adopted by the national regulators, the Lake Victoria Management Board (LVMB), the WRUAs, the WUAs, Earthwatch Europe and the Global Environment Monitoring System for Water (GEMS/Water).

Several activities were carried out to achieve the expected results and to identify areas for improvement and further development:

a) site identification with the Ministry of Water and LVMB and an initial selection of WUAs and WRUAs;
b) co-design of monitoring protocol with Ministry staff, WUAs and WRUAs;
c) online training of Ministry staff, focusing on the recruitment of citizen scientists (taking into consideration gender and location balance), training of citizen scientists, data quality control and support of citizen scientist activities
d) training and equipping of citizen scientists by Ministry staff with support from WUAs and WRUAs (see *photo* of Water Resources Authority staff working with citizen scientists from a WRUA in the Mara basin to test water quality using the Freshwater Watch kit);
e) monitoring and quality control by citizen scientists;
f) collaborative data analysis;
g) feedback and consultation with citizen scientists;
h) integration of citizen scientist-generated data with Ministry monitoring data.

Efforts were made to identify areas of the Mara basin where regulatory monitoring was limited or absent, and regulatory monitoring was present. For the former, an effort was made to fill key knowledge gaps and provide needed data to local communities through the WRUAs and WRAs. For the latter, sites were identified where data collected by citizen scientists could be compared with regulatory monitoring, both for quality control and demonstration purposes.

Measurements were taken monthly at all sites in the last week of each month, on both the Kenyan and Tanzanian sides of the Mara River. Phosphate concentrations showed a clear seasonal dynamic, as did suspended particulate matter (measured as turbidity), suggesting an influx of phosphate and particulate matter ($p<0.05$) during periods of precipitation. These concentrations have important implications for the receiving lake (Lake Victoria). Nitrate concentrations were low and did not show any significant seasonal variation ($p=0.86$) over the period of the study across all sites. Ongoing discussions between the Ministry, the Water Resources Authority, Earthwatch Europe and GEMS/Water have focused on integrating the citizen scientist data collected to date ($n=184$) with regulatory data for submission under SDG indicator 6.3.2.

Water Resources Authority staff working with citizen scientists in the Mara basin to test water quality

Photo credit: William Hamisi, Water Resources Authority, Kenya.

Source: Case study provided by Steven Loiselle, Senior Freshwater Researcher, Earthwatch Europe, 2023.

Further reading

United Nations Economic Commission for Europe (2000). *Guidelines on Monitoring and Assessment of Transboundary Groundwaters*. Geneva. Available at www.unece.org/DAM/env/water/publications/assessment/guidelinesgroundwater.pdf

____________ (2014). Model Provisions on Transboundary Groundwaters. Geneva. Available at www.unece.org/info/publications/pub/21742

United Nations Educational, Scientific and Cultural Organization (2020). *Conjunctive Water Management. A Powerful Contribution to Achieving the Sustainable Development Goals*. Paris. Available at www.unesdoc.unesco.org/ark:/48223/pf0000375026.locale=en

Chapter 4

Bridge over Syr Darya River in Tajikistan

Types of data and information shared

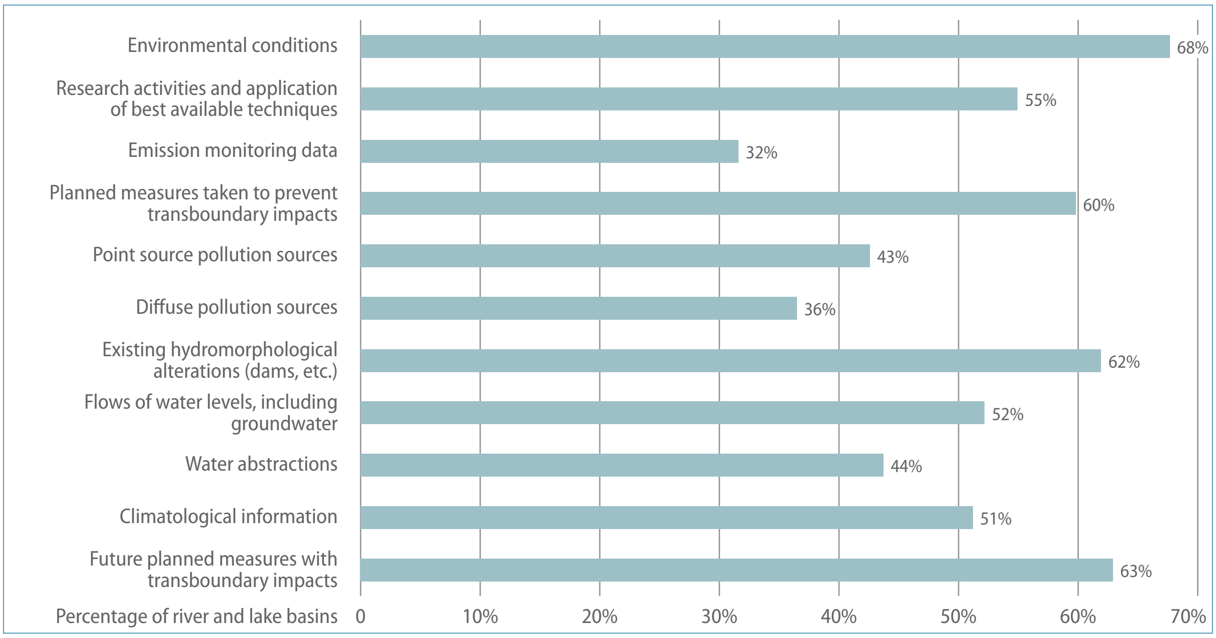
Riparian countries may exchange information on a variety of themes (see *Figure A*). However, the sharing of data and information requires agreement about the subject and types of information needed to ensure informed decision-making. Examples include hydrometeorological and water quality data as well as information about planned activities, legislative and regulatory measures, or dam operations, among others.

In general, for water management, data and information is needed on water uses (e.g. drinking water, irrigation, energy production, recreation, etc.), the main basin functions (maintenance of ecosystems, protection of habitats and aquatic species), issues (e.g. flooding, sedimentation, salinization, pollution, morphological alterations and damming) that hinder the proper use and functioning of the watercourse, and planned and/or implemented measures taken to address these issues. Consequently, data and information may be needed and shared on the following themes, among others:

- water flow, water abstractions;
- environmental conditions of the waters (hydrology, water quality, meteorological data, etc.);
- best available technology;
- results of relevant research and development;
- measures taken and planned;
- national regulations;
- critical situations (e.g. emerging floods or droughts);
- other data (population, socioeconomic, agricultural, land use, pollution sources, etc.).

A variety of sources exist for these topics producing different types of data, and the data-sharing process should account for such differences.

Figure A **SDG Indicator 6.5.2 reporting template, section II, question 6(d) – If countries regularly exchange data and information, on what subjects are information and data exchanged? (based on at least one country within a basin responding positively to the question)**



Source: UNECE, UNESCO and UN-Water (2024). Progress on Transboundary Water Cooperation – Mid-term status of SDG Indicator 6.5.2, with a special focus on climate change, 2024.

Chu River, border between Kazakhstan and the Kyrgyz Republic

Lesson 22 Agree within joint bodies to progressively enlarge the types of data and information collected and shared

Basin commissions and other joint bodies for transboundary water cooperation are important for steering the level of cooperation. They can be instrumental in progressively enlarging the topics and types of data and information that are shared.

Case studies that cover this lesson: Case study 39.

Case study 39 Working Group on Environmental Protection in the Chu and Talas River basins

Lessons learned covered in this case study: Lesson 20, Lesson 22, Lesson 27, Lesson 35 and Lesson 39.

In 2000, the governments of Kazakhstan and the Kyrgyz Republic signed an agreement on the use of intergovernmental water management facilities on the Chu and Talas Rivers, which are shared by the two countries. In 2006, a Commission on the Use of Water Management Facilities of Intergovernmental Status was established, and in 2015 the 20th meeting of the Commission created the Working Group on Environmental Protection. The decisions of the Working Group are advisory in nature.

The Chu and Talas river basins are divided into upper, middle and lower sections. In the upper and middle sections, water sampling and analysis are carried out by Kyrgyz authorities, such as Kyrgyzhydromet, the State Agency for Environmental Protection and Forestry Management, the Land Reclamation and Hydrogeological Expedition, and the Department of State Sanitary and Epidemiological Supervision of the Ministry of Health. In the lower section of the Chu River, as well as the middle and lower section of the Talas River, water sampling and analysis are performed by laboratories of Kazhydromet.

Until 2019, water samples were taken by each Party separately within their own territory at different points in time. The Working Group concluded that it was essential to develop a coordinated surface water quality monitoring programme. Accordingly, the Commission requested the Organization for Security and Co-operation in Europe (OSCE) for support to develop and implement the programme.

Since 2019, every year there have been four seasonal coordinated sampling campaigns. The sampling by Kyrgyzhydromet and Kazhydromet takes place in parallel at transboundary points at the same time (taking into consideration the time for water to travel to the sampling points from Kyrgyzstan to Kazakhstan). The sampling follows the same standard (GOST 31861-2012), and sampling points and indicators were agreed upon by Working Group members.

The created joint platform has supported the monitoring of surface water quality in the river basins and increased cooperation between the countries.

The Chu and Talas example demonstrates how cooperation has gradually progressed over the years from joint maintenance of several water management facilities to other areas of cooperation, including water quality monitoring and assessment. The role of the joint Commission and its secretariat has been crucial in this respect.

Source: Case study based on presentation by Gulmira Satymkulova, Secretariat of Chu-Talas Commission, 2023.

Lesson 23 Develop procedures for sharing data and information on planned measures

In addition to the general exchange of information on water quantity and quality, pollution sources, geology and/or forecasts (hydrological, meteorological, hydrogeological and ecological), riparian countries should exchange information on planned developments including measures and uses. A procedure to share data and information on planned measures, including notification and consultations, can help to avoid mismanagement and prevent misunderstanding and disputes.[80]

Case studies that cover this lesson: Case study 4, Case study 23, Case study 24, Case study 28, Case study 40, Case study 41, Case study 47, Case study 49 and Case study 64.

Case study 40 ZAMCOM procedures for notification of planned measures

Lessons learned covered in this case study: Lesson 4 and Lesson 23.

In 2017, the Zambezi Watercourse Commission (ZAMCOM) Council of Ministers endorsed the Procedures for Notification of Planned Measures (Parts I and II), developed through a series of national consultations in the eight Zambezi Watercourse States. The duty of notification regarding planned measures for ZAMCOM Watercourse States is stipulated in Article 16 of the Agreement establishing the Zambezi Watercourse Commission (ZAMCOM Agreement) and Article 4 of the Revised SADC Protocol on Shared Watercourses.

The Procedures consist of two parts: Part I is an introductory section highlighting the legal basis for the Procedures and the guiding principles; Part II contains the detailed procedural rules and processes for carrying out a notification process in practice. The Procedures include detailed notification requirements, such as timelines, format, required supporting information, actions in the absence of notification, and so on, with the aim to ensure faster project development, approval and implementation, and significantly reduce the possibility of disputes arising over planned projects. They also include the various forms to be used to ease and streamline the notification process. In addition, the Procedures clearly specify the roles of ZAMCOM bodies (ZAMCOM Council, ZAMCOM Secretariat, ZAMTEC, etc.) in the process of notification and consultations.

Since the operationalization of the Procedures (February 2017), they have been applied to a total of 15 planned measures in the Zambezi Watercourse: one in Botswana, nine in Malawi, three in Mozambique, and one each in Namibia and Zimbabwe. The planned measures include, among others, water abstraction, irrigation projects, water supply and sanitation projects, the development of resilient landscapes, instilling confidence and trust among riparian states, and the enhancement of transboundary cooperation.

One of the projects to be implemented in accordance with the Procedures is the Blantyre Water and Sanitation Improvement Project (BWSIP), which aims to address a range of challenges, including socioeconomic development, sustainability and climate change adaptation. The BWSIP represents a significant investment in the water sector of Malawi.

80 This also relates to the principle of notification in international treaties. See, for instance, Article 13 of the Water Convention www.unece.org/DAM/env/water/pdf/watercon.pdf

The Procedures for Notification of Planned Measures are an important tool for promoting the sustainable development of the Zambezi River basin. They help ensure that planned measures are developed in a way that benefits all riparian states, promotes cooperation, protects the environment and reduces the possibility of disputes among riparian states. They help ensure that planned measures are developed in a sustainable and equitable manner.

Source: Case study provided by Hastings Chibuye, Zambezi Watercourse Commission (ZAMCOM), 2023.

Case study 41 Regular reporting on water quality in German-Polish border waters

Lessons learned covered in this case study: Lesson 4, Lesson 8, Lesson 23 and Lesson 35.

In April 1991, a German-Polish Border Water Commission was established following the conclusion of an Agreement on Cooperation in the Field of Water Management of Border Waters between the Federal Republic of Germany and the Republic of Poland. The delegations of each country in this Commission consist of representatives of environment ministries and agencies. Article 2a) and b) of the Agreement establish the Working Group W2, which is mandated by the Commission to carry out joint monitoring and joint improvement of the border waters. This group has three subcommittees dedicated to monitoring issues, transitional/coastal waters and analytical quality management. Each country finances its own activities.

Data are exchanged in accordance with the EU WFD, and cover:

- the measurement results of water chemical parameters, in particular those supporting biological quality elements;
- assessment of the results of chemical quality elements (priority substances and specific substances);
- assessment of the results of biological quality elements;
- surface waters, transitional waters and coastal waters (for border waters).

A joint assessment of the situation in each water body is made on the basis of the shared data, including the hydrological conditions of the relevant year.

Both countries have jointly established a coordinated monitoring programme based on a defined network of monitoring sites. All laboratories testing the boundary waters work according to the established quality system, confirmed by the ISO 17025 certificate, and use reference or equivalent methods. Inter-laboratory comparisons are performed at regular intervals.

Data are stored at the national level and are exchanged once a year in the form of data files. While there is no accessible database, reports are prepared annually and adopted at annual meetings of the German-Polish Border Water Commission and published online. The reports are publicly available but the information they contain is not actively disseminated to the public.

Redzinski Bridge over Oder River

The main difficulties and challenges in sharing data and information relate to lack of available resources, especially staff.

Data-sharing leads to the development of quality components (every year) and status classifications (every six years). In addition, joint activities are undertaken to identify the sources of inputs of particularly conspicuous substances and to reduce or eliminate their discharge where possible. Regular joint reports allow for a long-term overview of the development of quality components of border waters and the identification of any need for action.

In 2021, monitoring was carried out as follows. The German-Polish border waters were examined at a total of 26 monitoring sites and 14 monitoring profiles (seven on the Lausitzer Neiße, six on the Oder and one on the West Oder) on both banks. The frequency of measurements ranged from 4 to 12 per year, depending on the parameters, with a total of 16 parameters assessed. On the Polish and German sides of the Szczecin Lagoon (Great and Small Lagoons), 23 cruises were conducted from January to December to sample the six monitoring stations. In the German and Polish part of the Pomeranian Bay, 21 sampling cruises were conducted at the six monitoring stations between February and December.

Source: Case study provided by Heide Jekel, Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of Germany, 2023.

Lesson 24 Develop a transboundary early warning system

Early warning of floods, droughts and pollution events is vital for countries to take timely measures. Such warnings may necessitate increased frequency of data-sharing, the sharing of additional themes and types of data, and the involvement of specific national authorities, among other requirements. Timely provision of information in critical situations can save lives, prevent environmental damage, reduce pollution and limit transboundary impacts. The development of an early warning system is therefore of paramount importance for transboundary basins.

Improved data and information encompassing the entire basin improves the overall quality of forecasts including for floods, low discharges that may influence irrigation possibilities or navigation, and pollution sources and accidental spills. In the short and medium term, such information enhances preparations for approaching agricultural seasons, while also improving long-term planning. Moreover, timely basin-wide information helps authorities to protect populations and property, and the public to make preparations to evacuate, if necessary. Advance warnings also reduce loss of life and livelihoods, associated health and social impacts, damage and negative economic effects, and impacts on the environment and ecosystems.

Case studies that cover this lesson: Case study 4, Case study 10, Case study 16, Case study 20, Case study 27, Case study 31, Case study 34, Case study 42, Case study 43, Case study 44, Case study 45, Case study 60 and Case study 61.

Case study 42 Early warning systems in Georgia

Lessons learned covered in this case study: Lesson 12, Lesson 19 and Lesson 24.

Georgia shares terrestrial surface waters (rivers and lakes) with Armenia, Azerbaijan, the Russian Federation and Türkiye, and transboundary aquifers with Armenia, Azerbaijan and Türkiye. The Protocol of Intention, signed in Tbilisi on 15 December 2022 between the Ministry of Environmental Protection and Agriculture of Georgia and the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, addresses the following topics:

- exchange of information on the occurrence of dangerous hydrometeorological and geological events;
- cooperation in the field of geology;
- reassessment, monitoring, study of geological conditions of groundwater basins in border regions;
- the organization of training and workshops, and the exchange of experience in the fields of geology, hydrometeorology and climate change.

Specific areas covered under the Protocol include the exchange of information on radar meteorological data and early warning systems, cooperation in the field of joint snow height measurement activities, and the preparation of joint forecasts on the flow of the transboundary Mtkvari, Alazni and Iori Rivers. The Protocol also provides for cooperation in the preparation and implementation of joint projects on climate change mitigation and adaptation.

According to the Protocol of the 12th session of the Intergovernmental Commission on Economic Cooperation Between Georgia and the Republic of Armenia, signed in Yerevan on 12 January 2023, the Parties agreed to exchange information on quantitative water indicators for the Debed/Debeda River basin, the data of ground surface meteorological stations, radar information, information on the management of natural resources, and ambient air, water and soil quality monitoring and assessments.

No agreements or protocols have yet been agreed on other transboundary rivers in the regions, which include the Tusheti Alazani (Andes Koisu), Assa, Arghun, Tergi, Potskhovitskal, Psou and Chorokhi, or the lakes Kartsakhi (Kosefin) and Jandar.

Hydrological information is not publicly available but is accessible to students and educational institutions. In addition, a hydrological database exists as part of the AQVARIUS programme and is regularly updated.

In March 2023, within the framework of the EU project "EU4Environment – Water Resources and Environmental Data", a series of workshops were held in Tbilisi, with the participation of Armenian, Georgian, Azerbaijani and international experts, to develop transboundary monitoring processes for groundwater bodies. This collaboration has since been extended with a view to establishing and implementing a programme for the joint monitoring of groundwater.

Source: Case study provided by Salome Oboladze and Lasha Inauri, Ministry of Environmental Protection and Agriculture, Georgia, 2022.

Case study 43 Development of Early Warning Bulletins in the Amu Darya and Syr Darya River basins

Lessons learned covered in this case study: Lesson 7 and Lesson 24.

The Scientific-Information Centre of the Interstate Commission for Water Coordination of Central Asia (SIC ICWC) prepares Early Warning Bulletins upon the request of the United Nations Regional Centre for Preventive Diplomacy for Central Asia (UNRCCA). The Bulletins help Central Asian states, and their international partners to improve their capacity to regularly monitor the status of transboundary rivers and provide early warning of potential issues that require attention. Each Bulletin details the actual situation in the Amu Darya and Syr Darya basins for the current month and offers a forecast for the next.

The following data sources are used in the Early Warning Bulletins:

- The Amu Darya and Syr Darya basin water organizations provide data on water resources including their distribution in time (daily) and the river section, the operation regimes of reservoirs and inflows to the Aral Sea.
- The "Energy" Coordination Centre makes available data on the operation regimes of hydroelectric power stations and electricity generation.
- The Aral-Syr Darya Basin Water Administration provides data on components of the water balance from the tail-water of the Shardara reservoir to the Northern Aral Sea.
- Open Internet sources are used as a source of climatic information.

The Early Warning Bulletins can be accessed online via the UNRCCA website.[81]

Source: Case study provided by Iskander Beglov, Scientific Information Center of the Interstate Commission for Water Coordination in Central Asia (SIC-ICWC), 2023.

81 www.unrcca.unmissions.org/early-warning-bulletins-2022

Amu Darya River in Uzbekistan

Case study 44 Emergency pollution notification for transboundary waters shared by the Republic of Moldova and Ukraine

Lessons learned covered in this case study: Lesson 4, Lesson 18 and Lesson 24.

Moldova and Ukraine share the Dniester and Prut Rivers. Cooperation between the countries is based on the intergovernmental "Agreement of the Cabinet of Ministers of Ukraine and the Government of the Republic of Moldova on the Joint Use and Protection of Transboundary Waters" (1994) and the "Treaty on Cooperation in the Field of Protection and Sustainable Development of the Dniester River Basin" (2012). The "Regulation on the assessment of the quality of transboundary waters" ensures regular sharing of information on the quality of border waters between Moldova and Ukraine. Furthermore, the two countries have reached an agreement on state (national) monitoring programmes and methods for evaluating results to the extent necessary to obtain comparable measurement data on water quality indicators. Based on these data, it is possible to jointly assess the quality of border waters and trends in changes. The monitoring programme for the quality of border waters includes monitoring sites and corresponding sampling points (gauges), stipulates sampling frequency and provides protocols for analysing water quality indicators.

In the event of an emergency caused by pollution of transboundary waters, additional requirements for the monitoring and sharing of data and information come into effect. These are defined in the "Regulation on actions during emergency pollution at transboundary rivers". In the event of a pollution incident, the Party where the pollution originates must immediately notify the other Party. In addition, Parties must:

- carry out additional water sampling and measuring of quality indicators;
- share operational information on the discharge volumes of pollutants;
- provide timely information on changes in the quality of transboundary waters;
- analyse the situation, develop and implement an action plan to cease the pollution, and eliminate its consequences.

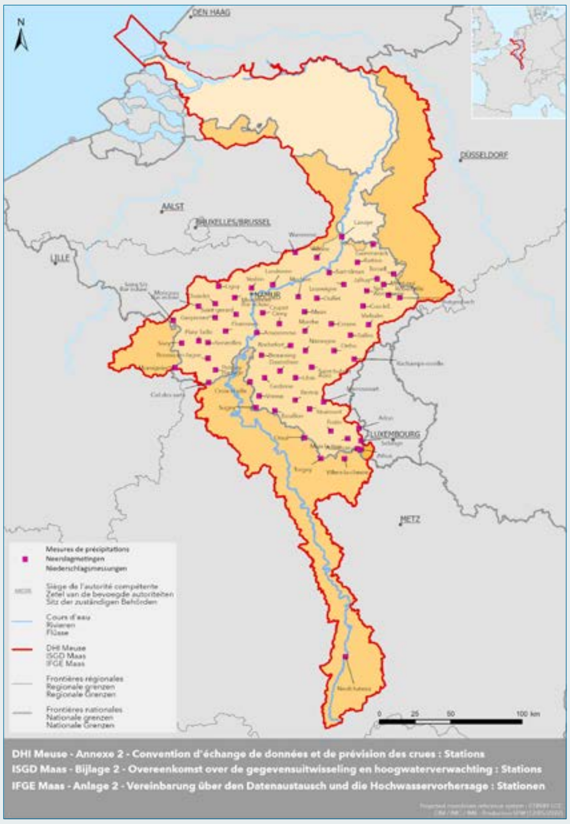
Source: Case study provided by Gavril Gilca, Environmental Protection Agency of Moldova, 2022.

Case study 45 Flood forecasting in the Meuse River basin

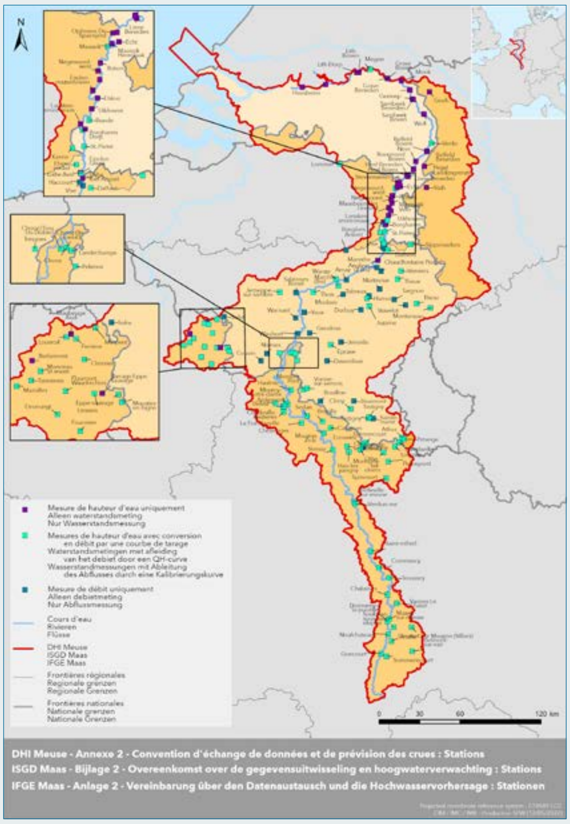
Lessons learned covered in this case study: Lesson 11, Lesson 12 and Lesson 24.

In December 2016, the members of the International Meuse Commission (IMC) signed an agreement on data exchange and flood forecasting (also known as the IMC Data Exchange Convention). This agreement enabled the creation of a platform via which the concerned states and regions can transmit raw precipitation measurement data (*Map 45.1*), water level and flow measurements from 160 hydrological stations, and calculated forecasts of water level or flow from 60 stations (*Map 45.2*).

Map 45.1. Precipitation measuring stations of the IMC Data Exchange Convention



Map 45.2. Water level and flow measuring stations of the IMC Data Exchange Convention



The designations employed and the presentation of material on these maps do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: International Meuse Commission, 2016. Available at: www.meuse-maas.be/Accords.aspx.

In mid-July 2021, catastrophic floods affected several European countries caused by high-impact rainfall events known as a "cold drop". The Meuse basin was among the affected areas. Due to the very erratic nature of the rainfall trajectory, the forecasting work of the Meteorological Institute of Belgium (RMI) and the Meteorological Institute of the Netherlands (KNMI) was particularly challenging both in terms of location and water quantity. For example, the MRI weather forecasting models predicted less than 200 mm of precipitation in the Vesdre and Amblève catchment areas (tributaries of the Meuse), whereas the actual precipitation reached almost 300 mm. As a result, the flood forecasting services in the international Meuse basin experienced difficulties in forecasting the hydrological impact of this rainfall. By relying on the network of IMC precipitation measurement stations, the flood forecasting services of the downstream states were able to feed their hydrological models with precipitation data measured in France and Wallonia, but also with water level and flow data from stations located on the Meuse and its tributaries.

With these data, the Dutch flood forecasting services were able to refine their forecasts as the weather events unfolded. The Dutch models predicted a flow of between 700 and 900 m³/s on 12 July for the St. Pieter station located downstream of the border with Belgium, then a maximum flow of 2,750 m³/s on 13 July. The exchange of data between the states and regions of the IMC enabled the national authorities to estimate the expected flood level in downstream areas as accurately as possible and to take all necessary measures to evacuate populations located in the risk areas from 14 July onwards (around 50,000 people), and to take protective measures to protect property by raising dikes, flooding non-populated areas or opening dams (see *photos* from Belfeld and Well).

Protective measures against flooding in Belfeld and Well

Photos credit: Wout de Vries, Rijkswaterstaat (NL). 2021.

Source: Jean-Noël Pansera, International Meuse Commission (IMC), 2023.

Lesson 25 Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies

Monitoring at the transboundary level is necessary for the proper management of basins. While existing monitoring systems are an important source of data and information, technological innovations can help to collect data and information at lower cost. Such innovations include Earth Observation systems, remote sensing and drones, Geographical Information Systems (GIS), self-monitoring by the private sector, citizen science, sensors and environmental DNA.

Case studies that cover this lesson: Case study 46.

Case study 46 Machine learning analytics for the Ramotswa Aquifer

Lessons learned covered in this case study: Lesson 19, Lesson 25 and Lesson 32.

The Ramotswa Aquifer system is considered one of the most important aquifers in southern Africa. It provides fresh water for agriculture and domestic use, including the municipal water supply for several towns. It straddles the border between Botswana and South Africa and extends into the North West and Gauteng provinces of South Africa. Problems associated with the management of the aquifer include declining groundwater levels, reduced groundwater storage, nitrate and faecal pollution, sinkhole formation due to dewatering and disappearance of spring flows.

Advances in remote-sensing missions, atmospheric and land surface models, social media and other Internet-related platforms are providing new sources of groundwater data to help address these issues. However, a problem with remote-sensing data and computer-based models is that their spatial resolution is better suited to regional or global studies, whereas groundwater-related investigations are local.

One innovative solution has been to utilize Machine Learning Analytics to downscale data to the local level. This has been done using an autoregressive approach to develop a set of generalized gradient boosting decision tree (GBDT) models for the Ramotswa / North West (NW) / Gauteng Dolomites aquifer.

