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Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins and experiences from its application: **synthesis**

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Foreword

Back in 2013, ECE was spearheading the debate on the water-food-energy nexus at the transboundary level. The work on the nexus under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) started with the development of a methodology for assessing intersectoral links, trade-offs and benefits in managing transboundary basins by cooperating across borders and sectors.

After six years of assessment work in seven transboundary basins, a wealth of lessons has been drawn about facilitating intersectoral transboundary dialogues. The methodology has evolved into a flexible, generic and open framework that adapts to the context and issues at stake, applies fit-for-purpose tools, and is continuously enriched also by the methods and experience of partners in the assessments. In the framework of the Convention's Task Force on Water-Food-Energy-Ecosystems, under the leadership of Finland, close to 300 officials, stakeholders and experts contributed to shaping the assessment exercise, either in specific basins or at the global level.

This publication presents the consolidated methodology which was improved upon application over the years. Moreover, it describes in some detail the assessment methodology's application in order to facilitate its further use and development.

These participatory assessments of transboundary basins and aquifers went through a process of jointly identifying intersectoral resource management issues and then proposing more sustainable and collaborative ways of development and stewardship of the respective basin's water, energy, land and environmental resources which reconcile different interests. The findings demonstrate the value of an integrated approach to development, and these insights are particularly relevant for the achievement of the 2030 Agenda for Sustainable Development as the interdependencies between the Sustainable Development Goals need to be taken into account when devising implementation policies and measures.

It is urgent to support practical measures to rationalize resource use, improve sustainability and reduce transboundary impacts. However, the synthesis lays out a number of obstacles in the way of more integrated and collaborative management. To start with, national and sectoral interests are difficult to overcome. Capacities of national administration is often lacking and matters of coordination are often not given priority.

A key enabling factor for a range of solutions to effectively address the nexus challenges is in fact good governance, including more coherent policies between water and land management, energy sector, climate policy and environment protection. For realizing potential benefits from the jointly identified actions, cross-sectoral and cross-border cooperation is key. While awareness about opportunities is a start, political commitment and concrete response actions will be decisive for further progress.

ECE, with its tools and instruments, standard-setting and convening power, will continue to assist the countries of the region in tackling the nexus with a regional perspective. It is at the regional or transboundary levels where various benefits from applying a nexus approach can be best reaped.

Olga Algayerova
Executive Secretary
United Nations Economic Commission for Europe

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This *Synthesis* publication on assessing the water-food-energy-ecosystems nexus could not have been prepared without the help and input of many individuals and organizations. The ECE secretariat would like to thank all those who contributed to the nexus assessments so far and to the work of the Task Force on the Water-Food-Energy-Ecosystems Nexus under Water Convention, and in particular the national focal points and local experts. This collective body of knowledge and experience has provided the basis for consolidating this publication.

The various contributors are acknowledged in the respective basin assessment reports and in the publication *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus* (United Nations, 2015), all available from http://www.unece.org/env/water/publications/pub.html.

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Contents

Abbreviations

LIST OF COUNTRY CODES

AZ	Azerbaijan
BA	Bosnia and Herzegovina
DZ	Algeria
GE	Georgia
HR	Croatia
IT	Italy
KG	Kyrgyzstan
KZ	Kazakhstan
LY	Libya
ME	Montenegro
RS	Serbia
SI	Slovenia
TJ	Tajikistan
TN	Tunisia
UZ	Uzbekistan

ACRONYMS AND ABBREVIATIONS

CAREC	Regional Environmental Centre for Central Asia
CBD	Convention on Biological Diversity
CLEWs	Climate, Land-use, Energy and Water strategies
ECE	United Nations Economic Commission for Europe
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
EIA	Environmental Impact Assessment
ESCWA	United Nations Economic and Social Commission for Western Asia
FAO	Food and Agriculture Organization of the United Nations
FASRB	Framework Agreement on the Sava River Basin
GDP	Gross Domestic Product
GEF	Global Environment Facility
IW	International Waters
GERE	Group of Experts on Renewable Energy
GHG	Greenhouse Gas
GWP	Global Water Partnership
GWP-Med	Global Water Partnership Mediterranean
HLPF	High-Level Political Forum on Sustainable Development
ICPDR	International Commission for the Protection of the Danube River
ICSU	International Council for Science
IRENA	International Renewable Energy Agency
ISRBC	International Sava River Basin Commission
IUCN	International Union for the Conservation of Nature
IWA	International Water Association
IW: LEARN	International Waters: Learning Exchange and Resources Network
IWRM	Integrated Water Resources Management
JRC	Joint Research Centre, European Commission
KTH	Royal Institute of Technology, Stockholm
MENA	Middle East and North Africa
NDP	National Policy Dialogue
NGO	Non-governmental organizaiton
NWSAS	North-West Sahara Aquifer System
OECD	Organisation for Economic Co-operation and Development
OnSSET	Open Source Spatial Electrification Tool
OSCE	Organization for Security and Co-operation in Europe
OSS	Sahara and Sahel Observatory
RE	Renewable energy
RG	Revised Governance
RND	Regional Nexus Dialogue
SEA	Strategic Environmental Assessment
SDG	Sustainable Development Goal
SPECA	Special Programme for the Economies of Central Asia
TBNA	Transboundary Basin Nexus Assessment
UNU	United Nations University

UNITS OF MEASURE

CO_2	carbon dioxide
GWh	gigawatt-hour
km	kilometre
km^2	square kilometre
kW	kilowatt
Mt	megatonne
m^3	cubic metre
TWh	terrawatt-hour

Background

The Meeting of the Parties, the main governing body of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), decided in its sixth session (Rome, 28-30 November 2012) to include in its work programme for 2013–2015 an assessment of the water-food-energy-ecosystems nexus based on a representative set of transboundary basins. Behind the decision was a recognition that there is often friction between sectors over water resources in transboundary basins, as well as weak policy integration and coherence between different sectors. Concretely, the Parties to the Water Convention called for an assessment mechanism that could provide a picture of various interdependencies across water, ecosystems, energy, food and other areas (e.g. climate change and biodiversity) in terms of uses, needs, economic and social benefits, potential synergies, conflicts and trade-offs. A further aim of the assessment was to identify possible policy responses.

In line with this mandate, a participatory methodology was developed that was piloted during an initial series of basin assessments and which involved both technical analysis and intersectoral transboundary dialogue about trade-offs and synergies in managing water and related resources.

It was later decided, in the seventh session of the Meeting of the Parties (Budapest, 17-19 November 2015), to disseminate conclusions and recommendations from the first basin assessments and to promote the application of the methodology through partners in other basins worldwide. Included in these planned efforts was the preparation of a synthesis.

Work on further basin assessments – including one aquifer assessment – has been under way from 2016 to the present, providing further insights into assessing intersectoral issues. The methodology involved has been further refined in parallel, especially regarding aspects of governance and the use of participatory methods. A global stocktaking workshop held in December 2016, organized in Geneva with the Water Convention's partners, provided an early opportunity to assess and synthesize developments, including contributions from other organizations working outside the Water Convention, and to discuss the use of different analytical tools, even as activities were ongoing.

This *Synthesis* publication contains lessons focusing on the nexus assessment process, on the methodology involved in the process, and on taking the process forward. These lessons are drawn from the collective experiences of Parties to the Water Convention and other States, joint bodies and numerous stakeholders who have participated in the nexus assessments. Consolidating such a wide range of input meets the Parties' demand for sharing experiences across various forums and processes of either a sectoral or cross-cutting nature, and at both the regional and the global level.

The consolidation of experience presented in this *Synthesis* publication was guided by the Task Force on the Water-Food-Energy-Ecosystems Nexus. Its content was presented for review to the Working Group on Integrated Water Resources Management and the Working Group on Monitoring and Assessment during a joint meeting held in Geneva on 29-30 May 2018. The Working Groups discussed the nexus assessments and the lessons learned, called for comments on the draft synthesis, and entrusted the finalization of the publication to the Water Convention secretariat.

The Working Groups recognized that practical application of a nexus approach and implementation of the solutions recommended in the assessments still requires more feedback and documentation. Consequently, that part of the synthesis from the nexus assessment work is still to be consolidated in further detail.

1 Introduction

1 Introduction

1.1 Work under the Water Convention on the water-food-energy-ecosystems nexus up to 2018

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) provides an intergovernmental platform for the development and advancement of transboundary cooperation. Among the obligations of the Water Convention is to carry out, at regular intervals, joint or coordinated assessments of the conditions of transboundary waters. These assessments have shown that there is often friction between sectors over use of and impact on water resources, as well as weak policy integration and coherence between different sectors. It was to tackle such issues that the Meeting of the Parties to the Water Convention decided in its sixth session (Rome, 2012) to assess the water-food-energy-ecosystems nexus in a representative set of transboundary basins. The Task Force on the Water-Food-Energy-Ecosystems Nexus (Task Force), established in the previously mentioned session of the Meeting of the Parties, is the body responsible for guiding and overseeing this work.[1]

The primary objective of the work performed on intersectoral links, trade-offs and synergies in the water-food-energy-ecosystems nexus carried out under the Water Convention is to foster transboundary cooperation. Related objectives include assisting countries in optimizing resource use and in building capacities to assess and address intersectoral impacts. The methodology for assessing nexus issues in transboundary basins in a participatory fashion was developed and piloted in the Alazani/Ganykh River Basin. Also under the Programme of Work for 2013–2015, nexus assessments of the Sava and Syr Darya River Basins were subsequently carried out[2], while an assessment of the Isonzo/Soča River Basin was initiated but not completed.

The methodology was further developed and fine-tuned under the Programme of Work for 2016–2018. An assessment of the Drina River Basin was carried out as a detailed extension of the Sava assessment, and the methodology was applied subsequently to a shared groundwater resource during a transboundary nexus assessment of the North-West Sahara Aquifer System (NWSAS). In addition, a global workshop was held in Geneva in December 2016 to take stock of nexus-related activities from past years, to review approaches and tools for assessing nexus issues, and to discuss possible management responses.[3]

This combination of developments provides a timely opportunity to synthesize all of the work performed to date, even as certain activities are ongoing.

1.2 About this publication

This publication has three objectives:

- Complete the documentation of the nexus assessment methodology.
- Promote the application of the methodology.
- Assist and promote follow-up actions to the nexus assessments carried out to date.

The publication consolidates all relevant aspects of the methodology to date, and details all past developments in a comprehensive format. References are also provided for readers who intend to apply the methodology.

Furthermore, the document summarizes experiences that are most relevant for organizations involved in transboundary resources management. While nexus assessments have demonstrated value at the scoping level, Governments now require deeper analysis of their situation as they continue to cooperate and develop policy, and this document aims to assist countries in taking meaningful next steps. With this in mind, the main target audiences of this *Synthesis* publication are:

- sectoral authorities of riparian countries who are engaged in a process of transboundary cooperation;

[1] The Task Force, which has met annually since 2013, has seen a gradual increase in participation over the years from non-water actors. The Task Force assists Governments involved in the process in the shaping and reviewing of assessments, while also providing a forum for discussion on relevant findings. Partner organizations, experts, development partners and civil society groups also work with the Task Force to exchange experiences in tackling nexus issues.

[2] The assessment methodology, as developed from 2013 to 2015, and the summary assessments of the first three basins can be found in: ECE, Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystemsnexus (New York and Geneva, United Nations, 2015).

[3] The documents and presentations from the stocktaking workshop are available at: http://www.unece.org/index.php?id=41736

- regional organizations and joint bodies;
- international organizations involved in supporting development and cooperation; and
- bilateral development partners.

This document consists of four main parts.

Chapter 2 describes the emergence and rise of the "nexus" concept and its significance for different sectors and transboundary cooperation.

Chapter 3 focuses on specific components of the nexus assessment methodology. It also gives a brief overview of nexus assessments that have been carried out under the Water Convention. Furthermore, this chapter includes a review of analytical frameworks and tools applicable for analysing transboundary nexus issues.

Chapter 4 reviews lessons learned in past years through working with the nexus under the Water Convention. It describes key aspects of the process design, synergies between the nexus assessment and other processes, and why the engagement of other sectors is so important. Limitations and recommendations on how to improve the nexus assessment process are also suggested.

Chapter 5 summarizes a wide range of solutions identified over the years with the aim of inspiring different sectors and countries to discuss possibilities and opportunities for implementation.

2

The importance of the nexus

2 The importance of the nexus

2.1 Emergence and rise of the "nexus" concept

Governments are often organized along sectoral lines, resulting in siloed management of environmental resources. This being the case, policy fragmentation remains a key challenge to overcome. While a given administration might lack established procedures and structures for working across sectors, disparate elements of the "real world" are strongly interwoven. From a water-focused perspective, several factors have impacts on water resources that lie outside the strict domain of water management. One can approach water issues from any number of perspectives, including energy, food, climate and waste. One guiding principle, however, remains constant: any one sector is influenced by several outside factors.

The interlinkages between water, energy and food have gained significant attention in recent years. Figure 1 shows some examples of how the three sectors are interlinked. The attention brought by the concept of the water-energy-food nexus can help reduce trade-offs and boost synergies between sectors, resulting in greater policy coherence and better resource-use efficiency. Holger Hoff lucidly describes the process in a background paper for the 2011 Bonn Nexus Conference[1]

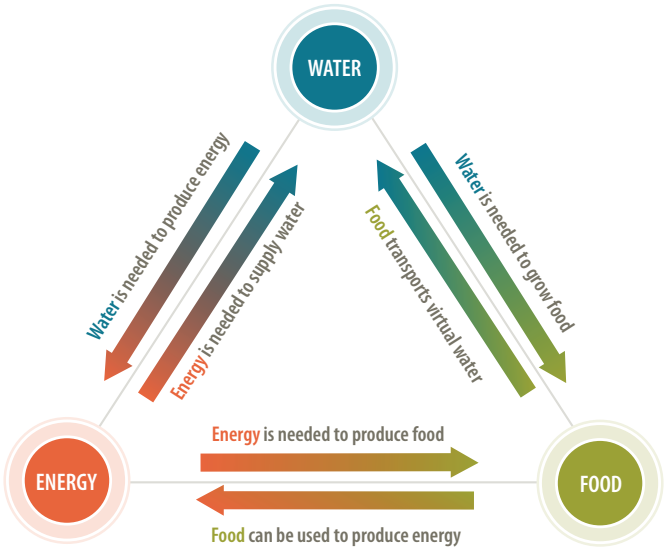
The "nexus" concept provides a new way of thinking that is not limited to just the water, energy and food sectors. Other approaches have been described in recent years as well, such as the water-soil-waste nexus or the water-food-energy-ecosystems nexus, both developed in the frameworks of United Nations entities.

As of 2012, the "Water-food-energy-ecosystems nexus in transboundary basins" is a defined area of work under the Water Convention with a strong focus on transboundary aspects. Waters that flow across national borders are often the connecting resource for food and energy, while international food trade and regional markets for electricity and energy carriers traverse state borders.

While research and discussion on the nexus have gathered great momentum in the past decade, the concept originated several years earlier when the United Nations University (UNU) launched its Food-Energy Nexus Programme in the early 1980s. In 2002, the World Summit on Sustainable Development in Johannesburg implicitly recognized the nexus by listing water and sanitation, agricultural productivity and energy among its priority areas. Shortly afterwards, the concept of "virtual water" and the assertion that increasing scarcity of water, food and energy would result in "the perfect storm" by 2030 catalysed further thought and discussion on the nexus. The 2008 launch of the World Economic Forum's report "Water Security: The Water-Energy-Food-Climate Nexus" and Hoff's background document for the Bonn Nexus Conference marked the emergence of the nexus as we know it today.

Following these early landmark publications, scientists have continued to advance the understanding about the interaction of different resource systems, while also dealing with scale and other related issues. A large body of academic research on the nexus concept with variable scoping of the nexus is available: some are more conceptual, while others focus on quantitative analysis, but a thorough overview is beyond the scope of this brief introduction. Liu and others

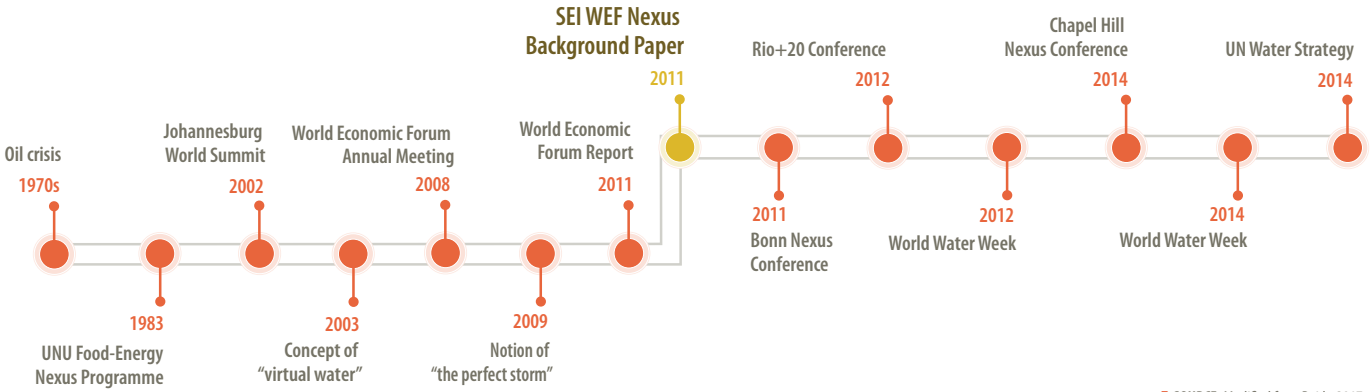
FIGURE 1
Nexus interlinkages



SOURCE: UNU-FLORES
UNU-FLORES. The Nexus Approach (2018). Available at: https://flores.unu.edu/en/research/nexus

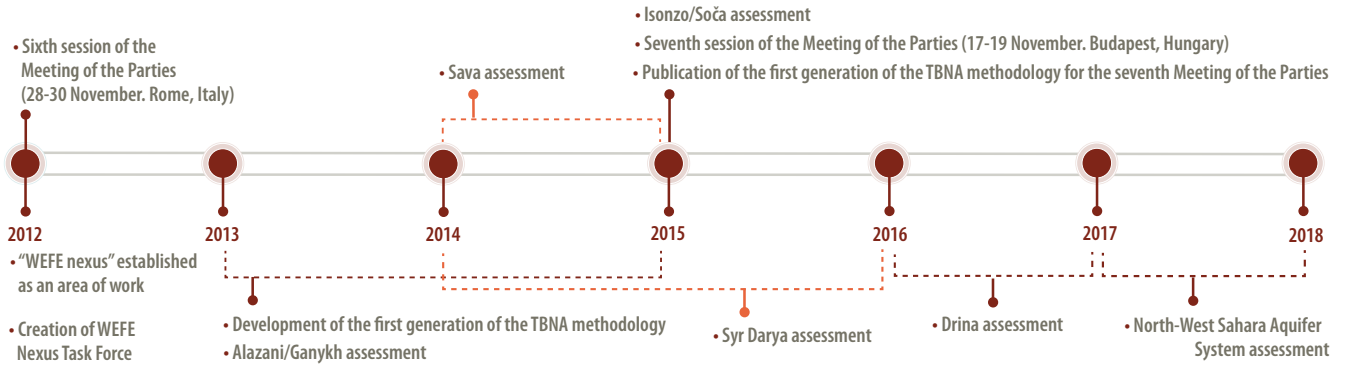
[1] Holger Hoff. Understanding the Nexus – Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus (Stockholm, Stockholm Environment Institute, 2011).

FIGURE 2 A
Evolution of the "nexus" concept to 2014



SOURCE: Modified from Roidt, 2017

FIGURE 2B
Water-food-energy-ecosystems nexus development under the Water Convention



SOURCE: Modified from Roidt, 2017

(2017)[2] and Brouwer and co-authors (2018)[3] provide recent reviews and references on nexus research from the technical perspectives of water and energy, respectively, while Weitz and others (2017)[4] discuss governance across sectors. From a more critical angle, Galaitsi and co-authors (2018) have called for evidence to support claims that nexus approaches have a positive impact on resources management, finding there to be little to show so far.[5]

Figure 2A presents key milestones in the development of the nexus concept, while figure 2B offers a general timeline of nexus activities under the Water Convention.[6]

2.2 Sustainable Development Goals call for a nexus approach

The 2030 Agenda for Sustainable Development (2030 Agenda), adopted by the United Nations General Assembly in 2015, includes 17 sustainable development goals (SDGs) and 169 targets, each of which is designed to stimulate concrete action over a 15-year period. The overarching aim of the 2030 Agenda is to achieve a fairer, more just, peaceful and prosperous global society by balancing the three inseparable dimensions of sustainable development, namely: economy, society, and environment.

[2] Junguo Liu and others. Challenges in operationalizing the water-energy-food nexus. Hydrological Sciences Journal, vol. 62, No. 11, 2017.
[3] Floor Brouwer and others. Energy modelling and the Nexus concept. Energy Strategy Reviews, vol. 19, No. 1-6, 2018.
[4] Nina Weitz, Claudia Strambo, Eric Kemp-Benedict and Måns Nilsson. Closing the governance gaps in the water-energy-food nexus: Insights from integrative governance. Global Environmental Change, vol. 45, July 2017, pp. 165—173.
[5] Stephanie Galaitsi, Jason Veysey and Annette Huber-Lee. Where is the added value? A review of the water-energy-food nexus literature. SEI working paper (Somerville, Stockholm Environment Institute, 2018).
[6] ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus (United Nations, New York and Geneva, 2015), pp. 2-4.

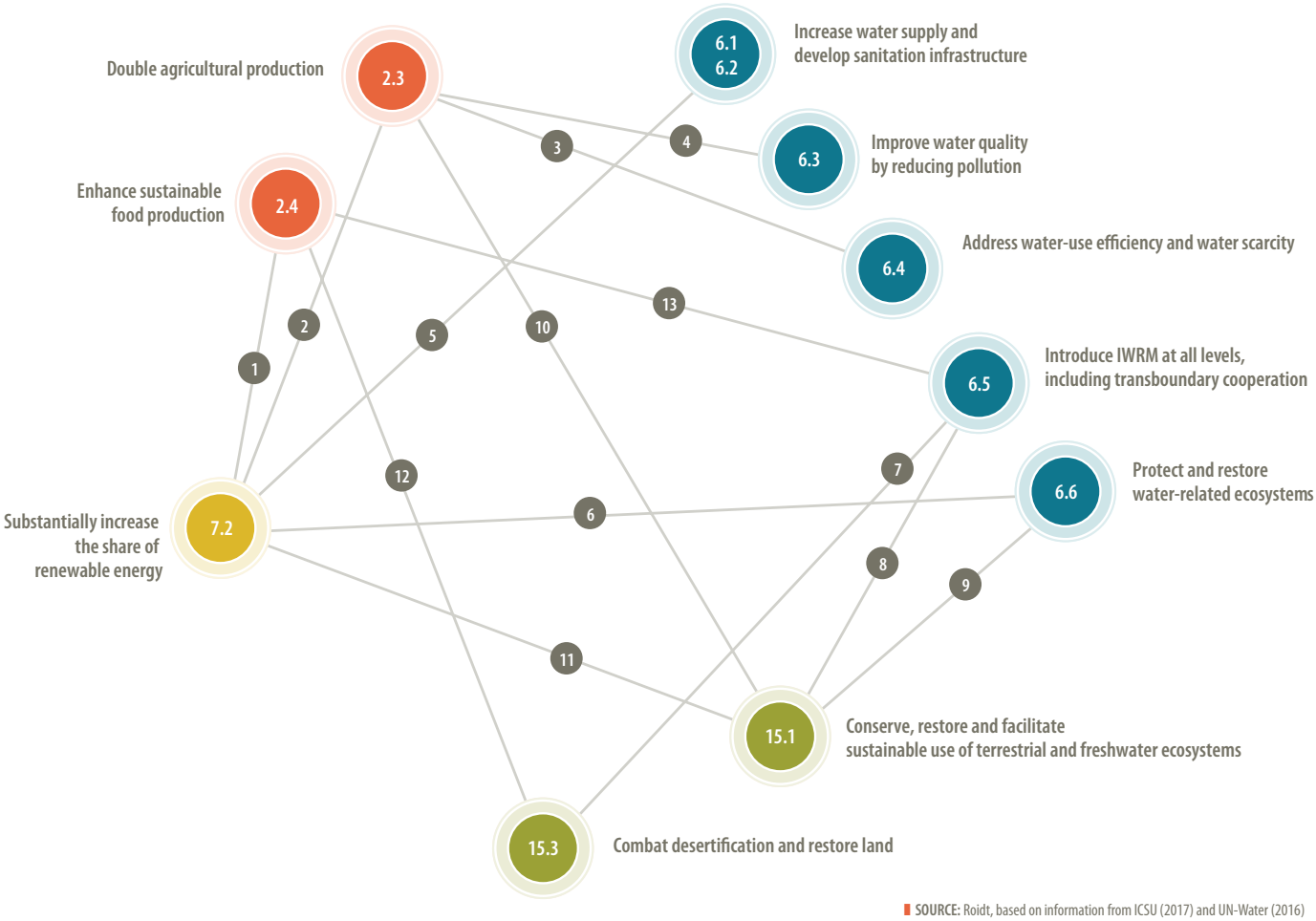
The SDGs span a wide spectrum of topics and issues, thereby establishing interlinkages between the different goals. No single goal can be attained in isolation, but rather only in conjunction with other goals. The interlinked nature of the SDGs requires an implementation approach that is holistic, multisectoral and multidimensional. As current administrative structures are largely based on divided sectoral policies, such an approach challenges conventional processes and requires different sectors to seek synergies between their individual sectoral development plans and to simultaneously deal with trade-offs that will occur inevitably as a result. The nexus concept is therefore well-positioned to inform actions and policies to support the achievement of SDGs (Stephan and others, 2018).[7] Key resource management sectors, such as energy and agriculture, are vital components in terms of overall strategizing and planning within the 2030 Agenda, and can benefit greatly from applying a nexus approach.