GBDT algorithms are popular machine learning algorithms that can be used for regression, classification and ranking. In machine learning, autoregression is a technique used to forecast time-series events by propagating the predictions of previous forecasts into subsequent forecast steps.

The GBDT model relied on a set of predictor features (regional-scale hydroclimatic variables) to predict a *predictant* (a local-scale variable such as depth to water table). The model then developed forecasted groundwater level changes across the Ramotswa/NW/Gauteng Dolomites aquifer. Machine Learning Analytics displayed a satisfactory ability to model groundwater level changes, with spatially distributed observations enabling the modelling to be applied spatially. Where observations were not well distributed, models were built per borehole. These models performed satisfactorily even where data were scarce. More high-quality data are needed, however, to ensure generality and robustness.

Source: Case study provided by Kevin Pietersen, SADC-GMI based on Gaffoor, Zaheed and other authors (2022) An autoregressive machine learning approach to forecast high-resolution groundwater-level anomalies in the Ramotswa/North West/Gauteng dolomite aquifers of Southern Africa. *Hydrogeology Journal*, vol. 30, pp. 575–600.[82]

---

82 www.doi.org/10.1007/s10040-021-02439-4

Further reading

United Nations Economic Commission for Europe (1993). *Guidelines on the Ecosystem Approach in Water Management*. Geneva. Available at www.unece.org/info/publications/pub/21714

___________ (2018). *A Nexus Approach to Transboundary Cooperation: The experience of the Water Convention*. Geneva. Available at www.unece.org/info/publications/pub/21761

___________ (2018). *Words into Action Implementation Guide for Addressing Water-Related Disasters and Transboundary Cooperation*. Geneva. Available at www.unece.org/info/Environment-Policy/pub/21762

___________ (1995). *UNECE Task Force on Monitoring and Assessment: Biological Assessment Methods for Watercourses*. Geneva. Available at www.unece.org/info/publications/pub/21698

WHO Regional Office for Europe (2011). *Policy Guidance on Water-Related Disease Surveillance*. Copenhagen. Available at www.who.int/europe/publications/i/item/9789289002363

___________ (2011). *Technical Guidance on Water-Related Disease Surveillance* Copenhagen. Available at www.who.int/europe/publications/i/item/9789289002417

North West Province, South Africa

Chapter 5

Blue Nile in Ethiopia

Harmonization and quality assurance

Sharing of data and information entails harmonization of methods and formats to ensure that the data and information are comparable and can consequently be used by other organizations. The data and information shared also need to be of good quality, which requires a process of quality assurance.

To facilitate the comparability of data, clear agreements should be made between neighbouring countries on the definition, coding and formats of collected data and supporting information. In addition, collected data should include "metadata" such as the date, location, measuring depth and measured values. Data quality control is needed for the detection of outliers, missing values and other obvious errors.

Lesson 26 Harmonize data to facilitate comparability between countries

Each country generally uses its own methods to collect, compile and analyse data. Because of these different methods, data from similar locations may differ. It is therefore important to harmonize the data to make them comparable. Harmonization can be achieved by adopting the same (international) standard for each parameter, but it can also be attained by producing a "translation" that indicates how the different values should be interpreted. For chemical analyses, laboratory intercalibration activities help to harmonize data. In addition, a common procedure for information and data-sharing is essential to ensure that the data and information collected by different Parties remain comparable.

Riparian countries must also have comparable capacities to share data and information. This includes interconnecting partner information systems to ensure interoperability and using a common language (common concepts and a referential dataset) and common procedures.

Case studies that cover this lesson: Case study 11, Case study 28, Case study 30, Case study 47, Case study 48, Case study 49, Case study 52, Case study 54, Case study 61, Case study 66, Case study 72, Case study 74 and Case study 75.

Case study 47 Development of a hydrological cycle observation system in the Nile River basin

Lessons learned covered in this case study: Lesson 12, Lesson 18, Lesson 23, Lesson 26, Lesson 31 and Lesson 36.

The Intergovernmental Authority on Development-Hydrological Cycle Observation System (IGAD-HYCOS)[83] was implemented by WMO in collaboration with IGAD from 2011 to 2017, funded by the European Commission. IGAD-HYCOS aimed at establishing a hydrological information system that would contribute to the production of decision-making tools and relevant information products needed by policymakers and users of hydrological services. The project was implemented in Burundi, Djibouti, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan and Uganda.

During the preparatory phase of IGAD-HYCOS, major gaps in monitoring networks, data management, advocacy and capacity building were identified as prioritized areas for project implementation. Within the five years, the project established a data-sharing protocol where all countries committed to share data to the regional database for use in generating common regional products. Redistribution of data at the regional centre was only *possible through authorization from the data provider (each participating country)*.

By 2017, the regional database was receiving data from over 70 newly installed real-time observing stations from seven countries, with all countries using the regional server as a shared infrastructure operation and/or system backup. The basic hydrological observation infrastructure was improved though the provision of 198 stations (122 surface water and 76 groundwater stations), and the rehabilitation and construction of stations sites. These key sites were identified by member states based on location for the performance of in-situ measurements needed to validate space observations.

The project was designed around national activities and the provision of needed resources, such as funds and vehicles, to support the inclusion of these resources in national plans and resources. The regional database is currently hosted by the IGAD Climate Prediction and Applications Centre (ICPAC), but some additional support is needed to carry out maintenance of the stations. All site construction, installation of stations and work on national databases is carried by regional personnel with assistance from international staff.

Ample attention was paid to capacity development with several training sessions conducted on station installation, gauge reading, data management and web portal management, among others. The training model used proved very effective: a group of selected experts from each country were trained on site then trained trainees in their in their own countries.

The project also established an outreach programme for children using a comic entitled "Amina" to explain about water, and organized visits by university students and engagements with relevant water ministers. In addition, a regional web portal was created to reach a larger audience and is updated regularly with relevant materials and links to social media platforms such as Facebook.

Source: Case study provided by Washington Otieno, World Meteorological Organization, 2023.

83 www.hydrohub.wmo.int/en/projects/IGAD-HYCOS

Case study 48 Coordination on the environmental status assessments of shared transboundary surface waters between Austria and Germany

Lessons learned covered in this case study: Lesson 8, Lesson 26 and Lesson 39.

Since 1992, Austria and Germany have carried out regular coordinated investigations on transboundary surface waters within the legal framework of the "Regensburg Treaty (1987) on Water Resources Management Cooperation in the Danube River Basin". The results of the investigations are used for mutual information, the coordination of actions relating to the environmental status of the shared transboundary surface waters and as a basis for water resources management in accordance with the EU WFD. The responsible institutions are the Bavarian State Ministry for Environment and Consumer Protection in Germany and the Federal Ministry of Agriculture, Forestry, Regions and Water Management in Austria.

River basin management planning for implementation of the WFD requires the coordination of all riparian states – including at the international level. For the transboundary surface waters between Austria and Germany, such coordination is carried out by the bilateral Permanent Water Commission under the Regensburg Treaty.

In order to monitor the achievement of and compliance with environmental objectives, and to plan measures efficiently in accordance with the WFD, surface waters must be divided into management units, so-called water bodies. The delineation of water bodies is the responsibility of the Member State of the European Union on whose territory the water body is located. In the case of transboundary waters, coordination between the two countries concerned is required.

Principles are jointly established for the harmonization of delineated water bodies for shared transboundary surface waters, and for mutual coordination and harmonization (if possible) of assessments regarding the achievement of environmental objectives in shared transboundary surface waters.

Despite differences in national methodologies, coordination between the countries resulted in successful harmonization of water bodies and status assessments. This was achieved through data-sharing, including of GIS data for the delineation of surface water bodies and environmental status data, based on monitoring, for assessment of the ecological status of surface water bodies.

An initial report detailing the coordination of shared transboundary waters between Austria and Germany was published in 2017 and is available on the websites of the two competent ministries. In accordance with the six-year WFD cycle, the report was updated in 2022.[84]

Source: Case study provided by Christian Schilling, Federal Ministry of Agriculture, Forestry, Regions and Water Management of Austria, 2023.

84 www.info.bml.gv.at/themen/wasser/wasser-eu-international/europaeische-und-internationale-wasserwirtschaft/gewaesserkommissionen/bericht-deutsch-oesterreichische-grenzgewaesser-2023.html

Case study 49 Sharing data in the Niger River basin

Lessons learned covered in this case study: Lesson 4, Lesson 23 and Lesson 26.

The Niger River flows through the following riparian countries: Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria. Cooperation between these states takes place within the framework of the Niger Basin Authority (NBA). The NBA National Focal Structures in each country are responsible for the exchange of data within the NBA Executive Secretariat and bring together the sectoral bodies responsible for the NBA's areas of competence, namely: energy, hydraulics, agriculture, livestock, fisheries and aquaculture, forestry, logging, transport, communication and industry.

In addition to the obligation of all riparian countries to inform the Executive Secretariat of any project or construction carried out in the basin (Article 4 of the 1987 Revised Convention establishing the NBA), an MoU which established National Focal Structures in each country includes a mandatory clause to "provide the NBA Executive Secretariat with hydrological and environmental data to allow it to prepare and update tools for the integrated management of the basin's natural resources".

The sharing of data and information is partially financed by the budget of the NBA Executive Secretariat and funded in part by projects. The financing of development activities (including fees for data, information and knowledge management) through a regional fund is currently being implemented.

The qualitative and quantitative data and information shared cover a range of environmental, socioeconomic and water resources-related areas, including:

a) monitoring data on the state of waters and ecosystems;
b) relevant research and development results;
c) data on pollutant emissions and wastewater;
d) authorizations or regulatory requirements relating to wastewater;
e) national regulations;
f) critical situations (e.g. emerging floods or droughts, accidental spills).

Available tools and measures to ensure data comparability and quality include:

- data collection and validation procedures;
- a data dictionary;
- a manual on updating data;
- data management and use measures;
- metadata.

Data are stored in regional and national databases, and are exchanged using electronic data formats via e-mail, standard mail, direct transmission and file transfer protocol (FTP). The frequency of data collection varies from daily to monthly and yearly according to needs and challenges. A joint report on the state of the environment is planned.

The data are freely accessible on request, and data and information products are available on institutional and project websites. Decision makers are informed of available information through existing channels, the NBA website, official correspondence, NBA bodies, forums and so on. The public is informed about data through its National or Regional Basin Natural Resource User Coordination (CRU/CNU) representative in the NBA bodies, who is responsible for the exchange of information.

Most difficulties associated with data-sharing in the Niger River basin relate to insufficient funding and a need for capacity-building to ensure that each stakeholder is able to fully assume their responsibilities.

Source: Case study provided by Didier Zinsou, Niger Basin Authority Executive Secretariat, 2023.

Lesson 27 Ensure regional coordination and technical cooperation

Coordination and technical cooperation between riparian countries is essential to ensure that any data and information generated is available in a compatible and harmonized format in accordance with agreed parameters and methodologies. International cooperation partners may provide support in this endeavour.

Case studies that cover this lesson: Case study 27, Case study 29, Case study 39, Case study 50, Case study 51, Case study 65 and Case study 77.

Case study 50 Cooperation in monitoring of transboundary basins between China and Kazakhstan

Lessons learned covered in this case study: Lesson 4, Lesson 8 and Lesson 27.

Cooperation between the People's Republic of China and the Republic of Kazakhstan on the use and protection of transboundary rivers is based on the principles of justice and rationality, and rooted in the values of sincerity, good-neighbourliness and friendship.

The main transboundary rivers shared between the countries are the Black Irtysh (Kara Ertis), the Ili (Ile), the Emel, the Khorgos, the Sumba, the Tekes and the Ulken-Ulast.

Water relations between China and Kazakhstan are regulated by the "Agreement between the Government of the Republic of Kazakhstan and the Government of the People's Republic of China on cooperation in the use and protection of transboundary rivers", signed in Astana on 12 September 2001. To implement the Agreement, the Kazakhstan-China Joint Commission on the use and protection of transboundary rivers (the Joint Commission) and its working group of experts were established.

Regarding the monitoring of transboundary basins, according to the Agreement the Parties will take appropriate measures and make efforts to prevent or mitigate possible serious damage caused by flood disasters and human-caused accidents. The Parties may cooperate on: negotiating and defining the locations of observation stations; measuring the volume and quality of water; researching common methods of observation; taking measurements; conducting analysis and evaluation; completing hydrological observations and measuring data at posts agreed upon by the Parties; conducting possible joint research to prevent or mitigate the effects of flooding, glaciation and other natural disasters; studying trends in future changes in the water content and quality of transboundary rivers; and, if necessary, conducting joint research and exchanging experience on the use and protection of transboundary rivers.

The Parties also agree to determine the content, quantity and time of data and information exchange. Hydrological information and data include average daily water levels, water flow, water temperature and ice events over the past year. The exchange of hydrological information is made in hard copy, in English, according to the approved format for transmitting data.

Data and information on the main transboundary rivers – the Irtysh, the Ily, the Emel and the Tekes – collected at the 10 hydrological stations (six in Kazakhstan and four in China) are exchanged at annual meetings of the working group of experts of the Joint Commission.

The Parties also signed an "Agreement between the governments of the Republic of Kazakhstan and the People's Republic of China on water quality protection of transboundary rivers" in Beijing on 22 February 2011. Within the framework of this Agreement, the Parties will cooperate on joint research activities to determine and agree on water quality standards for transboundary rivers acceptable to both states, as well as on the monitoring rules and methods of their analysis; and to conduct monitoring, analysis and assessment of water quality and exchange agreed information relating to their results.

In order to coordinate and implement this Agreement, a Kazakh-Chinese Commission for cooperation in the field of environmental protection was created. Two working groups operating within the framework of this Commission address monitoring, analysis and assessment of the water quality of transboundary rivers, and rapid response to emergencies and prevention of pollution. The working groups hold at least one meeting each year in accordance with the schedule.

Source: Case study provided by Kulpash Zhaken, International Water Assessment Centre (IWAC), based on UNECE (2020). *Water Allocation in a Transboundary Context: To Strengthen Water Cooperation of the Eurasian Countries*. Nur-Sultan, Kazakhstan. www.iwac.kz/storage/app/media/publikaciy/IWAC%20Brochure%20on%20WA.pdf

Case study 51 Coordination and cooperation in the International Commission for the Protection of the Rhine (ICPR)

Lessons learned covered in this case study: Lesson 11, Lesson 18 and Lesson 27.

The Rhine River basin is shared between Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, the Netherlands and Switzerland. Cooperation between the riparian countries takes place through the International Commission for the Protection of the Rhine (ICPR), based on the Convention for the Protection of the Rhine (1999).[85] Funding of the ICPR is provided by the ordinary contributions of the States to the ICPR, as set out in the internal and financial regulations.

Sharing of monitoring data takes place, for example as part of the 2022–2027 Umbrella Management Plan, in accordance with the European Water Framework Directive (2000/60/EC). Monitoring data are derived from the coordination of district-wide monitoring programmes, providing an overall view of the Rhine district. Each Umbrella Management Plan covers a six-year cycle. These joint documents attest to the coordination between countries/federal states sharing the same international river basin district, and to the coherence of the whole basin. In order to certify the status and/or potential of water bodies under the WFD, states exchange physico-chemical data and samples of specific and significant substances.

85 www.iksr.org/en/icpr/legal-basis/convention

Besides monitoring for the EU WFD, the ICPR has specific monitoring programmes, which are designed to maximize synergies between the Rhine 2040 Programme and WFD monitoring. For example, the Rhine Chemical Analysis Programme aims to assess the overall water status of the Rhine basin, while the Rhine Biological Analysis Programme incorporates qualitative and quantitative inventories of biological quality elements, such as "fish", "macrozoobenthos", "phytoplankton", "macrophytes" and "benthic diatoms".

The water quality of the Rhine is monitored from Switzerland to the Netherlands by the ICPR member states and their nine monitoring stations along the Rhine, with the help of an international coordinated measuring programme. To ensure successful international monitoring, the following components are considered:

- common objectives, participating departments, a net of monitoring stations and the scope of the measurement;
- a common data collection, completeness and plausibility checks;
- evaluation and assessment of the data as well as their documentation.

In concrete terms, this means, for example, that the list of substances of relevance for the Rhine is updated every three years by an expert group of the ICPR. The main monitoring stations are then obliged to measure these substances. Once per year all the data are collected, checked and published with the help of the German Federal Institute of Hydrology. Every three years the expert group prepares a report about the data and the water quality of the Rhine.

Water quality in the Rhine and its tributaries is continuously monitored by the international network of analysis stations. The ICPR gathers, validates and evaluates these data to identify trends in Rhine water quality, and publishes a report annually.

Ad hoc working groups, with technical support from the ICPR Secretariat, ensure data harmonization. Continuous exchanges take place within the Commission's working groups, through direct transmission, report writing and online access.[86] The ICPR stores public measurement and monitoring data on its website (accessible to the public), and reports are produced jointly at different intervals, as set out in the Commission's work schedule.

This cooperation has led to a global vision of the Rhine and coherent management of the Rhine River basin district. The level of cooperation at the Swiss-German border (Basel/Weil am Rhein) as well as at the German-Dutch border (Bimmen/Lobith) is remarkable. The monitoring station in Weil am Rhein is jointly financed by Germany and Switzerland. In Bimmen/Lobith, two monitoring stations are located close to each other but on different sides of the river, with one in Germany and the other in the Netherlands. The laboratories of these stations are located on the same site to facilitate close collaboration and information exchange.

Source: Case study provided by Tabea Stötter, International Commission for the Protection of the Rhine (ICPR) and Renaud Corniquet, Ministry of Ecological Transition of France, 2023.

---

86 www.iksr.bafg.de/iksr/auswahl.asp?S=1

Lesson 28 Harmonize and integrate the use of models with measurements

Models can support decision-making by extrapolating from certain events. However, models need to be calibrated using observational data to ensure accurate information. A combination of measurement data and models can therefore help to provide relevant information. If different models are used in different countries, it is important to harmonize their outputs (see Lesson 26).

Case studies that cover this lesson: Case study 52, Case study 56, Case study 60, Case study 61 and Case study 74.

Case study 52 The OKACOM Decision Support System

Lessons learned covered in this case study: Lesson 4, Lesson 26 and Lesson 28.

The Okavango River basin is shared between Angola, Botswana and Namibia. Each country has a statistical agency which functions as the primary national institution mandated with documenting, storing and distributing national data.

The development of the OKACOM Rules and Procedures on the Sharing of Data and Information in the Cubango Okavango River Basin, otherwise known as the Data Sharing Protocol, or DSP, started with member state visits to identify and compile the various legal instruments and procedures governing data-sharing. Following national consultations, a regional workshop on the DSP was held in October 2019 in Gaborone, Botswana (see *photo*). The workshop brought together members of the Okavango Basin Steering Committee (OBSC), the Water Resources Technical Committee (WRTC) and representatives from the three member states. At the workshop, the draft DSP was discussed, and a decision taken to adopt a one-part structure comprising general rules and procedures and relevant annexes.

Regional workshop on the OKACOM DSP in Gaborone, Botswana

Photo credit: OKACOM. 2019.

Okavango Delta in Botswana

The regional workshop also paved the way for OKACOM to finalize and endorse the DSP as the jointly agreed guidelines and instrument for data-sharing among member states.[87] Since 2020, data-sharing has been carried out based on this agreement. The DSP also describes the broader categories of water resources data and information required for responsible basin management. This approach facilitated the establishment of the OKACOM Environmental Monitoring Framework, a compendium of procedures and standards for monitoring and data collection.

The data-sharing procedures also specify some quality assurance principles. The OKACOM Decision Support System (DSS) ensures that data from all Member States will be stored in a consistent format, and, at the same time, provides a platform for the harmonization of national databases in terms of data format, technology and systems used for hydrometeorological gauging and data storage. To fill data gaps and augment data availability at strategic management points in the basin, OKACOM, with financial assistance from the European Union, has installed eight hydromet stations.

The data from the hydromet stations is fed into the flood early warning system and used for basin assessment through modelling. Decision makers are informed of the results through direct information-sharing and at twice-yearly OKACOM statutory meetings. The DSS also incorporates a basin assessment module that provides password-protected access to data and modelling results. Essential information is posted on the OKACOM website. However, detailed analytics of the water resources situation in the basin are accessible through the DSS dashboard section, which provides similar information to the public through the Web. In addition, key information is shared with local basin communities through visits and awareness programmes.

Source: Case study provided by Phera Ramoeli, Permanent Okavango River Basin Water Commission (OKACOM), 2022.

87 www.okacom.org/rules-and-procedures-sharing-data-and-information-cubango-okavango-river-basin

Lake Fertő in Hungary

Case study 53 Reconciling water balance data in Lake Fertő

Lessons learned covered in this case study: Lesson 4 and Lesson 29.

Lake Fertő straddles the border between the Republic of Austria and the Hungarian People's Republic. An agreement signed by the two countries on 9 April 1956 established the basis for the regulation of water management issues in the region and the sharing of hydrological data from Lake Fertő and its watershed. Collected hydrological data are produced and processed by Hungarian and Austrian institutes funded by the central budgets of the Hungarian government and Burgenland federal government. Each Party to the Agreement supplies data to the other free of charge.

Annual hydrological data are jointly processed and shared by Hungarian and Austrian water management institutes. These include water level, water discharge, precipitation and evapotranspiration time series data drawn from numerous hydrological monitoring stations on Lake Fertő and its watershed. Each Party also exchanges the hydrological and meteorological information needed to calculate the water balance for the lake. The countries process the data individually and then evaluate the water balance together at a joint meeting, making improvements as necessary.

Hydrometeorological elements of the water balance are stored in MS Excel format, and the summarized results are appended to the annual minutes of the common Hungarian-Austrian Committee, which are drawn up in both languages.

Each partner stores the data in their own database. Hungary, for its part, stores data from Lake Fertő in the Hydrographical database (VRA) and makes the processed data of Hungarian stations available free of charge to researchers, students or for any non-commercial use. However, this permission does not extend to data from its Austrian partner.

Source: Case study provided by László Sütheő, North Transdanubian Water Management Directorate, and Peter Kovacs, Ministry of Interior, Hungary, 2022.

Lesson 29 Perform joint monitoring to facilitate data harmonization

Harmonization of data can be achieved by performing joint monitoring on the same stretch of river or at the same well or borehole. The countries can either produce a joint dataset or undertake separate processing and analysis procedures and then compare the results – an option that can shed a light on differences in approaches and the corresponding results. One example of such monitoring involves a joint monitoring station or setting up "regattas" in which different teams measure the same object and then verify whether the data match and work on ways to make them match. Interlaboratory comparisons can be organized to check the ability of laboratories to deliver accurate testing results or to find out whether a certain analytical method performs well.

Case studies that cover this lesson: Case study 53, Case study 54 and Case study 55.

Case study 54 Joint monitoring in the Dniester and Prut River basins by the Republic of Moldova and Ukraine

Lessons learned covered in this case study: Lesson 4, Lesson 26 and Lesson 29.

The "Regulation of Ukrainian-Moldovan Cooperation on Monitoring the Quality of Border Water" ensures regular sharing of information on the quality of border waters in the Dniester and Prut basins. The two countries have agreed to set up state (national) monitoring programmes and methods for evaluating results, in order to obtain comparable measurement data on water quality indicators. Based on these data it is possible to jointly assess the quality of border waters and trends in its change.

The Parties share test reports containing the data of physical and chemical analyses for a certain period. Each Party assumes financial obligations to ensure the presence of laboratory staff during the joint selection process.

The programme for monitoring the quality of boundary waters includes monitoring sites and corresponding sampling points (gauges), sampling frequency and analysed water quality indicators. Locations for monitoring the quality of boundary waters are selected based on national capabilities for organizing observations, and, as a rule, are located on joint sections and boundary gauges of watercourses that form the state border between the Parties.

Sampling points (targets) are selected at the agreed monitoring sites based on their potential to provide adequate information about the reference quality of the boundary waters. Information about the monitoring site and point of sampling (range and altitude) is drawn up in the form of a sampling protocol, and the unified format for the protocol is agreed upon by the Parties.

The agreed list of indicators for the quality of border waters reflects key parameters for the protection of water use, with a pronounced emphasis on transboundary pollutants, and are subject to the intensity of anthropogenic activities in the watershed. By agreement of the Parties, specific lists of water quality indicators may be established for individual watercourses, reflecting their specific characteristics, water use and pollution features.

Sampling is carried out by the relevant competent authorities and other state (national) organizations nominated for this purpose, who perform regular observations of the state of the waters in accordance with national programmes, simultaneously or jointly. For each sample, a protocol for sampling and the results of analytical measurements is filled out.

Analyses of the water quality parameters are carried out by state (national) laboratories certified and accredited in accordance with the accreditation procedures established by each of the Parties. The Parties strive to the extent possible to harmonize methods, rules, and procedures for sampling and analytical work to increase the convergence of results.

Data are stored in the internal database of the water quality laboratory. Data are disseminated via a hardcopy bulletin, with e-mail and other means of communication permitted for data-sharing.

On the basis of the data gathered on the quality of border waters during the calendar year, the Working Groups of each of the Parties compile annual national reports for submission to the Plenipotentiaries of Moldova and Ukraine (a joint body under the 1994 Agreement of the Cabinet of Ministers of Ukraine and the Government of the Republic of Moldova on the joint use and protection of transboundary waters) for approval at their next meeting.

Source: Case study provided by Gavril Gilca, Environmental Protection Agency of Moldova, 2022.

Prut River in Ukraine

Danube River in Wachau, Austria

Case study 55 Joint Danube Surveys

Lessons learned covered in this case study: Lesson 11, Lesson 12, Lesson 19, Lesson 29 and Lesson 35.

The International Commission for the Protection of the Danube River (ICPDR) comprises 15 contracting Parties (Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Moldova, Montenegro, Romania, Slovakia, Slovenia, Serbia, Ukraine and the European Union). The legal basis for international cooperation is the Danube River Protection Convention, signed in 1994. Italy, Switzerland, Poland, Albania and North Macedonia also cooperate with the ICPDR under the EU Water Framework Directive.

The TransNational Monitoring Network (TNMN) is a monitoring tool of the ICPDR. Formally launched in 1996, the TNMN aims to provide a balanced overall view of pollution and long-term trends in water quality and pollution loads in the Danube and its major tributaries. The annual assessment of water quality published in the TNMN Yearbooks is complemented by periodic investigative surveys carried out every six years synchronous with the river basin management planning period according to the EU WFD.

The main objectives of the Joint Danube Surveys (JDS) are: (i) to provide comparable information on selected water quality elements for the Danube, including its major tributaries, on a short-term basis; (ii) to provide an opportunity for basin-wide harmonization and training in WFD-related monitoring; (iii) to fill information gaps as necessary for updates of the Danube River Basin Management Plan; (iv) to test new approaches to water quality monitoring; and (v) to raise public awareness for a healthier and cleaner Danube.

The first Joint Danube Survey was conducted in 2001, providing, for the first time, comparable data for the entire course of the river covering more than 140 different biological, chemical and bacteriological parameters. These data were used as an essential source of information for the first analysis of the Danube River Basin District, in accordance with Article 5 of the EU WFD. Six years later, the second Joint Danube Survey (JDS2) established a comprehensive and homogeneous database on the status of the aquatic ecosystem of the Danube and its main tributaries. This first survey of fish species along the entire Danube provided a unique data set and contributed to methodological harmonization between EU and non-EU countries. The results of the JDS2 contributed to the first Danube River Basin Management Plan and were used in the EU intercalibration process for large rivers.

The third Joint Danube Survey (JDS3), which took place in 2013, comprised the largest amount of knowledge on Danube water pollution ever collected in a single scientific exercise. It confirmed the high level of biodiversity in the river. In-situ measurements of hydrological, morphological and hydraulic conditions were taken along the entire Danube and its tributaries, significantly improving the level of information on hydromorphological conditions. The survey also included the first comprehensive antibiotic resistance test carried out along the full extent of the Danube.

The fourth Joint Danube Survey (JDS4)[88] represented a milestone. For the first three surveys, a Core Team of leading experts undertook all the sampling and, in the case of biology, microbiology and hydromorphology, the analysis of the samples, while national experts joined the Core Team only in their respective countries and mostly observed how the work was performed (sometimes assisting the Core Team). JDS4 took the opposite approach: a significant proportion of the survey work (biology, hydromorphology, physico-chemical analyses) was carried out by the national experts, while the Core Team adopted a coordinating and advisory role to ensure coherence between the different methods used by the national experts. This approach, together with training workshops for each biological quality element organized prior to the survey, provided an excellent opportunity for harmonization and training in WFD-related monitoring, thus giving a prominent place to the above-mentioned long-term key objective of the JDS. An additional ambition of JDS4 was the parallel application of classical monitoring methods in biology and chemistry, together with novel approaches such as (e)DNA analysis for biota and target and non-target screening of chemicals. This parallel application of standard and novel monitoring techniques at the large scale of the Danube River provided a unique opportunity to assess the potential of these new approaches.

Due to the active involvement of national teams and its extremely broad scope, JDS4 mobilized the largest number of actively participating experts in the history of the ICPDR. In total, more than 130 laboratories from across Europe participated in the JDS4 analysis programme. The survey programme brought together the majority of the ICPDR expert bodies: the Monitoring and Assessment Expert Group functioned as the main survey organizer, the HYMO Task Group focused on hydromorphological assessment, the Groundwater Task Group organized groundwater monitoring, the Information Management and GIS Expert Group dealt with data management, the Public Participation Expert Group handled public outreach and communication, the Pressures and Measures Expert Group managed wastewater assessment, and the River Basin Management Expert Group used the JDS4 results as the basis for preparation of the Danube River Basin Management Plan Update 2021.

Discussions among ICPDR experts post-JDS4 produced overall positive feedback on the new approach, which was considered successful both in terms of national and international exchange of experience and harmonization of sampling methods. The training and harmonization workshops were found to be particularly helpful, and the new JDS4 approach enhanced the strength of national activities and the level of commitment among the concerned authorities and their staff.

Source: Case study provided by Igor Liska, International Commission for the Protection of the Danube River, 2023.

88 www.danubesurvey.org/jds4

Further reading

United Nations Economic Commission for Europe (1996). *UNECE Task Force on Monitoring and Assessment: Quality Assurance*. Geneva. Available at www.unece.org/info/publications/pub/21701

____________ (2002). *UNECE Task Force on Laboratory Quality Management and Accreditation. Technical report: Guidance to Operation of Water Quality Laboratories.* Geneva. Available at www.unece.org/info/publications/pub/21696

World Meteorological Organization (2017). *Guide to the Implementation of Quality Management Systems for National Meteorological and Hydrological Services and Other Relevant Service Providers*. Geneva. Available at www.library.wmo.int/index.php?lvl=notice_display&id=15574

____________ (2021). *Manual on the WMO Information System (WMO No. 1060): Annex VII to the WMO Technical Regulations*. Geneva. Available at www.library.wmo.int/index.php?lvl=notice_display&id=9254

Danube River in Vienna, Austria

Chapter 6

Iguazu Falls on the Parana River, shared by Argentina and Brazil

Data management, processing and sharing

Data need to be stored, analysed and processed prior to sharing. This includes potentially harmonizing assessment methods and modelling.

Data should be stored properly in databases, with sufficient supporting information to enable interpretation, comparison, processing (conversions, etc.) and reporting. For data analysis, an agreed (statistical) operation is required, which includes, for instance, comparison against standards. Most of the data used for transboundary water resources management is provided by national organizations. Therefore, the transboundary information system, when designed, should ideally rely on national information systems with (direct) access to data sets made available by national partners. This implies a need to reinforce national capacities in data management and to develop capacities to exchange comparable data and ensure interoperability with the information systems of partners, using a common language and common procedures. Formats for the exchange of data should be defined and agreed upon by the users.

Lesson 30 Technical cooperation can be a springboard for multidisciplinary cooperation

Cooperation at the technical level can be a way to showcase the importance of working together. The information resulting from such collaborations, which may not require a formal mandate, can highlight the benefits of cooperation and also reveal gaps in knowledge essential for proper decision-making. Filling these may lead to the involvement of other disciplines at the technical level. Once such cooperation is recognized at the political level, formal mandates can be developed, and the process can be expanded.

Case studies that cover this lesson: Case study 56.

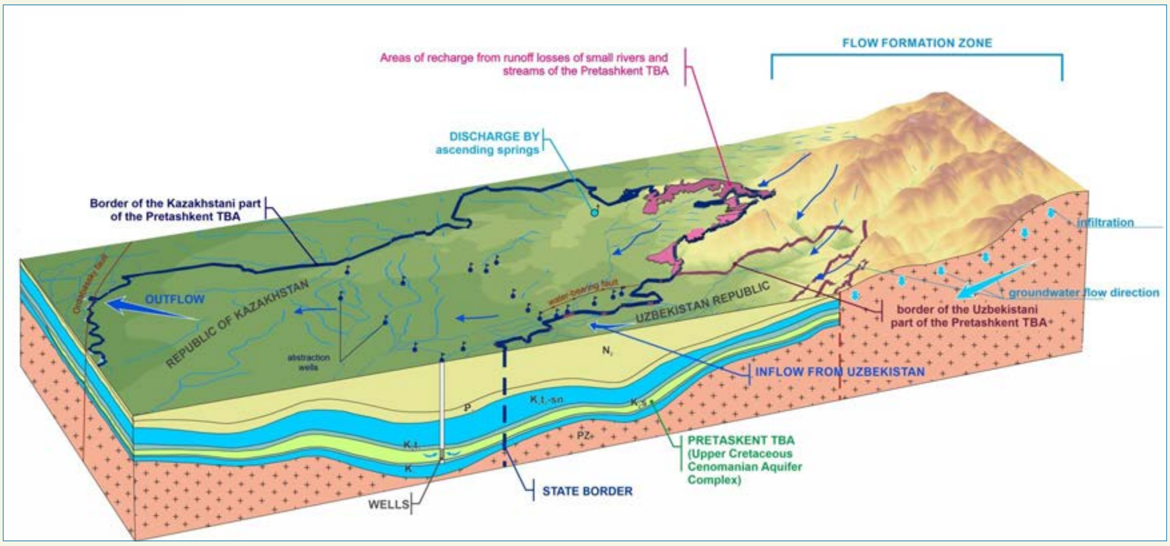
Case study 56 Sharing of data and information in the Pretashkent Transboundary Aquifer

Lessons learned covered in this case study: Lesson 7, Lesson 11, Lesson 12, Lesson 19, Lesson 28, Lesson 30, Lesson 32 and Lesson 40.

The Pretashkent Transboundary Aquifer (see *Figure 56.1*) is an example of a medium-sized, deeply buried artesian aquifer[89] with negligible recent recharge. It is shared between Kazakhstan and Uzbekistan. There are two main challenges associated with the aquifer: (i) depletion of groundwater storage and (ii) potential degradation of groundwater quality.

The Governance of Groundwater Resources in Transboundary Aquifers (GGRETA) project, implemented by UNESCO-IHP in close partnership with IGRAC and national counterparts and with the support of the Swiss Agency for Development and Cooperation (SDC), aims at strengthening regional stability, cooperation and peace through the establishment of cooperative frameworks for transboundary groundwater governance. The Pretashkent Aquifer was chosen as one of three pilot aquifers on three different continents.

Figure 56.1 Conceptual model of the Pretashkent Transboundary Aquifer



Source: IGRAC, 2016. Available at: www.un-igrac.org/case-study/pretashkent-aquifer.

The first phase of the GGRETA project (2013–2015) provided a scientific and multidisciplinary understanding of the groundwater dynamics, legal and institutional frameworks, and socioeconomic conditions of the pilot aquifers.[90] The second phase (2016–2018) focused on building institutional capacity for transboundary water cooperation and strengthening dialogues between Kazakhstan and Uzbekistan.

89 An artesian aquifer is a confined aquifer containing groundwater under positive pressure. An artesian aquifer has trapped water, surrounded by layers of impermeable rock or clay, which apply positive pressure to the water contained within the aquifer.

90 www.un-igrac.org/sites/default/files/resources/files/Pretashkent_web.pdf (in Russian).

The aim was for the countries concerned to agree on a pathway towards cooperation on joint management of the Pretashkent Aquifer, while ensuring that the exchange of data would align with national security requirements. The recommended approach was twofold: (i) to establish teams of national experts to create and operate a mathematical simulation model for use by national government institutions as a basis for groundwater management, and (ii) to develop a consolidated strategy for Kazakhstan and Uzbekistan to manage the risk of degradation of the aquifer. A mathematical simulation model of the aquifer was subsequently created as part of the project's third phase (2019–2022) along with three scenarios for future management of groundwater resources.

Building upon this technical cooperation, Kazakhstan and Uzbekistan developed a strategy in the form of a joint roadmap to support the sustainable use and management of the Pretashkent Aquifer and continued cooperation. The roadmap was endorsed on 30 November 2022 by the Geology Committee of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan and the State Committee for Geology and Mineral Resources of the Republic of Uzbekistan.

The next steps were identified as follows:

1. Make the model a permanent operational tool for aquifer management across the two states.
2. Build capacity for international cooperation on the optimal joint management of groundwater resources based on agreed scenarios, the permanent operational model and the exchange of hydrogeological monitoring data.
3. Ensure ongoing monitoring of the groundwater resources in all operating wells, regardless of their affiliation and purpose. Assess and monitor the technical and environmental condition of water intake wells.
4. Improve national legislation to ensure mandatory groundwater monitoring of the aquifer.
5. Limit the extraction rate in intake wells in strict accordance with the values of exploitable resources agreed and approved by the countries.
6. Ensure the development of an accounting system for the volume of groundwater abstraction and use at the national and interstate levels, and a regional water cadastre (a database) to register groundwater abstraction across the aquifer. The database would constitute the primary input to the aquifer management model.
7. Upgrade the state of the groundwater monitoring system by installing modern equipment for recording the discharge rates and pressure in wells. Implement data quality control measures in accordance with international standards. Develop groundwater quality monitoring programmes covering the entire aquifer.
8. Develop international cooperation between Kazakhstan and Uzbekistan on the groundwater quality of the aquifer, agree on water quality assessment standards and develop an arrangement for the exchange of this type of data between the states.

Source: Case study based on presentation by Oleg Podolny, "KazHYDEC" Ltd. and Valentina Rakhimova, UM Akhmedsafin Institute of Hydrogeology and Geoecology, Kazakhstan, 2023.

Lesson 31 Build a common data repository, database or information system

A common repository supports data harmonization and facilitates accessibility, among others. Clear arrangements are needed to ensure proper operation and maintenance of such a repository, which should be housed, preferably, by the (joint) coordinating body for the shared basin.

Some countries have amassed large historical datasets that may be difficult to convert into a common format. In such cases it may be more beneficial to build a national portal that enables ease of access to such data.

Case studies that cover this lesson: Case study 2, Case study 4, Case study 5, Case study 8, Case study 12, Case study 22, Case study 31, Case study 47, Case study 57, Case study 58, Case study 59, Case study 61, Case study 66, Case study 68, Case study 72, Case study 75, Case study 76 and Case study 77.

Case study 57 The Drin Information Management System

Lessons learned covered in this case study: Lesson 17, Lesson 31, Lesson 35 and Lesson 39.

The basin of the Drin River is shared by Albania, Greece, Kosovo,[91] Montenegro and North Macedonia. The basin provides water resources for drinking, energy, fishing, agriculture, biodiversity, tourism and industry. The competent riparian authorities in the basin collect significant quantities of complex data, albeit not in a harmonized manner. In 2011, the five riparian countries signed an MoU prioritizing, among others, the "improvement of information sharing through the establishment of a system for regular sharing of relevant information among [the] competent authorities of each party".

The GEF Drin Project (implemented by UNDP and executed by the Global Water Partnership – Mediterranean (GWP-Med) in cooperation with the Water Convention Secretariat) has supported the implementation of the MoU since 2016. Recognizing the crucial importance of the Drin River basin, the Drin Core Group (DCG) designed a tool that would enable the storage and sharing of comprehensive scientific data on the water level of the Drin basin. The Drin Information Management System is a GIS-based free online tool available in all Drin languages that allows for the easy collection, sharing and presentation of environmental, social and economic data concerning the Drin basin. This important tool supports cooperation between the riparian countries and is currently maintained by the Secretariat of the DCG (GWP-Med).[92]

In response to the need for more coordinated monitoring, the GEF Drin project also instituted a pilot activity in cooperation with UNESCO, aimed at designing and testing a modern multi-purpose, coordinated groundwater monitoring network in the Skadar/Shkoder – Buna/Bojana Delta transboundary alluvial aquifer (Albania and Montenegro), in accordance with relevant EU legislation. The results will be used to upscale related activities in the Drin basin.

Source: Case study provided by Ylber Mirta, Ministry of Environment and Physical Planning, North Macedonia, 2022.

91 References to Kosovo shall be understood to be in the context of Security Council Resolution 1244 (1999).

92 https://www.gwp.org/en/GWP-Mediterranean/WE-ACT/News-List-Page/2022/drin-ims/

Drin River in Albania

Case study 58 The Arab Groundwater Knowledge Platform

Lessons learned covered in this case study: Lesson 3, Lesson 16, Lesson 19, Lesson 31, Lesson 33, Lesson 39 and Lesson 40.

The Arab region is one of the most water-scarce regions in the world: 19 states are below the water scarcity threshold, including 13 states below the absolute water scarcity threshold. More than 11 Arab countries rely primarily on groundwater as their main source of freshwater.[93] Unfortunately, information on groundwater in the Arab region is fragmented, inaccessible or poorly monitored.

During its 14th session, the Intergovernmental Committee on Water Resources of the United Nations Economic and Social Commission for Western Asia (UNESCWA) recommended the establishment of a digital platform dedicated to groundwater knowledge.[94] The objective was to facilitate access by decision makers and stakeholders to the latest studies, reports, data, information and tools related to groundwater in the Arab region. In collaboration with the Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD), UNESCWA successfully launched the Arab Groundwater Knowledge Platform (Figure 58.1),[95] a centralized repository of data on groundwater resources in the Arab region for a diverse audience, including water and natural resource managers, researchers and analysts.

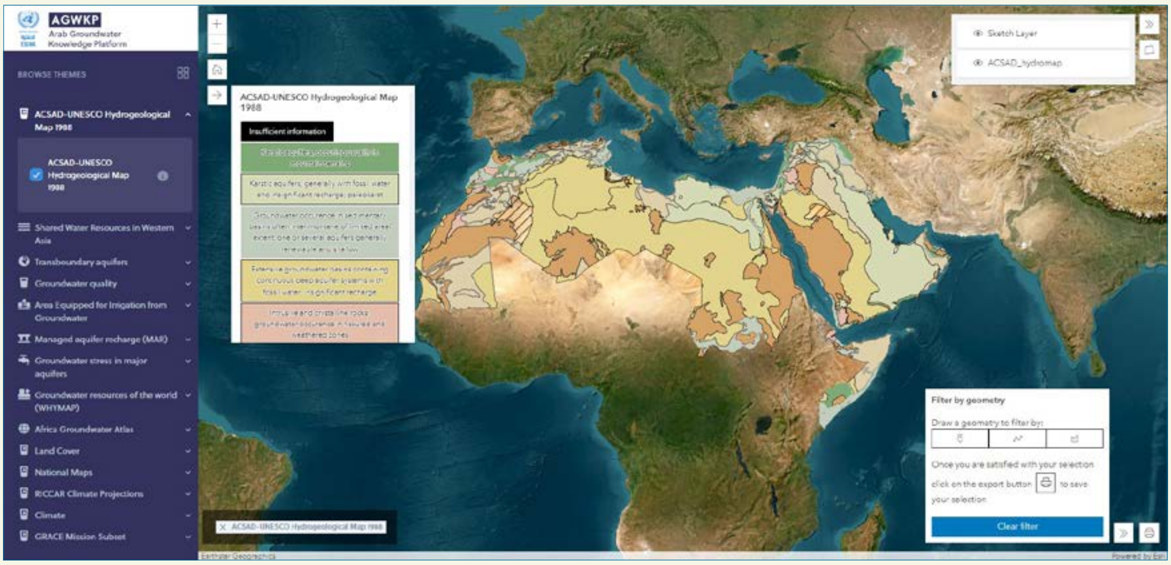
93 UNESCWA (2022). *ESCWA Water Development Report 9: Groundwater in the Arab Region*. Beirut. www.unescwa.org/publications/water-development-report-9

94 UNESCWA (2022). *Report of the Committee on Water Resources on its fourteenth session held virtually on 29–30 September 2021*. Beirut. www.unescwa.org/sites/default/files/event/materials/2200050%20%20report%20of%20the%20Committee%20on%20Water%20Resources%20on%20its%20fourteenth%20session.pdf

95 www.agwkp.unescwa.org

The primary objective of the Arab Groundwater Knowledge Platform is to streamline access to data and information, thereby minimizing the time and effort spent by policy advisors, researchers and experts in the collection, preparation and pre-processing of data. The platform consolidates a wealth of remote sensing, geospatial and climate data related to groundwater resources in the Arab region. In addition, an Arab Network of Groundwater Focal Points has been established, bringing together national focal points from various ministries responsible for groundwater resources management. The Network provided feedback and support on the proposed development of the Arab Groundwater Knowledge Platform during an inception meeting, contributing national groundwater data to enrich the platform. Currently, the platform is being populated with groundwater and hydrogeological data received from national focal points.

Figure 58.1 Interface of the Arab Groundwater Knowledge Platform



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: Arab Groundwater Knowledge Platform, accessed in May 2024.

This open-access Arab Groundwater Knowledge Platform is designed to be user-friendly and highly interactive, serving as a valuable online resource for stakeholder consultation and transboundary dialogue. Through the joint and continuous efforts of UNESCWA, ACSAD, National Focal Points and external consultants, the Platform will support groundwater management in the Arab States to inform initiatives aimed at enhancing water security in the region.

Source: Case study provided by Tracy Zaarour and Ziad Khayat, United Nations Economic and Social Commission for Western Asia (UNESCWA), 2023.

Case study 59 A global portal and framework for international data exchange: the WMO Hydrological Observing System (WHOS)

Lessons learned covered in this case study: Lesson 3 and Lesson 31.

Floods, droughts and water stress are becoming more frequent and intense with climate change. The availability, access and usability of data needed to understand and better predict hazards and water stress, and to effectively implement early warning systems for all, remains a challenge, however. Such data are not effectively shared for a variety of technical, capacity, political, legal, financial and other reasons.

Effective information-sharing requires the formulation of data exchange protocols, data-sharing platforms and the establishment of common monitoring, standards and technologies based on globally and regionally acceptable solutions. In order to break silos and improve access to and the availability and usability of hydrometeorological data, in 2015 WMO launched the WMO Hydrological Observing System (WHOS)[96] as a one-stop shop for interoperable hydrometeorological data. WHOS is now a hydrological component of the WMO Information System (WIS2.0) and the WMO Integrated Global Observing System (WIGOS).[97]

WHOS is a framework that strengthens and builds upon existing systems, platforms and agreements to improve the interoperability, access, exchange and publication of hydrological data and metadata at different scales (national, regional, global). It uses standardization and mediation approaches for the benefit of national meteorological and hydrological services, non-NMHS data providers and users, and to promote transboundary cooperation. WHOS does not prescribe specific tools but encourages the use of open standards and web services to link hydrological data (including groundwater and water quality) providers (heterogeneous sources) and users (multiple uses), and consensus data-sharing agreements based on the WMO Unified Data Policy.

WHOS also provides a set of toolsets for ingesting, processing, publishing, discovering, visualizing, accessing and downloading hydrometeorological data using standards-based and mediation approaches in accordance with WIS2 principles. In addition, it promotes metadata interoperability through the implementation of the WHOS ontology, which supports the mapping of different metadata. All data exchanged within WHOS can be visualized and accessed through the WHOS Global Portal, which displays the map and a list of data providers.

WHOS has been implemented in the River Plata basin, shared by Argentina, Bolivia, Brazil, Paraguay and Uruguay, where the exchange of information is carried out by consensus among the institutions responsible for data and information related to the waters of each country. WHOS enables free access, interoperability and brokering (harmonization) of all data from each state. In addition, the system incorporates the harmonized data into a regional decision support system (DSS), allowing for the visualization and processing of information from different countries in a single interoperable platform (Delft-FEWS). WHOS also provides data to and supports the effective implementation of the Hydrometeorological Forecasting and Early Warning System in the La Plata Basin (PROHMSAT),[98] which enhances the capacity of the region's NMHSs to provide flood forecasts, thereby reducing the vulnerability of surrounding communities to the impacts of floods.

96 www.community.wmo.int/en/activity-areas/wmo-hydrological-observing-system-whos

97 www.community.wmo.int/en/activity-areas/WIGOS

98 www.community.wmo.int/en/projects/hydrometeorological-forecasting-and-early-warning-system-la-plata-basin-prohmsat

The WHOS-Arctic Portal makes available hydrometeorological data shared by Canada, Finland, Denmark (for Greenland), Iceland, Norway, the Russian Federation and the United States of America for the Arctic-HYCOS Basic Network of Hydrological Stations (BNHS). The WHOS-Arctic Portal is implemented using ArcGIS Online for the map interface and USGS GWIS (Graphing Water Information System) for the time series plots. The countries identified locations for the stations, agreed on a common set of metadata provided in their national languages but made available in English through the WHOS broker, and established protocols for sharing the agreed data sets.

Source: Case study provided by Tommaso Abrate and Washington Otieno, World Meteorological Organization (WMO), 2023.

Rio de la Plata in Montevideo, Uruguay

Lesson 32 Use models for assessment, interpretation and forecasting

Models allow data to be extrapolated geographically. This enables better evaluation and interpretation of the data which is particularly important for integrated aquifer systems. Models can also extrapolate data to future events under different circumstances, enabling the forecasting of potential events. In this way, models can be used to forecast the effects of measures, among other interventions.

Case studies that cover this lesson: Case study 31, Case study 46, Case study 56, Case study 60, Case study 61, Case study 74 and Case study 76.

Case study 60 The Rhine Alarm Model

Lessons learned covered in this case study: Lesson 18, Lesson 24, Lesson 28 and Lesson 32.

After a fire in the chemical plant at Sandoz near Basel in 1986, during which great amounts of extinguishing water contaminated with chemicals flowed into the Rhine, the 7th Conference of Rhine Ministers charged the ICPR with designing a Rhine Alarm Model[99] for the Rhine and its main tributaries in collaboration with the International Commission for the Hydrology of the Rhine basin (CHR).

The Rhine Alarm Model is a common, uniform communication tool allowing the riparian countries to access and share rapid, reciprocal information, optimize the characterization and monitoring of pollution, and enable operational services to take the necessary measures. After sudden discharges of pollutants, the model can calculate the development of the wave of pollutants and has proven to be an indispensable instrument during numerous sudden pollution incidents, as part of the International Warn and Alarm Plan (IWAP) Rhine.

The IWAP Rhine includes seven international main warning centres (IMWCs),[100] competent authorities which cooperate with each other within the IWAP framework. The plan is based on three types of declaration exchanged between centres, depending on the nature of the event, and the impact and risks on the environment or uses of the areas concerned (warnings, information and search notices). These exchanges are carried out via an Internet platform (InfoPol Rhine) and are listed annually in an ICPR report. The IWAP Rhine clearly identifies, depending on the location of the pollution incident, the competent international main warning centre, and the upstream and downstream information chain of its counterparts, in a predefined and agreed format to avoid any misinterpretation. Regular exercises are carried out to ensure that the IWAP Rhine and communications between IMWCs are properly applied. Feedback is periodically exchanged between stakeholders within a dedicated ICPR expert group, which may propose options to optimize the plan and its application procedures.

Reliable predictions of sudden pollutant waves are extremely important for the IWAP Rhine, to ensure timely implementation of required measures at the right time. Among such measures are halting the intake of raw water for drinking water production or having the fire brigade or civil protection put up oil barriers in the Rhine or its tributaries. The Rhine alarm model is used by international main warning centres, national warning centres, warning centres of the German federal states, the institutions consulting these centres (e.g. operators of monitoring stations) and drinking water companies to predict the substance distribution of a sudden water pollution event.

---

99 www.iksr.org/en/topics/pollution/international-warning-and-alarm-plan/rhine-alarm-model

100 www.iksr.org/en/topics/pollution/international-warning-and-alarm-plan

The Rhine alarm model encompasses the entirety of the river from Lake Constance to the North Sea. In addition to the main river, the tributaries Aare (draining the majority of Switzerland), Neckar, Main, Moselle, Meurthe and Saar are mathematically modelled. Model calibration has been carried out using particular pigments (tracers) that do not harm aquatic organisms, which were discharged into the Rhine and are measurable in very low concentrations. When required, the place, time and amount of pollution discharged, a substance breakdown, the floatability of the substances (e.g. oils, gasoil and petrol), and the discharge and/or water levels serve as input data for the Rhine alarm model.

The model will then calculate the concentration of a substance for the observed river location depending on the time of the peak of the pollutant wave at the location observed and the development of the pollutant wave from the discharge location to the North Sea. This model can predict not only the development of a pollutant wave downstream but also the spread of a pollutant cloud over the width of the river. For selected periods of time (usually one day), this model can calculate where the wave will be in the watershed. If required, an animation can be produced to predict the development of the pollutant wave from the discharge location up to the North Sea, with about 98 per cent reliability.

The Rhine alarm model has served as the basis for developing similar models for the Danube and the Meuse. Preparations are currently underway for a new or updated version of the model.

Source: Case study provided by Tabea Stötter, International Commission for the Protection of the Rhine (ICPR) and Renaud Corniquet, Ministry of Ecological Transition of France, 2023.

Case study 61 Integrated information system in the Sava River basin

Lessons learned covered in this case study: Lesson 1, Lesson 2, Lesson 3, Lesson 4, Lesson 12, Lesson 18, Lesson 24, Lesson 26, Lesson 27, Lesson 28, Lesson 31, Lesson 32, Lesson 33, Lesson 35 and Lesson 40.

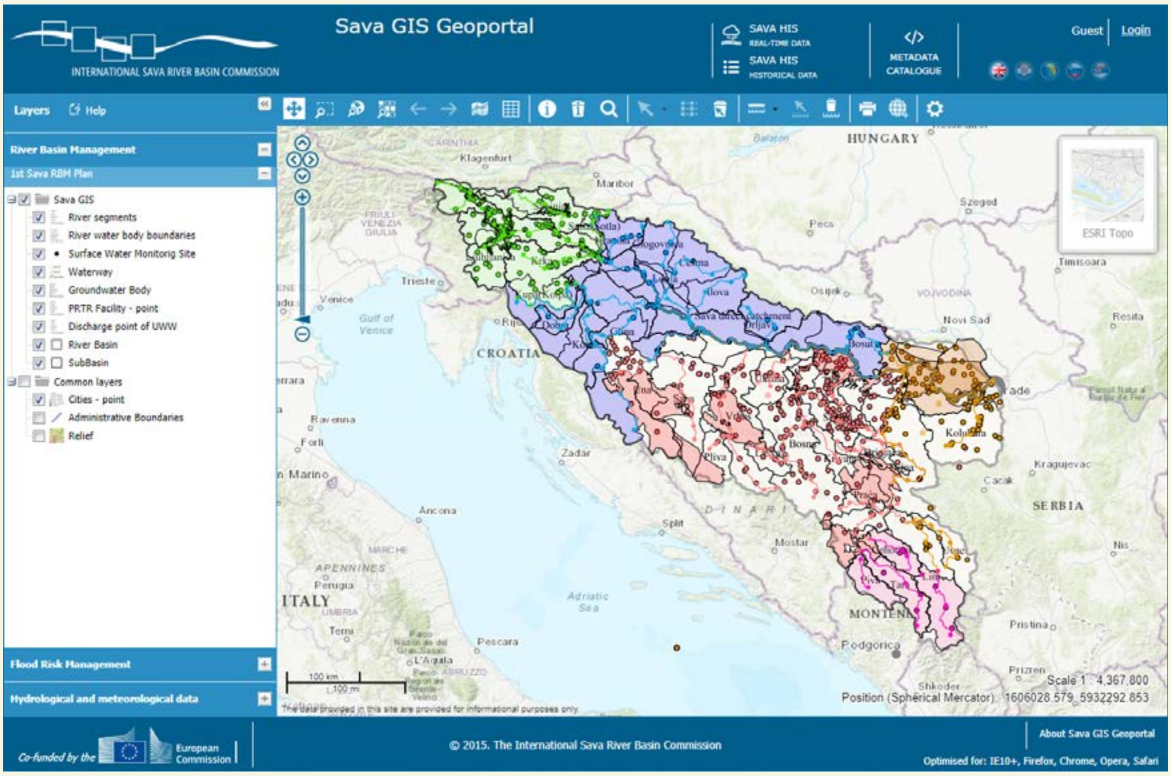
The Sava River basin is shared by Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Slovenia and a small part of northern Albania (Case study 10). Based on the 2002 Framework Agreement on the Sava River Basin (FASRB 2002), the countries agreed to cooperate on the sustainable management of the waters of the Sava River basin to ensure inland navigation and water management, including the integrated management of surface and groundwater resources. As part of this process, it was recognized that the sharing of data and information at the basin level was vital both for the sustainable management of water resources and the mitigation of water-related hazards. The riparian countries are therefore obliged to exchange information on the water regime of the Sava River basin on a regular basis.

The ISRBC established the vision, principles and objectives for the development of the Sava River basin Geographic Information System (GIS), otherwise known as Sava GIS, to enable the sharing and dissemination of information and knowledge on water resources protection and water management activities in the basin.