Four SDGs are particularly relevant for the nexus under the Water Convention: the water and sanitation goal (SDG 6), which includes sustainable water management and improving transboundary cooperation beyond rivers; the goal to end hunger (SDG 2), which includes achieving food security and the promotion of sustainable agriculture; the goal to deliver affordable and clean energy (SDG 7), which includes providing access to sustainable energy for all; and the goal to preserve life on land (SDG 15), which includes the protection, restoration and sustainable management of ecosystems.

Although each of the 17 SDGs is linked to an array of other goals and targets, the four goals highlighted above are connected in especially strong ways. Action taken with regard to one of these four goals is likely to have direct implications for one or all of the other goals. Figure 3 illustrates some of the interlinkages between these goals, making an implicit

FIGURE 3

Nexus interlinkages between SDGs for food, water, energy and environment



SOURCE: Roidt, based on information from ICSU (2017) and UN-Water (2016)

[7] Raya Marina Stephan and others. Water-energy-food nexus: a platform for implementing the Sustainable Development Goals. Water International (2018).

TABLE 1
Examples of nexus interlinkages with SDGs (see figure 3)

Number shown in figure 3	Corresponding examples of nexus interlinkages
1	Agricultural products and waste can serve as sustainable energy sources.
2	Increased agricultural activity (irrigation, fertilizer, machinery) is energy intensive.
3	Increased agricultural production (irrigation) requires increased water-use efficiency.
4	Increased agricultural activity (fertilizers, pesticides) influences water quality.
5	Increased water supply and sanitation infrastructure development requires energy (pumping and treatment).
6	Energy production (hydropower, cooling) influences water-related ecosystems.
7	Water management can aggravate desertification.
8	Water management has direct impact on freshwater ecosystems.
9	Both goals focus on protecting water-related ecosystems.
10	While increased agricultural production (land use) impacts ecosystems, it also depends on functioning ecosystem services.
11	Energy production (all resources and technologies) have major impacts on ecosystems.
12	Sustainable agriculture conserves ecosystems and restores land.
13	Sustainable agriculture influences water management practices.

call of its own for a nexus approach towards advancing sustainable development. Table 1 explains these interlinkages in more detail.

There are several sources available that very well describe the impossibility of addressing SDGs in isolation. UN-Water (2016)[8] focuses on SDG 6 and its connection across other SDGs, while the International Council for Science (ICSU) (2017)[9] explains the interlinkages between four goals, namely those on health, food, energy, and oceans. ECE (2017)[10] tackles the issue of implementing all SDGs. While not going into explicit detail, these documents, taken as a whole, offer important perspectives on the numerous interlinkages between the SDGs and on how a nexus approach is an important means of addressing them.

Sources that go into more explicit detail on the potential value of a nexus approach in achieving the 2030 Agenda goals are already available. The value of nexus assessment-related experience was highlighted, for example, during the ECE Regional Forum on Sustainable Development in 2018.[11] Similar insights were shared during preparatory reflections on SDG interlinkages leading up to the High-Level Political Forum on Sustainable Development (July 2018), which focused on, among others, progress made towards achieving SDGs 6 and 7.

2.3 Increased recognition and application of nexus-driven approaches

Alongside the growth in acceptance of the nexus concept and its wider application (e.g. extending as well to environmental governance and policymaking), different tools have been developed to analyse nexus-related interlinkages in more specific ways (a review can be found in section 3.9).

Through a closer examination of these vital connections, one can understand and provide further evidence to show how all sectors can achieve greater sustainability through nexus-driven approaches. One can now also demonstrate how operators in different sectors are incorporating "nexus thinking" into the exercise of their mandates on an increasingly regular basis.

[8] UN-Water. Water and Sanitation Interlinkages across the 2030 Agenda for Sustainable Development (Geneva, 2016).
[9] ICSU. A Guide to SDG Interactions: From Science to Implementation (Paris, 2017).
[10] ECE. Building more inclusive, sustainable and prosperous societies in Europe and Central Asia. Regional advocacy paper (2017).
[11] The information notice "Sharing Water: Balancing Competing Needs in a Context of Declining Resources" (2018) from the Regional Forum's SDG 6 round table provides more information about the forum and related country cases. The information notice is available at: https://www.unece.org/rfsd2018.html.

2.3.1 Water

Water forms a natural connection with other sectors within the nexus. Water, soil and nutrients, for example, are underlying resources for the production of food and energy.

Because water has played such a prominent role throughout the ascendancy of the nexus concept, it should come as no surprise that the nexus is now established in the water community. In his review, Roidt (2017) infers that the rationale behind majority academic support for a nexus approach is tied to a critique of the IWRM approach and its shortcomings. The debate over IWRM and the need for a nexus approach are thus often linked together, granting water a more prominent role in debates with other sectors. Hoff (2011) is explicit in placing water directly at the centre of the nexus.

Nexus assessments under the Water Convention have promoted recognition of the fact that water is not only a key connector between sectors, but also between countries. This being the case, water is established as the entry point for transboundary nexus assessments. Other sectors, too, have gained experience and developed an understanding of what is entailed in applying a nexus approach from their respective sectoral vantage points.

2.3.2 Agriculture

The work of the Food and Agriculture Organization of the United Nations (FAO) is a high-profile example of the agriculture sector's recognition of the water-energy-food nexus. FAO's general goal is to achieve food security, and food production involves a vast range of interlinkages to water, energy and the environment. The FAO mandate thus marks an important entry point to the nexus through the food and agriculture sector, which includes land management. In 2014, the FAO Committee on Agriculture approved the "Water Governance for Agriculture and Food Security" programme, along with an FAO mandate to define the nexus for the food and agriculture sector and to develop a related conceptual approach.

FAO's water-energy-food nexus approach, which includes a nexus assessment methodology, is described, for example, in FAO (2014).[12]

FAO's nexus approach acknowledges the different goals and interests of the water, energy, and food sectors, as well as their interlinkages with respective resource bases. Capital and labour are included in these resources bases alongside land, energy and water. This approach to nexus management refers to three specific working areas, namely:

- to provide evidence of nexus interlinkages;
- to contribute to scenario development by also including the drivers that impact the nexus; and
- to prepare response options through a process of stakeholder dialogue (response options range from governance solutions to technical interventions).

FAO's concept is underpinned by a methodological approach to the aforementioned areas of work and its use of the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) tool for analysing the nexus (see section 3.9). FAO's nexus assessment methodology was developed in close collaboration with the energy sector through the "Sustainability Energy for All" initiative. Based on this methodology, FAO developed its WEF Rapid Appraisal online tool, which allows for a brief overview of the nexus situation and shows how interventions can be assessed for each country based on available national indicators from sectors to be used for the purposes of communication and awareness-raising.

Under the Water Convention, the food component of the nexus includes the agriculture sector (primarily with regard to agricultural practices), trade in agricultural products, and land management. Related incentives applied with the nexus approach include: the development of more sustainable and "green" agriculture; ensuring the meeting of water needs for growing food, fodder and fibres; managing competing land uses; and meeting the agriculture sector's energy needs in sustainable ways.

2.3.3 Energy

The energy sector has come to explore and discuss the value of the water-energy-food nexus perspective, as is well documented in several publications. Reasons for this interest include, on the one hand, potential benefits, while on the other hand there are pressures on the sector to: firstly, respond to challenges, such as improving climate resilience of energy infrastructure; secondly, managing risks; and thirdly, attempting to limit environmental impacts. Some countries, for example, are making efforts to improve resilience and risk management by seeking to diversify energy-supply sources to reduce their high dependency on hydropower in the face of changing water availability, or even water scarcity.

The energy sector's discourse about the nexus is reflected in the respective work of the International Renewable Energy Agency (IRENA) and the ECE Group of Experts on Renewable Energy (GERE). The annual World Energy Outlook[13] also recognizes the manifold interlinkages that exist between water

[12] FAO. The Water-Energy-Food Nexus. A new approach in support of food security and sustainable agriculture (United Nations, Rome, 2014).

[13] OECD/IEA. Water Energy Nexus. Excerpt from the World Energy Outlook 2016 (OECD/IEA, Paris, 2016).

and energy. Furthermore, a report from the ECE Regional Tracking Framework[14] highlights the need to track progress made towards achieving sustainable energy across the energy network in a holistic manner, while also drawing close attention to energy-sector links to other areas, including climate, water and food.

In 2015, IRENA supplied evidence of nexus interlinkages from an energy perspective and delivered an analysis of opportunities that renewable energies can provide to address related concerns.[15] Key opportunities include: integrating renewable energies into the food chain to contribute to food security, and using renewables to provide sustainable energy for irrigation. Often less water-intensive in their application, renewables can also contribute to improved water accessibility, affordability and safety. Also in 2015, IRENA proposed, on a preliminary basis, a conceptual framework for a tool based on the energy balance that can offer an energy-specific view to analysing the water-energy-food nexus. As a first step, a baseline energy balance would be provided that could then be adapted to an alternative balance by incorporating new policies on renewable energy. Such a tool could then be used to calculate implications for water, land, emissions and costs of adaptation to a new energy balance.

An excerpt on the water-energy nexus from the aforementioned World Energy Outlook not only describes the relevant interlinkages themselves, but also explains the significance of these interlinkages to economic growth and well-being.

In a document published in 2017, the development of which involved a review within the GERE framework, ECE describes the powerful role that renewable energy can play in a nexus context (nexus assessments carried out under the Water Convention go into further detail by highlighting both opportunities and trade-offs).[16] GERE functions as a neutral discussion platform for policymakers and stakeholders, and is mandated to carry out action-oriented, practical activities to increase the uptake of renewable energy in ECE Member States. To this end, nexus-related issues (including experience gained from conducting assessments under the Water Convention) were also discussed at the International Forum for Energy for Sustainable Energy, both in Baku (2016) and in Astana (2017).

The 2030 Agenda goal of transitioning to sustainable energy poses requirements and risks that will impact water resources, but which may also result in positive impacts on the environment and in mitigating climate change through reduced greenhouse gas (GHG) emissions. Part of the added value of the nexus approach is that it merges both climate change mitigation- and climate change adaptation strategies with different targets under SDG 7 on energy (including improved energy efficiency and access to clean energy) and other SDGs. Lower energy demand through improved energy efficiency commonly translates into reduced water demand, which in turn reduces impacts on water resources.

Integrated approaches that involve strengthened consultation can win wider support for efforts to generate energy more sustainably. What makes a nexus approach particularly interesting for this sector is the possibilities that it opens up for discussing sectoral development with a wider range of stakeholders, thereby enabling an evaluation of environmental trade-offs and a means of addressing these trade-offs (e.g. where hydropower development is concerned). Broader development and use of renewable energy sources could further address several trade-offs between water, energy, food, and ecosystems, although the development of renewable energy also entails trade-offs.

Nexus assessments under the Water Convention, with added insights from GERE, demonstrate that the exploration of synergy opportunities with other sectors can facilitate the overall development of renewable energy. In the agriculture sector, for example, the renovation of irrigation systems offers possibilities for integrating renewable energy sources to provide power for the agriculture sector's needs, including pumping. Linking the development of renewable energy to rural development and sustainable tourism could also help deliver some intersectoral synergies within the nexus. It should be noted, however, that new investments in renewable energy require investigation into various funding options and mechanisms.

Regional or multi-country approaches are also valuable for the energy sector. Diversification of energy sources, good interconnectivity, the efficient use of energy, as well as regional energy trade and a properly functioning electricity market, are among the factors that can promote energy security. On the other hand, investments that are not coordinated with neighbouring countries may lead to inefficiency, over-capacities, energy poverty, negative environmental impacts (some through water) and political tension. Such problems are likely to be exacerbated if harmonized environmental standards are lacking.

At the national level, the water-energy nexus has been a topic of consideration at country-level investment meetings, or "Hard Talks", that have taken place in Azerbaijan, Georgia,

[14] ECE. Global Tracking Framework: UNECE Progress in Sustainable Energy (United Nations, Geneva, 2017).

[15] IRENA. Renewable Energy in the Water, Energy and Food Nexus (IRENA, Abu Dhabi, 2015).

[16] ECE. Deployment of Renewable Energy: The Water-Energy-Food Nexus Approach to Support the Sustainable Development Goals (United Nations, Geneva, 2017).

Kazakhstan, and Ukraine. With the aim of supporting the achievement of energy-related SDGs (notably, SDG 7), and based on key findings from the REN21 UNECE Renewable Energy Status Report 2017 [17], the "Hard Talks" are bringing together major players in the energy field from both the public and private sectors to discuss key issues, to identify priorities, and to propose concrete recommendations. Such changes in policy are needed to overcome political, legal, regulatory and technical barriers, and to take advantage of untapped renewable energy potential. New, multi-stakeholder "Hard Talks" focused on key aspects related to cross-cutting issues of water management and renewable energy development are planned to take place in three riparian countries of the Drina River Basin: Bosnia and Herzegovina, Montenegro, and Serbia.

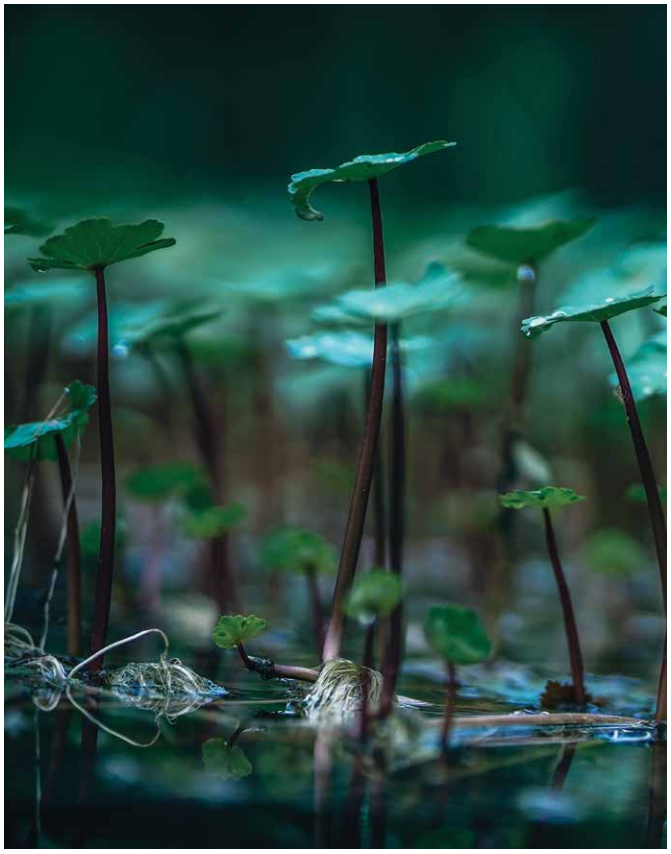
What is now required is a dialogue and assessment of how energy-related actions can best support the achievement of goals set forth in the 2030 Agenda. As this section attempts to make clear, the achievement of goals for many SDGs greatly depends on successful energy strategies. To facilitate the exploration of synergies and trade-offs between the "three pillars" of sustainable energy (energy security, energy and environment, and energy for quality of life), ECE implements the "Pathways to Sustainable Energy" project. The aim of this country-driven initiative is to provide answers regarding how countries can attain sustainable energy by 2050 through a combination of scenario-modelling techniques and policy workshops for stakeholders. The importance of nexus perspectives was recognized in the first subregional workshop in Central Asia (Bishkek, June 2018), as was the need to develop holistic and cross-cutting policy solutions that address not only the energy sector, but also water and agriculture. In terms of energy security, the Central Asia region ascribes high importance to energy independence and diversification of national energy supply, but workshop participants from the region showed particular interest in analysing opportunities for increased intraregional cooperation, including energy-water trading schemes.

2.3.4 Ecosystems

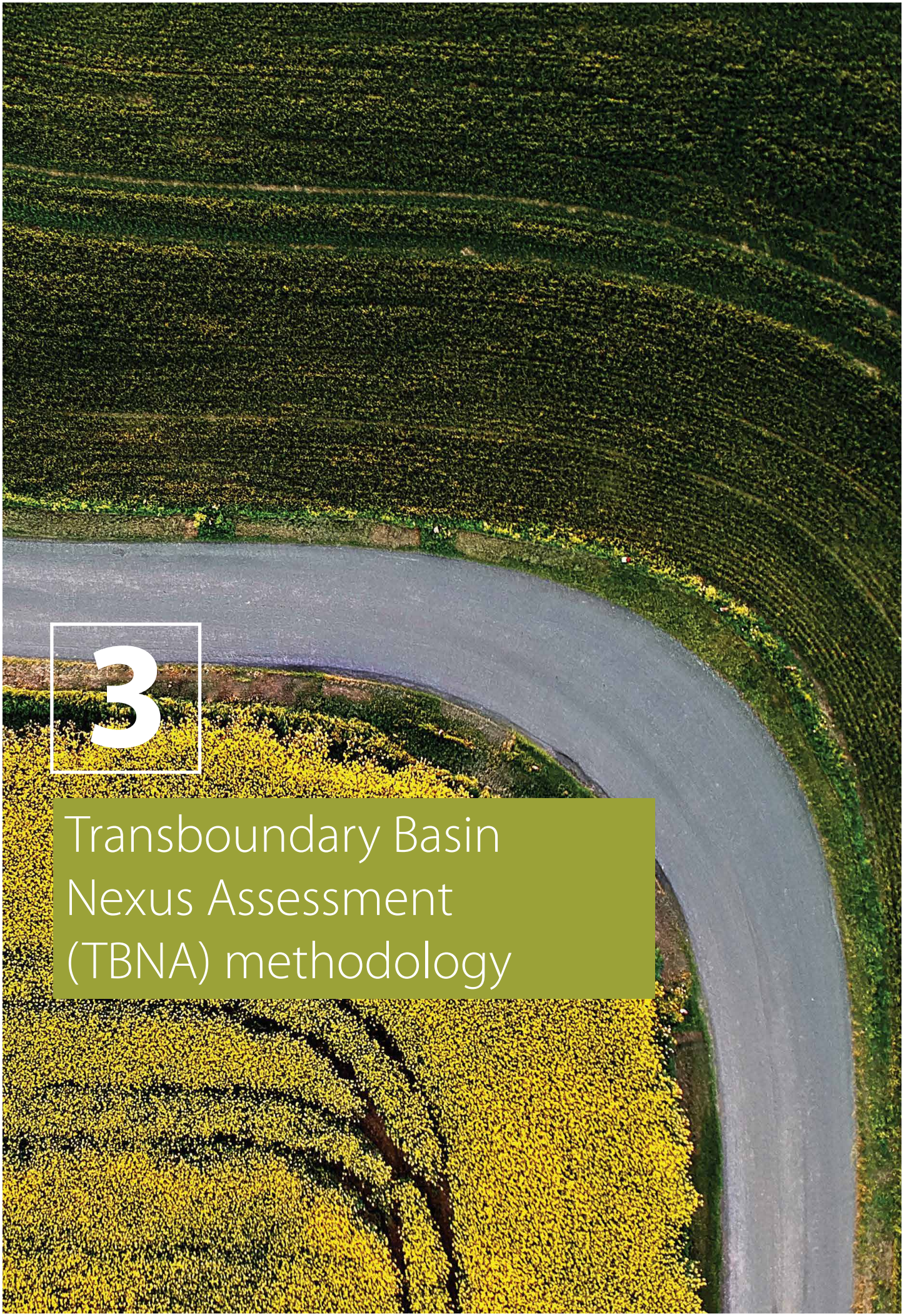
Ecosystems are a major nexus component. All means of energy production have an influence on ecosystems, either as sources of energy (e.g. wood, bioenergy, fossil fuels), sinks for pollution (e.g. cooling water, air) or locales for structural changes (e.g. rivers used for hydropower generation). The agriculture sector profits from ecosystems and influences them heavily through changes in land use, while the water sector exploits ecosystems as sources for freshwater and as sinks for pollution from domestic and industrial use.

Compared to the water-energy-food nexus sectors, ecosystems themselves are not considered directly as an "economic" sector, but their services constitute a valuable environmental resource. Furthermore, ecosystems are considered indirectly in decision-making through sectors such as tourism, through valuations of ecosystem services, or through the voices of environmental stakeholders.

One example of how the nexus has entered the activities of environmental stakeholders is through the work of the International Union for the Conservation of Nature (IUCN). Through the entry points of water and ecosystems, the International Water Association (IWA) and IUCN have joined forces to facilitate discussion on ecosystem-based solutions to nexus problems. From 2012, the two organizations have combined to serve as the secretariat of the Nexus Dialogue on Water Infrastructure Solutions (Dialogue). The Dialogue aims to facilitate transformations in water infrastructure planning, financing and operation, as well as to form new partnerships and to identify new ways to operationalize the nexus.



[17] REN21 UNECE. Renewable Energy Status Report 2017. REN21/UNECE, Paris, 2017).



3

Transboundary Basin Nexus Assessment (TBNA) methodology

3 Transboundary Basin Nexus Assessment (TBNA) methodology

3.1 A brief overview of the TBNA methodology

The primary aim in applying a pragmatic approach to assessing the water-food-energy-ecosystems nexus is to deal with the deep complexities that are revealed when several sectors are analysed together. The complex dynamic of water, energy, food and ecosystems considered as a whole results in a great diversity of stakeholders and a multiplicity of institutional settings in the management spheres of these resources, and complexities are multiplied in a transboundary context in which several countries are involved.

The development of the first generation of the TBNA methodology is described in detail in an ECE publication and a peer-reviewed article, both of which are highlighted below.

> ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus (United Nations, New York and Geneva, 2015), pp. 13-26.
>
> de Strasser and others. A Methodology to Assess the Water Energy Food Ecosystems Nexus in Transboundary River Basins. Water, vol. 8(2), No. 59, 2016.

The TBNA methodology enables stakeholders to identify positive and negative linkages, benefits and trade-offs between relevant sectors, while allowing the possibility to account for potential climatic and socioeconomic changes. Linkages are identified and mapped in a qualitative way through the participation of involved experts and officials. This establishes a basis for quantifying those linkages which are deemed a "high priority" and for which data and tools for analysis are available. The methodology further provides for governance assessments aimed at increasing the understanding of how a coherent integration of sectors might be achieved.