In several phases, the ISRBC has established a fully functional system, operated through the Sava GIS Geoportal.[101] The Sava GIS Geoportal (see *Figure 61.1*) is a scalable and flexible tool for data visualization and management, which supports multilingual usage (English and the six official languages of the Contracting Parties) and implements open source technologies as well as open web services. A web application for editing, loading and retrieving data and metadata has also been established, allowing registered users to view, visualize, share and retrieve geographic information and data sets stored in a database for the whole basin.

The Sava GIS database, which is compliant with the Infrastructure for Spatial Information in Europe (INSPIRE) and other relevant EU directives and guidelines, enables the collection of necessary and available spatial data from the Parties in a properly structured manner, their storage in a central database, and the processing and management of the data using web-based tools. Data contributors upload their data to a common Sava GIS database via web interfaces or in other structured ways and use the provided tools and processes to harmonize the data. Currently, 34 governmental institutions from the five Sava River basin countries are involved in the data exchange process (i.e. 13 institutions in the role of data providers and recipients, and another 21 institutions as data recipients).

Figure 61.1 Overview of the Sava River basin GIS Geoportal



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

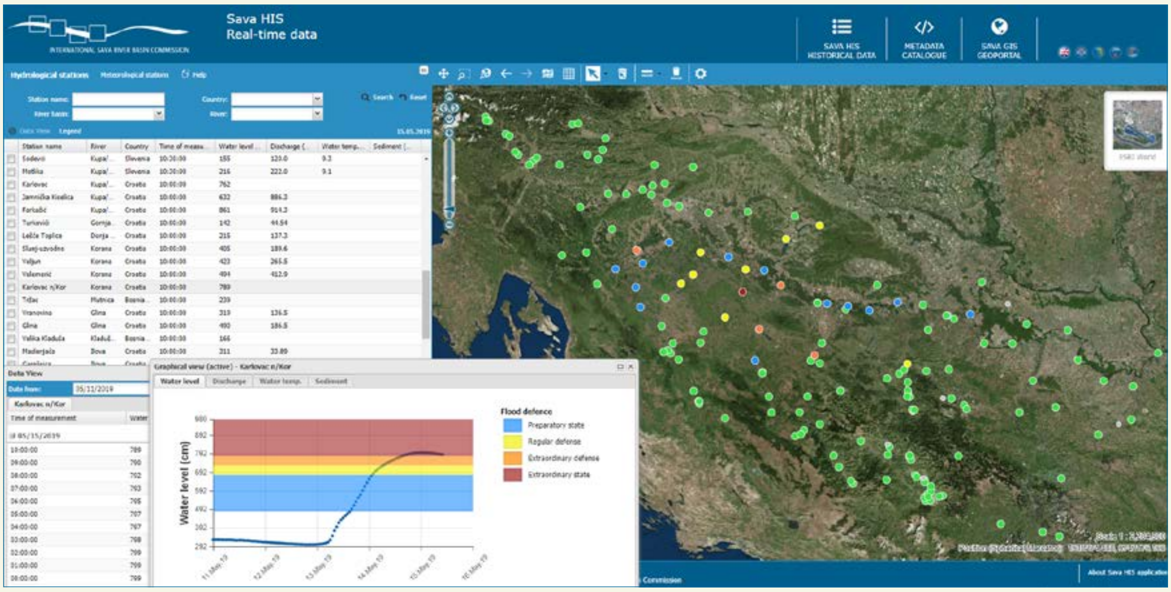
Source: ISRBC, 2023.

101 www.savagis.org

Using the Sava Geoportal and its submodules, interested parties (government institutions, private entities, public, etc.) are already able to obtain an overview of available datasets related to river basin and flood management, inland navigation, and accidental pollution prevention and control. A plan is also in place to expand the Sava Geoportal to cover sediment management issues as well as to upgrade the portal with advanced tools for mapping and reporting services and DSS.

As an integral part of Sava GIS, the ISRBC has also established the Hydrological Information System for the Sava River basin, Sava HIS,[102] which enables the exchange of hydrological and meteorological data and information. Sava HIS currently collects observed data from 299 hydrological and 212 meteorological gauges, with the number of stations increasing continuously since its establishment because of growing commitment on the part of countries who have recognized the efficiency of the system and the concomitant benefits (see *Figure 61.2*).

Figure 61.2 Overview of the Sava River basin Hydrological Information System



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

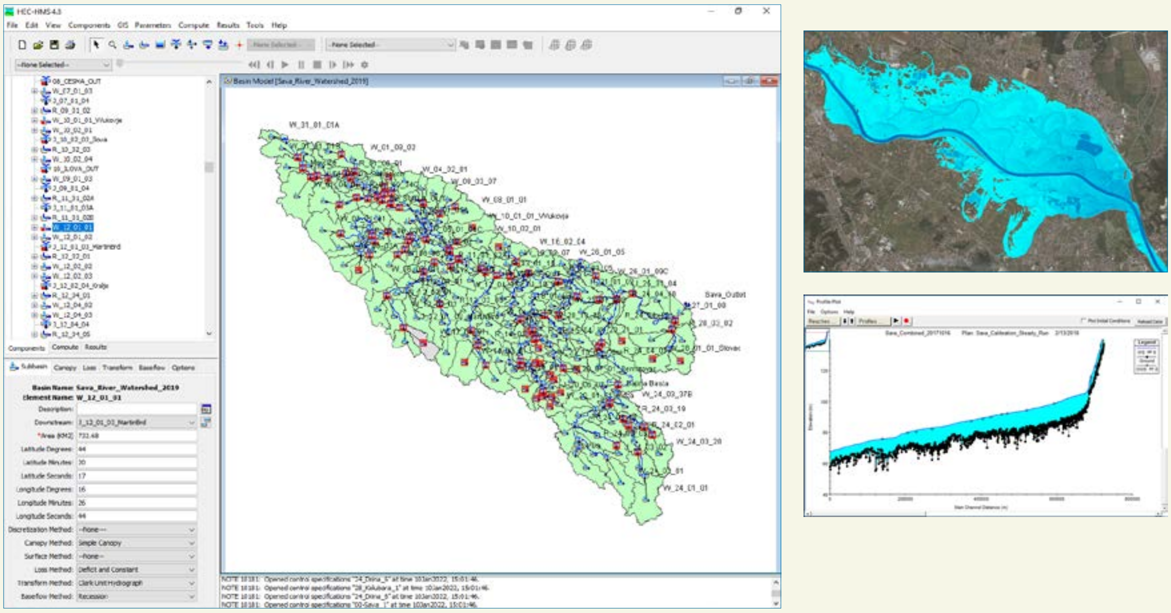
Source: ISRBC, 2023.

The system enables the storage of water observations, time series data and spatial information in a standard format and their sharing and publication via a web service for further use. For example, the system is already connected to the WHOS (see *Case study 59*).

102 www.savahis.org/his

In addition to the activities related to the collection and exchange of data and information, the ISRBC also coordinated the modelling activities at the basin level[103] by developing a comprehensive hydrological model of the Sava River basin and a hydraulic model of the Sava River (see *Figure 61.3*). Both models were developed through several development phases, including knowledge transfer on how to use the models, which are continuously improved by the ISRBC together with the relevant institutions of the countries as the main users of the models. During the development of the models, several workshops were organized for experts from the national institutions to transfer the knowledge on how to use the models.

Figure 61.3 Illustration of the hydrological model for the Sava River basin and the hydraulic model for the Sava River



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: ISRBC, 2023.

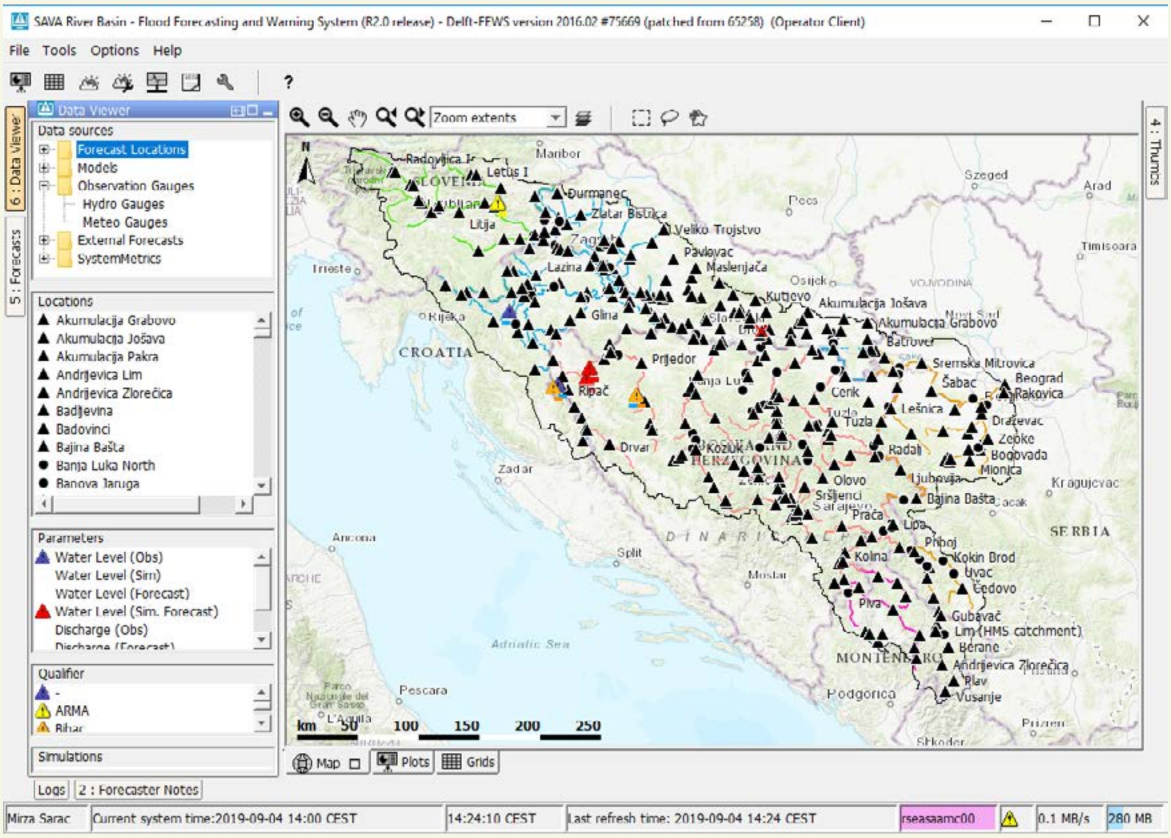
The cooperating countries have benefited directly from the successful development of the Sava River basin models for flood forecasting and warning, with plans in place to capitalize on the models' potential for many other purposes, including sediment transport analysis, water pollution modelling, low flow analysis, climate change and nautical studies.

103 www.savacommission.org/activities/cross-cutting-issues/hydrologic-and-hydraulic-models/282

In addition, the Sava countries, coordinated by ISRBC, have successfully established a joint Flood Forecasting and Warning System in the Sava River Basin (Sava FFWS),[104] which functions as an umbrella for data and information exchange and modelling at the Sava River basin level (see *Figure 61.4*). Sava FFWS is operational and in regular daily use by 10 national institutions responsible for flood forecasting. The system is an open and flexible platform for managing the data handling and forecasting process, allowing a wide range of external data and models to be integrated. This concept is particularly important for the five cooperating Sava countries, which use several different models that could easily be "plugged" into a common Sava FFWS by means of available adapters.

Physically, Sava FFWS consists of five hosting locations: one primary and three backup servers located in the responsible national institutions and an archive and web server located in the ISRBC.

Figure 61.4 Overview of the Sava River basin Flood Forecasting and Warning System

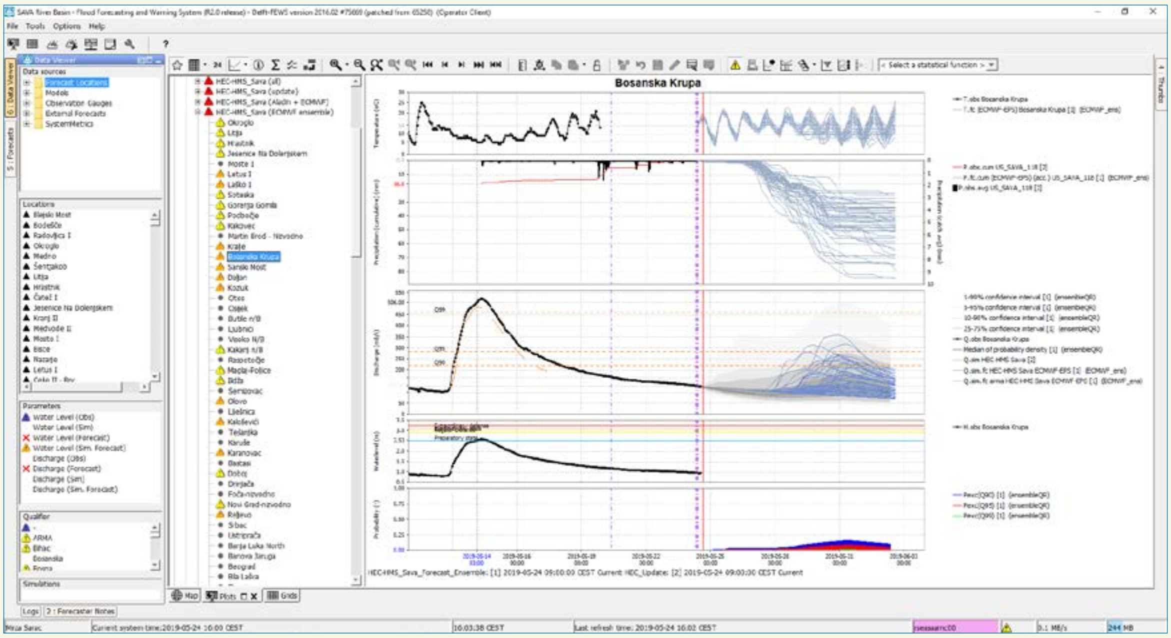


The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: ISRBC, 2023.

104 www.savacommission.org/flood-forecasting-and-warning-system/579

Figure 61.4 **Overview of the Sava River basin Flood Forecasting and Warning System (continued)**



Source: ISRBC, 2023.

Sava FFWS integrates the Sava HIS as a data hub for the collection of real-time observed hydrological and meteorological data as well as the above-mentioned hydrological and hydraulic models, as its core models. In addition, Sava FFWS incorporates eight different numerical weather prediction models, weather radar and satellite imagery, outputs of the existing national forecasting systems, and different local hydrological and hydraulic models.

Sava FFWS enables the five Sava countries involved to make the right management decisions and implement operational measures to prevent and mitigate severe floods and droughts based on reliable forecasts of water levels and discharges with a long lead time within the area of an entire river basin.

Source: Case study provided by Mirza Sarač, International Sava River Basin Commission (ISRBC), 2024.

Further reading

World Meteorological Organization (2021). *Manual on the Global Data-processing and Forecasting System (WMO No. 485): Annex IV to the WMO Technical Regulations*. Geneva. Available at www.library.wmo.int/index.php?lvl=notice_display&id=12793

Chapter 7

Rhine River in Germany

Reporting and use of data

Reporting should be based on interpretation of the available data and plays a key role in decision-making for water management and the further development of monitoring and assessment programmes. It is therefore important that the reporting and use of data and information is integrated into the development of the overall monitoring network.

Reporting is not limited to the production of reports; it also entails the dissemination of information about water resources in a variety of forms. Such information contributes to environmental reporting and may inform planning relevant for water-using sectors. Information dissemination should therefore take place on a regular basis and the interpreted data made available in an easily accessible and understandable format tailored to the audience in question. The same information should be readily available for use for a variety of purposes, including different reporting obligations, and by a variety of users. The level of detail included in reports and the frequency of compilation will also depend on the target audience. Reporting of environmental information plays an especially important role in increasing public awareness of water problems, climate change and biodiversity impacts, and in promoting public participation in water management.

Reporting may take place through a joint body entrusted with the development of reports focused on water management in transboundary basins. The form of these joint reports should be agreed upon in detail by the riparian countries. Harmonization of reporting is strongly encouraged, and the information presented in the reports should contribute usefully to management decisions.

The use of information should also feed back into the design of the monitoring programme, leading potentially to revision and improvements, as well as to the review of and possibly changes in information needs and consequent priorities for monitoring and assessment.

Lesson 33 Disseminate information to all relevant sectors, ministries and the public

To ensure support from different sectors, ministries and the public, it is important that all parties are informed of monitoring outcomes. Reports should provide ministers and other decision makers with relevant information to support informed decision-making, but also consistently reiterate the importance of monitoring. The sharing of information between different stakeholders and the public at large is also beneficial and can initiate and enhance public participation. All such disseminated information should be based on documented and agreed evidence.

Case studies that cover this lesson: Case study 19, Case study 22, Case study 33, Case study 58, Case study 61, Case study 62 and Case study 67.

Case study 62 Stakeholder participation in the International Commission for the Protection of the Rhine (ICPR)

Lessons learned covered in this case study: Lesson 9, Lesson 11 and Lesson 33.

Cooperation between the members states of the ICPR (France, Germany, Luxembourg, the Netherlands, Switzerland and the European Commission) and Austria, Liechtenstein and the Belgian region of Wallonia, as well as Italy, helps protect the Rhine and all waters that flow into the river.

Intergovernmental organizations whose work relates to the ICPR Convention and NGOs whose areas of interest or tasks address related themes, can be recognized as observers to the ICPR. Observers participate in expert meetings and working groups, the plenary assembly and a yearly meeting with the ICPR president. While they do not have the right to vote, they can share and receive information from the ICPR. In some working groups they actively contribute to reports.

One example of such stakeholder contributions is the involvement of the International Association of Waterworks in the Rhine Basin (IAWR) in an annual report on the International Warning and Alert Plan (IWAP). The first chapter of the report, which is produced by the IAWR and based on data received from drinking water associations, provides information about contamination incidents and the associated impact on drinking water abstraction from the Rhine, including stoppages.

Source: Case study provided by Tabea Stötter, International Commission for the Protection of the Rhine (ICPR), 2023.

Lesson 34 Ensure the sharing of knowledge between technical specialists and decision makers

Active dissemination of monitoring results to decision makers leads to better understanding of the situation at the basin level, which in turn increases the likelihood of better-informed policy decisions.

Case studies that cover this lesson: Case study 8, Case study 63 and Case study 69.

Case study 63 Information-sharing in the Aral Sea basin

Lessons learned covered in this case study: Lesson 14, Lesson 20 and Lesson 34.

There are five Central Asian states within the Aral Sea basin: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

In response to requests from national agencies and other stakeholders, the SIC-ICWC prepares information and analytical reviews on the state of water resources and accompanying forecasts and compares operational forecasts and actual data on the use of water resources and river water balances in the main rivers of the region. The analytical reviews are based on mathematical calculations and modelling and facilitate integrated assessments of the water management situation in the basins of the Amu Darya and Syr Darya rivers and their sections.

The SIC-ICWC has also created the Regional Information System on Water and Land Resources in the Aral Sea Basin (CAWater-IS),[105] an online system located on the SIC-ICWC portal that includes a user interface with integrated databases. Most of the information on CAWater-IS is open to all users, with about one third (national data) disclosed upon official requests and analytical information provided on a contractual basis. Access to CAWater-IS is granted to all ICWC members and their authorized organizations.

The SIC-ICWC also publishes and disseminates a weekly newsletter in Russian entitled "Water Sector, Irrigation and Ecology in Eastern Europe, the Caucasus, and Central Asia", which is available online.[106] It contains information about key events in the region in the field of water management, land reclamation, ecology and power generation. Analyses of the water management situation in the Amu Darya and Syr Darya river basins for 10-day periods are also included in the newsletter.

The reports prepared by Amu Darya and Syr Darya Basin Water Organizations are publicly available in the ICWC Bulletins.[107] Reports published within the framework of joint projects are available in open source format. All periodicals are regularly shared with ICWC members, ministries and agencies, as well as ICWC partners within and outside Central Asia.

105 www.cawater-info.net/data_ca
106 www.cawater-info.net/news/index.htm
107 www.icwc-aral.uz/icwc_bulletins_ru.htm

Aral Sea in Uzbekistan

Expenses related to the development and maintenance of the SIC-ICWC's information system should be covered by contributions to the International Fund for Saving the Aral Sea (IFAS), with costs shared between the five countries in a manner proportionate to the volume of water resources used. In reality, the activities of the central offices of the Amu Darya and Syr Darya Basin Water Organizations and the SIC-ICWC are funded by the Republic of Uzbekistan as a contribution to the IFAS. Other financing sources include projects funds and grants. Data collection activities take place under paid contracts with hydrometeorology services, and statistical bulletins are purchased from sectoral authorities.

Source: Case study provided by Dinara Ziganshina, Scientific Information Center of the Interstate Commission for Water Coordination in Central Asia (SIC-ICWC), 2022.

Lesson 35 Ensure that the collected information serves better management through cooperation

The sharing of monitoring data should improve the understanding of the situation at basin level. Furthermore, the provision of common information creates a basis for agreements on water management in the basin, ensuring that the resource is used in an equitable and sustainable manner. Monitoring and data-sharing in relation to water resources can also extend to water dependent ecosystems or related natural resources, such as fish stocks, to help promote better, more sustainable and cooperative management.

Case studies that cover this lesson: Case study 3, Case study 12, Case study 16, Case study 18, Case study 23, Case study 29, Case study 32, Case study 34, Case study 39, Case study 41, Case study 55, Case study 57, Case study 61, Case study 64, Case study 65, Case study 66, Case study 69 and Case study 71.

Case study 64 Data-sharing for improved water management in the Oder / Odra River basin

Lessons learned covered in this case study: Lesson 4, Lesson 8, Lesson 23 and Lesson 35.

The Oder/Odra River basin is shared between the Czech Republic, Germany and Poland (see *Map 64.1*). All exchanges of data within the framework of the International Commission for the Protection of the Oder River against Pollution (ICPO)[108] take place through the Secretariat of the ICPO. The mandate for the transfer of data within the ICPO is the responsibility of delegation spokespersons in the Working Group on Data Management "G5", who represent institutions such as the State Water Holding, the Polish National Water Management Authority, the Ministry of the Environment of the Czech Republic and the State Environment Authority of the Land of Brandenburg.

Oder River in Opole, Poland

108 www.mkoo.pl/index.php?lang=EN

Map 64.1 **Overview of the International Oder River basin District**

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: IMS-Odra module: www.mkoo.pl/index.php?mid=19&aid=102&lang=EN.

The G5 Working Group on Data Management also deals with all data issues related to the needs of the ICPO. Tasks within its mandate include:

- data management to meet the needs of the ICPO:
- collection, maintenance, updating and sharing of data relevant to the work of the ICPO;
- development and implementation of conceptual frameworks for the development of the ICPO data set and associated necessary tools;
- development and implementation of conceptual frameworks for the consistent presentation and publication of information about the activities of the Commission and the results of its work on the website of the ICPO, with particular emphasis on the development opportunities of the GeoPortal;
- cooperation with groups and subgroups of the ICPO in the fields of:
- analysis and visualization of data necessary for the implementation of tasks under the responsibility of groups and subgroups of the ICPO, especially in relation to works under the WFD and Floods Directive;
- use of GIS in conducted works;
- advice on technical issues related to the provision of information on the activities and products of the groups and subgroups of the ICPO.

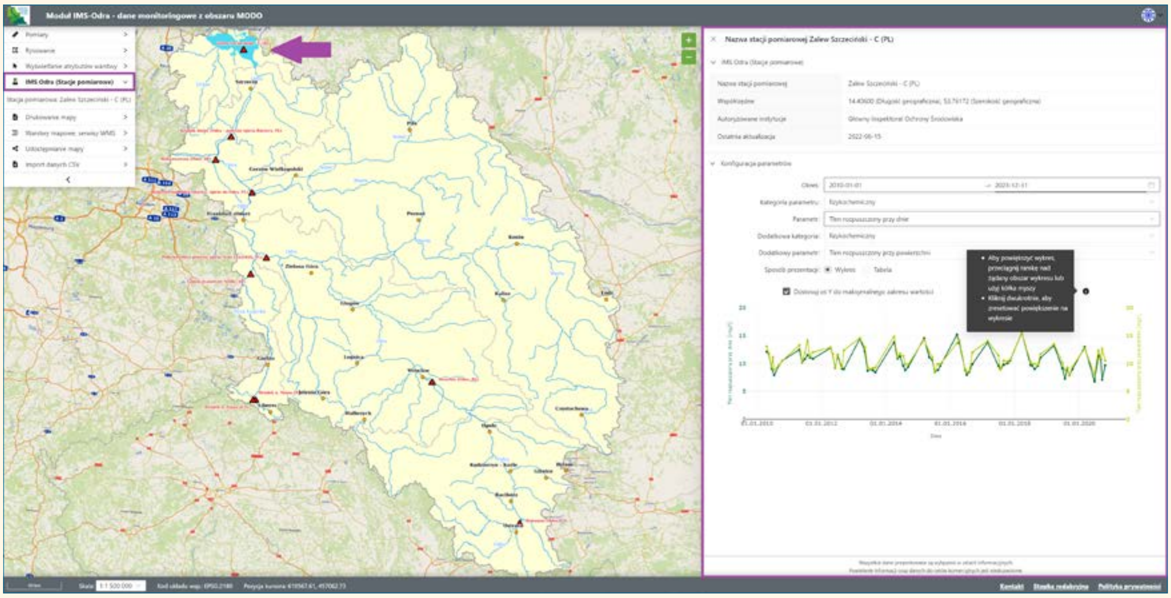
At the ICPO level, exchange of data and information is free of charge.

For each update of the River Basin Management Plan (RBMP) for the International Odra River Catchment Area (MODO), monitoring data (measurement points and assessments) are provided by delegation spokespersons in the G5 Working Group on Data Management to the ICPO Secretariat, to enable the development of joint maps and statistics. This takes place every six years in accordance with WFD requirements, and includes:

- Part II, Chapter 2.2: List of emissions, discharges and losses of all priority substances and pollutants in accordance with Article 5 of Directive 2008/105/EC
- Part II, Chapter 4: Monitoring networks and the results of monitoring programmes.

The Sub-working Group on Monitoring (GM) is responsible for providing data for the International Monitoring Stations (IMS) Odra module. It has agreed that at the end of each year, GM delegation spokespersons will submit to the Secretariat the required data (physico-chemical and biological parameters), collected from measurement points at individual monitoring stations. These data will then be processed by the Secretariat and uploaded to the module. Data are often reported with varying degrees of detail and may require further clarification with individual delegations. A GIS Specialist is employed by the ICPO Secretariat to verify all data provided and, in case of doubts regarding their quality, contact the delegation spokespersons in the G5 Working Group. The data are transferred by e-mail in the form of an Excel or shp files.

Figure 64.1 **Information on selected physicochemical, chemical and biological parameters from international surface water monitoring points presented in the IMS-Odra module**



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: IMS-Odra module: www.mkoo.pl/index.php?mid=18&aid=139&lang=EN. Accessed in August 2024.

All data submitted to the Secretariat are integrated into the ICPO data set. This includes all digital spatial data (including relevant documents) needed for the implementation of joint international tasks of all contracting Parties to the ICPO. The databases themselves are not accessible by the public, and the associated terms of use/sharing can be found on the ICPO website. Annual reports are published online.[109] The data are available via the ICPO Geoportal[110] as the International Water Management Plan for MODO and can be accessed by the public through the ICPO website.

Source: Case study provided by Przemysław Susek, Regional Unit of Environmental Monitoring in Zielona Góra, Chief Inspectorate for Environmental Protection, Poland 2022.

109 www.wasserblick.net/servlet/is/110115/?highlight=deutsch-polnisch

110 www.geoportal2.mkoo.pl/client/?applicationId=3696

Case study 65 Joint research and monitoring data on fish stocks by Finland and Sweden: the key to sustainable management of migrating salmon in Torne River

Lessons learned covered in this case study: Lesson 4, Lesson 14, Lesson 21, Lesson 27 and Lesson 35.

Torne River and its tributary, Muonio River, constitute the common border between Finland and Sweden, stretching from the Baltic Sea coast to the northernmost point of the border.

Finland and Sweden manage Torne River on the basis of the "Agreement between Finland and Sweden Concerning Transboundary Rivers" (signed in 2010 replacing a previous agreement from 1971). The Agreement covers all water uses of Torne River, and its objectives include ensuring the equitable use of the rivers by both countries; preventing flood and environmental damage; coordinating programmes, plans and measures; and promoting further cooperation including with regard to the sustainable use of fish stocks. This case study covers the management and sustainable use of fish stocks.

The authorities responsible for fisheries management at the national level are the Finnish Ministry of Agriculture and Forestry, the Swedish Ministry of Rural Affairs and Infrastructure, and the Swedish Agency for Marine and Water Management. Cooperation at the regional level occurs between the Lapland Centre for Economic Development, Transport and the Environment (ELY Centre) and the Norrbotten County Administrative Board *(Länsstyrelsen Norrbotten)*.

Torne River is currently home to the largest Atlantic salmon population in the world. This was not always the case. The recovery of the salmon stock is an extraordinary success story resulting from fisheries management measures in the Baltic Sea and the river itself.

The 2010 Border River Agreement provides the basis for sustainable use of the transboundary rivers. In addition to defining the area to which the agreement applies and the competent authorities, the Agreement stipulates that cooperative research and monitoring of fish stocks must be carried out between the two countries and includes obligations to protect fish stocks from disease and the introduction of alien species or fish stocks.

The practical rules for fishing are set out in a separate Fishing Regulation, annexed to the Agreement. It contains, for example, paragraphs on fishing seasons, types of fishing gear that may or may not be used, and provisions on the organization of the sale of fishing licenses. Crucially, the fishing rules are flexible and can be changed if necessitated by the state of fish stocks (or if the planned changes do not have a negative impact on the state of fish stocks).

Data collection is carried out cooperatively to compile annual catch and biological data on fish stocks. This includes fish counts collected using sonar and experimental fishing, catch samples for age analysis and juvenile densities from electrofishing data.

Biological data are produced by designated research institutes. This work and the exchange of information is funded nationally, with both countries covering their own costs. As salmon is one of the species included in the EU Regulation on the collection of data[111] to support fisheries management, part of the data collection process is integrated into this programme.

111 EUR-Lex - 02017R1004-20210714 - EN - EUR-Lex (europa.eu).

Extensive exchange of data and information is carried out within the framework of the Finnish-Swedish Transboundary River Commission.[112] The information of greatest relevance to this case study, however, is the core data used for annual fisheries management. The number of migrating salmon in the river has been monitored by sonar since 2009, at an echo-sounding site located about 100 km upstream of the river mouth. The migration numbers are published in real time,[113] which has heightened interest in the Torne River salmon stock. These data are combined with counts of descending salmon smolts, parr densities in the river and catch statistics.

Catch statistics are based on mandatory catch declarations and surveys of recreational fishers, supplemented by interviews. The Joint Organization for Fishing License Sales, which sells fishing licenses for most of the border river, also plays an important role in data collection, as license sales data are used for surveys. The organization also brings together most of the holders of salmon fishing rights for Torne River, including the state in Finland and (partly) in Sweden, ELY Centre (Finland) and Länsstyrelsen (Sweden). The prices of fishing licenses are set jointly in advance. ELY Centre and Länstyrelsen also jointly manage the income from licenses belonging to both countries, the revenue from which is predominantly used to fund fisheries inspection, which is also carried out jointly.

The National Resources Institute of Finland (LUKE) and Sveriges lantbruksuniversitetet (SLU) are responsible for collecting, compiling and reporting data, and produce an annual joint report on the status of salmon, sea trout and whitefish stocks in the border river. These data are used each year when the competent authorities assess the need for changes to the fishing regime under the flexibility principle. The collected data are also used by the International Council for the Exploration of the Sea (ICES) working group on Baltic salmon and trout, as the Torne River salmon stock is by far the largest in the Baltic Sea.

Source: Tapio Hakaste, Ministry of Agriculture and Forestry of Finland, 2023.

Torne River in Finland

112 Information about the Commission and the agreement is available at: www.fsgk.se/en/finsk-svenska-gransalvskommisionen-english

113 The daily number of fish and their cumulative number by year are published (in Finnish) at LUKE's web site at: www.kalahavainnot.luke.fi/fi/seurannat/tornionjoen-nousulohiseuranta

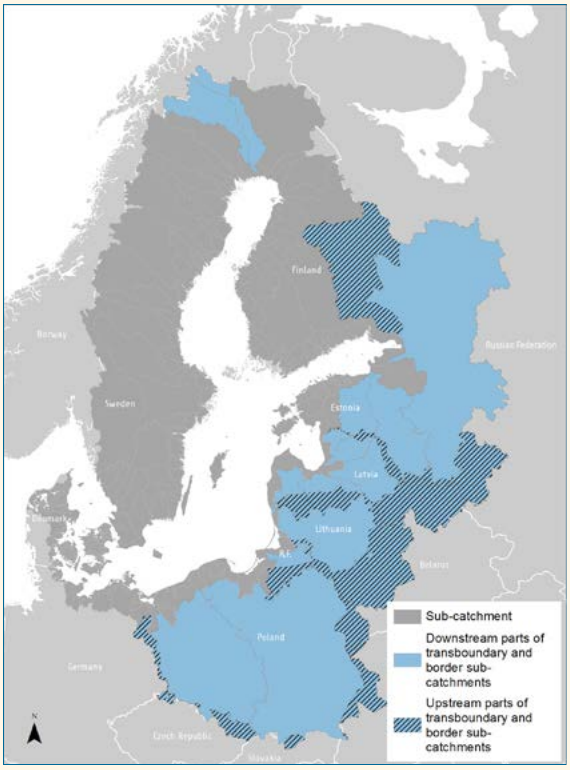
Case study 66 Pollution load control in the Baltic Sea catchment area

Lessons learned covered in this case study: Lesson 2, Lesson 4, Lesson 26, Lesson 31, Lesson 35 and Lesson 39.

The Baltic Sea forms part of the Atlantic Ocean and is bordered by Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, the Russian Federation, Sweden, and the North and Central European Plain. The aforementioned countries, with the addition of the European Union, are Parties to the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention),[114] which established the Helsinki Commission (HELCOM). Belarus and Ukraine are observers to the Helsinki Convention.

Map 66.1 Monitored and unmonitored areas in the Baltic Sea catchment

Map 66.2 Transboundary and border rivers in the Baltic Sea catchment



The designations employed and the presentation of material on these maps do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: Juuso Haapaniemi, HELCOM Secretariat.

HELCOM coordinates data collection in the Baltic Sea catchment area. The Parties to the Convention are represented in HELCOM by their respective competent authorities. In most countries, these authorities are the ministries responsible for environmental affairs. Reporting is undertaken by a designated national organization, which in most countries is either an agency or a scientific institution carrying out activities related to environmental monitoring.

114 www.helcom.fi/about-us/convention

In accordance with Articles 3 and 16 of the Helsinki Convention, the Parties agree to take measures to prevent and eliminate pollution of the marine environment of the Baltic Sea and to provide data on pollution loads, where available. The compilation of pollution load data has been an integral part of the HELCOM assessment system since 1987 and focuses on annual and periodic assessments of nutrient inputs and selected hazardous substances.

The main regional policy agreements related to the protection of the marine environment of the Baltic Sea are formulated in the Baltic Sea Action Plan (BSAP),[115] which includes the HELCOM Monitoring and Assessment Strategy. The eutrophication section of the BSAP contains concrete environmental targets in the form of maximum allowable inputs (MAIs) and nutrient ceilings (NICs). These targets are set for the whole Baltic Sea, its sub-basins and individual counties, and together they form the basis for environmental management at regional and national levels. The Parties to the Helsinki Convention have made political commitments to achieve the respective nutrient input targets by 2030, with 36 practical actions agreed to implement the ambitious environmental goals. These actions address different sources of nutrients, including agriculture, industry, transport, wastewater management and others.

At the regional level, several recommendations have been issued to facilitate the implementation of these actions at the national level. These include HELCOM recommendations on wastewater management, sewage sludge management, stormwater management and others. The Baltic Sea Nutrient Recycling Strategy,[116] which includes the reduction of nutrient inputs to the Baltic Sea as one of its objectives, was adopted by the HELCOM Ministerial Meeting in 2021.

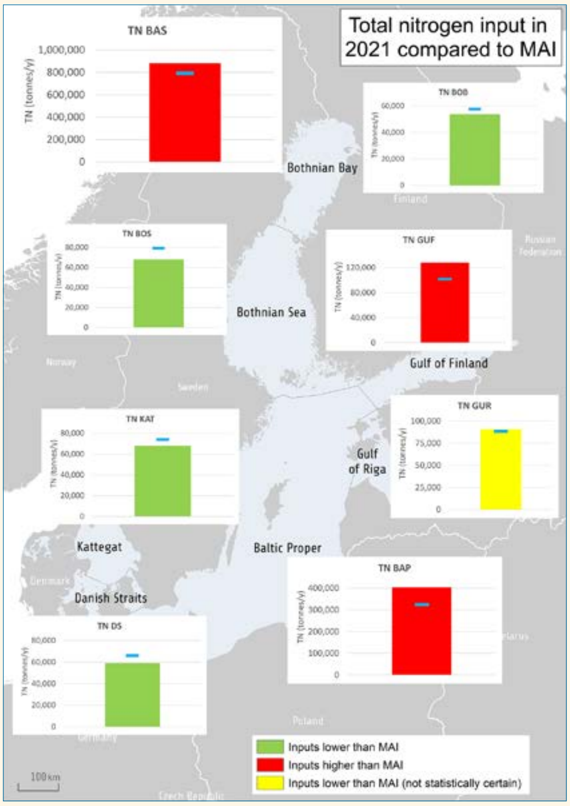
The main objective of data collection by HELCOM is to estimate the inputs of nutrients and selected hazardous substances to the Baltic Sea and to allocate these inputs to respective sources. The reported information can be divided into annual and periodic (once in three to six years) reporting. Annually reported information includes the total inputs of nutrients and hazardous substances, quantifying flows from monitored rivers, unmonitored areas and point sources discharged directly to the sea. Periodically reported information is used for a comprehensive assessment of the inputs of pollutants into the Baltic Sea and includes discharges from indirect (inland) point sources, losses from diffuse sources and natural background losses from waters within the Baltic Sea catchment area.

The list of reported parameters includes total nitrogen and total phosphorus, their fractions, annual flow and seven major heavy metals. In addition, several parameters required for data quality assurance are reported, such as the Limit of Detection/Limit of Quantification method and background information on emission sources.

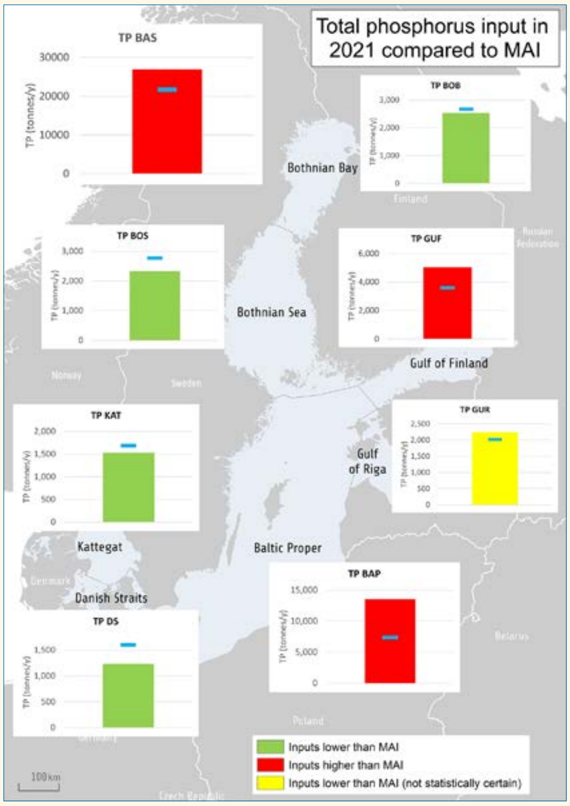
115 www.helcom.fi/baltic-sea-action-plan

116 www.helcom.fi/wp-content/uploads/2021/10/Baltic-Sea-Regional-Nutrient-Recycling-Strategy.pdf

Map 66.3. Total nitrogen inputs compared to Maximum Allowable Inputs to the Baltic Sea sub-catchments in 2021



Map 66.4. Total phosphorus inputs compared to Maximum Allowable Inputs to the Baltic Sea sub-catchments in 2021



The designations employed and the presentation of material on these maps do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: Juuso Haapaniemi, HELCOM Secretariat.

Note: the scales on the y-axes differ in the charts. Basin abbreviations: Archipelago Sea: ARC, Baltic Proper: BAP, Bothnian Bay: BOB, Bothnian Sea: BOS, Gulf of Finland: GUF, Gulf of Riga: GUR, Kattegat: KAT, The Sound: SOU, Western Baltic: WEB and Baltic Sea: BAS.

Maps 66.3 and 66.4 show the total input of nitrogen and phosphorus to each sub-basin and the whole Baltic Sea (BAS). The trend-based estimate of total nitrogen and phosphorus inputs in 2021 (tons per year) including statistical uncertainty are compared with the maximum allowable nutrient inputs (MAI t/y, shown as a blue line). The colour green indicates that estimated inputs including uncertainty during 2021 were lower than the MAI; red indicates that the inputs were higher than the MAI; and yellow indicates that when considering the statistical uncertainty of input data, it is not possible to determine whether the MAI was reached.

National data on waterborne nutrient inputs are produced as part of national monitoring programmes and financed from the respective national budgets. Monitoring is organized according to the regularly updated HELCOM Guidelines for the annual and periodic compilation and reporting of waterborne pollution inputs to the Baltic Sea (PLC-Water).

Sunset in the Turku Archipelago, Finland

Data on airborne nitrogen inputs are provided by the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP). Data on nitrogen deposition to the Baltic Sea are modelled by EMEP using the respective national data reported by the HELCOM countries as well as by countries outside the Baltic Sea catchment area. The input dataset for the modelling also includes information on nitrogen emissions from shipping in the North Sea and Baltic Sea. Data on airborne nitrogen inputs are provided annually as part of a contract between HELCOM and the respective EMEP Centre.

Coordination of data reporting, data management, data processing and quality assurance is carried out within a recurrent regional project, Pollution Load Compilation (PLC), funded from the HELCOM budget.

PLC data collection and reporting is largely harmonized throughout the Baltic Sea region. There are three main regional documents that provide the methodological background for HELCOM PLC work. Of these, two are HELCOM Recommendations (HELCOM Recommendation 37-38/1-Rev.1 Waterborne Pollution Input Assessment (PLC-WATER)[117] and HELCOM Recommendation 37-38/2-Rev.1 Monitoring of Airborne Pollution Input).[118] The main document is the PLC-Water Guidelines, mentioned above.[119]

The technical procedure for data quality assurance and quality control (QA/QC) is described in the HELCOM PLC-Water Guidelines and consists of four steps. QA1 and QA2 are automated procedures that check data completeness and perform statistical data checks based on long time series. QA3 and QA4 involve data validation because of specific statistical data processing and expert control. In addition, a compilation of methodological approaches for estimating nutrient losses from unmonitored areas and source apportionment models is regularly published by the respective HELCOM PLC projects.

117 www.helcom.fi/wp-content/uploads/2022/08/Rec-37-38-1-Rev.1.pdf

118 www.helcom.fi/wp-content/uploads/2022/08/Rec-37-38-2-Rev.1.pdf

119 www.helcom.fi/wp-content/uploads/2022/04/HELCOM-PLC-Water-Guidelines-2022.pdf

All data are reported in digital format through an online reporting application of the PLC-WATER database,[120] using uniform reporting templates. The system includes identification of data reporters and access rights and performs appropriate QA procedures.

The reported information is used in several HELCOM PLC products, which are regularly published and provide the scientific basis for regional decision-making. The most recent assessment products available are:

a) an annual update of the HELCOM Core Pressure Indicator on nutrient inputs (maximum allowable inputs (MAI) fulfilment follow-up) covering data from 1995 to 2021;[121]

b) assessment of progress towards national nutrient ceilings (NIC assessment) covering data from 1995 to 2020;[122]

c) assessment of sources and pathways of nutrients to the Baltic Sea environment in 2017;[123]

d) nutrient inputs from the seven largest rivers from 1995 to 2017;[124]

e) evaluation of the effectiveness of measures to reduce nutrient inputs to the Baltic Sea;[125]

f) assessment of the inputs of selected hazardous substances.[126]

In addition, summaries of the reported data on airborne and waterborne inputs are published annually at the end of each reporting cycle in the form of Baltic Sea Environmental Fact Sheets. The latest reports are available on the HELCOM website.[127]

Methodological differences in estimating nutrient losses from unmonitored areas and national models of nutrient sources, including the identification of natural background losses, represent key challenges at this stage. Poor availability of transboundary data from non-HELCOM Contracting Parties is also an obstacle.

Source: Dmitry Frank-Kamenetsky and Juuso Haapaniemi, Baltic Marine Environment Protection Commission (Helsinki Commission, HELCOM), 2022.

120 www.nest.su.se/helcom_plc

121 www.indicators.helcom.fi/indicator/inputs-of-nutrients

122 Key policy message: www.helcom.fi/baltic-sea-action-plan/nutrient-reduction-scheme/national-nutrient-input-ceilings Assessment results: www.helcom.fi/wp-content/uploads/2023/04/Annex-1.-NIC-2020-assessment-results-with-country-per-basin.pdf

123 www.helcom.fi/wp-content/uploads/2022/12/PLC-7-Assessment-of-sources-of-nutrient-inputs-to-the-Baltic-Sea-in-2017.pdf

124 www.helcom.fi/wp-content/uploads/2021/09/The-seven-biggest-rivers-in-the-Baltic-Sea-Region.pdf

125 www.helcom.fi/wp-content/uploads/2022/02/Effectiveness-of-measures-to-reduce-nutrients-inputs.pdf

126 www.helcom.fi/wp-content/uploads/2021/09/Inputs-of-hazardous-substances-to-the-Baltic-Sea.pdf

127 www.helcom.fi/helcom-at-work/publications

Lesson 36 Develop a shared communication plan

Dissemination of data and information is important to support informed decision-making. In a transboundary context, it is of particular importance that messaging based on reported data and information is agreed upon by the riparian countries.

A joint communication plan can help streamline the results from shared data and information. The communication plan should define which audiences should be reached and what their needs are in terms of information. The subsequent information products and messages should be tailored to the needs of the various target audiences. Reaching these audiences may require different channels and instruments (tables, reports, infographics, presentations, etc.) to convey the messages, with appropriate instruments selected for each audience.

Data and information must be relevant to the needs of the audience in question. Furthermore, in order to reach the intended audience, the presented data and information should tell a story. This requirement extends beyond the mere presentation of data and information from the monitoring system.

Case studies that cover this lesson: Case study 24, Case study 37, Case study 47 and Case study 67.

Case study 67 A shared communication plan for the Danube

Lessons learned covered in this case study: Lesson 9, Lesson 33 and Lesson 36.

The communication and dissemination of information is crucial for informed decision-making, especially in transboundary contexts such as the Danube River basin. The ICPDR provides an example of the implementation of effective communication strategies in transboundary settings. This case study demonstrates how a joint communication plan tailored to different audiences can improve decision-making and stakeholder engagement in transboundary water management.

Public participation and stakeholder engagement

The ICPDR actively involves stakeholders in its decision-making processes. This includes the direct collection of comments, the organization of stakeholder consultation workshops and social media campaigns, and the distribution of online questionnaires. The ICPDR's approach ensures that data and information are not only shared, but also shaped by feedback from different stakeholders.

Tailored communication for diverse audiences

Recognizing the diversity of stakeholders, the ICPDR uses a variety of channels and tools to communicate effectively. These include detailed reports for policymakers, accessible flyers and brochures including infographics for the general public, and interactive workshops for stakeholders. Such tailored communication ensures that each audience receives information in a format that is most relevant and accessible to them.

Storytelling and information products

Beyond presenting raw data, the ICPDR focuses on storytelling to make the data relatable and understandable. This approach helps connect the data to the real-life impacts and needs of audiences, thereby increasing the effectiveness of the information disseminated.

Multifaceted communication strategies

Because communication is key, the ICPDR's communication strategies are multifaceted and include multiple avenues:

a) consultation with open invitation – engaging a broad range of participants in discussions on key documents and plans;
b) consultation with direct invitation – focused dialogues on specific issues for sustainable solutions;
c) observer status participation – involving organized interest groups in the decision-making process;
d) public participation-driven communication plans tailored to each activity.

The ICPDR Communication Plan has contributed significantly to effective transboundary water management in the Danube River basin. By ensuring that all stakeholders are informed and that their feedback is taken into account, the ICPDR has fostered a collaborative environment conducive to sustainable decision-making. This approach has resulted in:

a) improved stakeholder engagement and public participation;
b) informed decision-making based on comprehensive and well-disseminated data;
c) harmonized interests among riparian countries.

Key communication by-products and ground-level actions

In addition to the strategic communication activities described above, the ICPDR recognizes the significance of "action on the ground" initiatives. These periodic events, such as Danube Day and its derivative product, the Danube Art Master, are crucial in translating communication and participation strategies into tangible experiences and engagements. They demonstrate the practical application of ICPDR's efforts in fostering environmental awareness and stewardship among diverse communities in the Danube River basin.

a) Danube Day is a flagship event celebrated throughout the Danube River basin that raises awareness about the importance of the river and the need for its protection. The event serves as a platform for disseminating information and engaging the public in efforts to protect the river.[128]

b) The Danube Art Master is a creative competition that encourages young people to express their connection to the Danube through art. It is an effective tool to engage the younger generation and educate them about environmental stewardship in a creative and interactive manner.[129]

c) The Danube Box is an educational toolkit designed for teachers and students to explore and learn about the ecology, culture and history of the Danube River. This tool is instrumental in disseminating information to the educational sector and promoting early awareness and involvement in river conservation.[130]

128 www.danubeday.org
129 www.danubeday.org/Danube_Art_Master
130 www.danubebox.org

The ICPDR's approach to data and information dissemination in the Danube River basin serves as a model for transboundary water management. A joint communication plan that is audience-specific, engaging and interactive can significantly improve the effectiveness of data dissemination and decision-making processes. This case study highlights the importance of tailoring communication strategies to meet the diverse needs of different stakeholders in transboundary contexts.

In conclusion, the ICPDR's multifaceted approach to communication, combining strategic information dissemination with engaging on-the-ground activities, exemplifies a model for effective transboundary water management. By integrating diverse methods of stakeholder engagement, from high-level consultations to community-centred events such as Danube Day and Danube Art Master, and targeted communication plans, the ICPDR ensures that its message of conservation and sustainable management is not only heard, but also acted upon. This holistic strategy fosters a well-informed and actively participating community, which is crucial for the long-term health and management of the Danube River basin. The ICPDR's success in this endeavour serves as an inspiring blueprint for similar transboundary environmental initiatives worldwide.

Source: Hélène Masliah-Gilkarov, International Commission for the Protection of the Danube River, 2023.

Danube River in Passau, Germany

Lesson 37 Establish mechanisms for regular review of the monitoring system

Information needs will change over time as a result of technological possibilities, new insights and emerging problems. As a result, the monitoring system may not provide all the relevant data. To ensure that the data and information from the monitoring system remains relevant, a mechanism should be established to periodically verify whether the information that the monitoring system provides is still relevant, and if new or other information may be needed. Based upon the review, a decision may be taken to adapt the monitoring system needs. Adjustments may include different or additional parameters, locations and frequencies, as well as different analytical methods. None of the case studies have described specific mechanisms for regular review, but Case study 27 and Case study 69, for example, show that such reviews take place.

Further reading

Joint Research Centre (2023). *Global Drought Observatory*.
www.edo.jrc.ec.europa.eu/tumbo/gdo/map

United Nations Economic Commission for Europe (2011). *Second Assessment of Transboundary Rivers, Lakes and Groundwaters*. Geneva. Available at www.unece.org/info/publications/pub/21808

Chapter 8

Lake Geneva shared between France and Switzerland

Impacts and benefits

Data- and information-sharing has clear benefits and produces positive impacts on cooperation and water management in transboundary river basins. Such benefits and achievements may include:

- mutual support in establishing a monitoring system and a joint approach to developing measures;
- optimization of activities including collective capacity-building, implementing a shared database and drafting joint studies;
- agreement on monitoring parameters and methods, and the harmonization of results from chemical, ecological and biological analysis of water from agreed monitoring stations;
- improved basin-wide, transparent, harmonized, "neutral" and reliable information, and data leading to greater technical and scientific understanding of the entire basin as the basis for better management of water bodies;
- enhanced forecasting, impact assessment and dissemination of results for better decision-making;
- the development of regular reports on the state of the basin and impact studies;
- improved early warning through the availability of continuous monitoring results to detect contamination in time for intervention, and enable flood forecasting and disaster risk management, including successful coordination and cooperation during flooding events;
- better understanding of the distribution of a basin's water resources and water balance, facilitating environmental flow setting, better control and operational rules for the basin and sub-basins, and efficient supply of water to all involved parties;
- shared concepts of pressures and impacts, providing a common ground for cooperation and offering a platform for dispute settlement and improved trust and confidence among riparian states, their institutions, citizens and Indigenous people.

Lesson 38 Use data and information as the basis for conflict prevention

Making data and information available in a transparent and meaningful manner can promote agreement on ways to address issues and problems. Such consensus can help discussions focus on solutions and ways forward.

Case studies that cover this lesson: Case study 68 and Case study 69.

Case study 68 Preventive diplomacy on the Guaraní Aquifer System

Lessons learned covered in this case study: Lesson 7, Lesson 10, Lesson 17, Lesson 19, Lesson 31 and Lesson 38.

The Guaraní Aquifer System (GAS) is the largest transboundary aquifer system in Latin America, covering an area of approximately 1,100,000 km^2. It is shared between Argentina (21 % of the aquifer, covering 8 % of the country), Brazil (68 % of the aquifer, covering 9 % of the country), Paraguay (8 % of the aquifer, covering 22 % of the country area) and Uruguay (3 % of the aquifer, covering 20 % of the country). In 2010, the four countries adopted a formal international agreement on cooperation on the aquifer system, the Guarani Aquifer Agreement (GAA), which subsequently entered into force in November 2020. This was the first international treaty on transboundary aquifers to reference the UN International Law Commission Draft Articles on the Law of Transboundary Aquifers.[131] The agreement represents a novel example of preventive diplomacy in the absence of antecedent transboundary conflicts over the use of, or impacts on, groundwater.

Over the period 2003–2009, the Guaraní Aquifer System Project (GASP), funded to the amount of USD 26 million by GEF and the four states, produced a Transboundary Diagnostic Analysis (TDA)[132] and a Strategic Action Programme (SAP) for the joint protection and sustainable development of the aquifer.[133] The project involved a significant level of joint assessment as well as the development and implementation of a GAS monitoring network. Smaller pilot projects, two of them transboundary, enabled the sharing of local data and the establishment of a joint database (SIGAS) for the entire aquifer.

A follow-up GEF-funded project, entitled "Implementation of the Guaraní Aquifer Strategic Action Programme: Enabling Regional Actions" aimed at supporting the implementation of the SAP. The project also sought to consolidate and expand the monitoring network and associated data-sharing practices.[134]

131 www.legal.un.org/ilc/texts/instruments/english/draft_articles/8_5_2008.pdf

132 www.iwlearn.net/resolveuid/81988aa912c2f9844b25cbb1d4594b0e

133 www.oas.org/DSD/WaterResources/projects/Guarani/SAP-Guarani.pdf

134 www.riob.org/sites/default/files/5.%20Lucia%20Samaniego_Guarani.pdf

An important precursor to the operationalization and coordination of cooperation, and a prerequisite for future information and data-sharing, is the creation of a joint commission for cooperation on the aquifer, as prescribed in the treaty. Using the framework set out in the La Plata Basin Treaty[135], the four countries are discussing how to establish the commission.

The follow-up GEF project explored ways to:

a) institutionalize mechanisms for strengthened transboundary cooperation among GAS countries;
b) enable countries to detect the evolution of key quality and quantity parameters in the aquifer across time and space at both regional and local levels;
c) foster gender equality as part of the proposed project and of the SAP itself;
d) reinforce capacities and increase awareness.

The second component of the project aimed to establish "Design and field pilot testing of regional monitoring networks and protocols", the purpose of which was to produce regional datasets on water quality and quantity responding to the need for reliable periodic information. Similar efforts are being undertaken at the national level, albeit in a less coordinated and standardized manner.

Within the framework of the development of the follow-up project, a workshop was conducted to allow the riparian countries to discuss the issue of data storage and exchange, and to select a design for the information-sharing platform from among different possibilities. The way in which the generated data will be shared is currently being defined as well as a roadmap for the future.

Source: Case study provided by Karen Villholth, Water Cycle Innovation based on reports by the Regional Centre for Groundwater Management in Latin America and the Caribbean (CeReGAS),[136] Uruguay, 2023.

Case study 69 Dialogue to address pressing challenges in the Genevese Aquifer

Lessons learned covered in this case study: Lesson 19, Lesson 34, Lesson 35 and Lesson 38.

The Genevese Aquifer is shared between France (10 per cent) and Switzerland (90 per cent) and represents a specific example of cooperation at the transboundary level but involving local entities. This cooperation relates to a managed aquifer recharge (MAR) scheme serving nearly 700,000 people in the border region between the two countries. The scheme requires the continuous monitoring and management of groundwater resources, due to natural as well as artificial recharge and discharge (pumping) processes. The sub-national institutions responsible for data collection and sharing are the Canton of Geneva, Switzerland and two French territorial units (Annemasse Agglo and the Communauté de Communes du Genevois).