Used as a means to identify solutions and concrete actions to achieve a more sustainable and collaborative management of resources, as well as to reduce tensions between sectors and countries, the TBNA methodology is based on six basic principles and carried out in six consecutive steps. The applicable basic principles are as follows:

- **Participatory Process –** Stakeholder views are considered through the joint identification of intersectoral linkages, through workshop dialogues, and through subsequent consultations and discussions. National administrations of the riparian countries work together on the assessments, which is not only in line with the collaborative spirit of the Water Convention but also ensures ownership.
- **Knowledge Mobilization –** The methodology is designed to use local knowledge, data and previous experiences to the highest possible degree, and to combine these elements for use in the nexus assessment.
- **Sound Scientific Analysis –** The nexus assessment process is informed by technically sound analysis based on available knowledge and scaled to the resources available. The analytical work should improve the quality of the assessment outcome and provide salient information for policymaking, decision-making and developing cooperation.
- **Capacity Building –** Application of the methodology during the assessment process should help the authorities of the riparian countries and other key stakeholders to gain, firstly, a greater understanding of interlinkages within their river basin (or aquifer) and, secondly, experience and awareness of how natural resources can be managed more sustainably.
- **Collective Effort –** Due to its focus on participation, the methodology produces nexus assessments that reflect a broad range of views and expertise.
- **Benefits and Opportunities –** The methodology's focus on the benefits of cooperation allows for a constructive and solution-oriented discussion aimed at mobilizing wide support.

The six steps of the nexus assessment process provide for a progression from the overall socioeconomic context of a basin and its surrounding region to a zooming in on the specific intersectoral issues at play. If the first part of the assessment is mostly a diagnostic of the basin's situation, resources and sectors, the second is characterized by a more active level of stakeholder engagement that aims to jointly uncover priority issues, develop possible solutions and assess the benefits of cooperation.

Throughout the assessment, the analysts make use of different participatory methods to gather information and facilitate dialogue among stakeholders, as well as frameworks and tools to analyse and quantify interlinkages, as appropriate and applicable. The paragraphs immediately below describe the six steps, whereas the participatory methods and frameworks and tools are described later on in this chapter.

STEP 1

During a desk study, analysts identify the socioeconomic context and general conditions of the basin. This includes information on: (i) the current state of energy, food, water and environmental security, and the availability of natural resources; (ii) the relations that exist within the region, the basin and its riparian countries; and (iii) main strategic goals, development policies and challenges.

STEP 2

Together with the relevant authorities[1], the analysts identify the key sectors to be analysed in the assessment (power production, agriculture, tourism etc.) in addition to corresponding key actors (competent authorities, utilities etc.). A factual questionnaire is used to help gather this information. This step also includes the identification of stakeholders who ought to be active in the assessment process.

STEP 3

With the help of authorities involved, the analysts now begin the analysis of key sectors. Resource flows are identified and, wherever possible, supported by quantitative indicators to help clarify their relative importance. The aim of the governance analysis is to develop an understanding of strategies, policies, rules and regulations, in addition to mandates, responsibilities and administration concerning the management of basin resources. The "desk study", which includes the information collected from Step 1 to Step 3, is used to inform participants and serves as preparatory material for the workshop(s).

STEP 4

The first workshop kicks off intersectoral and transboundary dialogue and provides the setting for direct consultation. During this workshop, the participants are split into groups to examine the key sectors in greater detail on the basis of information from the desk study (i.e. on resource flows and governance set-ups) and the participants' expertise. The groups are asked to identify interlinkages and discuss them from a sectoral perspective. This results in the development of lists of basin-specific interlinkages and pressing intersectoral issues (water needs both for hydropower and irrigation, energy-access constraints for agriculture, or severe threats to a key ecosystem service, for example).

STEP 5

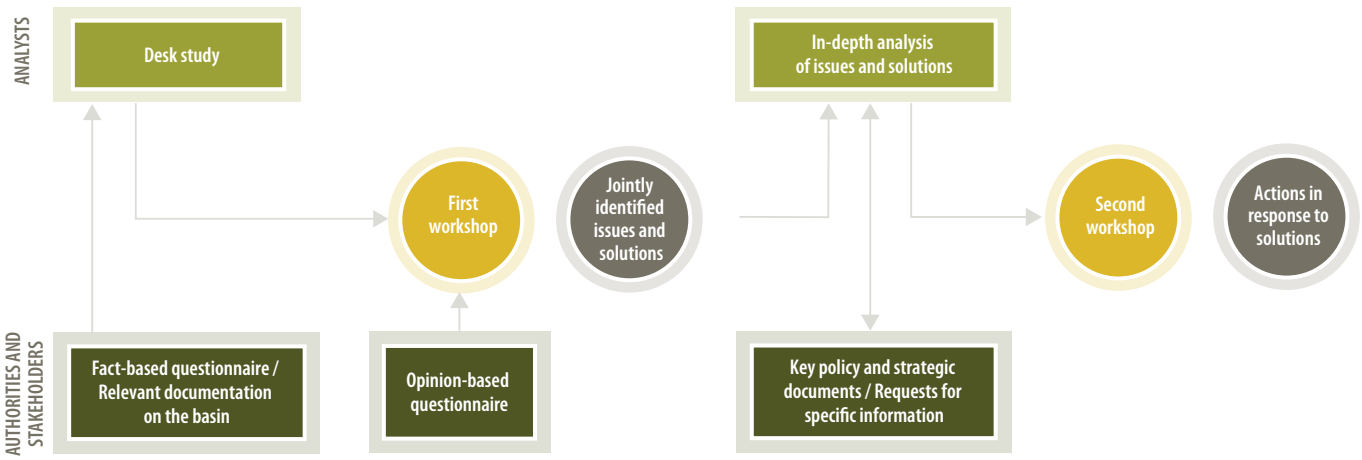
Still in the first workshop, the nexus dialogue takes place. During a plenary session, all stakeholders share their sectoral perspectives, agree on prioritizing the identified interlinkages, and discuss how they are expected to change in the future. An opinion-based questionnaire handed out to workshop participants, which is aimed at comparing perspectives on resource management issues from different sectors and countries, informs this process. This leads to the uncovering of nexus storylines (more or less clear and detailed, depending on the case) that explain and connect different interlinkages. Potential solutions to priority issues emerge naturally from the nexus dialogue process.

STEP 6

The analysts investigate the jointly identified issues and solutions, quantifying them wherever possible. The aim of the analysis is to reveal possible solutions to increase synergies in the management of water and other resources through a number of technical solutions and policy interventions. Proposed solutions are to be tied explicitly to benefits for the key sectors. This type of in-depth analysis informs the second workshop, during which participants

FIGURE 4

Nexus assessment development and the information-exchange process



discuss solutions and translate them into feasible actions that will be, ideally, linked to actual policies or projects on the agendas of national Governments or basin organizations. A nexus assessment report is then produced.

While the basic principles and steps of the TBNA methodology remain generally applicable, assessments may vary on a case-to-case basis. Steps 4, 5 and 6 in particular will sometimes be altered to best fit the specific context of the participatory process, or to take advantage of available opportunities (the Drina assessment, for example, involved a third workshop during which stakeholders were able to validate the findings).

The assessment builds upon an active exchange of information between the analysts carrying out the assessment and the stakeholders involved in the process. A variety of inputs are collected and processed along the way, which ultimately leads to the joint determination of a broad range of solutions and actions. Figure 4 illustrates how the TBNA methodology is designed to facilitate information exchange throughout the nexus assessment and to reach a level at which stakeholders can jointly identify actions.

3.2 Development of the TBNA methodology

This section describes how the methodology has evolved over the course of its application, and explains how new experiences and unique local conditions create the need for constant adaptation.

Scholars, experts and partners from United Nations Member States contributed to the development of the TBNA methodology as part of the Programme of Work for 2013–2015 under the Water Convention.[2] By design, the methodology was developed in an iterative manner to allow for improvement through experience. Development and improvement during the methodology's first version was carried out in three phases (see figure 5).

While Phase A focused on the initial development of a broad-based methodology, Phase B (i.e. the basin assessments) is where experience was gained. The six steps of the methodology were first used in a basin-specific context during a pilot project carried out in the Alazani/Ganykh River Basin (section 3.4.1).

The methodology was again improved following lessons learned through its application in other basins: Sava (section 3.4.2), Syr Darya (section 3.4.3), and Isonzo/Soča (section 3.4.4). Conclusions were reached in Phase C: the methodology was revised accordingly, and the first-generation TBNA was published in a stocktaking report (ECE, 2015).

The methodology was again improved following lessons learned through its application in other basins.

It is not necessarily the case, however, that each adaptation resulted in permanent changes or general methodological improvements. In fact, to some extent the methodology is always adapted to the case, particularly when it comes to steps 4, 5 and 6, which are highly participative: here, the priority is the effectiveness of the participatory process, rather than a consistency of application across different basin assessments.

As more nexus assessments were carried out, the methodology was further applied under the Programme of Work for 2016–2018. During this period, three processes were crucial to the methodology's further development. The first was an assessment of the Drina River Basin (a sub-basin of the Sava River Basin), which involved zooming in more closely on a previously assessed basin to obtain a more detailed understanding (section 3.4.5). Second, the nexus assessment on the North-Western Sahara Aquifer System (NWSAS) marked the first time that the methodology was applied to a shared groundwater resource, rather than a river basin (section 3.4.6). Third, a global stocktaking workshop on assessments of the water-food-energy-ecosystems nexus and response measures in transboundary basins was held in Geneva in December 2016. The main objectives of the global workshop were to review key methodologies and relevant initiatives for assessing nexus issues in transboundary basins, to take in lessons learned, and to gain an overview of tools used in the application of nexus assessments. All three of these processes influenced how the methodology was further developed, involving considerations of scale (section 3.5), revised governance methodology (section 3.3), further development and improvement of participatory methods (section 3.6) and benefit assessments (section 3.7), and wide-ranging discussion on information needs, indicators and tools used for nexus assessments (sections 3.8 and 3.9).

Figure 6 shows how the three phases of development have since evolved into a wider circle for feedback and development. Partners have gradually started to play larger roles in nexus assessments over the years, and emphasis has shifted towards the sharing of experiences and providing advice. The Global Water Partnership, for example, has played the lead role in implementation during nexus assessment work on the NWSAS and the Drina River Basin.

The iterative character of the development of the TBNA methodology has thus continued from 2016 to the present, resulting in what can now be called the "second generation" of the methodology. The following sections attempt to synthesize these developments.

[1] National focal points from national administrations (e.g. ministries of environment, agriculture, energy, water, natural resources etc.) can provide valuable guidance during this first phase of the assessment.

[2] Key expert input for developing the methodology was provided by the Royal Institute of Technology (KTH, Stockholm).

FIGURE 5
Development of the TBNA methodology between 2013 and 2015

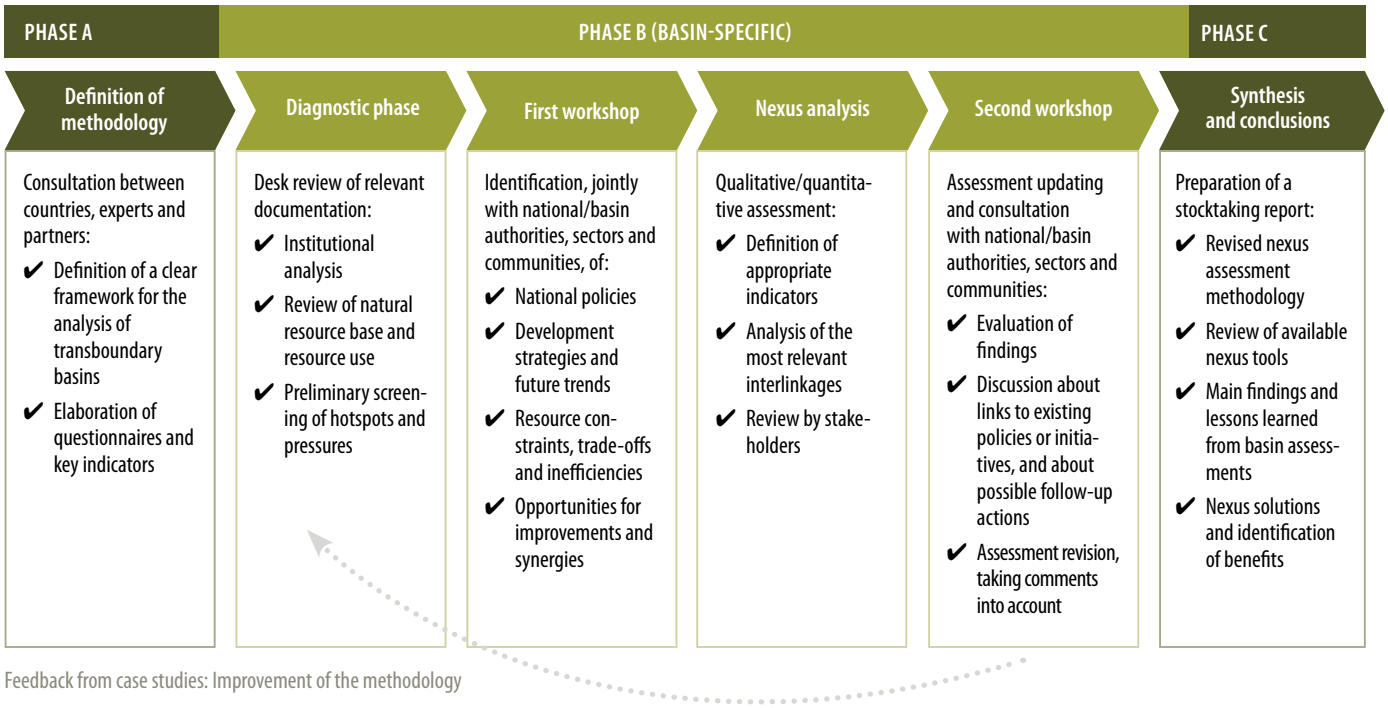
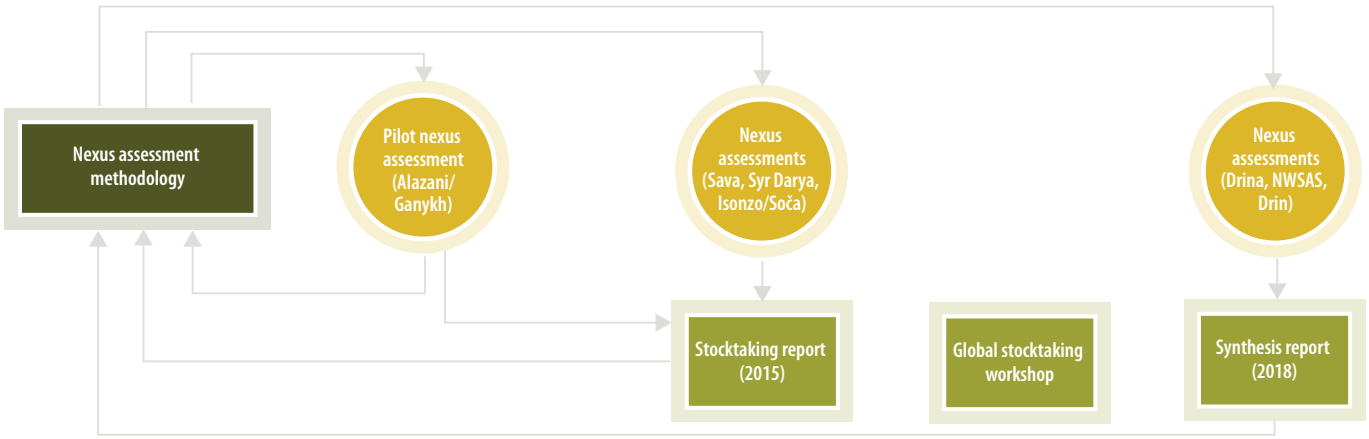


FIGURE 6
Phases of development of the TBNA methodology



3.3 Development of governance methodology (part of the TBNA)

A key purpose of the nexus assessment process is to identify potential conflicts and synergies across national boundaries and sectors, and this requires more than just a technical analysis of resource flows. Governance aspects must also be understood in order to fully grasp the myriad of uncertainties, difficulties and opportunities that arise in managing water, energy and land resources, in making efforts to protect the environment, and eventually in the course of implementing solutions.

A "governance" perspective recognizes that the complexities, challenges and shortcomings in strategic planning and administrative practice, as well as the analysis of these components, are critical in order to reach practical solutions. The TBNA methodology has incorporated this kind of thinking from its inception and was thus developed as a two-track approach, with the two tracks being fully complementary.

The first track is a technical assessment of natural resources in terms of their availability and quality, and considers the evolution of their multiple uses in terms of demands and impacts. This track is well described in ECE (2015) and de

Strasser and others (2016), and has been applied in nexus assessments from their early days, including through the use of indicators and modelling (see sections 3.8 and 3.9).

The second track (governance[3]), which aims to facilitate the understanding of how rules and actors determine the management of these resources, is the track that has evolved the most in terms of methodology: it is only initially described in ECE (2015) and de Strasser and others (2016), but emerged in 2017 as a fully developed part of the TBNA methodology.

3.3.1 The initial governance analysis and its development

A governance methodology was developed at the University of Geneva that was applied and tested in a research project on the Rhone River Basin. The methodology calls for a four-step analysis: (i) analysis of the main uses of resources; (ii) analysis of the main regulations; (iii) analysis of the actors' configuration; and (iv) the identification of specific hotspots. In addition, the fourth step explores the salient characteristics of an institutional framework by considering four variables of the governance system, namely: extent, coherence, robustness, and flexibility.

This method was further developed and described as the draft governance methodology for the nexus assessments under the Water Convention in the paper highlighted below. The focus of the analysis is on policy coherence, as well as on identifying overlaps, gaps and complementarities of responsibility.

Christian Bréthaut. A draft methodology for assessing governance aspects of the water-food-energy-ecosystems nexus. (Informal paper. University of Geneva, 2014).

The first four basin assessments (Alazani/Ganykh, Sava, Syr Darya, Isonzo/Soča) were carried out based on this draft methodology. Short descriptions of how the governance analysis was carried out in those assessments are given in the ECE and de Strasser sources cited above. There, the method is loosely defined and accompanied by a set of questions guiding the analysis.

The practical experience, however, of carrying out the governance analysis using this draft methodology highlighted important limitations. As the draft methodology gave prominence to water governance, further development was required to better consider the other sectors. Also, overall, it was felt that a more specific definition of what features were to be considered was needed. Furthermore, at the level of implementation, the governance analysis as such was not properly integrated into the overall process of the TBNA, which was a problem (particularly at the workshops) when technical aspects immediately occupied a central place in the discussion.

As the need to consolidate the governance analysis became clear, various pieces of the puzzle were brought together into what is now described as the Revised Governance (RG) methodology.

3.3.2 The Revised Governance (RG) methodology within the TBNA

The Revised Governance methodology was made available for the meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus in 2017, and was further applied in the Drina and NWSAS assessments. The report highlighted below, on which this section is based, describes how the RG methodology was consolidated.

Stephen Stec. Revised Governance Methodology for Assessing the Water-Food-Energy-Ecosystems Nexus. Report for the fifth meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus (2017).

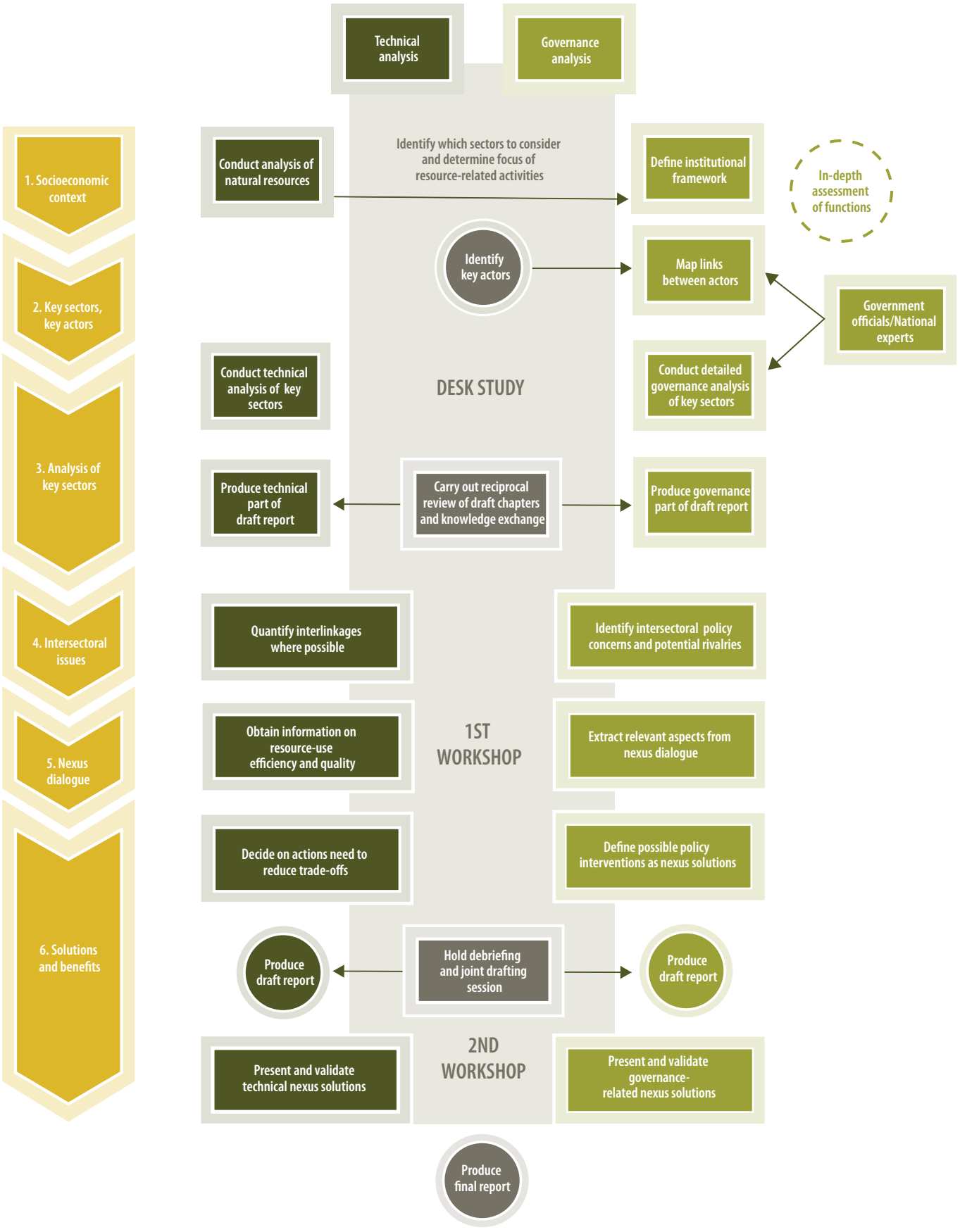
The RG methodology is an approach that describes in a comprehensive and detailed way how the governance analysis of a nexus assessment is to be carried out throughout the six steps of the TBNA. Before reviewing the RG methodology in detail, key aspects of its evolution are listed below:

- The RG methodology describes in detail the roles that governance analysts will play throughout the entire assessment. Taken up as a whole, the six steps of the methodology illustrate how governance analysts are to approach the assessment.
- The RG methodology supplies lists of questions regarding each task to be fulfilled during the analysis. When necessary, these lists are split and then grouped according to the sectors being analysed.
- From a loosely defined concept of the coexistence of the "governance" and "technical" tracks, the RG methodology explains how and where governance and technical analysts are to work together directly, keep each other informed, and exchange knowledge (see figure 7).

[3] The definition of "governance" adopted here is: "The rules and mechanisms that characterize how a society functions. Specifically, the governance analysis of a nexus assessment looks at the legislative, institutional and policy framework of the basin, the countries and the region." For other definitions, see the Glossary of Terms in ECE (2015).

FIGURE 7

Responsibilities of governance and technical experts throughout the nexus assessment process



- An important improvement to the initial governance methodology was the integration of discussion on planning cycles and geographic scales of decision-making in different sectors.