135 www.ecolex.org/details/treaty/treaty-on-the-rio-de-la-plata-basin-tre-001020

136 CeReGAS: Centro Regional para la Gestión de Aguas Subterráneas en América Latina y el Caribe, www.ceregas.org

The mandate for information and data-sharing is implicit in the Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer, which entered into force in 2008. However, cooperation over the Genevese Aquifer dates back further, with a first agreement being signed in 1978. In the same year, the Geneva Groundwater Committee, a binational committee in charge of groundwater exploitation, was set up to regularly review the state of the resource. The Committee gives advance notice on all matters submitted to it in connection with the management and protection of the aquifer.

With respect to data and information transmission, each riparian institution is responsible for its own funding, as is the case for any work on its territory. Information on groundwater levels and well pumping and MAR data is provided at annual meetings of the Geneva Groundwater Committee.

Water analyses are carried out by laboratories specific to each party, while the supervisory and verification bodies of each party are in constant contact and apply the same accreditation for chemical analyses. The Canton of Geneva maintains a database (GIS) hosting substantial data related to groundwater quality and quantity and the environment, as well as a publicly accessible website.

Vehicles for internal data/information sharing include reports, data files, online platforms and direct transmission, depending on the topic and the type and purpose of exchange (plenary meeting, specific working group meeting, etc.). Exchange occurs at minimum annually (plenary meetings) but may be more frequent in the event of technical working group meetings or on an ad hoc basis (telephone exchanges). The Geneva Groundwater Committee uses a specific work site (SharePoint) where common elements related to the management and protection of the aquifer are available to all members, enhancing the level of knowledge of both countries.

The monitoring and sharing of hydrogeological data have a valuable impact, increasing understanding of the flow and hydrogeological limits of the aquifer, and ultimately contributing to its protection. A better overview also enables the Committee to determine the importance of the different flows and the reasons for pollution in certain parts of the aquifer. These considerations have environmental, financial and necessarily social consequences for drinking water.

The Genevese Aquifer is internationally recognized for its transboundary resource management agreement, signed by the Swiss and French local authorities, and described as the first transboundary aquifer management agreement in the world. This agreement has long been a model for other organizations throughout the world, in particular by UNESCO-IHP and the Transboundary Aquifer Commission of the International Association of Hydrogeologists (IAH).[137]

Like many countries around the world, France and Switzerland have experienced critically dry summers over the past few years. Water management in the Greater Geneva cross-border basin has faced several complicated episodes with both surface and groundwater availability decreasing, triggering water use restrictions. In this context, the Genevese Aquifer is becoming a fallback resource for the area concerned.

137 www.tba.iah.org

Mont Salève in France, overlooking the Lake Geneva basin

The approach applied in the cross-border agreement for use of the aquifer involves the participation of local French authorities in the costs of managing the resource and the MAR scheme, depending on the total pumping volume. Given this situation, the local French authorities formally asked the authorities of the Canton of Geneva to review the conditions and calculation methods linked to the quotas of the 2008 agreement.

In the fall of 2022, a cross-border working group was established to review the current and future state of the resource, taking into account climate change, and to clarify the financial arrangements related to management and protection of the shared groundwater resource from the Genevese Aquifer. Substantial work to improve knowledge of the resource in order to calibrate a digital model of groundwater management is at the centre of these discussions, which should lead to a revision of the terms of the agreement. Such a revision provides a good example of adaptation in cross-border cooperation, addressing the differences in management of a shared resource resulting from the impacts of climate change.

Source: Case study provided by Karen Villholth, Water Cycle Innovation based on reports by the Republic and Canton of Geneva, Department of Territory (DT), Office Cantonal de l'Environnement (OCEV), Service of Geology, Soil and Waste (GESDEC), 2023.

Lesson 39 Enable improved water management through information and data-sharing

Improved basin-wide data- and information-sharing strengthens the scientific understanding of shared waters and, thus, enables a reduction in current and future degradation trends. This in turn can help develop a transboundary vision and joint strategic action plans, thereby improving management decisions addressing how best to protect the environment and which socioeconomic activities to promote. It also helps demonstrate how responsible development ensures environmental sustainability and at the same time can enhance social justice and economic development, especially among riparian communities. It further helps to advance the coordinated and integrated management of water resources and contributes to the transparency of decision-making.

Case studies that cover this lesson: Case study 3, Case study 9, Case study 14, Case study 17, Case study 20, Case study 21, Case study 29, Case study 32, Case study 39, Case study 48, Case study 57, Case study 58, Case study 66, Case study 70, Case study 71, Case study 72 and Case study 76.

Case study 70 Improved water management in the Rhine River

Lessons learned covered in this case study: Lesson 2, Lesson 11, Lesson 16, Lesson 39 and Lesson 40.

The beginning of advanced industrialization during the second half of the nineteenth century and the rapid expansion of industrialization after the foundation of the German Empire in 1871 were characterized by the construction of numerous factories and rapid industrial growth. However, environmental awareness had not yet developed and irrespective of the eventual harm caused, the wastewater of the many factories along the Rhine and its tributaries were discharged into the river without any prior treatment. The increasing pollution of the Rhine with organic and inorganic waste gave rise to tensions between the bordering states. Thus, in 1950, ICPR began discussions on issues related to Rhine protection and monitoring with a view to finding joint solutions. To achieve this goal, mutual trust had to be carefully built within the international working groups of the ICPR.

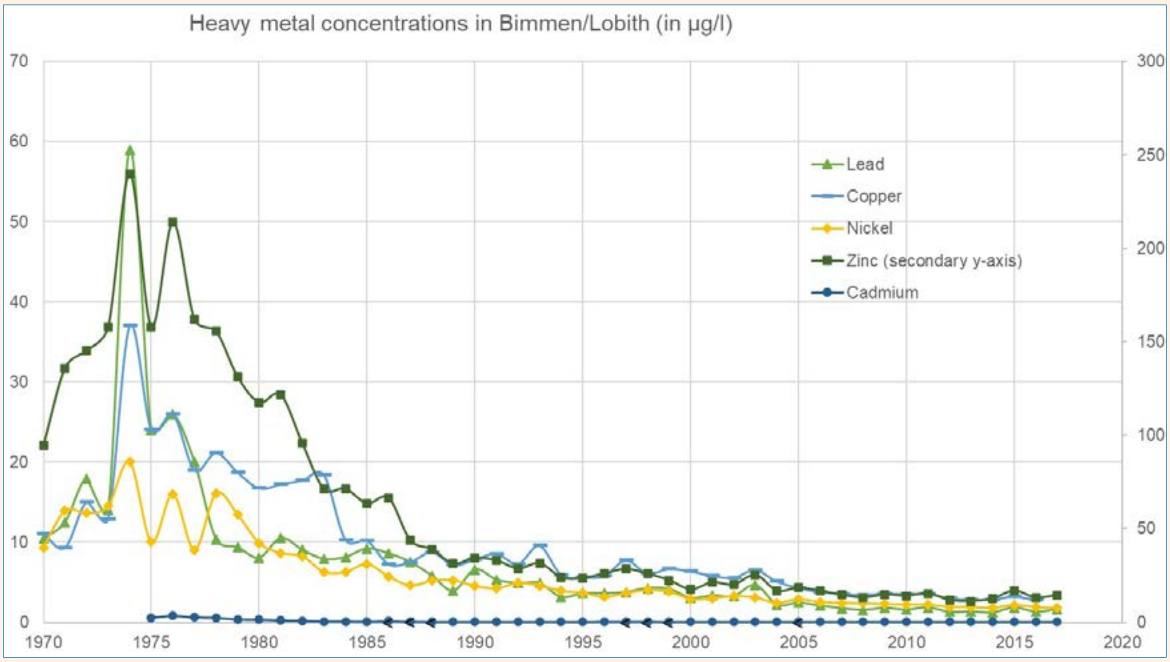
High pollutant loads and salt contamination of the Rhine were of great concern for downstream users. In the aftermath of the Sandoz accident in 1986 (see *Case study 60*) and amid increasing growth in public environmental awareness, the ICPR experienced intensive, yet successful years.

Within a short timeframe, three Conferences of Ministers were staged, leading to the adoption of the Rhine Action Programme in 1987. Its target was to improve water quality to such an extent that formerly indigenous species, such as salmon, would be able to return to the river. One consequence of the Rhine Action Programme was that requirements concerning municipal and industrial wastewater treatment plants became stricter and a third treatment stage was introduced to eliminate discharges of phosphorous and nitrates. The impact of the new regime quickly became apparent, with an initial survey in 1992 finding evidence of a considerable reduction in pollutants. At the same time, the Rhine Action Programme aimed to enhance the entire ecosystem while improving chemical water quality and strengthening the flora and fauna.

Nowadays, water quality has improved to the extent that it no longer represents an obstacle to salmon resettlement. With the reduction in massive loads of nutrients and heavy metals, among others (see *Figure 70.1*), reduction efforts can focus on micropollutants.

Concerning flora and fauna, within the context of an international monitoring campaign, every six years the ICPR investigates the development of five important bio-indicators (phytoplankton, benthic diatoms, macrophytes, macrozoobenthos and fish fauna) (Rhine Monitoring Programme Biology 2024/2025[138]) along the Rhine. Research programmes are also developed by providing water samples for later analysis with environmental DNA (eDNA) to identify the species in the river. Another study has started to evaluate the development of the salmon population in the Rhine River basin.

Figure 70.1 Concentrations of heavy metals 1970 – 2017 in Bimmen/Lobith



Source: ICPR 2023, data available on www.iksr.bafg.de/iksr.

Source: Case study provided by Tabea Stötter, International Commission for the Protection of the Rhine (ICPR), 2023.

138 ICPR technical report No. 291

Case study 71 Benefits from cooperation in the Sava River basin: the perspective of Bosnia and Herzegovina

Lessons learned covered in this case study: Lesson 4, Lesson 11, Lesson 12, Lesson 35, Lesson 39 and Lesson 40.

Bosnia and Herzegovina developed transboundary cooperation for the Sava River basin based on the following agreements:

- the 1996 Agreement between the Government of the Republic of Croatia and the Government of Bosnia and Herzegovina on the regulation of water management relations;[139]
- the 2015 Agreement between the Council of Ministers of Bosnia and Herzegovina and the Government of the Republic of Croatia on the rights and obligations of using water from public systems for water supply across state borders;[140]
- the 2002 Framework Agreement on the Sava River basin;
- The 1994 Convention on Cooperation on the Protection and Sustainable Use of the Danube River.

Bosnia and Herzegovina is also a member of the ICPDR and the ISRBC, with the latter housed in Zagreb, Croatia. The latter is a joint body with the international legal capacity necessary for the performance of its functions, specifically the implementation of the Framework Agreement and the realization of the following jointly agreed goals:

a) establishing an international navigation regime on the Sava River and its navigable waterways;
b) establishing sustainable water management and undertaking measures for communication;
c) limiting hazards as well as eliminating harmful consequences caused by floods, ice, droughts and accidents involving materials hazardous to water.

Data-sharing is accomplished through online access and direct transmission and financed for the most part by the state budget. However, decision makers have recognized the exchange of information and data as a priority, and in need of upgrading.

From the perspective of Bosnia and Herzegovina, the sharing of data and information offers great potential with countries increasing cooperation across the region. Important achievements could include establishing personal relationships, building team spirit and exposure for regional cooperation at the international level. The dissemination of some information and data could reverse current and future degradation trends by improving scientific understanding of the shared basin. It would therefore be advantageous for countries in the region to develop a platform-based network focused on systematic monitoring of the quality and quantity of water and adopt measures accordingly. Potential outcomes could include the following:

- increased stakeholder involvement and awareness-building;
- creation of knowledge and improved communication;
- improved access to finance;
- improved governance;
- building of adaptive management;
- construction of physical capacity/infrastructure (including green infrastructure).

Source: Case study by Biljana Rajić, Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, 2022.

139 Official Gazette of Bosnia and Herzegovina, no. 6/96 – International Agreements.

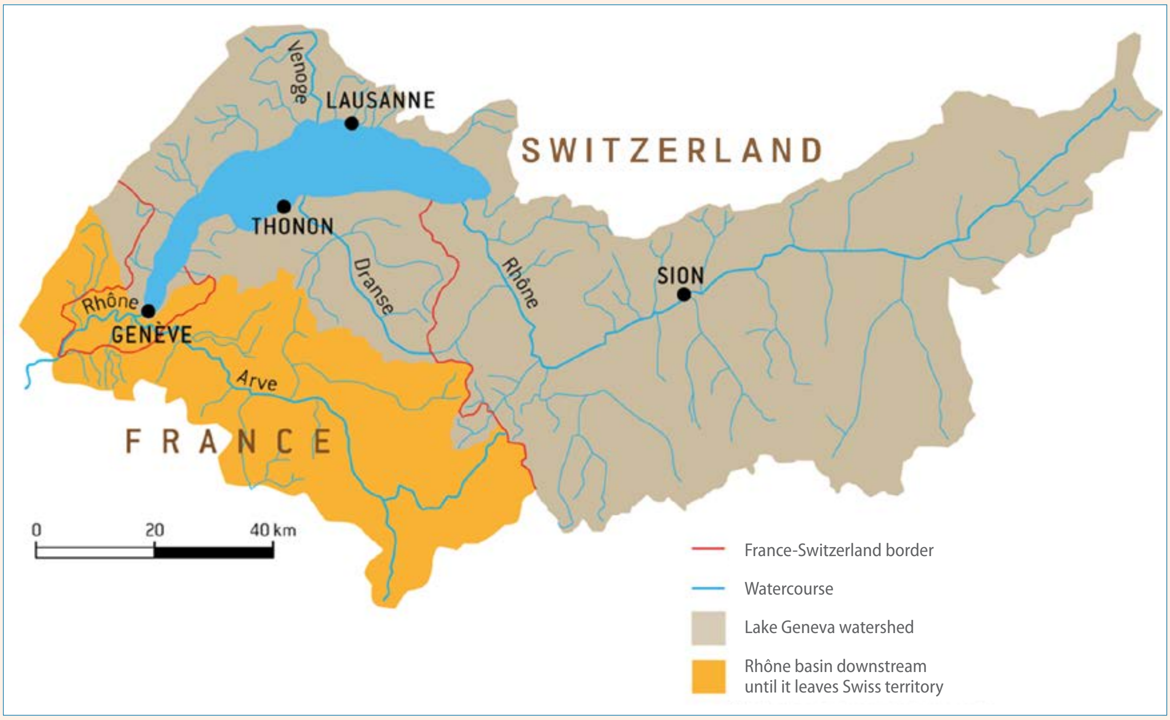
140 Decision on ratification of the agreement, Official Gazette of Bosnia and Herzegovina, no. 10/15.

Case study 72 International Convention for the Protection of the Waters of Lake Geneva

Lessons learned covered in this case study: Lesson 14, Lesson 26, Lesson 31 and Lesson 39.

The International Convention for the Protection of the Waters of Lake Geneva (Commission Internationale pour la Protection des Eaux du Léman (CIPEL)), created in November 1962, was the outcome of Franco-Swiss cooperation. Its aim is to improve the quality of the waters of Lake Geneva, where the main identified issue is eutrophication. The Convention covers the Lake Geneva basin and the Rhône downstream to the France-Switzerland border (Arve basin) (see *Map 72.1*).

Map 72.1 The Lake Geneva transboundary basin



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: CIPEL, 2022. Available at: www.cipel.org/la-cipel.

CIPEL has four main objectives:

a) Monitoring changes in the water quality of Lake Leman and its tributaries.

b) Organizing and commissioning all necessary research to determine the nature, extent and origin of pollution incidents, and applying the results of this research.

c) Recommending to the French and Swiss governments measures to be taken to eliminate present pollution and to prevent any future pollution of the lake.

d) Informing the public.

The confluence of the Rhône and Arve Rivers in Switzerland

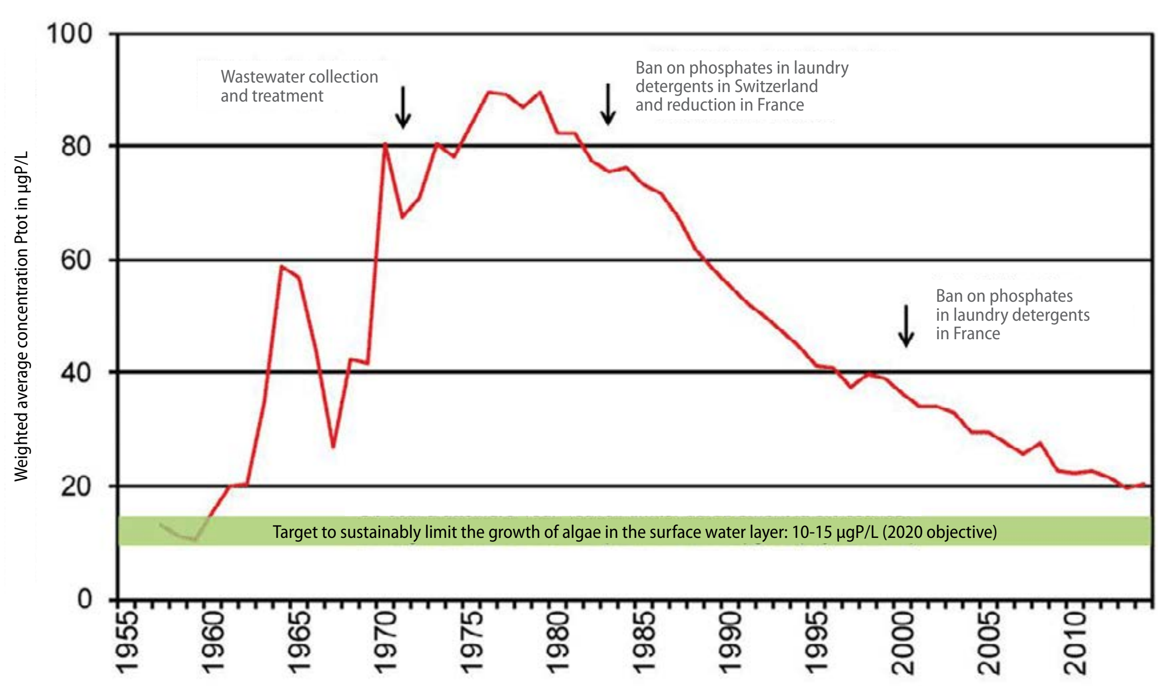
CIPEL is responsible for maintaining or restoring the ecological quality of the water and the aquatic environment as a whole (physical characteristics, state of the banks, bottom, etc.). Its goal is to ensure that the lake's waters, after simple treatment, can be used sustainably as drinking water, that recreational activities (fishing, swimming, water sports, etc.) can be carried out in optimal conditions, and that the natural reproduction of noble fish (arctic char, vendace/whitefish, trout, etc.) can be guaranteed.

CIPEL proposes 10-year action plans of which the current iteration covers 2021–2030. Main activities include an annual plenary meeting; the Operational Committee for general management of the Action Plan, which meets several times per year; and thematic working groups composed of experts from both member countries addressing domestic pollution, agricultural pollution, industrial pollution and the natural environment. Importantly, CIPEL has an independent Scientific Council that enables it to mobilize the expertise needed to formulate its recommendations. The governance mechanisms of the Convention facilitate the exchange of data between countries. The annual budget of CIPEL is approximately CHF 900,000, with France contributing 25 per cent and Switzerland 75 per cent in proportion with their respective territorial coverage of the lake.

The validation and harmonization of data is carried out by the Scientific Council and the Permanent Secretariat of the Convention. The data are exchanged continuously by direct transmission, with CIPEL responsible for storage. The recorded data are publicly available.

In terms of impact, the work coordinated by CIPEL has led to a significant reduction in nutrient flows (phosphorus, nitrogen, etc.) (see *Figure 72.1*). These results have affected aquatic biodiversity, leading to an increase in noble fish populations. CIPEL's work has also impacted micropollutant pollution (pesticides, pharmaceuticals, metals) at levels compatible with drinking water production, with the quality of bathing water in Lake Geneva shown to be very satisfactory.

Figure 72.1 Phosphorus concentrations in Lake Geneva



Source: Nemery, J. (2018). Phosphore et eutrophisation, Encyclopédie de l'Environnement. www.encyclopedie-environnement.org/eau/phosphore-et-eutrophisation.

A number of issues still need to be monitored:

a) a continued rise in lake water temperature due to climate change, resulting in a +2.5°C increase for surface water and +1°C for bottom water, which poses a risk to fish reproduction (Arctic char);

b) milder winters where winter water circulation is often incomplete, preventing bottom reoxygenation;

c) persistence of pharmaceuticals in the lake, with France and Switzerland adopting different strategies to reduce micropollutants;

d) the rising importance of microplastics as a new area in need of vigilance;

e) strong and growing demographic pressure due to the attractiveness of the territory, which leads to an increase in pollutant discharges.

Source: Case study provided by Renaud Corniquet, Ministry of Ecological Transition of France, 2022.

Lesson 40 Improve awareness and strengthen transboundary cooperation through information and data-sharing

Sharing data and information helps to develop a common language between the riparian countries and to reach a wider public, including academia, users and the press, among others. This increases public awareness of the situation in every part of the international basin and improves understanding of water resources. It also helps to consolidate entities and international support and increase public awareness and stakeholder participation.

The sharing of data and information and thus the co-creation of knowledge helps to build trust through the development of personal relationships and the building of team spirit. It has positive impacts at the environmental level, but also at the diplomatic level. Regular sharing of experiences, knowledge, methods, approaches and practices, evidence-based bilateral coordination of transboundary protection of groundwater resources, access to data across national borders and so on, supports the professional growth of experts and provides a better understanding of the challenges, all of which promote better decisions for the development of transboundary river basins. Furthermore, it can strengthen the coordinating role of the RBO or other joint body, especially in combining efforts and seeking synergies based on common objectives.

Case studies that cover this lesson: Case study 12, Case study 14, Case study 15, Case study 19, Case study 24, Case study 38, Case study 56, Case study 58, Case study 61, Case study 70, Case study 71, Case study 73, Case study 74, Case study 75 and Case study 77.

Case study 73 Developing transboundary water quality monitoring of the Teno River

Lessons learned covered in this case study: Lesson 4, Lesson 11 and Lesson 40.

In 1980, Finland and Norway signed an "Agreement concerning the Finnish-Norwegian Transboundary Water Commission". The text of the Agreement defines the transboundary water areas to which it pertains and aims to "preserve the unique natural conditions of the transboundary water bodies and their surroundings, and to secure the interests of both parties to the agreement, and especially the residents of the border region, in matters concerning the use of transboundary water bodies".

To implement the Agreement, the Parties appointed a Joint Transboundary Water Commission, which acts as a joint cooperation and liaison body of the contracting Parties in matters concerning transboundary water bodies. According to the Agreement, the role of the commission is to provide advice and promote cooperation. The Commission can also issue proposals and statements and create initiatives. It does not possess actual decision-making power regarding transboundary waters.

The government of each Party must appoint three members and one or more deputy members to the Commission, with one member required to have worked for the state water authority and another to have experience of conditions in the border region. In addition, a third member is appointed as a representative of the local Indigenous population (Sámi).

Teno River, on the border of Finland and Norway

At the second meeting of the Commission, it was decided that Finnish and Norwegian regional authorities would appoint an expert working group to prepare a joint water quality monitoring and reporting programme for the Teno River – an important spawning river for Atlantic salmon shared between the two countries. The programme was approved in 1987, and physical-chemical monitoring of water quality began in 1988, followed by biological monitoring in 1989. In 1990, the programme published the first loading and water quality report for the river, which identified significant impacts linked to domestic wastewater from the Norwegian side. The Norwegian government complied with the Commission's recommendation by constructing water treatment plans.

The programme was implemented jointly by the two countries: the Norwegian authorities were charged with collecting water samples and the Finnish authorities with analysing them; subsequent processing and reporting of results was carried out in Norway. This approach distributed the costs from the monitoring programme almost equally.

This method of monitoring, based on mutual trust, was unique in transboundary water cooperation at the time. The applied methodology strengthened cooperation between the participating authorities, which was positively reflected in the work of the Commission. After Finland joining the European Union, the monitoring of Teno River was developed further to meet the requirements of the WFD and the Flood Directive.

Source: Case study provided by Kari Kinnunen, Water Convention Implementation Committee, 2023.

Plains near Milk River in Alberta, Canada

Case study 74 Informal cooperation on hydrogeological assessments of the Milk River Transboundary Aquifer

Lessons learned covered in this case study: Lesson 3, Lesson 5, Lesson 17, Lesson 26, Lesson 28, Lesson 32 and Lesson 40.

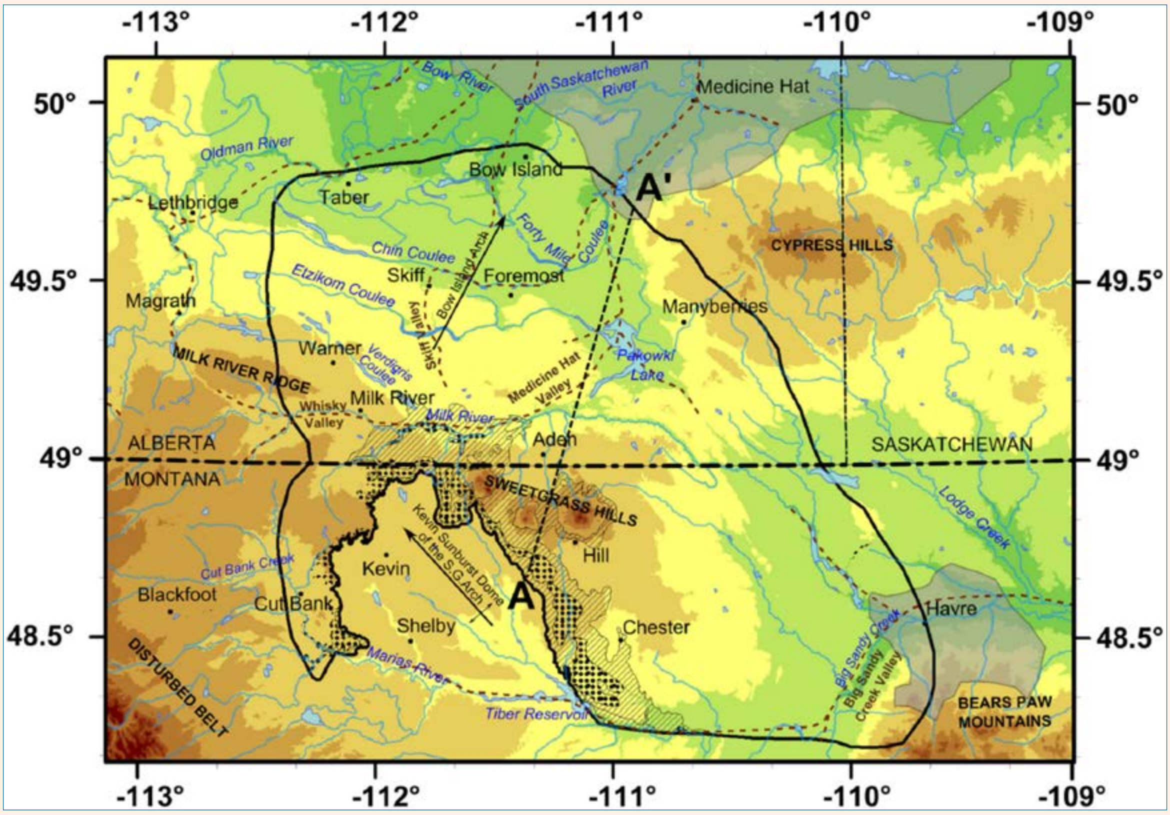
The Milk River Transboundary Aquifer[141] is one of 10 transboundary aquifer systems identified along the Canada-US border. This regional groundwater system (26,000 km²) has been exploited for over a century and remains an important groundwater resource for agricultural, municipal and industrial use in southern Alberta, Canada and northern Montana, US.

Concerns about groundwater depletion have been raised since the mid-1950s, while the aquifer continues to be exploited on both sides of the international border. However, no formal agreement has been enacted between Canada and the US on the use and joint management of the aquifer.

Transboundary management of the Milk River Aquifer is challenging due to the fragmentation of data and information. Previous studies have been limited to either side of the border, while the development of independent and different stratigraphic frameworks has resulted in gaps in knowledge of the aquifer's hydrodynamics.

141 ISARM #20N

Map 74.1 The Milk River Transboundary Aquifer



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: Pétré, Marie-Amélie & Rivera, Alfonso & Lefebvre, René & Folnagy, Attila & Lafave, John & Palombi, Dan. (2021). The hydrogeological assessment of the Milk River Transboundary Aquifer (Alberta, Canada -Montana, USA): a basis towards joint management plans. DOI:10.13140/RG.2.2.32523.00803.

The Milk River Transboundary Aquifer Project (MiRTAP),[142] which covered the period 2010–2017 and was funded by the Geological Survey of Canada, was designed to assess the full physical and chemical components of the Milk River aquifer along its natural boundaries. The project brought together an impressive number of stakeholders from both sides of the border, including representatives of academia, governments and an independent watershed council. Transboundary collaboration took place through informal sharing of data and information, as well as support for field work and digitization or harmonization of geologic data. The results of the project included the first transboundary delineation of the Milk River aquifer, a unified 3D geological model, a conceptual hydrogeological model and a 3D numerical groundwater flow model, with the models following the physical boundaries of the aquifer rather than the jurisdictional boundaries. To overcome the fragmentation of information and the multiple stratigraphic nomenclatures in the study area, geological, hydrogeological and isotopic data were combined and harmonized through focused field work on both sides of the border in cooperation with stakeholders.

142 www.mrwcc.ca/resource/milk-river-transboundary-aquifer-project

This hydrogeologic assessment provides a common scientific knowledge base for the transboundary aquifer, a prerequisite for joint management plans. In addition, all data and models produced under the project have been made publicly available through two open file reports, a PhD thesis, four scientific publications and a project website.[143] After the end of the project, the resulting legacy of the aquifer assessment project ensured the continuation of discussions and data-sharing towards shared management of the aquifer, even in the absence of formal agreements.

The project partners also recommended the establishment of an international Technical Advisory Committee (TAC) to prioritize studies on the future development of the Milk River transboundary aquifer to meet different needs.[144] Diplomacy is required to initiate discussions between the two countries on an operational agreement that could include provisions for annual meetings, exchange of information and data, updates to the Joint Aquifer Management Plan and other joint activities.

Source: Case study provided by Marie-Amélie Pétré and Alfonso Rivera, International Association of Hydrogeologists' Transboundary Aquifers Commission, 2023.

Milk River in Alberta, Canada

143 www.milkrivertransboundaryaquifer.weebly.com/

144 UNESCO (2022). *Transboundary Aquifers: Challenges and the Way Forward*. Paris, UNESCO. www.unesdoc.unesco.org/ark:/48223/pf0000383775 (pp. 108–114).

Pelican colony in the Danube Delta in Romania

Case study 75 ICPDR data-sharing in the Danube River basin

Lessons learned covered in this case study: Lesson 3, Lesson 26, Lesson 31 and Lesson 40.

For the ICPDR, sharing data and information has always been fundamental to improving awareness and strengthening transboundary cooperation. Since its inception, the organization has compiled and published Danube basin-wide water quality data collected by its TransNational Monitoring Network (TNMN).[145] This endeavour has grown into a source of long-term data providing a structured and balanced overview of the status and changes of water quality, with a particular focus on transboundary pollution loads, including those entering the Black Sea.

A key milestone that brought the ICPDR's information and data-sharing to a new level was the opening up of the Danube River Basin Geographic Information System (DanubeGIS)[146] to the public. Initially, this working tool was used to collect, validate, harmonize and compile national data for reporting under Part A of the EU WFD and the Floods Directive. However, with the publication of the Danube River Basin Management Plan (DRBMP) and the Danube Flood Risk Management Plan (DFRMP) in 2015, DanubeGIS provided access to all data layers used for the more than 40 thematic maps in these reports.

145 www.wq-db.icpdr.org

146 www.danubegis.org

Danube River on the border between Serbia and Romania

These data can be viewed interactively as part of online web maps and, more importantly, accessed and – with the exception of certain specific restrictions imposed by the data providers – downloaded using the open interface standards Web Map Service (WMS) and Web Feature Service (WFS). The decision to provide open access enabled the use of these data layers in other mapping activities. The data available in DanubeGIS have since been updated in parallel with the publication of recent management plans in 2021, and used by numerous projects, observers, scientists and students as a basis for their work in the Danube River basin.

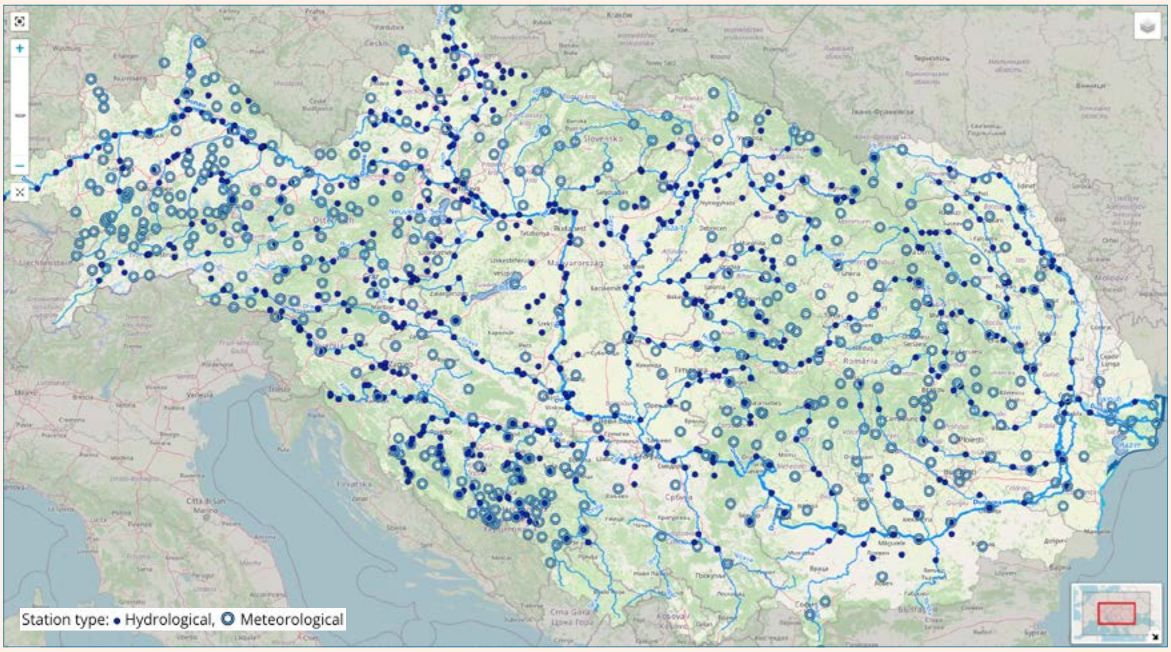
The ICPDR is currently in the process of expanding its output with the release of near-real-time hydrological and meteorological data, a challenge that involves the automatic conversion of different data formats used by countries in the region. To achieve this objective, the ICPDR is building on the results of the DAREFFORT project, which developed the HyMeDES Environet data exchange software.[147] This software minimizes the effort required by national data providers to transfer data to the platform in question, while still meeting high standards of data availability and quality.

The ICPDR established and operates the central platform, maintains and develops the open source software, and complements it with a web portal to view water level, river discharge, water temperature and precipitation data on maps and graphs. Data can be downloaded in the open standard WaterML 2.0. Data submission and sharing is voluntary for data providers with the rules and guidelines set out in the DanubeHIS Policy document for data exchange. At its launch, the Danube River Basin Hydrological Information System (DanubeHIS)[148] included more than 1,100 stations. Looking ahead, the goal is to add validated long-term data series and to make these data available for flood risk management or any water-related scientific activities in the Danube River basin.

147 www.github.com/environet/environet

148 www.danubehis.org

Figure 75.1 **Hydrological and meteorological stations in the Danube River basin Hydrological Information System**



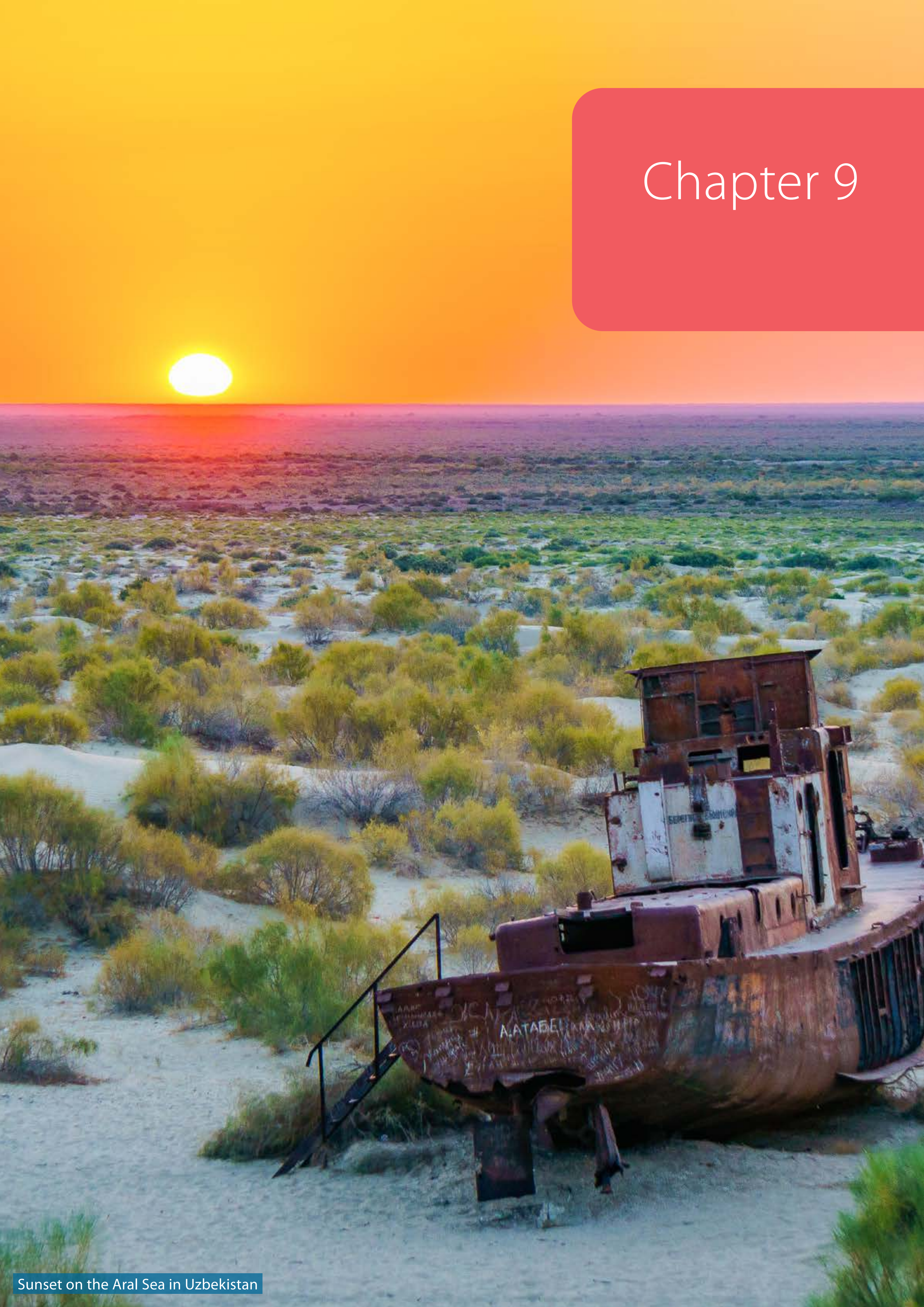
The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Source: DanubeHIS: www.danubehis.org/stations/list. Accessed in July 2024.

Source: Case study provided by Alexander Höbart, International Commission for the Protection of the Danube River (ICPDR) Secretariat, 2023.

Sunrise on the Danube River in Budapest, Hungary

Chapter 9

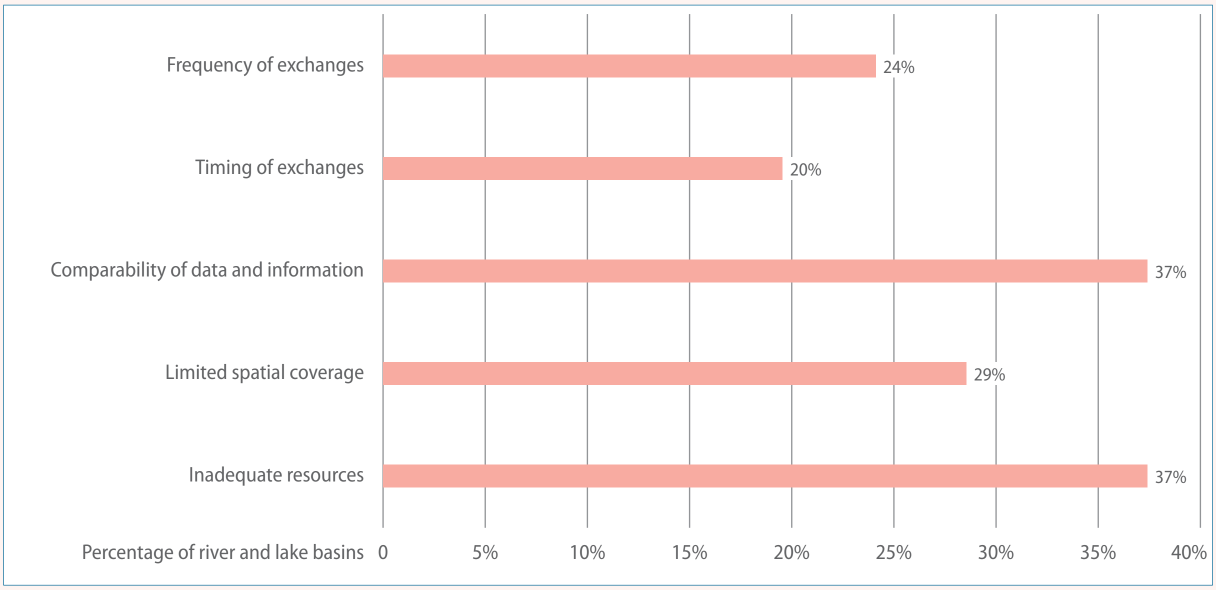


Sunset on the Aral Sea in Uzbekistan

Main difficulties and challenges

As part of the third reporting exercise on progress towards SDG Indicator 6.5.2 (2023), countries were asked to identify the key difficulties and challenges they faced in exchanging information and data. As shown in Figure B, out of the five main responses, the two most significant were comparability of data and information (37 % of river and lake basins) and inadequate resources (37 % of river and lake basins). The lessons learned in this chapter focus on overcoming these obstacles to information and data-sharing.

Figure B **SDG indicator 6.5.2 reporting template, section II, question 6(g) – What are the main difficulties and challenges to data exchange? (based on at least one country within a basin responding positively to the question)**



Source: UNECE, UNESCO and UN-Water (2024). Progress on Transboundary Water Cooperation – Mid-term status of SDG Indicator 6.5.2, with a special focus on climate change, 2024

Lesson 41 Ensure the availability of sufficient resources for information and data-sharing

Transboundary cooperation often struggles with limited resources. Funding constraints, a common limitation, restrict the number and maintenance of monitoring stations and reduce opportunities for face-to-face meetings and training. Insufficient human resources represent another impediment to transboundary cooperation. Ensuring that these resources are in place is therefore crucial to long-term monitoring and information and data-sharing.

This issue is of particular importance for groundwater systems, which are three-dimensional, often complex environments. As a result, groundwater monitoring is an expensive, long-term process requiring substantial resources. For most groundwater systems, the first step is to assess and understand the system, identifying the location and volume of the groundwater and the direction and rates of flow (which may vary with depth and over time). Once an aquifer has been assessed sufficiently, the collected data must be interpreted, which requires continuous efforts, again due to the complexity of groundwater systems.

Case studies that cover this lesson: Case study 24 and Case study 76.

Case study 76 Limited management capacity for the Ramotswa Aquifer

Lessons learned covered in this case study: Lesson 5, Lesson 7, Lesson 11, Lesson 12, Lesson 17, Lesson 19, Lesson 31, Lesson 32, Lesson 39, Lesson 41 and Lesson 42.

The Ramotswa Transboundary Aquifer is a dolomite aquifer shared between Botswana and South Africa. The aquifer is located in the Limpopo River basin, which is shared between Botswana, Mozambique, South Africa and Zimbabwe. The institutions responsible for groundwater data collection and sharing are the Botswana Department of Water and Sanitation (DWS-BOT), the Water Utilities Corporation (WUC) in Botswana, and the South Africa Department of Water and Sanitation (DWS-RSA). The DWS-BOT shares groundwater data upon request, while the data collected by DWS-RSA can be accessed free online from the National Groundwater Archive.[149]

Data exchange between the two countries is not a regular practice. Rather, data-sharing occurs on a case-by-case basis, as part of groundwater assessment, joint projects and capacity-building.

149 www.dws.gov.za/NGANet/Security/WebLoginForm.aspx

Data have been collected, harmonized and made available via the Ramotswa Information Management System (RIMS), which is hosted by the SADC Groundwater Information Portal (GIP).[150] This joint endeavour took place between 2015 and 2019, during a USAID-funded and IWMI-led project.[151] The data sets supported the first joint baseline assessment and integrated modelling of the Ramotswa Aquifer as well as the environmental, socioeconomic, legal, institutional and livelihood contexts of the Ramotswa Transboundary Aquifer Area (RTBAA). Since 2019, the RIMS remains available online but there has been no further collection of data. In the Joint Strategic Action Plan (JSAP), developed as part of the project,[152] the two countries committed to sharing data and to engaging in joint groundwater monitoring activities.

The two countries meet a few times per year to address groundwater issues, as part of the Limpopo Groundwater Committee (LGC). The LGC is a recent addition to LIMCOM, and functions as an advisory body for groundwater matters and transboundary aquifers. The LGC comprises representatives from the four LIMCOM member states, and meetings are an opportunity for the countries to exchange information on transboundary groundwater, including the Ramotswa Aquifer. However, monitoring data are not exchanged via the LGC, and the Committee has only limited capacity to carry out regional groundwater assessments.

There is no financial commitment on the part of the two countries and advances in transboundary cooperation are highly dependent on external donors through funded projects, such as the Potential Role of the Transboundary Ramotswa Aquifer (RAMOTSWA Project) phase I and II and the Big Data and Transboundary Water Collaboration Project.

The necessary conditions for effective transboundary data-sharing between the two countries are in place:

a) Groundwater data are available.

b) Data can be shared and, in the case of South Africa, are available open source.

c) A joint data platform (RIMS) exists to support the exchange of data.

d) The two countries are on good terms and have collaborated on the Ramotswa Aquifer for many years.

e) The two countries have committed to sharing data via the Ramotswa JSAP and the LGC.

f) There are good reasons for investing in joint groundwater management, as the surface water reservoirs in the area are scarce. The Ramotswa Aquifer provides an alternative source of water, while the aquifer is under threat from nitrate pollution in places.

The JSAP, agreed in 2020, represents a positive development, capitalizing on the creation of stronger political commitment to regularly exchange data and information on the Ramotswa Aquifer, and to develop the necessary human, technical and financial capacities.

Source: Case study provided by Arnaud Sterckx, International Groundwater Resources Assessment Centre (IGRAC), and Karen Villholth, Water Cycle Innovation, based on reports by the Botswana Department of Water and Sanitation, 2022.

150 www.sadc-gip.org

151 www.iwmi.cgiar.org/success-stories/striving-for-a-groundwater-secure-future-in-the-limpopo

152 www.conjunctivecooperation.iwmi.org/wp-content/uploads/sites/38/2020/02/Ramotswa-JSAP_-May-2019-.pdf

Lesson 42 Build trust to enable information and data-sharing

Where there is mistrust between riparian countries due to political rivalries and conflicts or political instability, sharing of data and information is difficult. Some countries lack open data policies, or data and information may be considered sensitive. In these situations, building trust is essential to enable information and data-sharing. Lesson 3, Lesson 5, Lesson 20, Lesson 30 and Lesson 40, among others, illustrate ways to build trust through data-sharing.

Case studies that cover this lesson: Case study 33, Case study 76 and Case study 77.

Case study 77 Trust-building through cooperation in the North-Western Sahara Aquifer System (NWSAS)

Lessons learned covered in this case study: Lesson 2, Lesson 19, Lesson 27, Lesson 31, Lesson 40 and Lesson 42.

The North-Western Sahara Aquifer System (NWSAS) is shared between the three countries, Algeria, Libya and Tunisia, and contains mostly non- or little renewable groundwater. The system is also known under the acronym SASS for its French name, Système Aquifère du Sahara Septentrional, and designates the superposition of two main deep aquifer layers: the Intercalary Continental (IC) and the Terminal Complex (TC).

The respective national institutions responsible for monitoring and data-sharing in the aquifer system are:

- the National Agency for Hydraulic Resources of Algeria (ANRH);
- the General Water Resources Authority of the Ministry of Water Resources of Libya (GWA);
- the General Directorate of Water Resources of Tunisia (DGRE).

In 2007, the three countries set up the NWSAS Consultation Mechanism, a joint body tasked with coordinating, promoting and facilitating the rational management of NWSAS water resources, including data and information exchange. The institutions that constitute the Consultation Mechanism are:

- the Ministerial Council comprising ministers in charge of water resources in the three countries;
- the Permanent Technical Committee (ANRH, GWA and DGRE);
- the Coordination Unit;
- ad hoc working groups;
- national committees.

The Coordination Unit was temporarily hosted at the headquarters of the Sahara and Sahel Observatory (OSS) in Tunisia. In April 2024, a ministerial meeting decided to host the Consultation Mechanism in Algiers. The Coordinator of the Coordination Unit is appointed by the appointee's country of origin for a two-year mandate based on an alphabetical rota between the three countries. In 2006, a declaration was signed by the responsible ministers of the three countries mandating the joint management of the water resources in the aquifer, including the exchange of data between the responsible national institutions. In addition, an Agreement Protocol was established, stipulating that the use of water resources in the NWSAS should consider the principle of cooperation, according to which it is necessary to develop relations between states, aquifer and basin organizations, and regional organizations, with a view to ensuring integrated, concerted and peaceful management of the environment and water resources of aquifer and river basins.

The Consultation Mechanism is presently coordinated and fully financed by the three countries, which contribute yearly to its functioning. This allows for the collection and exchange of data, updating of the database, and modelling and visualization tools. The Consultation Mechanism also organizes awareness and capacity development sessions (at national and regional level). Information related to these activities is published on a dedicated webpage, accessible to the public.[153]

The types of data and information exchanged through the Consultation Mechanism relate mostly to hydrogeology, hydrology, socioeconomics and climate change. They also include metadata, mostly related to remote sensing. The exchange of information mainly concerns:

- monitoring data on the conditions of transboundary waters, notably water abstraction, water levels and water quality;
- information on best available technologies
- experience and best practices;
- results of relevant research and development, including studies on recharge and climate change impact, estimation of water abstraction using remote sensing, etc.;
- installation of water drainage systems and discharge of wastewater
- measures taken and planned;
- permits or regulations for wastewater;
- water quality assessment.

The gathered data are processed and integrated into a joint database called SAGESSE (*Système d'Aide à la Gestion des Eaux du Sahara SEptentrional*), which is hosted at OSS and installed in the three countries. It can be accessed by the national focal directorates in charge of water resources management at the relevant ministries and national users working in or with the ministries. The data are not open to the general public. The outputs and information resulting from data-processing are findable, accessible, interoperable and reusable by the general public and decision makers.

More than 17,000 boreholes are recorded in the database, and monitoring data for subsets of the boreholes are transmitted on an annual basis from the national institutions responsible for water resources management. The data supplied to update the database mainly concern water levels, water withdrawals, salinity (Total Dissolved Solids) and, to a lesser extent, the results of chemical analyses.

An integrated database, GIS, and dynamic model was created to enable the elaboration of thematic maps (incorporating water levels, piezometry, water abstraction, water quality/salinity, etc.) and water abstraction scenarios. In addition, several maps based on applied remote sensing have been created and are available in the database. Uniform geographical references and data units have been agreed and adopted by the three countries to ensure the compatibility, comparability and quality of the data (metadata, data dictionary, etc.).

153 www.oss-online.org/en/nwsas-cm

Chebika Oasis in Tunisia

The results of the monitoring and studies are published in joint reports, and an annual report on the status of the database and an update on model simulations is shared with the countries. The GIS model is also used by countries for their national investigations and project development planning. In addition, decision makers (the national directors of water resources) receive an annual report informing on the status of the shared aquifer resources. These reports are validated during an annual technical committee meeting, which serves to formulate recommendations for better management of the NWSAS.

The publication and exchange of data and information (e.g. conclusions from model simulations) among stakeholders raises awareness of issues related to aquifer over-abstraction and quality degradation. It thus helps improve the livelihood of the populations by contributing to the maintenance of their means of subsistence, while facilitating cooperation between the riparian countries.

The three countries meet regularly to discuss the best conditions for sustaining the structure of the Consultation Mechanism and to explore ways to make best use of the strategic NWSAS groundwater resources. The main challenge encountered in exchanging data and information at the outset of the initiative was the establishment of trust between the countries, though this was remedied by the gradual growth in confidence among the parties. A delay in annual financial contributions from the three countries to the operating budget of the Consultation Mechanism does remain a concern, however.

Source: Case study provided by Karen Villholth, Water Cycle Innovation based on reports by the Sahara and Sahel Observatory (OSS), 2023.

Lesson 43 Reduce the knowledge gap between countries to enable sharing of data and information

Differences in level of knowledge between riparian countries can hinder the sharing of data and information. Another obstacle to cooperation and exchange is the absence of training, which can prove difficult to implement in certain contexts. In addition, different countries do not use the same systems leading to issues around harmonization. In some cases, data quality may be insufficient, or the information may be fragmented across different agencies, making it difficult to obtain relevant data of sufficient quality. It is therefore important to introduce a process to counter these differences and enable the sharing of data and information.

Case studies that cover this lesson: Case study 27 and Case study 78.

Case study 78 Main challenges to strengthening data-sharing at the regional level in Central Asia

Lessons learned covered in this case study: Lesson 13 and Lesson 43.

In February 2023, the International Water Assessment Centre (IWAC), in cooperation with the Water Convention Secretariat and the GIZ Green Central Asia Programme, organized a regional workshop on monitoring, assessment and information-sharing in the transboundary basins of Central Asia. The workshop aimed at facilitating the exchange of experience related to monitoring water resources and improving cooperation on the protection and use of water resources between five countries in the region: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

Workshop participants identified positive data-sharing trends at the regional level and numerous instances of cooperation on monitoring and data-sharing. Notable examples include: the Chu-Talas Water Management Commission in Kazakhstan and Kyrgyzstan (see *Case study 39*); water quality monitoring in the Syr Darya River basin shared between Kazakhstan and Uzbekistan (see *Case study 25*); hydrological data-sharing between national hydrometeorological authorities (see *Case study 36*); and cooperation, assessment and modelling in the Pretashkent transboundary aquifer of Kazakhstan and Uzbekistan (see *Case study 56*).