It should be stressed that the RG methodology is a continuous process that functions in parallel with the technical analysis of the nexus, and as such is an integral part of the TBNA methodology. At each step, a specific part of the RG methodology is applied alongside its technical component.

The steps of the RG methodology are described below. For a description of the steps to be carried out by the technical analysts, please refer to the publications ECE (2015) and de Strasser and others (2016).

STEP 1 – Define the institutional framework

Step 1 includes the scoping of existing uses and the identification of key actors, macroeconomic factors and broad political set-up, all of which are to be seen in a transboundary context. While the technical experts analyse the natural resources, the governance assessment defines the institutional framework. This is done by mapping the key actors at different scales, their relations with one another, and any existing conflicts between sectoral policy objectives. The technical experts inform the governance analysts on which sectors to consider and on which resource-related activities to focus – and vice versa. The key to this step is to map out the following: the scale of decision-making for each sector; processes, milestones and planning cycles at each level; and governance mechanisms for each transboundary process.

STEP 2 – Identify key actors and map links between them

In Step 2, the technical and governance analysts jointly identify the key actors and sectors with the support of national governments and experts. The governance analysts then commence a deeper study of policymaking processes at different geographical and political levels, while also looking into their governance aspects. This includes mapping the types of links between the identified institutions and other actors through agreements (private or public), while also noting the institutional levels of agreements and so forth. It is also important to understand time frames for planning and decision-making processes, as these may differ from sector to sector. Whether presented as simple maps or more complex tables (if different sectors, countries and levels are included), this mapping becomes a part of the nexus assessment report.

During this phase, the governance part of the factual questionnaire (see section 3.6) is prepared for collecting further details at the national levels.

Depending on resources, the RG methodology calls for an in-depth assessment of functions, mandates and responsibilities within each identified sector.

STEP 3 – Provide detailed governance analysis of key sectors

It is the responsibility of technical and governance experts alike to analyse key sectors during Step 3, but the task of the governance analysis is to gain an understanding of the relevant policy documents and legislation for a given sector, which can be either transboundary, national or subnational in scope. The RG methodology puts forth an extensive list of questions to be answered within this step. This part of the analysis takes into account the following four analytical variables: (i) extent of regulations; (ii) coherence between policies and regulations; (iii) robustness in terms of capacity of the regulatory framework to effectively control different uses; and (iv) flexibility and adaptability for self-organizing. For each of these variables, the RG methodology provides a list of questions and guidelines to support the analysts.

With the emergence of a clear picture of policy, regulations and institutions, the analysis digs deeper into the governance culture. Key considerations are: whether decisions are made through formal or informal processes; if decision-making is top-down or bottom-up; to what extent consultations take place; and whether processes are cooperative or authoritarian. Again, the RG methodology provides a list of questions for the analysts to address during this phase.

STEP 4 – Identify intersectoral policy issues and rivalries

In Step 4, governance analysis continues in the nexus assessment workshops. During a workshop, the participants jointly identify intersectoral issues. At this stage, the purpose of the RG methodology is to identify policies that can target objectives which are in conflict with the objectives of other policies in other sectors, whether in a national or a transboundary context. This is closely connected to the identification of physical resource flows (e.g. the identification of upstream-downstream tensions).

In contrast to the desk study, in which governance analysts focus on policy coherence within a sector, the workshops focus on coherence between sectors. Differences in geographical and political scales, time frames for planning and decision-making, and governance cultures are each taken into account. The RG methodology, again, provides a list of questions that can help in the successful identification of nexus-related issues. Most of Step 4 is conducted through participatory exercises within the workshops (see section 3.6).

STEP 5 – Extract relevant governance aspects from the nexus dialogue

Step 5, the nexus dialogue, is carried out from both a technical and a governance perspective. One element of the exercise is that participants develop a shared understanding of nexus issues; on the governance side, ri-

valries between sectors and countries are discussed. The governance analysts then seek to provide explanations of how specific rivalries and conflicts have emerged, while subsequent discussion aims to reveal the strengths and weaknesses of institutional frameworks in this regard. This process is often accompanied by a case study in which the analytical variables (extent, coherence, robustness and flexibility) are examined.

Governance experts are to take special note of any governance-related concerns that are raised during the discussions, and to add their observations during the final step of the nexus assessment.

STEP 6 – Define, present and validate possible policy interventions as nexus solutions

In the last stage of the process, participants discuss nexus solutions (section 3.6.7) and the benefits of transboundary cooperation, whether in a merely technical or a more institutionalized fashion.

At this stage, the technical and governance analysts hold debriefing consultations on the outcomes of the first workshop. A joint drafting plan for the report is prepared, and then a draft report with technical and governance components is sketched out and circulated as preparation for the second workshop.

During the second workshop, the governance analysts are to focus on those solutions which are practical, implementable, and which take existing governance contexts into consideration. Different forms of solutions are offered from the governance side, and each technical solution is followed by a brief overview of the governance context. Separately, governance analysts give presentations on solutions related to cooperation, coordination frameworks and other policy interventions.

The tasks here are: (i) to examine technical solutions, while paying close attention to governance aspects, and (ii) to examine gaps in transboundary cooperation frameworks with the aim of proposing ways forward.

A draft assessment is produced after the presentation of proposed possible solutions for discussion. In finalizing the draft assessment, feedback from the officials and other key stakeholders regarding perspectives on implementation must also be taken into account. An important part of the validation process is to circulate the draft assessment, including its solutions, to the participating ministries. The draft can be circulated either before or after the final workshop.

3.3.3 Considerations for application and future development needs

Compared to aspects pertaining to water and the environment, aspects related to agriculture and land, as well as energy, are not yet as detailed in the governance methodology

as they should be. The main reason for this is that it has not been possible to involve experts on the governance of all the different resources being studied – neither in the course of developing the methodology nor in specific basin assessments. An important aim for analysts in the future, therefore, is to cooperate with experts from all sectors and further refine the underdeveloped parts of the RG methodology.

Experience from the workshops shows that there is room to improve how the newly aligned methodology is to be applied in practice. The agreed recommendation is to coordinate scheduling and working meetings so that the group of experts can work cohesively as a team and thus gain maximum benefits from input and output.

3.4 Use of the TBNA methodology in basin assessments

Work on the nexus under the Water Convention consists of several nexus assessments that have been or were being carried out at the time of this publication's finalization in transboundary basins in Southern and South-Eastern Europe, the Caucasus, Central Asia, and North Africa. This section of the report draws on examples and experiences obtained to date from these assessments. Table 2 and sections 3.4.1–3.4.6 provide a useful overview of the nexus assessments carried out to date, including some of their most important characteristics.

3.4.1 Pilot project in the Alazani/Ganykh River Basin

COOPERATION SETTING

While Azerbaijan and Georgia, the two riparian countries involved in this pilot study, share a cooperation framework for energy trade, no joint cooperation body exists for the management of transboundary waters. A draft bilateral agreement on the Kura River is being negotiated, however, with the support of ECE and the Organization for Security and Co-operation in Europe (OSCE). Nevertheless, international cooperation between Georgia and Azerbaijan is generally good, and the countries have participated in a number of joint projects.

PROCESS DETAILS AND SPECIFICITY

The pilot assessment included the organization of one participatory workshop, which resulted in a clear description of a nexus storyline (table 2). Organizing the workshop in tandem with the GEF-led project on the Kura River provided synergy; and in terms of expert support, the European Union Water Initiative's National Policy Dialogues (NPDs) on IWRM furnished a helpful occasion for presenting and promoting further discussion about the nexus assessment results between different ministries and agencies in both countries.

The pilot assessment offered the first opportunity to test the newly developed TBNA methodology in practice, and also served as a scoping-level study used to explore possible synergetic actions and nexus-based solutions to address relevant concerns.

3.4.2 Assessment of the Sava River Basin

COOPERATION SETTING

Sava River Basin stakeholders enjoy a solid foundation of good governance for the integrated management of basin resources. The International Sava River Basin Commission (ISRBC), established to implement the Framework Agreement on the Sava River Basin (FARSB) – to which Bosnia and Herzegovina, Croatia, Serbia, and Slovenia are parties[4] – has a thematically broad mandate to support water management. FASRB's implementation strategy also includes the objective to integrate water policy with other sectoral policies, while Danube Basin-related agreements apply as well.

PROCESS DETAILS AND SPECIFICITY

The Sava assessment was carried out in a similar manner to the Alazani/Ganykh pilot project, but was afforded greater visibility following a workshop on regional forums that provided for a broader outreach and, notably, included the energy sector. Nexus issues and solutions were developed and prioritized (table 2), but were not merged to form a specific storyline. Assessment findings were circulated for review and comments were submitted to stakeholders (including a consultation through the ISRBC website). In addition to the transboundary nexus assessment workshop, the participating countries requested that national-level meetings be organized to discuss the findings.

The Sava assessment was unique in that the availability of data and resources, as well as an established analytical synergy with the European Commission's Joint Research Centre (JRC), provided a quantitative analysis of the water-energy nexus through a multi-country energy model (which included hydropower) and a spatial analysis of land use and related water demand for irrigation. Moreover, the presence of a well-functioning and proactive river basin commission (i.e. ISRBC) allowed for broad and diverse stakeholder participation.

[4] Montenegro, also a riparian country, has signed a memorandum of understanding on cooperation with the ISRBC, and in practice already cooperates on hydrometeorological issues, flood management and river basin management, among others.

TABLE 2
Basin assessment summary

ALAZANI/GANYKH RIVER BASIN (2013–2015)	
Basin size	11,700 km^2
River length	391 km
Basin-sharing countries	GE, AZ
Climate	Warm, temperate
Main nexus storyline	Lack of access to affordable energy aggravates deforestation, which increases exposure to flash floods, erosion and landslides. Irrigation systems that are dilapidated and poorly maintained exacerbate the impacts of flash floods in terms of loss of fertile soil and damage to settlements. Sedimentation, in turn, affects morphology and infrastructure.
Main nexus interlinkages	Water-Energy (hydropower) Land-Energy-Water (biomass use, erosion/sedimentation, environmental flow)
SAVA RIVER BASIN (2014–2015)	
Basin size	97,700 km^2
River length	945 km
Basin-sharing countries	SI, HR, BA, ME, RS
Climate	Warm, temperate
Main nexus storyline	Energy production in the countries depends on water availability in the Sava River Basin. Targets for renewables and climate mitigation help push countries to develop more hydropower. There are concerns about dam construction in environmentally sensitive areas.
Main nexus interlinkages	Water-Energy (flood risk, hydropower) Land-Water (sediment management). Water-Food-Ecosystems (water quality, morphological alterations)
SYR DARYA RIVER BASIN (2014–2016)	
Basin size	410,000 km^2
River length	3,019 km
Basin-sharing countries	KZ, KG, TJ, UZ
Climate	Arid/semi-arid
Main nexus storyline	Energy insecurity and food insecurity drive countries to prioritize self-sufficiency over cooperation; this dynamic also aggravates an already sub-optimal use of resources.
Main nexus interlinkages	Water-Land-Ecosystems (irrigation, salination, unsustainable agriculture, insufficient environmental flow) Water-Energy (hydropower)

TABLE 2
Basin assessment summary (continued)

ISONZO/SOČA RIVER BASIN (2015)	
Basin size	3,400 km^2
River length	140 km
Basin-sharing countries	IT, SI
Climate	Mediterranean-influenced, partly humid
Main nexus storyline	Diverse ecosystem services need protection. Hydropeaking affects biodiversity and water availability for irrigation. Water-efficient technology reduces the amount of water needed for irrigation. Groundwater abstraction for irrigation requires energy and may cause seawater intrusion.
Main nexus interlinkages	Water-Energy-Ecosystems (river-flow continuity, hydropeaking). Water-Energy-Food (irrigation). Water-Energy (groundwater pumping, hydropower, cooling of thermal power plants)
DRINA RIVER BASIN (2016–2017)	
Basin size	20,320 km^2
River length	346 km
Basin-sharing countries	BA, ME, RS
Climate	Warm, temperate
Main nexus storyline	Water-flow regulation for power generation is sub-optimal and has impacts on flood and drought risks. Application of environmental flows regulation is challenging. Low agricultural productivity and a lack of infrastructure hamper rural development. Failure to address pressures (solid waste, wastewater) has resulted in declining water quality.
Main nexus interlinkages	Water-Energy (flood risk, cooling, uncoordinated hydropower operations) Water-Food (irrigation, flood risk) Water-Food-Ecosystems (water-quality degradation, mainly from waste and wastewater)
NORTH-WEST SAHARA AQUIFER SYSTEM (2017-2019)	
Basin size	1,000,000 km^2
River length	N/A
Basin-sharing countries	TN, DZ, LY
Climate	Arid/hyper-arid
Main nexus storyline	Intense aquifer use is unsustainable. Irrigation is heavy, with high-volume water losses. Inadequate drainage management leads to water- and soil salination from irrigation. Water management (pumping form higher depth, treatment etc.) requires sustainable energy solutions.
Main nexus interlinkages	Water-Energy (groundwater pumping, water use for solar power, desalination) Water-Ecosystems (salination, desertification)

3.4.3 Assessment of the Syr Darya River Basin

COOPERATION SETTING

Existing institutional frameworks and capacity for transboundary cooperation are not used effectively in the Syr Darya River Basin due to lack of trust between the riparians. It was therefore necessary to adapt the assessment to accommodate a situation in which participation was incomplete.[5] The assessment was not convened in a regional framework, and a progression of solutions was outlined from the national level to the transboundary level (see below).

PROCESS DETAILS AND SPECIFICITY

On top of the transboundary nexus assessment workshop, a focused discussion on the nexus was organized as part of the European Union Water Initiative's twelfth NPD Steering Committee meeting. Local experts and officials from participating countries also met for the third meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus (April 2015), and consultations were held in countries linked to the NPD on IWRM. Findings were also presented and discussed in meetings of the energy sector, most notably at the Forum on Energy for Sustainable Development (Baku, 2016 / Astana, 2017), and in the Thematic Working Group on Water-Energy-Environment of the United Nations Special Programme for the Economies of Central Asia (SPECA).

A feature specific to this process was that the participatory workshop included a scenario exercise developed in cooperation with FAO to explore the future of nexus-related issues. Furthermore, given the challenges to cooperation in the region, nexus solutions for the Syr Darya River Basin were structured according to a logic in which action could progress from "no regret" measures taken at the national level to solve domestic problems. Such actions were deemed likely to reduce transboundary impacts, help increase trust and facilitate long-term cooperation.

3.4.4 Assessment of the Isonzo/Soča River Basin

COOPERATION SETTING

The bilateral Italian-Slovenian Hydro-Economic Commission provides the institutional framework for cooperation between the two countries in water management. A water allocation agreement between Italy and Slovenia, the so-called Osimo Agreement, dates from 1957. Technical cooperation is reported to be good, and the countries work together to coordinate river basin development plans.

PROCESS DETAILS AND SPECIFICITY

Just one workshop was held in Italy, with no participation from Slovenia due to human resources constraints in the latter country.

Because of the different levels of engagement between the countries, the assessment itself focused largely on the downstream (Italian) section of the basin. While this severely limited the assessment's transboundary relevance, fruitful discussion did take place on how to enhance intersectoral cooperation at a more local level. Subsequent bilateral projects in other frameworks have touched on some related issues and have provided other channels for cooperation.

3.4.5 Assessment of the Drina River Basin

COOPERATION SETTING

At present, a permanent framework for separate, legal and institutional cooperation does not exist at the Drina River Basin level. However, as the Drina is part of the Sava River Basin, water management issues related to the Drina are discussed in the framework of ISRBC, as well as in the framework of the International Commission for the Protection of the Danube River (ICPDR).

PROCESS DETAILS AND SPECIFICITY

The Drina assessment offered a closer look into and built on the results of the Sava nexus assessment, but with a focus on Drina-specific issues and potential solutions. The assessment was carried out based on previous experience in using the TBNA methodology, but also included new adaptations.

Uniquely, the assessment allowed for more workshops (a second and a third), and the project benefited from the active involvement of the energy sector – including a link to cooperation with the ECE Group of Experts on Renewable Energy (GERE). As the process allowed for a trio of workshops that were devoted entirely to discussing the nexus, it was possible to explore solutions in more detail. Time was allotted in particular for carrying out a "benefits of cooperation" assessment (see section 3.7), during which the participants discussed the benefits that identified solutions to nexus issues can bring to riparian countries, and also considered how solutions should be communicated to decision-makers. A "benefits of cooperation" perspective has since then become an integral part of the nexus assessment.

[5] Uzbekistan did not associate itself with the assessment beyond commenting, but there was participation from regional organizations and civil society.

3.4.6 Assessment of the North-Western Sahara Aquifer System (NWSAS)

COOPERATION SETTING

Algeria, Libya and Tunisia, the three aquifer-sharing countries, established in 2008 a consultation mechanism (CM) for the North-Western Sahara Aquifer System (NWSAS). The CM secretariat is ensured by the Sahara and Sahel Observatory (OSS), a regional organization overseen by a coordinator appointed by the participating countries.

The CM aims to "facilitate technical coordination between countries, identify hydraulic problems and possible solutions, and promote participatory management through dialogue." At a practical level, the CM functions as an "observatory of the aquifer system" and is responsible for responding to technical and scientific questions related to water use, data collection, the exchange and consultation of information, and the joint development of simulation models.

PROCESS DETAILS AND SPECIFICITY

The nexus assessment is part of a broader project focusing on the Middle East and North Africa (MENA) region, led by the Global Water Partnership Mediterranean (GWP-Med). The aforementioned CM provides a framework for the nexus assessment, which is being implemented in cooperation with GWP-Med and the OSS. One participatory workshop has taken place in Algeria, but the expressed preference of the countries is to organize discussions on solutions at the national level prior to holding a second workshop. At present, political instability in Libya limits possibilities for stakeholder engagement from that country.

What is unique about this project is that the methodology is adjusted for use on an aquifer system. GWP-Med's tools and approaches, such as a detailed stakeholder analysis (see section 3.6.6), are also new. This approach also involves a study of the benefits of transboundary cooperation.

3.5 Scales of applying the TBNA methodology

One key aspect that differentiates the nexus approach from other environmental management approaches is that it aims to tackle interlinkages at various scales. The different resources and sectors that are part of the nexus are bound to different geographical scales that respond uniquely to natural settings and/or artificial, administrative boundaries. Useful summaries on the subject explain how these variables sometimes overlap, but only rarely – a dynamic that requires the analyst to understand these different types of interactions.[6,7]

Nexus assessments performed under the Water Convention exemplify the importance of working at several scales. A focus on finding solutions to foster transboundary cooperation does not strictly limit the analysis to aspects that are relevant only at the transboundary scale: the methodology calls instead for the analysis of each aspect at its most appropriate scale.

The technical analysis considers different scales. Key indicators are mostly provided at the national scale for riparian countries, but are also described for the basin when relevant and if possible – "water resources" and "agricultural land" being two such examples. Because of the regional character of the electricity and energy-carrier markets, as well as the commonly international extent of interconnectivity, the dynamics of the sector need to be analysed beyond the basin scale. Analysts typically aim to describe single power plants and installed capacity at the local scale, which is not only an important factor in identifying local nexus interlinkages but also relevant for modelling the energy system.

Governance analysis, meanwhile, takes place at various scales and across sectors. The overview of institutions relevant in terms of managing basin resources is provided at the transboundary scale (basin commission, regional and subregional institutions), the national scale (central government, state agencies and enterprises), the subnational scale (regional water agencies, provincial government), and the local scale (municipalities, associations). Also, intersectoral and multisectoral state bodies are mapped out, as are mechanisms related to intersectoral coordination on issues such as sustainable development or climate change-related coordination.

Nexus issues and proposed solutions are not limited to any one scale. Governance solutions (such as facilitating access to energy through regional energy trade, using basin-commission platforms for coordination and further development of mandates, and advancing policy coherence at the national level) and technical solutions (such as enhancing wastewater treatment at the municipal scale, or reducing inefficiencies in the energy system) demonstrate the various levels at which a nexus approach can provide options. When nexus interlinkages are identified to help formulate solutions, it is important to describe their respective scales as clearly as possible.

[6] J. Liu, H. Yang, C. Cudennec, A.K. Gain, H. Hoff, R. Lawford, J. Qi, L. de Strasser, P.T. Yillia and C. Zheng. Challenges in operationalizing the water-energy-food nexus. Hydrological Sciences Journal, vol. 62, No. 11, 2017, pp. 1714–20.

[7] T. Avellán, M. Roidt, A. Emmer, J. von Koerber, P. Schneider and W. Raber. Making the Water-Soil-Waste Nexus Work: Framing the Boundaries of Resource Flows. Sustainability, vol. 9, No. 10, 2017.

Box 1

Examples of nexus studies carried out at different scales[8]

TRANSBOUNDARY — ALAZANI/GANYKH BASIN[9]
Ecosystem services are a valuable link between energy and water sectors. While Azerbaijan has successfully combined its reforestation plan in the basin area with a policy of fuel substitution, deforestation in upstream Georgia is still largely the result of a lack of clean and affordable alternatives to wood fuel. As fuel switching and reforestation become important not only at the national level (e.g. to improve health in households), but also at the basin level (e.g. to limit the effects of flooding downstream), the assessment under the Water Convention creates room for sharing knowledge.

CONTINENT/COUNTRY — AFRICA/UGANDA[10]
Climate uncertainties affect investments in large energy and water infrastructure. Investing in large dams for irrigation and hydropower in Africa will require planning for resilience because various climate scenarios do not give consistent results. In particular, an increase or decrease in rainfall with respect to a fixed assumption can result in dams being undersized or oversized. The World Bank supports countries in developing capacity for planning under conditions of uncertainty.

ISLAND — MAURITIUS[11]
Sugar or biofuels? By investing in cogeneration, it is possible to increase the production of biofuels from sugarcane bagasse. This leads to reduced imports of fossil fuels, reduced CO_2 emissions, and reduced expenditures. However, as water will become scarcer with climate change, the country, which relies heavily on hydropower, will need to invest in desalination, which in turn — and counterintuitively — may result in higher coal consumption. As these considerations would not be grasped without a nexus approach, country authorities have recognized its importance for the island's development planning.

STATE — PUNJAB (INDIA)[12]
What are the long-term effects of cheap energy for irrigation? With generous subsidies for irrigation, groundwater is withdrawn faster than can be naturally replenished in Punjab. Agricultural land has thus been transformed into desert, deeply compromising local food production. Moreover, this has affected the state's volume of energy consumption: as the groundwater table decreases, more energy is needed for irrigation.

CITY — NEW YORK CITY[13]
A study on bathroom appliances showed that improving efficiency in water use reduces energy consumption (e.g. lower-flow shower heads require less energy to warm the water, and low-flow flush toilets require less energy for pumping and treating water). When utilities work together, any improved efficiency is mutual. On a large urban scale like that of New York City, this can have a significant impact.

While nexus assessments under the Water Convention have a clear focus on transboundary (river or aquifer) basins, nexus issues can be assessed at various scales. At the global stocktaking workshops held in Geneva in December 2016, several nexus-related projects, ranging in scale from that of a city to that of a large, transboundary basin, were presented and described. Some of these projects, summarized in the workshops report, are presented in Box 1.

3.6 Participatory methods

Cooperation is the backbone of the Water Convention, and also of the nexus assessments. Also, broad participation, one of the basic principles of the Water Convention, is crucial in helping to jointly identify the main nexus issues, to ensure ownership of the process, to employ diverse expert knowledge to increase the accuracy of the assessment, and to brainstorm on nexus solutions that are relevant both locally and regionally.

Nexus assessments are prepared in response to a request from countries or joint bodies for transboundary cooperation, and in close cooperation with the national authorities of the riparian countries. It is important to include all countries of a given basin in the assessment the Water Convention through official processes, and ECE requests each of the main counterpart ministries to nominate a focal point for the assessment. In addition, local experts and other stakeholders are invited to participate.

Compared to earlier assessments, the methodology now provides more opportunities for consultation. Because of its

[8] Drawn from the keynote presentation of Mark Howells at the global stocktaking workshop on assessing the nexus in transboundary basins. Available at: https://www.unece.org/index.php?id=41736#/

[9] ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus. (United Nations, New York and Geneva, 2015).

[10] KTH. Country-level CLEWs (2017). Available at: www.kth.se/en/itm/inst/energiteknik/forskning/desa/projects/country-level-clews-1.663650

[11] M. Welsch, S. Hermann, M. Howells, H.H. Rogner, C. Young, I. Ramma and D. Le Blanc. Adding value with CLEWS – Modelling the energy system and its interdependencies for Mauritius. Applied energy, No. 113, 2014, pp. 1,434-45.

[12] M. Gulati and S. Pahuja. Direct delivery of power subsidy to manage the energy-groundwater-agriculture nexus. Aquatic Procedia, No. 5, 2015, pp. 22-30.

[13] R.E. Engström, M. Howells, G. Destouni, V. Bhatt, M. Bazilian and H.H. Rogner. Connecting the resource nexus to basic urban service provision – with a focus on water-energy interactions in New York City. Sustainable cities and society, No. 31, 2017, pp. 83-94.

attention to stakeholder engagement and to representing a broad range of views and reconciling different interests, the assessment provides a solid basis for improving resource management and policy, as well as for future cooperation and support. The workshops in particular are the keys to participation. Several methods have been developed over time to gather different perspectives and input. The methods used so far are described below and alongside related lessons learned over the past years.

3.6.1 Factual questionnaires to gather information

To support the desk study, the analysts prepare a factual questionnaire, which is handed out to the representatives from each country and to the local experts at the workshops. Often the local experts fill out the factual questionnaire in agreement with the national administration.

The first part of the factual questionnaire (which coincides with the factual questionnaire as initially envisaged and used in the first assessments) is of a technical nature. As such, it aims to identify, in a preliminary manner, which main pressures and hotspots exist in the basin. The questions are used to screen the different sectors and collect important information on the availability of resources, socioeconomic conditions and economic activities.

The second part of the factual questionnaire, which focuses specifically on governance, was developed as part of the Revised Governance methodology (section 3.3) and as a separate questionnaire to be integrated with the technical part. It aims to illuminate institutional frameworks and decision-making levels, as well as relevant actors and the relationships between them. This questionnaire was first used in the Syr Darya assessment and has since been applied successfully in more recent assessments.

The use of this questionnaire informs the desk study with relevant information gathered directly from the stakeholders. This helps to ensure that all existing information and earlier studies are taken into account.

Up to now, the factual questionnaire has been initially developed along the four areas of water, energy, land use/agriculture, and ecosystems. In using this approach, however, it has become clear that to include questions on the key sectors identified in Step 2 (e.g. tourism) would also be useful.

3.6.2 Opinion-based questionnaire to reveal different views

At the first workshop, a second questionnaire is handed out for gathering stakeholders' opinions (rather than facts). The questionnaire is distributed to participants, filled out and

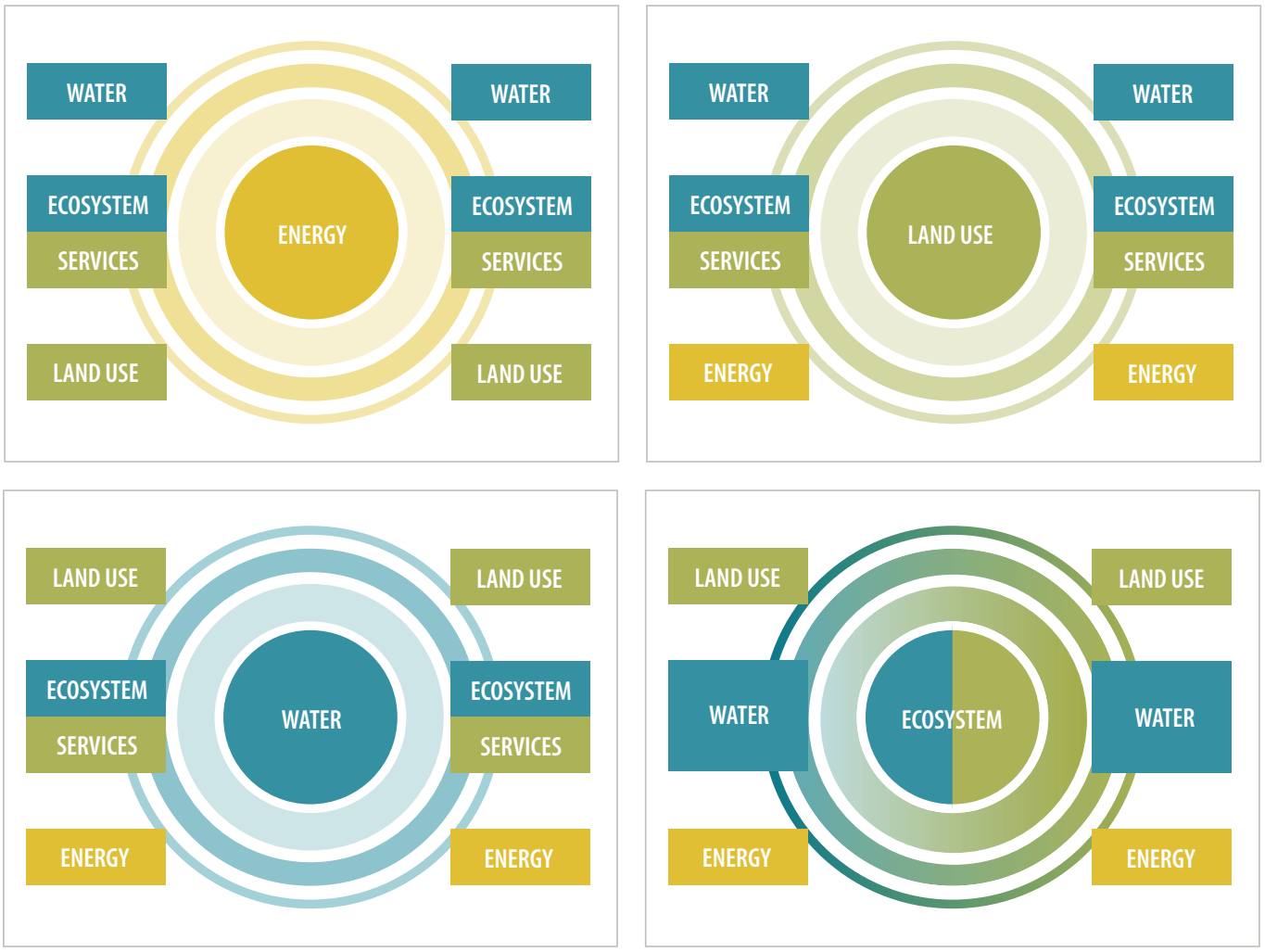
TABLE 3
Summary of participatory methods and application considerations

METHOD	STEP USED	PURPOSE	KEY TOOL(S)
Factual questionnaire	Step 2: Desk-based	Inform the desk study	Questionnaire
Stakeholder mapping and analysis	Step 2: Desk-based	Identify key stakeholders; understand their interests and influence	Stakeholder lists Interest/influence grid of network analysis
Opinion-based questionnaire	Step 4: Workshop 1	Measure the extent to which groups agree or disagree	Questionnaire and presentation of results to the plenary
Overview presentations	Step 4: Workshop 1	Set the stage and present the basin overview	Guidance template for presentation
Brainstorming exercise	Step 4: Workshop 1 (a)	Identify nexus issues and interdependencies from sectoral perspectives	Simplified diagrams for sectoral groups
Nexus dialogue	Step 5: Workshop 1 (a)	Agree on and prioritize nexus interlinkages; develop a shared understanding of the nexus issues	Simplified diagrams to support the nexus dialogue
Identification of solutions	Step 6: Workshop 2 (a) (b)	Identify nexus solutions	Post-its Short presentations of good measures and relevant projects from the region

(a) It can happen that these are spread over more workshops (depending on the basin-specific design of the participatory process). It is important, however, that the brainstorming exercise and the nexus dialogue are kept in the same workshop.

(b) The identification of solutions often starts in the first workshop, as a natural evolution of the nexus dialogue.

FIGURE 8
Simplified diagrams[14] for sectoral groups: identifying intersectoral issues



collected before discussions begin. This exercise captures differences in perspective by country and by sector. While the questionnaire is anonymous, information on the respondent's sector and country must be disclosed. This ensures that comparisons between groups can be made, which helps to reveal the different perceptions of the sectors and countries. It may be the case that participants from the water sector will describe water as "scarce", while those from the energy sector will share a different view. The overall purpose of this exercise is to reveal the extent to which the groups agree or disagree, and to show how each country and sector views a particular issue or issues.

There is a need to refine this tool from a generic questionnaire, and to tailor it to each case as necessary in order to gain deeper insights. As for the factual questionnaire, obtaining opinions from all key sectors helps to create a more complete picture.

3.6.3 Overview presentations to set the stage

To set the stage for the workshop and to familiarize participants with the assessed basin and its characteristics, different thematic or regional overview presentations are given, as well as an overview of the sectors and national policy developments. The sectoral and national presentations in particular are not given by external experts, but by the respective authorities or national representatives. A template was developed with the TBNA methodology to ensure that the presentation contents are streamlined. The template includes the main topics to be addressed, such as: (i) national development plans and sectoral goals of a given country in the river

[14] These simple diagrams have been adapted for each assessment, often together with stakeholders. They might, for example, have been built around key sectors or rewritten with different wording (e.g. "food" instead of "land use").

basin; (ii) regional development programmes involving key sectors in the basin; and (iii) respective implementation measures. The full template is published in ECE (2015), Annex IV.

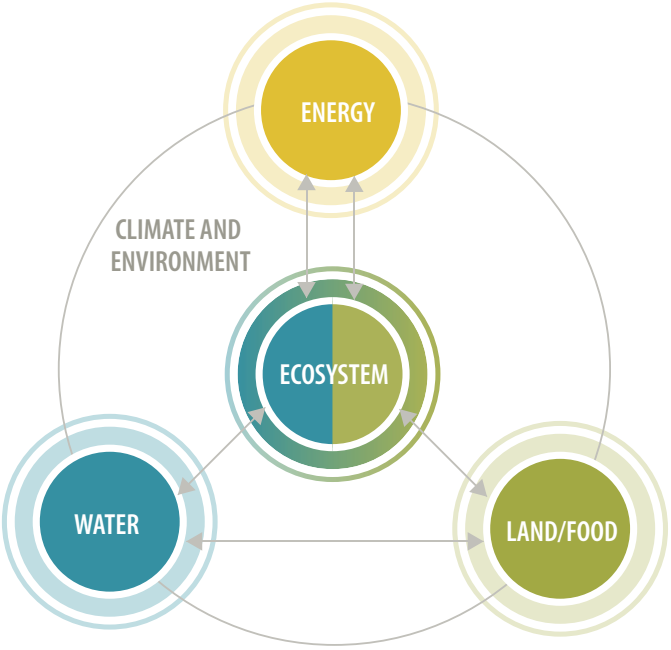
Experience has shown that the presentations serve as important kick-off moments for the interactive phases. The thematic presentations with a more regional scope provide overviews of some of the resources and help to ensure that some known issues relevant to the basin are discussed. Presenting the previous work is important for getting participants to understand the starting point of the analysis. The sectoral presentations give a sense of the targets of the different sectors, which is relevant for reflecting on their compatibility.

3.6.4 Brainstorming exercise to identify nexus issues

As part of the workshop, the participants are asked to jointly identify the nexus issues (interlinkages) that exist in the basin. Groups are formed according to the key sectors that were considered relevant at the workshop (or simply according to the generic groups of water, energy, land use/food, and ecosystems). The participants are asked to envision the view from their sector towards the others. Each group is provided with a diagram that shows their sector in the centre and surrounded by the other sectors (figure 8). As a brainstorming exercise, the groups discuss how their sector affects others, is affected by others, provides input to another sector — or, vice versa, how their sector requires input from another sector or resource. Arrows are drawn on the provided templates in which all pressing issues are welcome and no answers are rejected as "wrong". The nature of the brainstorming session allows for all ideas to be shown without discussion or prioritization.

FIGURE 9

Simplified diagrams[15] to support the nexus dialogue



The discussions are facilitated and informed by the results of the desk study. Yet, this method again draws on the local knowledge of participants and ensures that country officials can express their views and knowledge. This step empowers the group to present the integrated nature of their sector to the other participants in the next step.

Experience from the workshops shows that decisions on which sectors are considered "key sectors" are often made at the workshops together with the participants, rather than being presented as predefined (e.g. water, energy, agriculture, and ecosystems). At times, participants were already well aware of the issues and found it more useful to continue directly with the nexus dialogue, in which solutions are discussed (as in the Drina assessment). The issues were more scattered in other cases, and it would have been difficult to move directly to the nexus dialogue phase. In situations where pressing "nexus issues" have been analysed many times already (as in the case of the Syr Darya River Basin), breaking down the discussion into sectoral perspectives can be particularly useful in preventing discussion from following a predetermined path.

Thus far, brainstorming on interlinkages has focused on the status quo and has included the consideration of future scenarios only to a limited extent: certain macrotrends (e.g. climate change) and some clear policy directions (e.g. expanded irrigation) will naturally emerge during discussion. However, if relevant scenarios are available, it may be possible to include the consideration of future sector developments in the brainstorming exercise – that is, as long as such scenarios are developed in time for the first workshop.

3.6.5 Nexus dialogue to encourage a shared understanding

The first workshop brings together all the sectoral views and identified interlinkages into a single nexus picture, and a nexus understanding is thus developed that all participants share. As small groups of participants will have examined the nexus from the vantage points of their respective sectors during the brainstorming session, the dialogue exercise brings all of these views together. All participants agree on the most important interlinkages and then draw them on the nexus dialogue template, in which all sectors are repre-

[15] These simple diagrams have been adapted, often together with stakeholders: climate, for example (here represented in the background) has sometimes gained more visibility.

sented equally (figure 9). The interlinkages identified in the brainstorming exercise are jointly prioritized as a result of the process. This portion of the assessment also includes the participants' perceptions of how these interlinkages are likely to change with future developments.

This exercise, especially, has undergone several methodological changes. It has sometimes proved useful to hold discussion in the plenary sessions; at other times, smaller, sectorally mixed groups have developed a shared understanding. Some stakeholders have emphasized that problems are typically already known (e.g. conflicts arising from the operation of a certain dam), and that the workshops should allow much more room for the nexus dialogue and for developing solutions. It is true that, if stakeholders participate actively, the nexus dialogue may uncover important sectoral perspectives that can serve as good bases for solutions. In the Alazani/Ganykh assessment, for instance, the topic of forest degradation would not have emerged without the sectoral phases having taken place.

3.6.6 Stakeholder mapping and analysis (the case of the NWSAS)

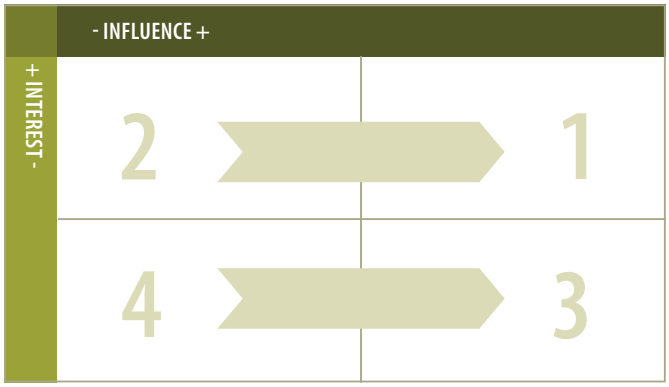
One participatory method that has been used only recently (during the nexus assessment of the NWSAS) is joint stakeholder mapping and analysis. The method was developed and implemented by GWP-Med, the key ECE partner in the NWSAS project. During the NWSAS assessment, the participants were asked during the first workshop to identify stakeholders and to provide new information about them, such as importance, interest and influence on aquifer management.

When using this method – whose future applicability is yet to be tested – a list of previously identified stakeholders from the desk study was handed out to participants who were then asked to add missing stakeholders to the list. Participants were then split into country groups where they were asked to prioritize which stakeholders they saw as the most important in terms of managing the aquifer system. In a third step, the participants placed the name of each stakeholder into the appropriate cell of an interest/influence grid. The grid (figure 10) shows where stakeholders may have strong or weak influence on aquifer management, and/or have a strong or weak interest in the aquifer (e.g. drinking-water supply).

3.6.7 Identification of nexus solutions

The identification of solutions (see chapter 5 for more details on nexus solutions) is the main focus of the last part of the assessment, and indeed the second workshop is entirely devoted to discussing solutions and assessing the benefits they might bring. Solutions might be technical in nature, or may take the form of policy interventions, changes in governance and so forth. The goal is to jointly develop a set of

FIGURE 10
Interest/Influence grid of network analysis



solutions with a cross-sectoral and transboundary dimension, and which may be considered "nexus solutions". Nexus solutions aim to tackle nexus- and/or transboundary-related issues, and are defined here as: "interventions that would benefit more than one sector and, in this context, also including interventions that reduce pressure on ecosystems or the environment at large."

The workshop participants are asked to write such solutions on post-its and to stick them on a board, the final contents of which are jointly discussed in the plenary. Solutions are mostly considered in terms of their applicability and beneficial impacts, and any links between solutions and benefits of cooperation are particularly relevant when evaluating solutions. If applicable, short presentations of good measures and relevant projects from the region can add to the discussion.

This exercise, one of the key moments of the nexus assessment, is when possible solutions start to emerge. Follow-up analysis is still necessary, however, to investigate the feasibility of the solutions in more detail. To some extent, such follow-up workshops have been organized as a part of the basin assessment process.

Since both local and international experts are involved in the development of solutions, it is very important to create strong links between them. It is crucial that they work closely with each other and interact as much as possible – and they should be actively encouraged to do so, primarily through the facilitation of exchange.

3.7 Identification, assessment and communication of the benefits of transboundary cooperation

3.7.1 The Water Convention and its work on assessing the benefits of transboundary water cooperation

Understanding the benefits and beneficiaries of transboundary water cooperation is naturally at the heart of the concerns of countries considering accession to the Convention and of Parties implementing the Convention. In 2015, the Meeting of the Parties to the Water Convention adopted the *Policy Guidance Note on the Benefits of Transboundary Water Cooperation. Identification, Assessment and Communication*[16], which provides recommendations on how to carry out a benefit assessment exercise to help countries to fully realize the potential benefits they can gain from strengthened transboundary water cooperation.

The Policy Guidance Note has inspired and guided, among others, three pilot benefit assessments in the Cubango-Okavango River Basin (shared by Angola, Botswana and Namibia), the Sio-Malaba-Malakisi River Basin (shared by Kenya and Uganda) and the Drina River Basin (mainly shared by Bosnia and Herzegovina, Montenegro, and Serbia). An exchange of experiences was facilitated through the organization of a dedicated global workshop[17] in February 2018.

3.7.2 An approach to assess the benefits of transboundary water cooperation

A benefit assessment exercise can comprise three separate but related tasks, described below.

TASK 1 – Identifying the benefits and beneficiaries of transboundary water cooperation

A broad range of stakeholders convenes to identify past and potential future benefits that transboundary water cooperation can generate. As some benefits are not familiar to all audiences, a typology such as the one proposed in the Policy Guidance Note can be a useful tool to guide stakeholders in the identification of benefits: these can be economic benefits, social and environmental benefits, regional economic cooperation benefits, as well as peace and security benefits. The benefits are then screened, and the most important can then be selected for assessment, based on their magnitude and other policy-related criteria.

TASK 2 – Assessing the benefits of transboundary water cooperation

Some benefits can then be assessed, which may include qualitative assessments, physical quantification, and monetary valuation. The assessment approach should be tailored not only according to the nature of the benefits (economic, social, environmental etc.), but also to the cooperation stage and political will of the participating countries.

TASK 3 – Communicating the benefits of transboundary water cooperation

Key to the entire exercise is the communication of the benefits of cooperation to decision-makers, which can help move from perception towards facts. Communication should be planned from the beginning of the assessment in order to use all possible communication channels as effectively as possible.

3.7.3 The assessment of the benefits of cooperation within the nexus assessment process

One of the key messages of the Policy Guidance Note is that a benefit assessment exercise can and should be linked to other basin-level analytical processes, examples of which are a transboundary diagnostic analysis (used in Global Environment Facility-funded projects) and a transboundary nexus assessment under the Water Convention.

An initial effort to integrate a benefit assessment into a nexus assessment took place in 2015. Each of the first nexus assessments (in the Alazani/Ganykh, Sava and Syr Darya River Basins) included a rapid, desk-based identification of the benefits of transboundary cooperation.

The first fully fledged effort to include a benefit assessment as part of a nexus assessment took place in 2016–2017 in the Drina River Basin. A similar approach is being followed while developing the nexus assessment of the NWSAS.

Assessing the benefits of cooperation should not be seen as an additional step in the TBNA methodology, but rather as a coherent and complementary process that can be integrated into the nexus assessment.

3.7.4 The assessment of the benefits of cooperation in the Drina River Basin

The methodology applied during the Drina assessment included three steps.

(1) As a first step, the approach for carrying out a benefit assessment exercise was introduced during the first basin-level multi-stakeholder workshop, after which a rapid identification of the benefits of cooperation in the Drina River Basin was carried out. This was a necessary step for raising participants' awareness on the broad range of benefits of cooperation (see table 4.) The first workshop also included a participatory exercise to assist in identifying target audiences for communicating the benefits of cooperation.

(2) As a second step, expert analysis was carried out, in the course of which several benefits of cooperation were in-

[16] The publication is available at: http://www.unece.org/index.php?id=41340

[17] Find more information on the workshop at: http://www.unece.org/index.php?id=46345

TABLE 4

How to assess the benefits of transboundary water cooperation and of nexus solutions

STEPS	METHODS
RAPID ASSESSMENT OF BENEFITS OF TRANSBOUNDARY WATER COOPERATION AT THE FIRST BASIN WORKSHOP	
Introduction of the broad range of possible benefits of cooperation Explain the rationale for carrying out a benefit assessment exercise, and for reviewing lessons learned and outcomes of similar exercises held previously. Detail the different tasks of a benefit assessment exercise.	Presentation
Identification of the benefits of cooperation Discuss the following questions with participants: • What are the main benefits of cooperation in the basin? • Who have been the main beneficiaries of cooperation in the basin?	Each participant writes down two benefits on two post-it notes. In a tour de table setting, each participant is invited to share one benefit that he/she has identified. The facilitator clarifies whether that benefit is an intermediate benefit (process benefit) or an outcome benefit.
Classification of the benefits of cooperation Classify the list of benefits in categories.	The facilitator builds up an empty matrix based on the typology of benefits included in the Policy Guidance Note. The typology can be adapted to a basin-specific context. The participants are invited to place their post-its on the matrix under the relevant category or categories.
Overview of the benefits of cooperation Check with the participants to see if any benefits are missing from the matrix.	The facilitator analyses the benefits categorized and clarifies any misunderstandings with participants. Benefits are added to the matrix, if necessary.
Communication of the benefits of cooperation Discuss the following questions with participants: • Whom (i.e. which target audiences) do we need to convince to promote (further) cooperation in the basin, and why? • Which existing processes are important to inform and influence stakeholders?	Ask participants to write down one key stakeholder to whom benefits of cooperation should be communicated. Collect all ideas in a tour de table setting. Every participant is given two votes (written on post-it notes) to identify priority target audiences for the communication of benefits of cooperation. They may either nominate two actors or give two votes to one actor. The facilitator adds up the votes and presents the results. Hold a plenary discussion on what types of communication efforts (tactics, types of messages etc.) are required to influence key decision-makers.
DETAILED DISCUSSION ON THE BENEFITS OF TRANSBOUNDARY WATER COOPERATION AND OF POSSIBLE NEXUS SOLUTIONS AT THE SECOND BASIN WORKSHOP	
Benefits of past cooperation in the basin and of sharing country perspectives Who have been the main beneficiaries in your country of past cooperation in the basin? What have been the main benefits in your country of past cooperation in the basin? To what extent have other riparians benefited from past cooperation?	Group work
Potential benefits of specific Nexus solutions in the basin Discuss the following questions with participants: • Which nexus solutions require international cooperation? • What are the benefits of those solutions? • What is the qualitative importance of those benefits? • Who will be the main beneficiaries of the nexus solutions?	Create groups to work on the different themes for improvement (one group for each theme). For each theme, participants discuss and attempt to agree on which of the possible nexus solutions, previously identified by the nexus analysts, require cooperation. Participants are asked to individually write down the benefits of each solution, and then to report back to the group to elaborate a list. Participants discuss about each benefit, then agree a rating on a four-point scale ("Very High", "High", "Medium" or "Low"). They are then asked to review their results so that 50% of benefits are rated "High" or "Very High", and 50% of benefits are rated "Low" or "Medium".
Communicating the benefits of past cooperation and nexus solutions in the basin Who are the target audiences? Which existing processes are important in terms of information and influence? What are the key messages and information to be communicated? Which communication tools could be used?	Moderated discussion with workshop participants

vestigated and described, based on the nexus analysts' description of nexus-related challenges and various ways to address them. In addition, a modelling exercise was carried out by experts working on solutions for co-optimizing flow regulation, which helped to quantify some of the potential benefits of cooperating on hydropower development.