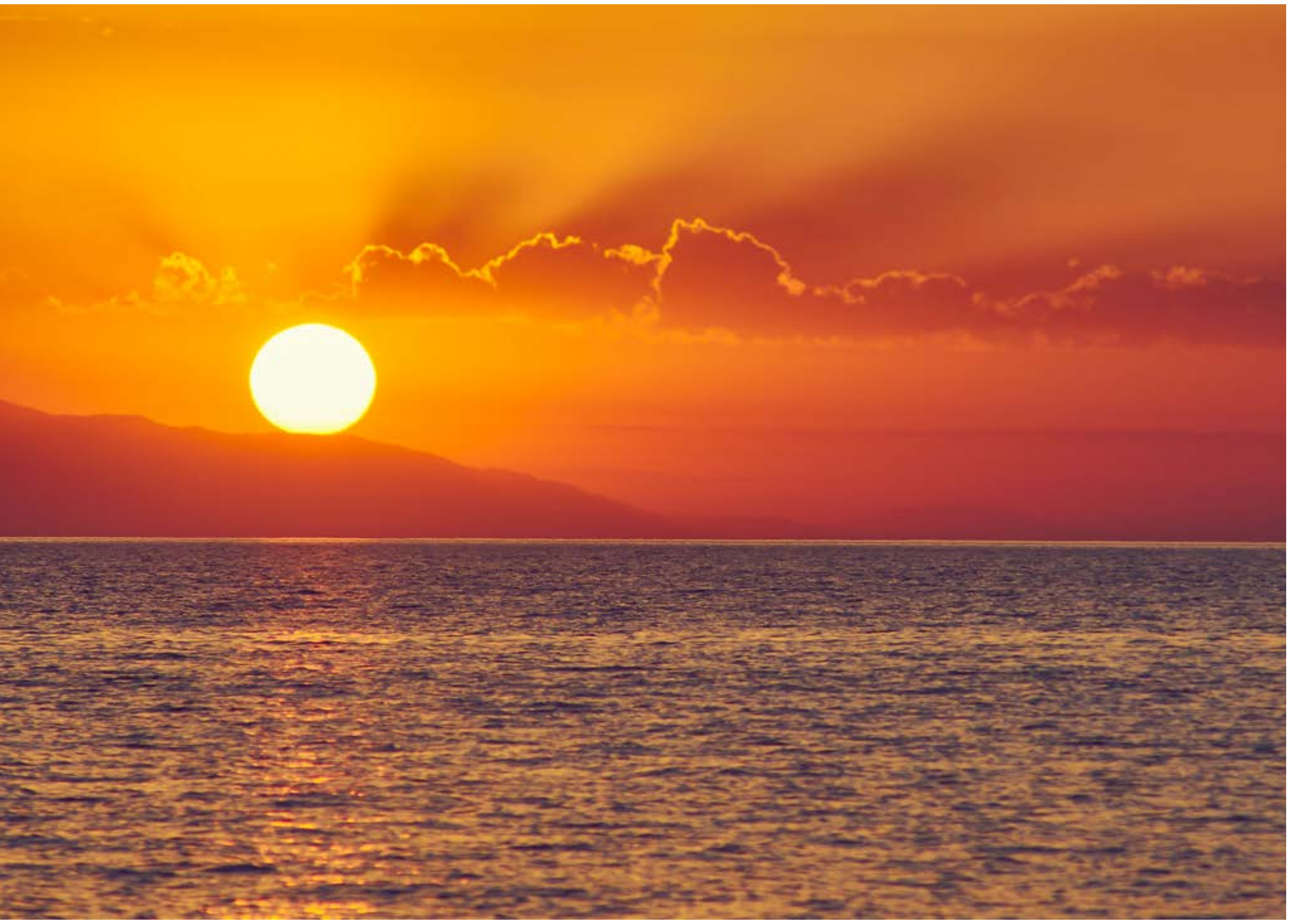
However, participants noted that several challenges to the monitoring and assessment of water resources in the region do not receive sufficient attention. The workshop highlighted the need for joint efforts to harmonize data collection, strengthen monitoring and data-sharing on water quality, develop early warning systems on water pollution at transboundary waters, and improve the collection and sharing of data on transboundary aquifers. Specific challenges noted by participants included limiting monitoring and data-sharing due to a lack of funding and proper equipment; a need for greater collaboration on hydrological forecasting and development; insufficient access to information and data on water resources; a limited focus on consolidating efforts to combat climate change effects; the absence of agreements on groundwater; and a need for joint bodies to coordinate monitoring and assessment.

Participants also emphasized the need for a phased approach to developing interactions between countries on data-sharing in transboundary basins based on existing national monitoring systems, the harmonization of methodology and standards for data collection, the development of a regional observation network and the elaboration of institutional mechanisms for regular data-sharing in transboundary basins. The workshop outcomes highlighted the importance of developing bilateral and regional agreements for cooperation including specific mechanisms for joint monitoring and assessment of water resources and regular data-sharing.

Source: Case study provided by Zhanar Mautanova, based on the Outcomes from the Regional Workshop on Monitoring, Assessment and Information Sharing in Transboundary Basins in Central Asia, 2023.

Further reading

United Nations Economic Commission for Europe (2021). *Funding and Financing of Transboundary Water Cooperation and Basin Development*. Geneva. Available at www.unece.org/environment-policy/water/areas-work-convention/financing-transboundary-water-cooperation



Sunset on the Issyk Kul Lake in the Kyrgyz Republic


Sunset in the Amazon River basin

ANNEX MATRIX OF LESSONS LEARNED AND CASE STUDIES

Case study x Lesson learned	1. Use basin management planning as a catalyst for developing monitoring and data-sharing systems	2. Ensure political support for the monitoring and data-sharing system	3. Embrace an open data approach to water data access	4. Ensure clear mandates for data-sharing at bilateral or basin level	5. Informal cooperation can still take place in the absence of a formal agreement	6. Ensure adequate and continuous financing for monitoring and data-sharing	7. Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible	8. Create a specific working group responsible for monitoring as part of a joint commission's institutional framework	9. Engage with key parties, including civil society, NGOs, and the private sector	10. Ensure an integrated and cross-sectoral approach for the monitoring system	11. Facilitate trust building and collaborative learning	12. Support awareness raising and capacity development	13. Adopt a step-by-step and iterative approach to monitoring in the transboundary basin	14. Engage with experts in institutional structures in charge of transboundary cooperation	15. Build on local knowledge	16. Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking	17. Raise awareness of the importance of acting at a basin-wide scale	18. Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle
1. Sharing of information between Chile and Argentina	●									●								●
2. Governance and management of the Stampriet Aquifer System (STAS)	●							●					●					
3. Ganga/Ganges Water Sharing Treaty		●																
4. The Amazon Regional Observatory			●															
5. Open data access in South Africa and the Gambia			●															
6. Legal mandates for information and data-sharing in the Aral Sea basin		●		●									●					
7. Buzi, Pungwe and Save basins: The BuPuSa Data-sharing Protocol		●		●														
8. Informal cooperation on transboundary aquifers along the Mexico-U.S.A border					●		●			●								
9. Informal information and data-sharing in the Tuli Karoo Aquifer					●		●											
10. Financing data-sharing in the Sava River basin				●		●												
11. Financing of the OKACOM data-sharing procedure						●												
12. Developing cooperation on the Ocotepeque-Citalá Transboundary Aquifer (OCTA)	●			●			●		●	●							●	
13. Extending the mandate of the Organization for the Development of the Gambia River				●			●											

19.Include information on groundwater and other water resources to promote conjunctive water management		●			●			●	●			●	
20. Support cooperation more flexibly and effectively through inter-agency cooperation programmes													
21. Apply citizen science to support information collection													
22. Agree within joint bodies to progressively enlarge the types of data and information collected and shared													
23. Develop procedures for sharing data and information on planned measures				●									
24. Develop a transboundary early warning system				●						●			
25. Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies													
26. Harmonize data to facilitate comparability between countries											●		
27. Ensure regional coordination and technical cooperation													
28. Harmonize and integrate the use of models with measurements													
29. Perform joint monitoring to facilitate data harmonization													
30. Technical cooperation can be a springboard for multidisciplinary cooperation													
31. Build a common data repository, database, or information system		●		●	●			●				●	
32. Use models for assessment, interpretation and forecasting													
33. Disseminate information to all relevant sectors, ministries and the public													
34. Ensure the sharing of knowledge between technical specialists and decision makers								●					
35. Ensure that the collected information serves better management through cooperation			●									●	
36. Develop a shared communication plan.													
37. Establish mechanisms for regular review of the monitoring system													
38. Use data and information as the basis for conflict prevention													
39. Enable improved water management through information and data-sharing			●						●				
40. Improve awareness and strengthen transboundary cooperation through information and data-sharing													
41.Ensure the availability of sufficient resources for information and data-sharing													
42. Build trust to enable information and data-sharing													
43. Reduce the knowledge gap between countries to enable sharing of data and information													

Case study x Lesson learned	1. Use basin management planning as a catalyst for developing monitoring and data-sharing systems	2. Ensure political support for the monitoring and data-sharing system	3. Embrace an open data approach to water data access	4. Ensure clear mandates for data-sharing at bilateral or basin level	5. Informal cooperation can still take place in the absence of a formal agreement	6. Ensure adequate and continuous financing for monitoring and data-sharing	7. Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible	8. Create a specific working group responsible for monitoring as part of a joint commission's institutional framework	9. Engage with key parties, including civil society, NGOs, and the private sector	10. Ensure an integrated and cross-sectoral approach for the monitoring system	11. Facilitate trust building and collaborative learning	12. Support awareness raising and capacity development	13. Adopt a step-by-step and iterative approach to monitoring in the transboundary basin	14. Engage with experts in institutional structures in charge of transboundary cooperation	15. Build on local knowledge	16. Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking	17. Raise awareness of the importance of acting at a basin-wide scale	18. Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle
14. A mechanism for cooperation in the KAZA Transfrontier Conservation Area					●		●										●	
15. Regional Working Group for the Senegalo-Mauritanian Aquifer Basin (SMAB)		●					●	●										
16. 'Hydrology' Working Group of the International Meuse Commission				●				●										
17. Harmonization of data for the International Commission for the Protection of the Rhine (ICPR)								●										
18. Towards binational monitoring of the transboundary aquifer system in Leticia-Tabatinga (Colombia and Brazil)									●									●
19. Involving Indigenous populations in the Sixaola basin				●					●									
20. Environmental priorities in recent transboundary water agreements between Ecuador and Peru				●						●								
21. Zambezi Watercourse Information System										●	●	●						
22. Data-sharing in the Buzi, Pungwe and Save basins				●						●								●
23. Sharing information on the transboundary groundwater body Karavanke				●						●								
24. Building multiple transboundary relationships: the experience of Hungary		●			●						●							●

						●			●	●	19.Include information on groundwater and other water resources to promote conjunctive water management
										●	20. Support cooperation more flexibly and effectively through inter-agency cooperation programmes
											21. Apply citizen science to support information collection
											22. Agree within joint bodies to progressively enlarge the types of data and information collected and shared
●	●										23. Develop procedures for sharing data and information on planned measures
				●				●			24. Develop a transboundary early warning system
											25. Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies
											26. Harmonize data to facilitate comparability between countries
											27. Ensure regional coordination and technical cooperation
											28. Harmonize and integrate the use of models with measurements
											29. Perform joint monitoring to facilitate data harmonization
											30. Technical cooperation can be a springboard for multidisciplinary cooperation
		●									31. Build a common data repository, database, or information system
											32. Use models for assessment, interpretation and forecasting
		●			●						33. Disseminate information to all relevant sectors, ministries and the public
											34. Ensure the sharing of knowledge between technical specialists and decision makers
	●					●		●			35. Ensure that the collected information serves better management through cooperation
●											36. Develop a shared communication plan.
											37. Establish mechanisms for regular review of the monitoring system
											38. Use data and information as the basis for conflict prevention
			●	●			●			●	39. Enable improved water management through information and data-sharing
●					●				●	●	40. Improve awareness and strengthen transboundary cooperation through information and data-sharing
●											41.Ensure the availability of sufficient resources for information and data-sharing
											42. Build trust to enable information and data-sharing
											43. Reduce the knowledge gap between countries to enable sharing of data and information

Case study x Lesson learned	1. Use basin management planning as a catalyst for developing monitoring and data-sharing systems	2. Ensure political support for the monitoring and data-sharing system	3. Embrace an open data approach to water data access	4. Ensure clear mandates for data-sharing at bilateral or basin level	5. Informal cooperation can still take place in the absence of a formal agreement	6. Ensure adequate and continuous financing for monitoring and data-sharing	7. Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible	8. Create a specific working group responsible for monitoring as part of a joint commission's institutional framework	9. Engage with key parties, including civil society, NGOs, and the private sector	10. Ensure an integrated and cross-sectoral approach for the monitoring system	11. Facilitate trust building and collaborative learning	12. Support awareness raising and capacity development	13. Adopt a step-by-step and iterative approach to monitoring in the transboundary basin	14. Engage with experts in institutional structures in charge of transboundary cooperation	15. Build on local knowledge	16. Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking	17. Raise awareness of the importance of acting at a basin-wide scale	18. Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle
25. Monitoring cooperation between Tajikistan and Uzbekistan		●	●								●							
26. Capacity development by the International Meuse Commission												●						
27. Step-by-step development of the activities of the Kazakhstan-Uzbekistan Working Group on Environmental Protection and Water Quality in the Syr Darya River basin		●		●				●					●					
28. Extension of monitoring in the BIO-PLATEAUX project			●	●									●					
29. Management of the transboundary deep groundwater body in the Lower-Bavarian/Upper-Austrian Molasse basin								●						●				
30. Promotion of Indigenous ancestral knowledge to facilitate transboundary water negotiations in Lake Titicaca				●								●			●			
31. Supporting decision-making in the River Plata basin				●												●		
32. Design and pilot application of a transboundary monitoring scheme for the Prespa Lakes basin													●				●	
33. Basin-wide information from the Upper Indus Basin Network (UIBN)					●												●	●
34. Pollution prevention in the Meuse and Scheldt River basins																		●

19.Include information on groundwater and other water resources to promote conjunctive water management					●					
20. Support cooperation more flexibly and effectively through inter-agency cooperation programmes										
21. Apply citizen science to support information collection						●				
22. Agree within joint bodies to progressively enlarge the types of data and information collected and shared										
23. Develop procedures for sharing data and information on planned measures				●						
24. Develop a transboundary early warning system			●				●			●
25. Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies										
26. Harmonize data to facilitate comparability between countries				●		●				
27. Ensure regional coordination and technical cooperation			●		●					
28. Harmonize and integrate the use of models with measurements										
29. Perform joint monitoring to facilitate data harmonization										
30. Technical cooperation can be a springboard for multidisciplinary cooperation										
31. Build a common data repository, database, or information system							●			
32. Use models for assessment, interpretation and forecasting							●			
33. Disseminate information to all relevant sectors, ministries and the public									●	
34. Ensure the sharing of knowledge between technical specialists and decision makers										
35. Ensure that the collected information serves better management through cooperation					●			●		●
36. Develop a shared communication plan.										
37. Establish mechanisms for regular review of the monitoring system										
38. Use data and information as the basis for conflict prevention										
39. Enable improved water management through information and data-sharing					●			●		
40. Improve awareness and strengthen transboundary cooperation through information and data-sharing										
41.Ensure the availability of sufficient resources for information and data-sharing										
42. Build trust to enable information and data-sharing									●	
43. Reduce the knowledge gap between countries to enable sharing of data and information			●							

Case study x Lesson learned	1. Use basin management planning as a catalyst for developing monitoring and data-sharing systems	2. Ensure political support for the monitoring and data-sharing system	3. Embrace an open data approach to water data access	4. Ensure clear mandates for data-sharing at bilateral or basin level	5. Informal cooperation can still take place in the absence of a formal agreement	6. Ensure adequate and continuous financing for monitoring and data-sharing	7. Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible	8. Create a specific working group responsible for monitoring as part of a joint commission's institutional framework	9. Engage with key parties, including civil society, NGOs, and the private sector	10. Ensure an integrated and cross-sectoral approach for the monitoring system	11. Facilitate trust building and collaborative learning	12. Support awareness raising and capacity development	13. Adopt a step-by-step and iterative approach to monitoring in the transboundary basin	14. Engage with experts in institutional structures in charge of transboundary cooperation	15. Build on local knowledge	16. Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking	17. Raise awareness of the importance of acting at a basin-wide scale	18. Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle
35. Sharing groundwater information in the Gambia River basin																		●
36. Cooperation through inter-agency programs between hydromets in Central Asia				●														
37. Involving citizens in data collection: Drinkable Rivers									●						●			
38. Transboundary citizen science water quality monitoring for SDG 6.3.2 in Kenya and Tanzania		●					●		●		●							
39. Working Group on Environmental Protection in the Chu and Talas River basins																		
40. ZAMCOM procedures for notification of planned measures				●														
41. Regular reporting on water quality in German-Polish border waters				●				●										
42. Early warning systems in Georgia												●						
43. Development of Early Warning Bulletins in the Syr Darya and Amu Darya River basins							●											
44. Emergency pollution notification of transboundary waters shared by the Republic of Moldova and Ukraine				●														●
45. Flood forecasting in the Meuse River basin											●	●						
46. Machine learning analytics for the Ramotswa Aquifer																		

●				●							●	19.Include information on groundwater and other water resources to promote conjunctive water management
							●			●		20. Support cooperation more flexibly and effectively through inter-agency cooperation programmes
								●	●			21. Apply citizen science to support information collection
							●					22. Agree within joint bodies to progressively enlarge the types of data and information collected and shared
					●	●						23. Develop procedures for sharing data and information on planned measures
	●	●	●	●								24. Develop a transboundary early warning system
●												25. Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies
												26. Harmonize data to facilitate comparability between countries
							●					27. Ensure regional coordination and technical cooperation
												28. Harmonize and integrate the use of models with measurements
												29. Perform joint monitoring to facilitate data harmonization
												30. Technical cooperation can be a springboard for multidisciplinary cooperation
												31. Build a common data repository, database, or information system
●												32. Use models for assessment, interpretation and forecasting
												33. Disseminate information to all relevant sectors, ministries and the public
												34. Ensure the sharing of knowledge between technical specialists and decision makers
					●		●					35. Ensure that the collected information serves better management through cooperation
									●			36. Develop a shared communication plan.
												37. Establish mechanisms for regular review of the monitoring system
												38. Use data and information as the basis for conflict prevention
							●					39. Enable improved water management through information and data-sharing
								●				40. Improve awareness and strengthen transboundary cooperation through information and data-sharing
												41.Ensure the availability of sufficient resources for information and data-sharing
												42. Build trust to enable information and data-sharing
												43. Reduce the knowledge gap between countries to enable sharing of data and information

Case study x Lesson learned	1. Use basin management planning as a catalyst for developing monitoring and data-sharing systems	2. Ensure political support for the monitoring and data-sharing system	3. Embrace an open data approach to water data access	4. Ensure clear mandates for data-sharing at bilateral or basin level	5. Informal cooperation can still take place in the absence of a formal agreement	6. Ensure adequate and continuous financing for monitoring and data-sharing	7. Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible	8. Create a specific working group responsible for monitoring as part of a joint commission's institutional framework	9. Engage with key parties, including civil society, NGOs, and the private sector	10. Ensure an integrated and cross-sectoral approach for the monitoring system	11. Facilitate trust building and collaborative learning	12. Support awareness raising and capacity development	13. Adopt a step-by-step and iterative approach to monitoring in the transboundary basin	14. Engage with experts in institutional structures in charge of transboundary cooperation	15. Build on local knowledge	16. Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking	17. Raise awareness of the importance of acting at a basin-wide scale	18. Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle
47. Development of a hydrological cycle observation system in the Nile River basin												●						●
48. Coordination on the environmental status assessments of shared transboundary surface waters between Austria and Germany								●										
49. Sharing data in the Niger River basin				●														
50. Cooperation in monitoring of the transboundary basins between China and Kazakhstan				●				●										
51. Coordination and cooperation in the International Commission for the Protection of the Rhine (ICPR)											●							●
52. The OKACOM Decision Support System				●														
53. Reconciling water balance data in Lake Fertő				●														
54. Joint monitoring in the Dniester and Prut River basins by the Republic of Moldova and Ukraine				●														
55. Joint Danube Surveys											●	●						
56. Sharing of data and information in the Pretashkent Transboundary Aquifer							●				●	●						
57. The Drin Information Management System																	●	
58. The Arab Groundwater Knowledge Platform			●													●		
59. A global portal and framework for international data exchange: the WMO Hydrological Observing System (WHOS)			●															

	●		●	●									19.Include information on groundwater and other water resources to promote conjunctive water management
													20. Support cooperation more flexibly and effectively through inter-agency cooperation programmes
													21. Apply citizen science to support information collection
													22. Agree within joint bodies to progressively enlarge the types of data and information collected and shared
										●		●	23. Develop procedures for sharing data and information on planned measures
													24. Develop a transboundary early warning system
													25. Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies
					●		●			●	●	●	26. Harmonize data to facilitate comparability between countries
								●	●				27. Ensure regional coordination and technical cooperation
			●				●						28. Harmonize and integrate the use of models with measurements
				●	●	●							29. Perform joint monitoring to facilitate data harmonization
			●										30. Technical cooperation can be a springboard for multidisciplinary cooperation
●	●	●										●	31. Build a common data repository, database, or information system
			●										32. Use models for assessment, interpretation and forecasting
	●												33. Disseminate information to all relevant sectors, ministries and the public
													34. Ensure the sharing of knowledge between technical specialists and decision makers
		●		●									35. Ensure that the collected information serves better management through cooperation
												●	36. Develop a shared communication plan.
													37. Establish mechanisms for regular review of the monitoring system
													38. Use data and information as the basis for conflict prevention
	●										●		39. Enable improved water management through information and data-sharing
	●	●	●										40. Improve awareness and strengthen transboundary cooperation through information and data-sharing
													41.Ensure the availability of sufficient resources for information and data-sharing
													42. Build trust to enable information and data-sharing
													43. Reduce the knowledge gap between countries to enable sharing of data and information

Case study x Lesson learned	1. Use basin management planning as a catalyst for developing monitoring and data-sharing systems	2. Ensure political support for the monitoring and data-sharing system	3. Embrace an open data approach to water data access	4. Ensure clear mandates for data-sharing at bilateral or basin level	5. Informal cooperation can still take place in the absence of a formal agreement	6. Ensure adequate and continuous financing for monitoring and data-sharing	7. Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible	8. Create a specific working group responsible for monitoring as part of a joint commission's institutional framework	9. Engage with key parties, including civil society, NGOs, and the private sector	10. Ensure an integrated and cross-sectoral approach for the monitoring system	11. Facilitate trust building and collaborative learning	12. Support awareness raising and capacity development	13. Adopt a step-by-step and iterative approach to monitoring in the transboundary basin	14. Engage with experts in institutional structures in charge of transboundary cooperation	15. Build on local knowledge	16. Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking	17. Raise awareness of the importance of acting at a basin-wide scale	18. Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle
60. The Rhine Alarm Model																		●
61. Integrated information system in the Sava River basin	●	●	●	●								●						●
62. Stakeholder participation in the International Commission for the Protection of the Rhine (ICPR)									●		●							
63. Information-sharing in the Aral Sea basin														●				
64. Data-sharing for improved water management in the Oder/Odra River basin				●				●										
65. Joint research and monitoring data on fish stocks by Finland and Sweden: the key to sustainable management of migrating salmon in Torne River				●										●				
66. Pollution load control in the Baltic Sea catchment area		●		●														
67. A shared communication plan for the Danube									●									
68. Preventive diplomacy on the Guaraní Aquifer System							●			●							●	
69. Dialogue to address pressing challenges in the Genevese Aquifer																		
70. Improved water management in the Rhine River		●									●					●		
71. Benefits from cooperation in the Sava River basin: the perspective of Bosnia and Herzegovina				●								●	●					

19.Include information on groundwater and other water resources to promote conjunctive water management									●	●		
20. Support cooperation more flexibly and effectively through inter-agency cooperation programmes				●								
21. Apply citizen science to support information collection						●						
22. Agree within joint bodies to progressively enlarge the types of data and information collected and shared												
23. Develop procedures for sharing data and information on planned measures					●							
24. Develop a transboundary early warning system	●	●										
25. Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies												
26. Harmonize data to facilitate comparability between countries		●					●					
27. Ensure regional coordination and technical cooperation		●				●						
28. Harmonize and integrate the use of models with measurements	●	●										
29. Perform joint monitoring to facilitate data harmonization												
30. Technical cooperation can be a springboard for multidisciplinary cooperation												
31. Build a common data repository, database, or information system		●					●		●			
32. Use models for assessment, interpretation and forecasting	●	●										
33. Disseminate information to all relevant sectors, ministries and the public		●	●					●				
34. Ensure the sharing of knowledge between technical specialists and decision makers				●						●		
35. Ensure that the collected information serves better management through cooperation		●			●	●	●			●		●
36. Develop a shared communication plan.								●				
37. Establish mechanisms for regular review of the monitoring system												
38. Use data and information as the basis for conflict prevention									●	●		
39. Enable improved water management through information and data-sharing							●				●	●
40. Improve awareness and strengthen transboundary cooperation through information and data-sharing		●									●	●
41.Ensure the availability of sufficient resources for information and data-sharing												
42. Build trust to enable information and data-sharing												
43. Reduce the knowledge gap between countries to enable sharing of data and information												

Case study x Lesson learned	1. Use basin management planning as a catalyst for developing monitoring and data-sharing systems	2. Ensure political support for the monitoring and data-sharing system	3. Embrace an open data approach to water data access	4. Ensure clear mandates for data-sharing at bilateral or basin level	5. Informal cooperation can still take place in the absence of a formal agreement	6. Ensure adequate and continuous financing for monitoring and data-sharing	7. Use existing RBO and non-RBO institutions and mechanisms for transboundary cooperation to the extent possible	8. Create a specific working group responsible for monitoring as part of a joint commission's institutional framework	9. Engage with key parties, including civil society, NGOs, and the private sector	10. Ensure an integrated and cross-sectoral approach for the monitoring system	11. Facilitate trust building and collaborative learning	12. Support awareness raising and capacity development	13. Adopt a step-by-step and iterative approach to monitoring in the transboundary basin	14. Engage with experts in institutional structures in charge of transboundary cooperation	15. Build on local knowledge	16. Involve decision makers from the outset in identifying information needs to ensure a participatory process that is integrated with policymaking	17. Raise awareness of the importance of acting at a basin-wide scale	18. Ensure the collection and sharing of appropriate and necessary data and information for the entire basin and across the water cycle
72. International Convention for the Protection of the Waters of Lake Geneva														●				
73. Developing transboundary water quality monitoring of the Teno River				●							●							
74. Informal cooperation on hydrogeological assessments of the Milk River Transboundary Aquifer			●		●												●	
75. ICPDR data-sharing in the Danube River basin			●															
76. Limited management capacity for the Ramotswa Aquifer					●		●				●	●					●	
77. Trust building through cooperation in the North-Western Sahara Aquifer System (NWSAS)		●																
78. Main challenges to strengthening data sharing at the regional level in Central Asia													●					

	●	●					19.Include information on groundwater and other water resources to promote conjunctive water management
							20. Support cooperation more flexibly and effectively through inter-agency cooperation programmes
							21. Apply citizen science to support information collection
							22. Agree within joint bodies to progressively enlarge the types of data and information collected and shared
							23. Develop procedures for sharing data and information on planned measures
							24. Develop a transboundary early warning system
							25. Expand traditional national monitoring to transboundary level and promote the use of innovative monitoring technologies
			●	●		●	26. Harmonize data to facilitate comparability between countries
	●						27. Ensure regional coordination and technical cooperation
				●			28. Harmonize and integrate the use of models with measurements
							29. Perform joint monitoring to facilitate data harmonization
							30. Technical cooperation can be a springboard for multidisciplinary cooperation
	●	●	●			●	31. Build a common data repository, database, or information system
		●		●			32. Use models for assessment, interpretation and forecasting
							33. Disseminate information to all relevant sectors, ministries and the public
							34. Ensure the sharing of knowledge between technical specialists and decision makers
							35. Ensure that the collected information serves better management through cooperation
							36. Develop a shared communication plan.
							37. Establish mechanisms for regular review of the monitoring system
							38. Use data and information as the basis for conflict prevention
		●				●	39. Enable improved water management through information and data-sharing
	●		●	●	●		40. Improve awareness and strengthen transboundary cooperation through information and data-sharing
		●					41.Ensure the availability of sufficient resources for information and data-sharing
	●	●					42. Build trust to enable information and data-sharing
●							43. Reduce the knowledge gap between countries to enable sharing of data and information

Sunrise on the Milk River in Canada

Good Practices and Lessons Learned in Data-sharing in Transboundary Basins

Most of the world's freshwater sources are shared between two or more countries. These transboundary waters face significant pressures due to population growth, increasing water demand and the impacts of the triple-planetary crisis of climate change, pollution and biodiversity loss. The sharing of data and information across different levels as well as political, sectoral, environmental and institutional boundaries is essential to ensure the sustainable, integrated and peaceful management of transboundary waters. Data- and information-sharing forms a common basis for transboundary cooperation, enables informed decision-making and helps maximize the benefits of cooperation over shared waters, leading to increased water security and trust between riparian countries.

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), hosted by the United Nations Economic Commission for Europe (UNECE), provides a legal framework for monitoring, assessment and exchange of data and information in transboundary basins. It calls for all Parties to provide for the widest exchange of information, as early as possible, on issues covered by the provisions of the Convention. Furthermore, it requires Riparian Parties to establish and implement joint programmes for monitoring the conditions of transboundary waters and to exchange reasonably available data within the framework of relevant agreements or other arrangements.

Good Practices and Lessons Learned in Data-sharing in Transboundary Basins presents a global collection of case studies related to different aspects of data and information sharing, building on real-life experiences across all levels. The publication provides a wide array of examples showing how monitoring and data-sharing programmes can be implemented, and thus complements previously developed guidance materials on monitoring and assessment.

The publication is intended for all actors working on monitoring programmes and data- and information-sharing in transboundary basins at both national and transboundary levels. They include joint bodies such as basin commissions and other institutions for transboundary cooperation and their national representatives; developers of monitoring strategies, especially in transboundary basins; decision makers; specialists working on monitoring and assessment in ministries; and other authorities, scientists and non-governmental organizations (NGOs). The publication supports the implementation of the Water Convention and improved transboundary water cooperation worldwide.

Information Service
United Nations Economic Commission for Europe

Palais des Nations
CH - 1211 Geneva 10, Switzerland
Telephone: +41(0)22 917 12 34
E-mail: unece_info@un.org
Website: http://www.unece.org

ISBN 978-92-1-003146-2

Layout and Printing at United Nations, Geneva – 2413395 **(E)** – October 2024 – 372 – **ECE/MP.WAT/73**