(3) As a third step, the participants of the second basin-level multi-stakeholder workshop identified and discussed during one session the past benefits of cooperation in the Drina River Basin from the perspective of each country. In a different session of the workshop, they discussed a number of possible actions that could be adopted for each key theme (i.e. themes that the experts identified previously in carrying out the nexus assessment) and rated their benefits on a four-point qualitative scale, ranging from "Very High" to "Low" (see table 4). Findings are summarized in a dedicated chapter in an ECE publication from 2017 titled *Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin*.

Recommendations to effectively and efficiently integrate an assessment of the benefits of cooperation into a nexus assessment process are:

- Discuss and jointly identify the past benefits of transboundary water cooperation during the first basin workshop.
- In the terms of reference for the relevant experts engaged in the nexus assessment, include as a task the identification and qualitative assessment of the benefits of the proposed cooperative solutions.
- Ensure that sufficient time is allocated between the drafting of the technical nexus chapters and the second basin workshop to complement the work on benefits carried out by the nexus analysts, as well as to draw up a blueprint of benefit sessions for the second workshop.

3.8 Information and nexus indicators

As each stage in the nexus assessment requires different kinds of information and data, having access to several types of data is necessary throughout the assessment process. Used most frequently during the first stages – that is, during the desk study – are non-spatial indicators and thematic maps of the countries and basins. During the workshops, information based on the opinions of participants is key. During detailed analysis, spatial data are increasingly necessary for modelling to quantify specific dynamics, and also to predict changes in the future.[18] Here, the data requirements have a "time" dimension as well.

The sections below describe what has been learned in the past years regarding data, their utilization through indicators, and their use in nexus modelling tools.

3.8.1 Good information and data are necessary for nexus assessments

Policy development and decision-making depend on sound information and data; and while transboundary dialogue is already a value in itself, decisions on basin management, policy adjustments or strategic shifts that follow such dialogues must be based on salient information and meaningful analysis, which in turn require access to adequate data.

Governments are the preferred sources for information and data. Due to the intergovernmental nature of the nexus assessments under the Water Convention, official data originating from national authorities are used as much as possible. Countries tend to trust their official data and nexus assessments are reviewed by the Governments, hence transparency about the sources used is necessary. Using databases with an official source (e.g. FAO, OECD, World Bank, ECE) can save time, turning the request for data into a request for validation. The range of information and data needed for a nexus assessment can sometimes exceed what national statistics can provide, but a trusted validation process will bring easier acceptance of a wider range of information sources (e.g. satellite images). It should also be noted that basin-level information is not always easily available.

Another great need is to share information across borders. Basin-wide monitoring, data verification and exchange, and knowledge-sharing are keys to producing a meaningful analysis of the transboundary nexus; and no matter the starting point of cooperation, these elements stand in constant need of improvement. In previous nexus assessments, this point has often been one of the first solutions to be identified (see also section 5.1.2).[19]

In contrast to sectoral management approaches, the application of a nexus approach calls for integrated analysis, which in turn requires information and data on different sectors. Lack of data from the different sectors or issues related to access across administrative domains is a critical problem:

[18] For example, the model used in the Syr Darya assessment examined the effects of improved energy efficiency and the integration of more non-hydro renewable energy into the energy system. In the Drina River Basin, the benefits of coordinated operation of hydropower plants (as opposed to optimization on a single-unit basis) were estimated, while also taking into consideration other flow-regulation needs.

[19] In the Drina assessment it was found that data sharing and cooperation could improve the safety of operations of hydropower plants. Even though limits in data sharing have not been an impediment to cooperation, important advances in common databases are often lacking. One example is that coherent and transparent mapping of water pollution sources, including the determination and quantification of type of pollutions and their effects on water quality, is missing for the Drina Basin.

first, it restricts the ability to understand complex dynamics between sectors and resources; second, it limits the opportunity to use the nexus approach as a means to reduce negative intersectoral impacts and to improve cooperation. The careful analysis of appropriate data, for example, greatly benefits any consideration of intersectoral impacts of plans and policies. Moving beyond siloed sectoral approaches requires the development of new databases and data-processing methods (or better linking and integration of existing sectoral databases), as well as easier access to these databases and methods. Different planning cycles, in addition to shortcomings in consultation and evaluation procedures, can also influence how information on intersectoral synergies and impacts is taken into account.

A lack of accurate, harmonized and up-to-date data and information will hinder efforts in any undertaking to achieve the highest levels of analysis. Even when needed data is available, the use of different indicators in collection and measuring methods, as well as differences in methods of measurement across countries or regions, present obstacles to successful data processing and analysis.

3.8.2 Use and categorization of indicators

The nexus "community" agrees that nexus assessments require more than good data. Different indicators must also be utilized to effectively describe nexus interlinkages and fully grasp their natures. Those who participated in the global stocktaking workshop in 2016 concluded that it is vitally important for indicators to be comparable across countries. Clear indicators are also important in determining the impacts of proposed solutions across sectors. As Roidt and others (2017) describe, the nexus approach stands to profit from obtaining nexus-specific indicators.

Nexus indicators as such are not yet widely used, and the scientific community continues to work on their development. To reflect the progress, a list of specific nexus indicators could be included for more systematic use in the methodology. To some extent, several indicators were collected as part of the various nexus assessments carried out in recent years under the Water Convention.

The concept of a "fixed set of indicators resulting in the possibility to see the differences between each country and each assessment" represents an ideal case. It is, however, impractical. Even if some key indicators are systematically available, in each assessment under the Water Convention some complementing and adaptation has been necessary. The main indicators used are listed in the publication cited below, along with the relevant source information.

Over the past years, several possible categories of indicators have been put forward with the aim of meaningfully integrating them into the nexus assessment methodology. In 2014, during the early stages of developing the methodology, indicators were categorized either by group or by source, as shown below.

> ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus (United Nations, New York and Geneva, 2015), pp. 104-6.

Indicators by group

- National indicators
- Basin indicators
- FAO nexus indicators
- Perspective indicators
- Specific indicators

Indicators by source

- Country experts
- Country (FAO, World Bank etc.) and basin statistics
- Spatial information
- Opinion-based questionnaire

Both types of categorization show that different indicators have different natures. Some are qualitative and some quantitative, some geospatial and some statistical. Also, data can be provided at country scale or at basin scale. Some indicators are from experts and national governments, while others are provided through international statistical services. Some information depends more on personal perspective and is provided through the opinions of the participants. Both types of categorizations have informed the use of the TBNA methodology, but neither has been explicitly integrated into the methodology.

As the methodology developed, indicators were adapted to fit the assessment process more closely. These indicators are categorized by methodological use and are presented as follows in ECE (2015) and de Strasser and others (2016):

- non-spatial indicators (screening indicators, perspective indicators, assessment-specific indicators); and
- geospatial indicators.

This categorization was used to carry out the assessments and is also reflected in the nexus assessment reports. The first group of indicators within the set of non-spatial indicators (screening indicators) is used to describe the basin and its context, and is based on information from experts, governments and international statistical services. Official data are generally prioritized over information coming from other sources. The second group of indicators (perspective indicators) is used in the opinion-based questionnaire and includes different kinds of information on resources and socioeco-

nomic conditions. The third group (assessment-specific indicators) consists of the nexus interlinkages and solutions that are identified, and greatly depends on the dynamics of the assessment. Experts need the set of geospatial indicators for modelling and further quantitative analysis, but these indicators are also used to map the distribution of different factors relevant to the nexus.

The screening indicators have thus far not been categorized into a nexus-specific grouping, so the aim here is to provide this information. As the resource base of each of the concerned sectors is of particular interest during the technical phases of the analysis, information on the availability of resources and their uses is crucial.

Table 5 shows the screening indicators from the perspectives of different resources. These lenses also reflect the structure of the nexus assessment reports. Both the indicators presented in ECE (2015)[20] and the indicators used in the Sava and Drina assessments are also included in table 5. Most of the indicators are presented in ECE (2015) and used in the assessments.

Key indicators help to distinguish differences between resource bases, uses and issues in the different basins being assessed, and an overview of categorizations and how they are used in the nexus assessments confirms this. No template of indicators or categorization exists that can be used in the exact same way for each nexus assessment. One set of indicators that comes close to this goal, however, is the group of "key indicators". The key indicators listed below are presented in a very similar way for each nexus assessment, which allows the participants to see the importance of the resources in each basin. Basin-level information is not always available, and subnational administrative units often do not correspond with basin boundaries.

Key indicators

- Total renewable freshwater resources
- Installed electricity-generating capacity (by source)
- Agricultural land
- Gross domestic product (GDP)
- Population

Key indicators are typically presented visually. Figures 11 and 12 show how the key indicators can be presented in alternative ways for different nexus assessments. Figure 13 offers an example of how indicators (water, in this case) can be used in the opinion-based questionnaire (see section 3.6.2).

3.9 Analytical frameworks and tools for quantification

The TBNA methodology adopts a number of qualitative tools that help to uncover interlinkages in a participatory way (see section 3.6), but it also requires the use of quantitative tools to quantify trade-offs and benefits of cooperation. More specifically, modelling can be particularly useful to substantiate the presentation of nexus solutions in the form of quantitative benefits (e.g. improved efficiency, reduced emissions, optimal costs etc.).

This section gives an overview of available analytical frameworks that are applicable at transboundary level (and therefore interesting for nexus assessments under the Water Convention and similar efforts), and which can be used to support decision-making processes involving quantitative information on nexus interlinkages and their evolution over time, according to different scenarios. It also describes the experience of modelling benefits as part of the TBNA methodology, and indicates the way forward to increase the use of quantitative tools in that capacity.

3.9.1 Frameworks and quantitative tools applicable at the transboundary basin scale

As a variety of nexus analytical frameworks are being formulated, the toolbox available for the technical analyst to quantitatively analyse nexus dynamics is being continuously enriched. Yet, at the same time, as nexus issues vary case by case, and basin by basin, the analyst needs to be careful in choosing the most appropriate and applicable framework.

A framework to quantitatively analyse the nexus includes the application of different types of tools (i.e. modelling software, or models). A list of such frameworks with relevance for the transboundary nexus assessment is presented in table 6, which also highlights other possible scales of application. All of these frameworks are based on a quantitative approach and take several nexus interlinkages into consideration. While almost all frameworks tackle water, energy or food perspectives, some include wider aspects such as climate, environment or socioeconomic indicators.

While analytical frameworks are designed to cover all different resources in the nexus, underlying software tools tend to have a sectoral focus. This is often due to the fact that the tools have been developed with a specific area of emphasis in mind, and have then been combined with other tools or extended in scope. As tools often have a clearly single focus (e.g. land, soil or agriculture), combining and extending tools provides for assembling an appropriate toolkit for different settings and variable sets of issues.

[20] ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus. (United Nations, New York and Geneva, 2015).

TABLE 5
Screening indicators for nexus analysis

		BASIN INDICATOR	COUNTRY INDICATOR
Basin information		**River length** **Basin area** **Basin shares by country (relative presence)**	**Country area** **Share of each country in the basin area (dependency)**
Socioeconomic data		**GDP share in basin** This is possible to obtain if the basin region overlaps with an economically valuable region; it is otherwise difficult to estimate. **Population share in basin** **Employment by sector (share in agriculture)**	**Gross domestic product (GDP):** (i) GDP; (ii) GDP growth (total, per capita) **Contribution of natural resources to GDP*:** (i) total; (ii) oil; (iii) natural gas; (iv) coal; (v) mineral; (vi) forest **Contribution to total GDP by sector:** (i) agriculture; (ii) industry; (ii) services **Population:** (i) total; (ii) rural*; (iii) below poverty line*; (iv) density* **Population growth:** (i) total; (ii) rural* **Employment by sector:** (i) agriculture; (ii) industry; (iii) services/domestic
Water	**Resources**	**Renewable water resources:** (i) total; (ii) mean annual run-off, (iii) mean annual precipitation **Groundwater balance** **Wastewater** (i) generated; (ii) treated (primary, secondary, tertiary)	**Renewable water resources:** (i) actual (total, per capita); (ii) internal (total, per capita); (iii) external (total, per capita); (iv) flow reserved for upstream and downstream countries through formal and informal agreements and treaties
	Use	**Main groundwater uses and measures** **Freshwater withdrawals:** (i) total; (ii) domestic; (iii) agriculture; (iv) industry; (v) energy **Water productivity:** (i) agriculture; (ii) industry; (iii) services/domestic	**Freshwater withdrawal:** i) total, ii) irrigation iii) other agriculture, iv) thermal power plants, v) other Industry, vi) domestic **Improved access:** i) water sources, ii) sanitation facilities
Energy	**Resources**		**Combustible renewables and waste** **Alternative and nuclear (including hydropower)**
	Use	**Energy productivity** (i) agriculture; (ii) industry; (iii) services/domestic	**Energy production** **Energy use:** (i) total; (ii) per capita **Use of fossil fuels** **Energy-use growth** **Electricity production capacity:** (i) coal; (ii) natural gas; (iii) oil; (iv) hydropower; (v) renewables; (vi) nuclear **Electricity access**
Land	**Resources**	**Agricultural land share in basin**	**Agricultural land area:** (i) total; (ii) permanent cropland; (iii) forest; (iv) arable land **Total wood resources**
	Use	**Land use** Various types (data are often available at the country level but not at the basin level)	**Logging harvest*:** (i) official; (ii) illegal **Agricultural irrigated land** **Land under cereal cultivation** **Fertilizer consumption*** **Agricultural machinery***
Environment			**Wastewater:** (i) quantity generated; (ii) treated (none, primary, secondary, tertiary) **Threatened species*:** (i) mammals; (ii) birds; (iii) fish; (iv) higher plants **Protected areas:** (i) terrestrial; (ii) marine **Greenhouse gas emissions:** (i) agriculture; (ii) energy; (iii) industry; (iv) waste

*** Indicator was identified in ECE (2015) but not used in the assessments.**

FIGURE 11

Key indicators as presented in the Sava assessment

This visual has been used in most basin assessments to date

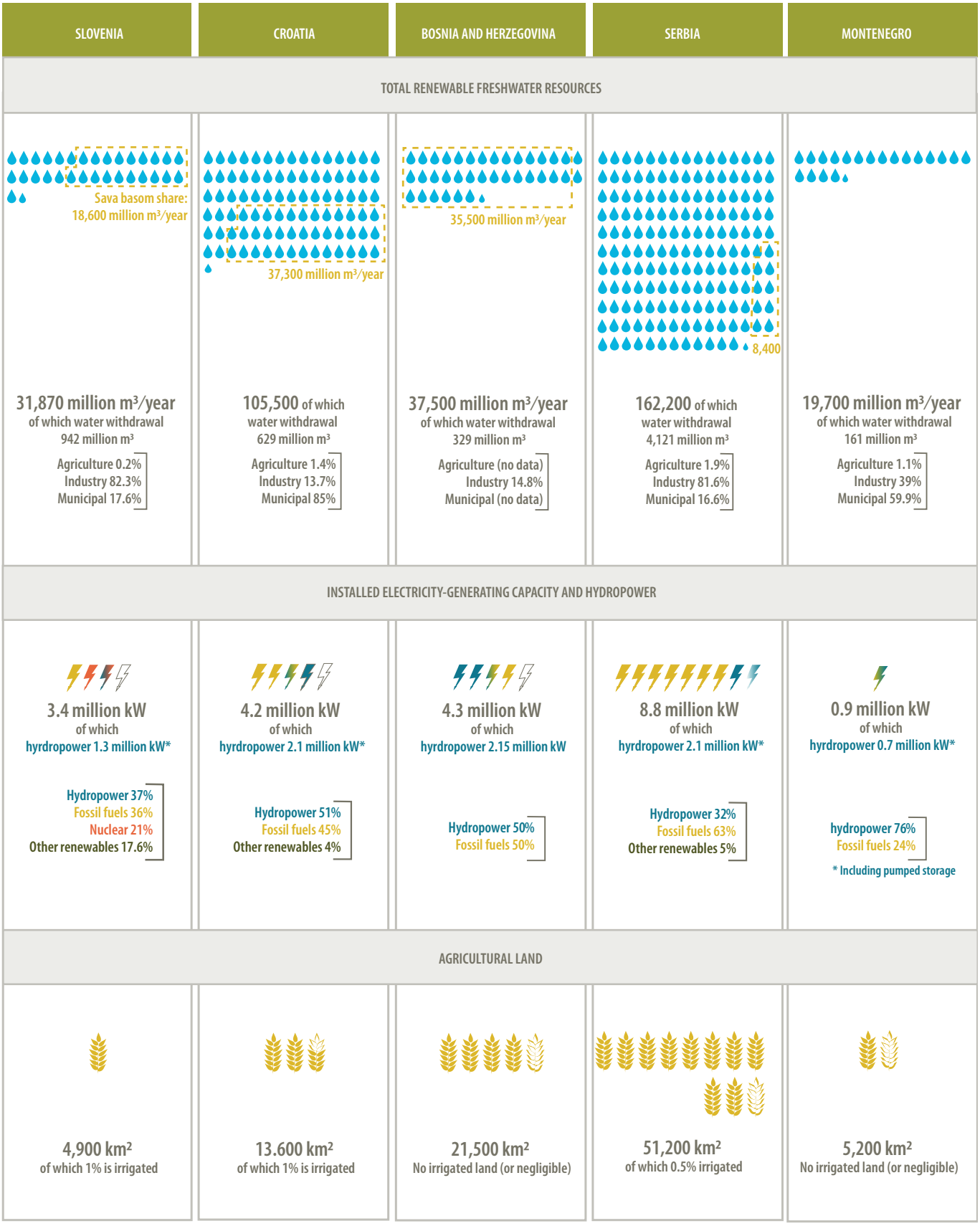


FIGURE 12

Key indicators as presented in the Drina assessment

A different presentation format was selected because of the smaller size of the basin and the fact that this assessment detailed further the nexus issue on the basis of the Sava assessment

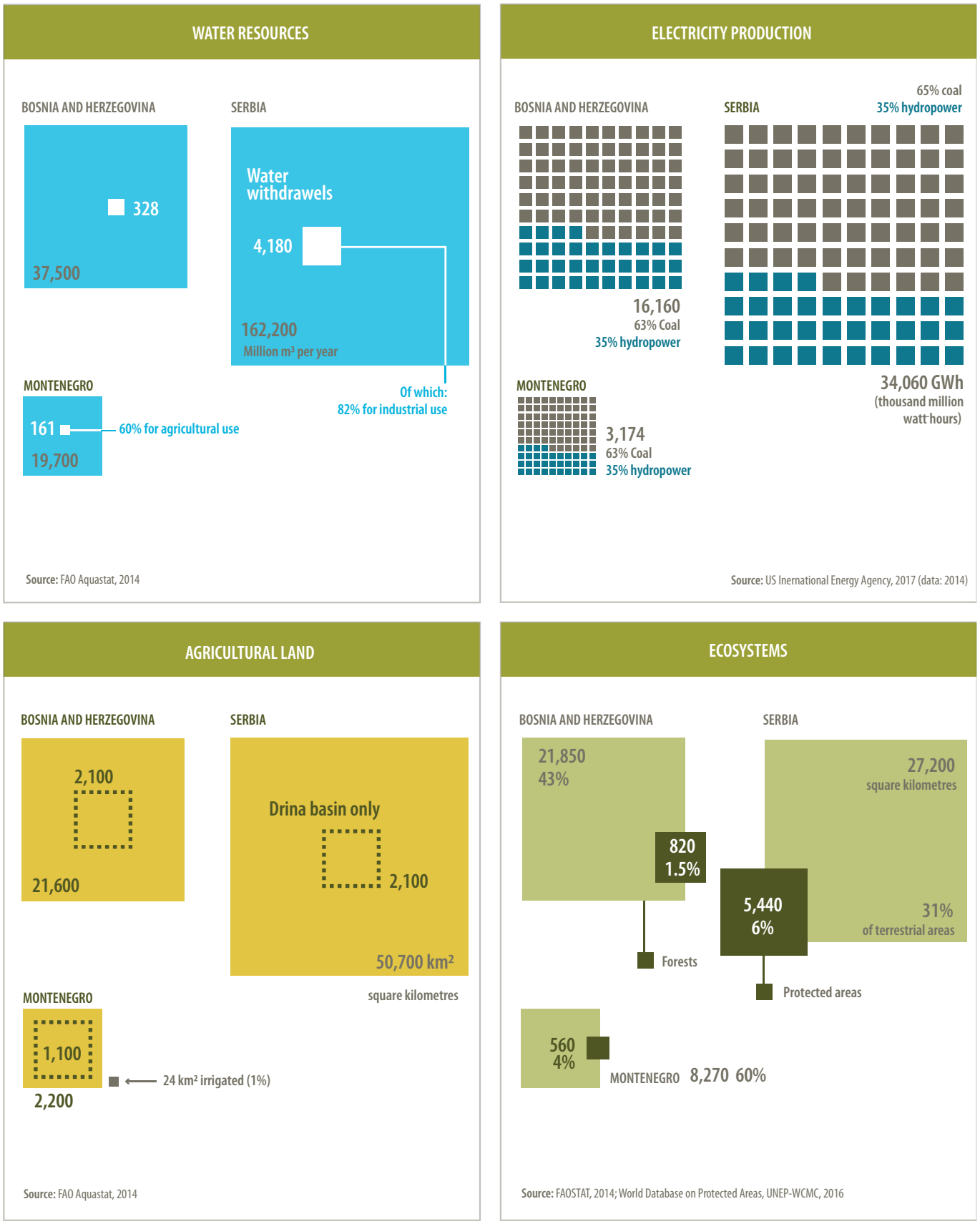


FIGURE 13
Use of indicators in the opinion-based questionnaires

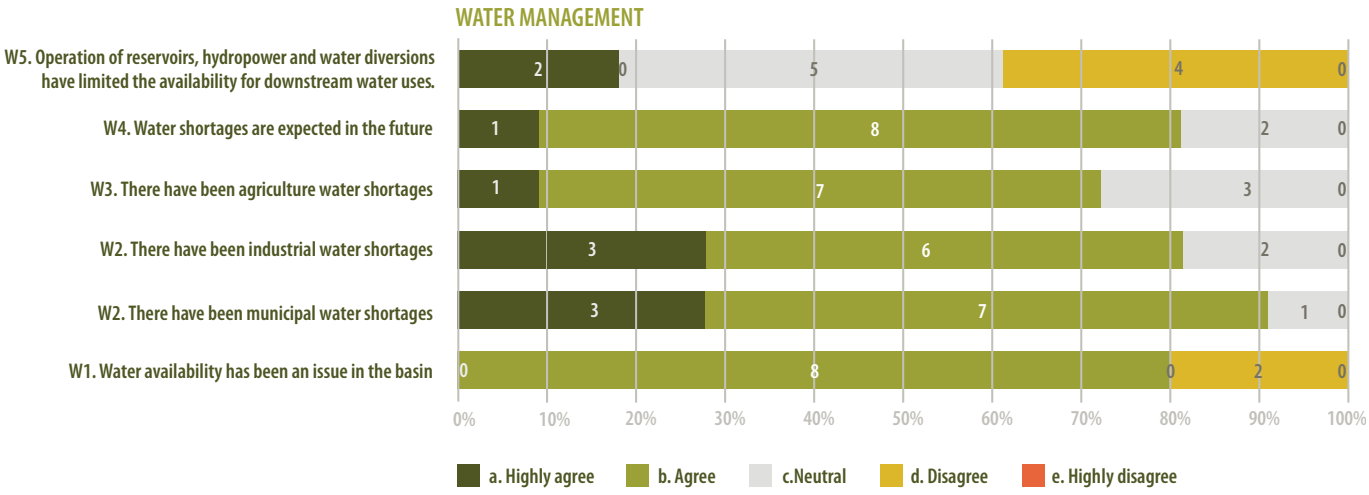


Table 7 describes the frameworks and their underlying modelling software tools. It should be noted that analytical frameworks are often built around free software. To allow the wider community of nexus stakeholders to work with these analytical frameworks, most of the underlying software is available to use free of charge, either through public domain or open-source licenses. As access to technical support is not always easily available, flexibility is a major advantage.

3.9.2 Experience so far within the TBNA

The tools available to quantify nexus interlinkages differ in their level of integration. Some are fully integrated, multi-resource modelling tools in which interlinkages can be investigated with the use of only a single software. Other models are extended-system models, or single models that are combined through soft-linking. The framework adopted for quantification in the basin assessments carried out so far – i.e. the transboundary Climate, Land-use, Energy and Water strategies (CLEWs) – is based on soft-linking. This allows analysts to remain flexible and potentially build on existing basin or country models, and also to carry out limited and illustrative quantifications in a modular way (e.g. for a specific sector) without the need to populate extensive datasets.

Most of the quantifications to date have been made using the OSeMOSYS open-source cost optimization tool (table 7). These quantifications, which accumulate through experience, are used to link energy sector benefits to water management trade-offs, most notably to hydropower.

The following examples of quantifications from the nexus assessments are illustrative.

In the Sava River Basin, each country has set long-term renewable energy (RE) targets, has expressed energy security concerns, and has set greenhouse gas (GHG) mitigation goals. The quantification exercise, performed by the Royal Institute of Technology (KTH) with input from the JRC, indicates that, taking the Sava River Basin countries as a whole, RE targets are within reach and can even be surpassed (reaching 55 per cent by 2020). Hydropower plants located in the Sava River Basin play a decisive role in meeting the RE targets: electricity generation from hydropower alone represents a possible 33 per cent of total contribution of RE sources. In light of such RE-generation opportunities, transboundary cooperation between Sava Basin countries could prove advantageous in providing energy security, decreasing energy dependency, and contributing to decarbonization of the energy system. [21]

A modelling exercise carried out as part of the Drina River Basin assessment shows that cooperative operation of hydropower dams could deliver more than 600 GWh of electricity over the 2017–2030 period. Setting aside 30 per cent of dam capacity for flood control would carry a cost through a change in the energy mix (about 4 per cent of the operational cost of the whole electricity system in the three countries). Pressure on hydropower generation could be reduced by increasing energy efficiency (by as much as 4.1 TWh in the combined Drina Basin in the 2017–2030 period) and would also deliver significant reductions in GHG emissions (from 38 Mt in 2017 to about 28 Mt in 2030, representing about 21 per cent of combined emissions for the three countries in 2015). [22]

[21] ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus (United Nations, New York and Geneva, 2015), Box 13, p. 71. Available at: http://www.unece.or 0g/fileadmin/DAM/env/water/publications/WAT_Nexus/ece_mp.wat_46_eng.pdf

[22] ECE. Assessment of the water-food-energy-ecosystem nexus and benefits of transboundary cooperation in the Drina River Basin (United Nations, New York and Geneva, 2017). Available at: http://www.unece.org/index.php?id=47750

TABLE 6
Analytical frameworks used to address transboundary nexus issues

ANALYTICAL FRAMEWORK	SCALE	NEXUS INTERLINKAGES ANALYSED	REFERENCES	TRANSBOUNDARY APPLICATION
Multi-Scale Integrated Assessment of Societal and Ecosystem Metabolism (MuSIASEM)	**Transboundary trade** Global Regional National Subnational	Water Energy Food Land GHG GDP	Giampietro and others (2013)[23]	**Nexus Security using Quantitative Story-Telling** magic-nexus.eu/documents/d41-report-nexus-security-using-quantitative-story-telling **MAGIC multiscale analysis Global level case study: External limits at the planetary level** https://magic-nexus.eu/
Climate, Land-use, Energy and Water strategies (CLEWs)	**Transboundary basins** Global Regional National	Climate, Environment ↕ Energy, Water, Land/Food	Alfstad and others (2016)[24] Howells and others (2013)[25]	**Nexus Assessments under the Water Convention – Alazani/Ganykh, Sava, Syr Darya and Drina River Basins** http://www.unece.org/publications/oes/welcome.htm
Open Source Spatial Electrification Tool (OnSSET)	**Transboundary basins** Continental Regional National	Energy ↔ Water Energy ↔ Land/Food Climate ↔ Energy	Mentis and others (2016)[26]	**Nexus Assessment under the Water Convention – North-Western Sahara Aquifer** (forthcoming)
Water Evaluation and Planning System/Long-range Energy Alternative Planning System (WEAP-LEAP)	**Transboundary** Global National	Water ↔ Energy Water ↔ Food Water ↔ Environment Energy ↔ Land Energy ↔ Environment Food ↔ Energy Land ↔ Food Land ↔ Environment	Stockholm Environment Institute Heaps (2016)[27] Sieber and Purkey (2015)[28]	**Upper Blue Nile Basin** [29]
e-nexus	**Transboundary** National Basin	Water Agriculture Climate Environment	European Commission Joint Research Centre	**The MEKROU project – promoting sustainability in the Mékrou basin** https://ec.europa.eu/jrc/en Udias and others (submitted)
Water-Hydropower-Agriculture Tool for Investments and Financing (WHAT-IF)	**Transboundary** Regional National Basin	Food Water Energy Welfare economics Financing	COWI AS in cooperation with OECE OECE (2018)[30]	**Lower Syr Darya Basin** www.oecd.org/environment/outreach/MPWI_Perspectives_Final_WEB.pdf **Zambezi River Basin**
WEF Nexus Tool	National	Water ↔ Energy Water ↔ Food Water, Energy, Food ↕ Land, Financing, Carbon, Environment	WEF Nexus Research Group Daher and Mohtar (2015)[31]	**Security, climate change, and the resource nexus** https://www.taylorfrancis.com/
DAFNE: A Decision Analytic Framework to explore the water-energy-food nexus in African transboundary river basins	**Transboundary**	Water ↔ Energy Energy ↔ Food Food ↔ Water Water, Energy, Food ↕ Environment	Burlando and others (2018)	**Omo-Turkana** https://dafne.ethz.ch/casestudies/ **Zambesi** https://dafne.ethz.ch/casestudies/

[23] M. Giampietro, R. J. Aspinall, S. G.F. Bukkens, J. Cadillo Benalcazar, F. Diaz-Maurin, A. Flammini, T. Gomiero, Z. Kovacic, C. Madrid, J. Ramos-Martín and T. Serrano-Tovar. An Innovative Accounting Framework for the Food-Energy-Water Nexus (FAO, 2013).

[24] T. Alfstad, M. Howells, H. Rogner, E. Ramos and E. Zepeda. Climate, Land-, Energy-, Water-use simulations (CLEWs) in Mauritius– integrated optimisation approach (EGU General Assembly Conference Abstracts, 2016), vol. 18, No. EGU2016-15765.

[25] M. Howells and others. Integrated analysis of climate change, land-use, energy and water strategies (Nature Climate Change, 2013), vol. 3, pp. 621-26.

[26] D. Mentis and others. Lighting the World: the first application of an open source, spatial electrification tool (OnSSET) on Sub-Saharan Africa (Environmental Research Letters, 2017), vol. 12, No. 8.

In order to investigate dependencies between the Syr Darya River Basin's water resources and the power-systems sector, a multiregional model of electricity systems in the four riparian countries was developed to simulate the causes and effects of changes in upstream hydropower generation. To identify opportunities for cooperation between the countries, scenarios were developed for the operation of integrated power systems. Following this was an analysis of dynamic response to electricity trade and changes in electricity-generation profiles. The scenarios included stated efforts to implement energy-efficiency measures (targeting both the supply and demand sides) and increased deployment of renewable energy. The comparative analysis allowed for the identification of key implications, thus demonstrating the value of energy-sector involvement in water-related concerns. [32]

Modelling experience to date has been built around one main set of interlinkages: energy-water and energy-climate. The reasons for this are mixed, such as: availability of data and previously developed models; the degree of interest

TABLE 7
Information on analytical framework software

ANALYTICAL FRAMEWORK	CATEGORY*	MAIN MODELLING SOFTWARE USED	SECTOR FOCUS	AVAILABILITY	ACCESS LINK
MuSIASEM	**QL/QN**	Currently internal	Socioecological systems	Planned to be public	N/A
CLEWs	**QN**	Osmosys	Energy	Open source	www.osemosys.org
		LEAP	Energy	Free for users in developing countries; priced licenses for users in other countries.	www.sei.org
		WEAP	Water		www.weap21.org/
		GAEZ	Land use	Free	www.gaez.iisa.ac.at
OnSSET	**QN**	OnSSET	Energy	Open source	www.onsset.org
WEAP-LEAP	**QN**	WEAP	Water	Free for users in developing countries; prices licenses for users in other countries.	www.sei.org
		LEAP	Energy		www.weap21.org
e-nexus	**QN**	e-water	Water	Open source	www.aquaknow.jrc.ec.europa.eu
		SWAT	Water and soil management	Public domain	https://swat.tamu.edu/
		EPIC	Soil management	US public domain	https://epicapex.tamu.edu/epic/
		Refran-CV	Water, meteorology	EU public license	https://aquaknow.jrc.ec.europa.eu
WHAT-IF	**QN**	GAMS MS Access Excel	Numerical programming and optimization language	WHAT-IF: Public domain MS Access: Proprietary Excel: Proprietary	MIKR@cowi.com
WEF Nexus Tool	**QN**	WEF Nexus Tool open-access interface	Food-centric for online version; energy-and water-centric applications have been developed by customizing the open version	Free open-access interface	http://wefnexustool.org

*** QL = qualitative** **QN = quantitative**

shown during the participatory process; and the specific competences of analysts involved in the assessment. While the latter can always be addressed by increasing the expertise of the team, the other obstacles can only be overcome together with stakeholders through, for example: seeking to obtain better data, or having a more focused dialogue on trade-offs and opportunities (e.g. bioenergy, agricultural trade, environmental assets etc.) that are often overshadowed by other topics (hydropower has been the "hot" topic in many of the previous assessments).

The long-term goal of the modelling exercise within a basin nexus assessment under the Water Convention is to establish a basis for creating a basin toolkit that can be used to quantitatively investigate both the variety of interlinkages and the benefits of cooperation. While the modelling results obtained within the scope of the assessment are mostly illustrative, proposed follow-up projects aim to improve the tools being used and to supply a deeper quantitative analysis.

[27] C.G. Heaps. Long-range Energy Alternatives Planning (LEAP) system (Stockholm Environment Institute. Somerville, United States, 2016) [Software version: 2018.] https://www.energycommunity.org.

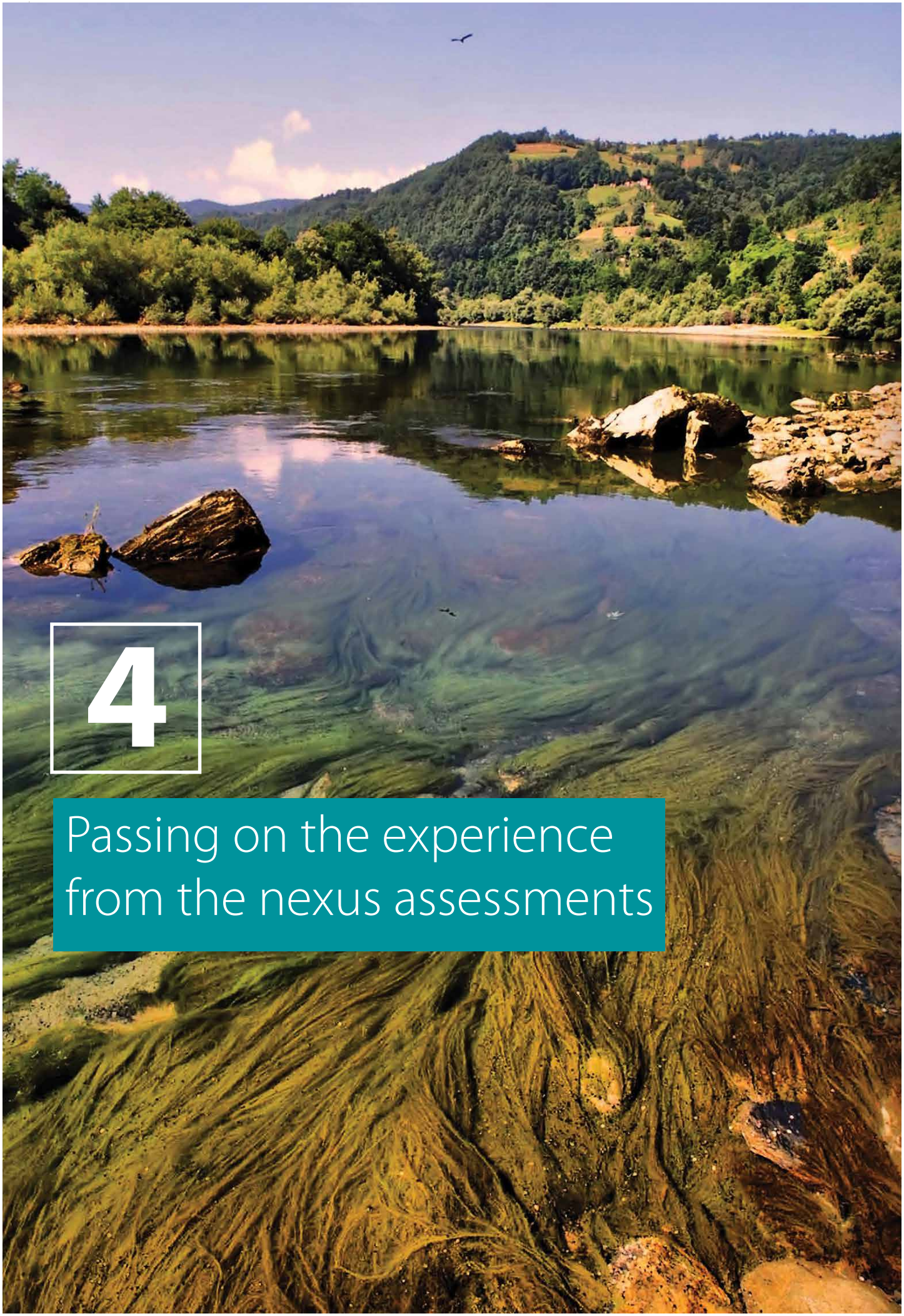
[28] J. Sieber and D. Purkey. User Guide for WEAP 2015 (Stockholm Environment Institute, U.S. Center, 2015) http://www.weap21.org/downloads/WEAP_User_Guide.pdf

[29] L. Karlberg and others. Tackling complexity: Understanding the food-energy-environment nexus in Ethiopia's Lake Tana Sub-basin. (Water Alternatives, 2015), vol. 8, No. 1, pp. 710-34.

[30] OECD. Strengthening Shardara Multi-Purpose Water Infrastructure in Kazakhstan. OECD Studies on Water (OECD Publishing, Paris, 2018).

[31] Bassel Daher and Rabi H. Mohtar. Water-energy-food (WEF) Nexus Tool 2.0: guiding integrative resource planning and decision-making (Water International, 2015).

[32] ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Syr Darya River Basin (United Nations, New York and Geneva, 2017). Available at: http://www.unece.org/index.php?id=45042.



4

Passing on the experience from the nexus assessments

4 Passing on the experience from the nexus assessments

4.1 Design of the nexus assessment process

This chapter focuses on additional experiences gained over the past three years.

The nexus assessment learning curve is still steep, and each assessment brings a new learning experience. A repeatedly confirmed lesson is that it is important to tailor the scope and focus of each assessment to the specific issues pertaining to each basin. Again, every assessment reveals that different sectors within a nexus focus play out at different scales and with different effects at multiple levels. Existing levels of cooperation and other specifics of the basin, region and participating countries have further influence on how a nexus assessment will be carried out, and also have a bearing on follow-up perspectives. Improving resource management in a basin requires improving the governance setting – by establishing more coherent national policies, for instance. These and several other conclusions and recommendations related to the nexus assessment process under the working programme of 2012–2015 remain valid and appreciated.[1]

There is a growing body of knowledge about nexus dynamics and tools. The attention that the nexus sparked in 2011 remains piqued, and this has resulted in increased scientific and policy-related activity to strengthen the nexus approach. Meanwhile, the global stocktaking workshop on the assessments of the water-food-energy-ecosystems nexus (Geneva, 6-7 December 2016) has shown that the developed tools and enhanced knowledge are also beneficial in a transboundary context. Workshop discussions have also pointed out that international agencies and donors play a significant role in promoting regional planning and transboundary cooperation.

While each assessment is a unique exercise, experience shows that transboundary basins share common issues related to water allocation and environmental impacts, and the assessments provide useful entry points in terms of motivating the examination of international cooperation opportunities to address these concerns. However, the nexus assessments are only the start of a longer discussion on cooperation across sectors and boundaries, a fact that must be considered when planning the assessments. The sections that follow discuss this issue in greater detail.

Compared to IWRM, a nexus approach considers sectors more broadly. The explicit aim here is to include sectoral perspectives, looking also beyond the basin, and to consider a wider range of opportunities for cooperation with an anticipated positive impact on the status of waters.

Several key lessons have been learned in recent years. These relate, in particular, to the following: the design of the nexus assessments (section 4.1), how the assessments create synergies with other processes (section 4.2), and how the energy and agriculture sectors are also exploring the value of nexus approaches (section 4.3). Further challenges and needed improvements are described in section 4.4.

4.1.1 Official engagement of countries facilitates ownership

As the results of an assessment may be controversial to a country or to a sector, it is important when designing the process to ensure its acceptance and ownership beforehand from the participating countries and the involved sectors, as well as to facilitate the creation of ownership and leadership to help steer the entire process. The official, intergovernmental nature of the assessment process is therefore important. All basin (or aquifer) riparians with a non-negligible share should agree to and engage in the process from the start, and to confirm their commitment through official correspondence. ECE first reaches out to the focal points of the Water Convention to establish engagement from the countries. Detailed consideration specific to each basin assessment has been given, and the means used to establish contacts and identify stakeholders have differed somewhat (some examples are given in table 8).

National focal points (ideally from different sectors, or perhaps from an inter-ministerial group) play a key role in the overall process. Local experts can prove invaluable in supporting the focal points to address technical questions and other matters related to the process. Furthermore, it is important to define clear roles for focal points and local experts from projects, and to ensure that they have adequate resources for their functions.

[1] ECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus (United Nations, New York and Geneva, 2015), pp. 99-102.

TABLE 8
Examples of approaches towards establishing contact with target countries

NEXUS ASSESSMENT TARGET BASINS	APPROACH	CONSIDERATIONS
Alazani/Ganykh, Sava	Stakeholder identification in basin management-related work was used as the basis, after which complementary actions were taken.	There was a good synergy with the GEF project, but there were delays in establishing dialogue with the energy sector.
Syr Darya	Focal point (water) ministries and foreign ministries were contacted about forming the national delegations.	Representative local participation was difficult to ensure, and diversity of participation was somewhat lacking from a gender point of view.
Drina	A network of contacts established in the Sava River Basin provided the basis, while the involvement of ECE Sustainable Energy Division/GERE provided means of identification.	The focal points involved local administrations and utilities quite effectively, while collaboration with the UNECE Group of Experts on Renewable Energy facilitated involvement of the energy sector.

An "official" process enables the assessment to help develop common understandings between the riparian countries. Such a commitment provides a better basis for the nexus approach and for specific conclusions and recommendations to be integrated into the strategic documents and development plans of the riparian countries. This is something that participants involved in previous assessments have called for.

Finally, ownership can be consolidated through the inclusion of all relevant sectors and participants from several levels of the national administration, as well as of other stakeholders. For the countries to gain maximum value from the exercise, participants must be actively involved throughout the process, and especially in the workshops.

4.1.2 Broad and sustained participation adds to the quality of the findings and fosters ownership

Creating ownership does not stop at officially including countries in the nexus assessment. As the previous section and the participatory methods detailed in section 3.6 make clear, the country officials do much of the assessment-related thinking during the workshops and provide direction for orienting and focusing the analysis. The process, designed to foster participation, begins with the inclusion of the focal points and local experts during the desk studies, continues throughout the workshops, and extends beyond the workshops through commenting and the publication of reviewed results.

An example of such a sequence is when stakeholders validated the results of the Drina assessment and also provided further details and views on how to implement the proposed actions. Compared to earlier applications of the assessment methodology, there were even more opportunities for consultation and input. The facilitated participation, which represented a broad range of views, provided a solid basis for improving resource management and policy, as well as for mobilizing funding.

Experience shows that the participatory process is challenging. The complexity involved in carrying out interdisciplinary work at multiple levels with diverse stakeholders requires a significant investment of time and learning.

The water-food-energy-ecosystems nexus aims to give equal consideration to each sector, but the entry point here is "water". As the assessments are carried out under the Water Convention, water is the element that connects the countries, and it is at the basin level where nexus impacts are studied. Furthermore, due to the nature of the institutional setting of the assessments and the participants they attract, the influence of the water sector might be higher, thus possibly introducing something of a "water bias". Any apparent bias must be duly considered and balanced through reaching out to other sectors (in such cases, sectoral partners can play a very helpful role) and including them as much as possible. This type of outreach in the countries improves the quality and increases the relevance of the assessments, thus extending intersectoral dialogues in the countries well beyond purely water-management perspectives.

To ensure that nexus-related activities reach all relevant sectors and touch all interests, the process must be designed to achieve a balanced participation. Care must be taken to identify and reach out to those stakeholders who are likely to be the most influential or most affected with regard to the management of resources considered in the nexus assessments. As explained above, there are differing approaches to identifying stakeholders, depending on the basin. While broad and representative participation is needed, experience shows that the workshops should be limited to key stakeholders. The involvement of too many stakeholders is no guarantee for a better outcome, as it tends to hinder the flow of discussion and exchange.

Partners with different sectoral mandates can make an invaluable contribution to the assessment process. As assessments are carried out under the Water Convention, bringing

an implied emphasis on water resources, partners from other sectors do need to be involved. FAO, for instance, has facilitated outreach to the agriculture and land-management sector, and the ECE Sustainable Energy Division has helped to promote discussion about water issues as part of wider sustainability considerations through the nexus at various energy sector forums.

4.1.3 Effective communication, adjusted to the audience, is necessary at different stages of the process

Communication is an important aspect throughout the assessment process. Prior to beginning the process, communication motivates involvement; during the process, it leads to forming valuable networks and reinforces mutual understandings between groups with different interests; at the end of the process, the communication of outcomes will have a greater impact on other processes. Including the "benefits of transboundary cooperation" perspective into this communication advances the nexus assessment process as a whole. One should also bear in mind that scoping-level nexus assessments only lay out possible directions for solutions, and that the nexus dialogues must be continued in order to move towards the implementation of nexus solutions. Assessing the feasibility (technical, financial) and acceptability of priority measures could be logical next steps in this direction. Some countries have called for further guidance on implementation and application of the nexus approach.

Clear communication about the "nexus" concept and related terms in the course of the assessment is highly beneficial. Well-defined terms serve to clarify the task at hand and help prevent possible misunderstandings between sectors, each of which tends to have its own specific language. Expanding the current nexus glossary proposed under the Water Convention (ECE, 2015) would be helpful for those applying the concept in a transboundary context.

Developing stronger cooperation after an assessment is complete requires the convincing of key decision-makers and stakeholders. Hence, an effective communication strategy is an important component in designing the nexus process. Depending on the target audience, a tailored communication of messages is necessary where assessment results are concerned.

A stakeholder consultation designed specifically for orienting communication efforts would help to tailor messages for an intended audience, while also focusing on the most pertinent findings. Participants in the Drina assessment, for instance, identified "national governments" as the stakeholder that most needed to be convinced of the benefits of co-managing Drina resources. Other stakeholders that have been identified as needing to be targeted include: finance ministries, relevant ministerial representatives, mayors, local populations and project financiers.

One of the objectives of a nexus assessment is to raise awareness among authorities about various policy actions, tools and instruments. The process design must include the dissemination of material to relevant policy and decision-makers. In order to address a wide range of audiences, there is a diverse range of publications for each assessment: publication types include policy briefs, larger policy documents, summaries of assessment reports, and full technical reports. The promotion of findings is carried out on a regular basis to ensure that the messages reach the concerned authorities, inform regional water management and development agendas, and are taken up in salient intergovernmental processes. ISRBC, for example, translated the findings of the Sava assessment into local languages for dissemination, thus ensuring their visibility in the basin countries.

One factor that has added to the importance of communication is the evolution and extension of the assessments over time. Due to the complexity of issues and thematic breadth of the studies – and also because of limited human resources – the assessments in many cases have taken longer than foreseen. In some cases, the longer assessment period occurred alongside changes within ministries and agencies – a dynamic that underlines the importance of regular communication.

Apart from project-specific communication, a need became apparent for general awareness-raising about the nexus approach at different levels. At the local level, this includes government authorities and civil society organizations. As for nexus-related capacity building, the involvement of junior experts in follow-up projects merits some attention. The general promotion of assessment results has also taken place at high-profile international events, such as World Water Week (August 2016), the Regional Forum on Energy for Sustainable Development (2016 and 2017) and the Environment for Europe Ministerial Conference in Batumi (2016). A devoted side event on the nexus assessments took place during the latter conference.

Many of the intersectoral impacts identified during the assessment process could be most effectively addressed through the policies and practices of certain economic sectors, notably energy and agriculture (the importance of creating synergies with these sectors is described in section 4.3). To raise awareness and encourage cooperation with other sectors, communication must directly target these sectors and their stakeholders, while highlighting relevant concerns and opportunities. For example, different perspectives on the benefits of cooperation can emerge from linking discussions on water management to discussions on transitioning to sustainable energy. The Drina nexus assessment is a case in point: electricity generation could be increased by coordinating the operation of hydropower plants and optimizing the flow releases, while taking different water needs into account could bring different co-benefits.

4.2 Scoping and complementing the methodological approach

4.2.1 The "benefits of transboundary cooperation" perspective strengthens the nexus assessments

Experience points to the significant benefits of enhanced cooperation between countries, such as making the countries less vulnerable to external shocks and reducing the costs of infrastructure development and use. The "benefits" perspective is explicitly included in nexus assessments under the Water Convention to strengthen these very aspects of cooperation. Similar to the Water Convention's policy guidance on benefits, the nexus approach invites its primary target audience to consider broader cooperation, rather than to just "allocate water".

Beyond identifying the benefits of cooperation across sectors and countries, it is important to communicate them, both to the workshop participants and in the final recommendations to policymakers in the basin report. This aspect has gained increasing importance during the workshops, and has become an integral part of the agenda.

4.2.2 A scoping-level nexus assessment is only a start

When designing and carrying out an assessment at the scoping level, one must keep in mind that this is only a start. The uptake of findings must be ensured if solutions are to be implemented. In past activities it was recognized that the assessment should be an initial step in a longer process. Once countries have gained a common understanding of the issues and have formulated actions for solutions, it is then time to continue dialogue between the countries on implementing these steps. Local and subregional cooperation organizations will be important for using and sustaining the results from the assessments, and for continuing the dialogues on resource management trade-offs.

Many key measures to address the nexus are such that they need to be taken beyond the level of water management. The promotion of dialogue in key sectors and among key actors is therefore very important after the assessments are completed, and existing intergovernmental structures can be used to assist follow-up actions. The momentum gained in the Drina nexus project, for example, might be sustained through continued dialogue between the countries and sectors on the assessment's findings. It could also be useful to explore how existing structures with multisectoral characteristics (e.g. ISRBC) can be built on to further intersectoral coordination. It is, however, important that officials and stakeholders have the will to progress to the next steps of nexus activities, such as focusing on proposed solutions and assessing them in detail – through a cost-benefit analysis, for example.

4.2.3 Synchronized technical and governance methods enhance assessment outcomes

A major lesson from previous years is that the technical and governance aspects of the assessments must be better synchronized and progress hand-in-hand (refer to section 3.3.2 to see how this has been done). Experience shows that such an approach has, indeed, enhanced the quality of the assessments, and it is now increasingly important to apply this approach in practice, as well as to encourage experts to form a close-knit team that feels "obliged" to talk to each other and collaborate.

4.2.4 Flexibility and learning in applying the TBNA methodology is necessary

Even in the first iteration of the TBNA methodology, it was stated that the assessments would be carried out in varying circumstances and with the consideration of a wide range of conditions and interlinkages. The method was thus designed as a simple and consistent framework that allows for flexibility in its application. Lessons learned throughout the years have taught that such a flexibility is necessary, as each assessment is a unique case.

The nexus assessment can be carried out in a progressive way by building on earlier work. The first part of the Drina assessment, for example, did not start from scratch, but rather was built directly upon the outcomes of the Sava assessment. During the participatory phase it proved useful to hold three workshops, instead of the two foreseen in the default methodology. The additional workshop allowed for the inclusion of perspectives on the benefits of cooperation and made more time available for discussing nexus solutions in the second workshop, while still allowing sufficient time to validate the results in the third workshop.

The NWSAS assessment demonstrates how the methodology can be applied and adapted to suit a groundwater focus and the specific issues at stake. This implies consideration of the effects of the aquifer's depletion, degradation of groundwater quality, and the energy solutions for pumping groundwater. To this end, different quantification tools are needed.

The nexus assessment methodology has also been gradually improved in terms of participatory methods. Earlier applications showed, for instance, that the process of stakeholder mapping needed to be carefully designed and carried out at the very beginning of the assessment. Therefore, a more participatory exercise was developed for the NWSAS assessment (see section 3.5), where stakeholders were mapped and their relationships and power balances were described early in the process.

The complexity involved in this kind of multi-level, interdisciplinary work means that getting through the process

takes time, and also that changes may need to be made. For example, the organization of an additional consultation opportunity or investigation of an issue that emerges during the process may turn out to be necessary. The methodological flexibility has proved very useful in terms of adaptability, and flexibility from the side of the funding agencies and participating organizations is extremely valuable as well.

4.3 Synergies with other processes

In the past decade, the nexus concept has influenced the work of many research institutes, development organizations and international donor agencies. Also, work under the Water Convention has been coordinated with other organizations, which has contributed to synergies between different nexus activities. Table 9 highlights different synergies that have emerged over the past years with other processes. Assessments have, for instance, sparked more activity in the regions. Some partnerships (e.g. Multilateral Environmental Agreements, such as the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)) and activities (e.g. benefits of cooperation assessments) are part of the ECE. Several other synergies have emerged that are related to projects funded by the Global Environment Facility (GEF).

Three different kinds of synergies can be distinguished:

- process synergies, which may result in the engagement of different sectors and stakeholders, or in the organization of events for the participatory process;
- substantive input, leading to possible orientation of further work and initiatives on the issues raised and solutions proposed in the assessment; and
- awareness-raising in regional and sectoral processes, which facilitates further consideration of the nexus in future activities.

Regional Nexus Dialogues (RNDs) provide one example of a "process synergy", demonstrating how nexus work performed under the Water Convention generally informs other processes. The RND programme, implemented by the European Commission and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), has been running from 2016. The overall aim of the programme is to support "regional stakeholders in developing concrete policy recommendations and action plans for future investments, with specific emphasis on multi-sector infrastructure and corresponding capacity development activities."[2] This activity will assist in implementation of the nexus approach at the regional and national levels, and thus has a transboundary implication. The nexus assessments have informed the shaping of the RNDs mainly through their provided experience, conclusions and recommendations. This has, in particular, informed the RND in Central Asia, but has also contributed to the RNDs in the Niger Basin and in Latin America.

Coordination with other United Nations Regional Economic Commissions serves as an example of complementarity and experience-sharing between regions. Case studies performed by the Economic Commission for Latin America and the Caribbean (ECLAC) highlight the water-food-energy nexus in water and wastewater services, while the Water Convention's nexus work provides insights relevant to ECLAC's work in public policy guidance. Meanwhile, the United Nations Economic and Social Commission for Western Asia (ESCWA) facilitates capacity building and promotes good practices that provide useful references in the MENA region.

As part of the Central Asia Nexus Dialogues, IUCN and the Regional Environmental Centre for Central Asia (CAREC) support multi-sectoral planning approaches. In the Central Asia RND, particular focus is placed on transboundary challenges found in the Aral Sea Basin. The Water Convention's Syr Darya nexus assessment supplied input and orientation regarding relevant concerns and possible solutions, and has contributed to raising awareness, thereby facilitating further nexus work.

The Drina assessment is also an example of an awareness-raising synergy. Through the Drina assessment, the nexus gained momentum in the Western Balkans, and the project has contributed to the debate on trade-offs related to the development of hydropower potential, while also raising awareness about related environmental considerations in the Energy Community, among others. The regional round table "Operationalizing the Water, Food, Energy and Environment Nexus in South-Eastern Europe (SEE)", held in June 2017, used key inputs from the Drina assessment. The project "Promoting the Sustainable Management of Natural Resources in Southeastern Europe, through the use of Nexus approach", carried out in cooperation with GWP-Mediterranean, contributes to the South-East Europe 2020 Strategy, which includes "advancing the water, energy and food nexus approach at national and transboundary levels" as one of its objectives.

4.3.1 Synergies with GEF projects and the potential value of a nexus approach

The Global Environment Facility (GEF), a major funding mechanism for multi-country collaboration, invests in the

[2] Available at: www.nexus-dialogue-programme.eu/about/nexus-regional-dialogue-programme/

TABLE 9
Synergies with other processes

ACTIVITIES UNDER THE WATER CONVENTION	CATEGORY	ORGANIZATION	PROJECT/ACTIVITY	SYNERGIES
Water Convention activities (nexus assessments)	Global	UN	High-Level Political Forum (HLPF) on Sustainable Development	Nexus experience was shared to inform debate on sustainable development, as well as to facilitate implementation of the 2030 Agenda. The HPLF quoted emerging insights from nexus assessments in its Issue Brief 5, "From silos to integrated policy making" (2014). The transboundary dimension and other aspects of nexus experience were highlighted also in 2018 during the HLPF's preparatory Expert Group reflection on SDG interlinkages.
		UN-ECE	Espoo Convention Protocol on Strategic Environmental Assessment (SEA)	While the nexus assessments have promoted SEAs in particular, they also promote EIAs as instruments for fostering the kind of intersectoral coordination that the nexus approach calls for.
			Benefits of Cooperation	Since 2016, nexus assessments have included a "benefits of cooperation" perspective.
		International Institute for Applied Systems Analysis (IIASA)	Integrated Solutions for Water, Energy and Land (SWEL)	Exchange of experience
		GEF	GEF IW:LEARN	Within the IW:LEARN framework, the Water Convention secretariat provides training and programmatic support on the nexus approach to address the WEFE nexus in the IW portfolio of projects. Experience in developing a nexus assessment can inform reflection on mainstreaming the nexus approach into GEF IW projects.
		UN Department of Economic and Social Affairs (UN-DESA)	Global Modelling Tools for Sustainable Development	Exchange of experience Analytical support to countries to help inform policy
		European Commission and GIZ	Regional Nexus Dialogues (RND)	In the RNDs, experience, conclusions and recommendations from the nexus assessments have informed the shaping of the Regional Dialogues, and particularly in the Niger Basin and in Central Asia, while also contributing to the Dialogue in Latin America.
	Regional	European Commission	European Water Initiative's (EUWI) National Policy Dialogues (NPDs)	There are parallels in implementation through an NPD process that allow for discussion of nexus findings.
		UN-ECE Group of Experts on Renewable Energy (GERE)		The GERE framework helps initiate discussion on the value of intersectoral synergies for the development and generation of renewable energy sources (RES): one such output is a joint policy document on the nexus and RES. This interaction has progressed to the positioning of nexus work to inform RES investment talks on water resource considerations.
		Sustainable Energy for All (SE4ALL)	Progress towards sustainable energy in the UNECE region	Notable examples include the providing of space for broadening stakeholder dialogue ("Pathways to Energy") and the *UNECE Regional Report for the Global Tracking Framework – Progress toward Sustainable Energy.*
	Sectoral	IUCN International Water Association (IWA)	Natural infrastructure in the nexus	
Alazani/Ganykh assessment	Regional	GEF	GEF project: "Reducing Transboundary Degradation in the Kura Ara(k)s River Basin"	The pilot study was a collaboration with the GEF project, thus providing an opportunity for mutual learning.
	Sectoral	UN-ECE GERE	Renewable energy investment "Hard Talks"	Stakeholders in renewable energy (policymakers and investors) in Azerbaijan recognized the importance of the nexus approach for renewable energy development.

TABLE 9 (CONTINUED)
Synergies with other processes

ACTIVITIES UNDER THE WATER CONVENTION	CATEGORY	ORGANIZATION	PROJECT/ACTIVITY	SYNERGIES
Syr Darya assessment	Regional	European Commission	EU Nexus Dialogue in Central Asia	The nexus assessment provided input for scoping and contributed to the identification of issues for nexus dialogues implemented by the Regional Environmental Centre for Central Asia (CAREC) and IUCN. The assessment also raised awareness about the nexus concept in the region, benefiting subsequent initiatives.
		OECD		Experience with various tools was exchanged. There was also input from OECD to the nexus assessment on economic instruments. Discussion was promoted about conclusions reached in the framework of the NPDs.
		UN Special Programme for the Economies of Central Asia (SPECA)		SPECA's Thematic Working Group on Water, Energy and Environment (TWG-WEE) provides a framework for discussing conclusions with Central Asian governments as a follow-up action. The nexus conclusions lay out a broad set of optional issues for the TWG to consider.
	Sectoral	FAO	Aral Sea Basin Initiative	The nexus assessment could draw on experience from the project. FAO provided support and expertise for a scenario exercise in the Syr Darya nexus workshop.
NWSAS assessment	Regional	UN-ESCWA	ESCWA nexus activities	The nexus solutions identified by ESCWA for the region serve as inspiration for the discussion on solutions in the NWSAS basin.
		GWP Swedish International Development Cooperation Agency (Sida)	Project "Making Water Cooperation Happen in the Mediterranean"	The nexus assessment contributes to the Shared Vision for management of the NWSAS. Specifying the benefits of cooperation is helping to make a case for stronger transboundary cooperation in the region.
Sava assessment	Regional	International Sava River Basin Commission (ISRBC)	Implementation of the Framework Agreement on the Sava river basin	The nexus assessment contributed to the Strategy for Implementing the Framework Agreement on the Sava River Basin by strengthening coordination with sectoral stakeholders, particularly in the energy and agriculture sectors.
		Austrian Development Agency (ADA) GWP-Med	Western Balkan Sub-Regional Nexus project: "Promoting the Sustainable Management of Natural Resources in Southeastern Europe"	Awareness-raising about the nexus approach Further analysis of nexus issues and benefits of related actions, possibly including the Drina Basin
		Joint Research Centre (JRC)	Danube Water Nexus Project	Complementary analysis with JRC on the Sava River Basin provides a larger set of tools, and consequently a broader range of issues to be analysed.
		Western Balkan countries, EU countries	2017 Western Balkans Summit (Trieste Summit)	At the Trieste Summit, the nexus approach inspired input on infrastructure from the International Sava River Basin Commission.
Drina assessment	Regional	Various	Regional initiatives including hydropower	The nexus approach has gained momentum in the Western Balkans. In particular, the Drina nexus assessment contributed to the debate about trade-offs and benefits related to hydropower development. This was timely, as the "Western Balkans regional hydro-power master plan" was prepared in parallel.
		Regional Cooperation Council		One contribution to regional process is the SEE 2020 Strategy's implementation efforts on the nexus topic, the "Environment" pillar, which entails "advancing the water-energy-food nexus approach at the national and transboundary level".
		GEF	GEF/World Bank West Balkans Drina River Basin Management Project	The Drina assessment contributed to the basis of information used in the Transboundary Diagnostic Analysis.
	Sectoral	Energy Community	Own platform	The Drina assessment drew attention to the need to revisit hydropower potential estimates and environmental needs in the Western Balkans.

TABLE 10
Interaction of nexus assessments under the Water Convention with GEF International Waters projects

BASIN	NATURE OF SYNERGY AND INTERACTION	EXPERIENCED VALUE ADDED	FURTHER OPPORTUNITIES
Alazani/Ganykh	Phase 1 of the GEF Kura project co-organized the nexus assessment workshop, and supported identification of stakeholders and stakeholder liaisons. Studies carried out in the project provided some useful sources of information.	Nexus issues were not taken as much on board as they could have been, for several reasons: the "nexus assessment" approach was still in early development; there were neither the resources nor adequate data with which to carry out substantive quantitative analysis; and the project was already at an advanced stage of Strategic Action Programme preparation. In addition, the action related to the energy sector that the nexus assessment calls for extends beyond the GEF project's scope.	The new, bilateral Kura GEF project for Azerbaijan and Georgia can potentially address some identified nexus-related issues. The bilateral agreement on waters shared by these two countries in the Kura River Basin, currently under negotiation, would also provide a framework for some intersectoral action.
Syr Darya	There was no interaction because there was no active GEF project at the time.[3]	The nexus assessment process is helping to create conditions in the Central Asia region to better enable cooperation on water resources, while benefiting other sectors as well. Added value is demonstrated in the number of sectoral actions in the field of energy, some of them at regional scale. Such actions are focused on the basin only, and are not identified as focusing on water management.	Actions outlined in the nexus assessment will hopefully create more fertile ground for initiating further GEF International Waters projects. A sustainable energy transition that adopts the nexus process would be complementary to any GEF-supported action.
Sava and its tributary the Drina	The nexus assessment was coordinated with the GEF project on the Drina River Basin, which was under preparation at the time (as were its forerunner projects), and efforts were made to share the gathered and developed information.	As several projects contributed towards providing sufficient quantities of necessary information on transboundary issues, it was not deemed necessary to carry out a fully fledged GEF-led Transboundary Diagnostic Analysis (TDA) of the Drina Basin. One of these projects was the Drina nexus assessment: the energy-system modelling for optimizing the operation of hydropower plants through cooperation in the nexus assessment contributed insights from the energy sector on flow regulation.	Drina nexus assessment spin-off projects could complement some flooding- and climate change-related actions to which the GEF project devotes significant attention. Also, the developed energy-system model could bring added benefits to any investigation of flow-regime optimization.
Drin	In cooperation with GWP Mediterranean and UNDP, the GEF TDA complements the thematic report on the WEFE nexus.	The nexus approach contributes to a more comprehensive understanding of impact drivers on waters, especially regarding energy sector development and operation.[4] While building on the diagnostic work (i.e. desk study and analysis) done during the preparation phase of the Drin GEF project, the nexus assessment can point to possible gaps and synergies related to, among others, energy policy, forestry and trade in agricultural products.	Potentially complementary quantification of selected nexus issues and solutions can be performed with the nexus assessment's spin-off project in the Western Balkans, led by GWP Mediterranean.
NWSAS	The nexus assessment can build on some of the earlier technical diagnostic work and tool development, most notably on aquifer models.	The nexus assessment allows reengagement, and on a broader basis, with the legacy of GEF-supported work on the NWSAS. The assessment also has notable synergies with some of GWP Mediterranean's contributing efforts, such as a study of institutional options and development of a "shared vision" for the NWSAS.	Once the countries review the implications of nexus issues for the aquifer and possible response actions in light of the nexus assessment, and following a review of the scope of work of the NWSAS Consultation Mechanism and institutions options outlined with GWP Mediterranean's assistance, various means of support (including investment support) from GEF and/or other development partners will be needed.

[3] The GEF project on groundwaters in the Syr Darya River Basin, developed by UNESCO-IHP, did not proceed to implementation.

[4] E.g. the role of hydropower in flood management; the impact of modern biomass production and forest management on sedimentation.

area of international waters (IW) to facilitate integrated, cross-sectoral approaches towards ensuring the sustainable use and maintenance of ecosystem services. The GEF-6 Replenishment strategy envisaged supporting initiatives to address the water-energy-food nexus. Regarding IW, trade-offs in GEF's "Water–Food–Energy–Ecosystem Security Nexus" were recognized among challenges related to the implementation of Strategic Action Plans (SAPs).[5] GEF:IW projects have traditionally tackled intersectoral issues, and the Transboundary Diagnostic Analysis methodology is a well-established approach for addressing transboundary issues from an ecosystems perspective.

The potential of the nexus perspective to add value to GEF projects and programming merits further attention. This is suggested by the interaction of nexus work under the Water Convention with several GEF-funded IW projects, notably in the Kura, Drina and Drin basins (table 10). Experience with the nexus assessments offers insights that look beyond water management and environmental protection. In particular, ongoing work in the Drina River Basin, in cooperation with GWP-Mediterranean, explores opportunities for the nexus assessment to contribute to identifying a broader spectrum of root causes of transboundary issues deriving from the energy and agriculture sectors, and which extend geographically beyond the basin area.

The nexus assessment process (or some of its elements) could complement GEF:IW projects, and perhaps projects within other GEF Focal Areas, in different ways, such as:

- broadening the scope of the diagnostic and contributing to a better understanding of sectoral and economic drivers of impacts on waters (e.g. energy policy, trade dynamics);
- providing analytical tools that can integrate multiple resources and process complex feedback, thus allowing for wider and more comprehensive diagnoses;
- identifying beneficial actions and motivating actors from economic sectors; and
- revisiting water-cooperation scenarios on a wider basis.

Extended dialogue with economic sectors about cooperation scenarios – and, eventually, synergetic action leading to environmental benefits – would be beneficial. Investments to address the nexus under the GEF-7 Replenishment cycle include integrated watershed management and land management, as well as supply-chain approaches, but generally have a water-management and water-services focus.[6]

Through the GEF: IW Learning Exchange and Resource Network (GEF IW:LEARN 4), nexus work under the Water Convention supports training and the provision of programmatic support to the GEF IW portfolio of projects. IW:LEARN can mobilize the experience and insights of GEF agencies and provide a channel for knowledge mobilization to support GEF programming. In parallel, increased awareness of Governments about nexus issues can assist in the identification of value-adding opportunities, whereas cross-sector action, informed by enhanced investigation, could also make a difference.

4.4 Engagement with other sectors

The involvement of all relevant sectors is a key part of the assessment exercise. At the same time, the framework that the nexus assessments use is the Water Convention. This is important for ensuring official engagement, but it also implies an emphasis on water resources as the entry point (see section 4.1.2). To achieve a good balance by extending equal consideration to each sector, it is important to seek out partners within other sectoral mandates and to involve them in nexus work.

Increased engagement from the economic sectors in recent years has resulted in greater overall awareness about intersectoral issues and possible solutions. The Drina assessment provides an illustrative example of involvement from all sectors, which in this case were: energy, water management, agriculture and rural development, and environmental protection.

4.4.1 Food and land management

SECTOR INTERESTS AND BENEFITS

The food and land management sector is purposely broad by definition. While there is an evident relationship between increased food demand and the use of natural resources, there are other aspects of the agriculture sector (e.g. biofuels production, modernization of agrifood value chains, food trade) for which the nexus assessment offers a good platform for intersectoral and international dialogue. There are also land management-related concerns in the forestry sector – and potentially in the fishery sector – that should not be neglected when exploring the nexus.

Agriculture is closely interlinked with water, energy and the environment. A globally growing need for food in coming decades will place enormous burdens on agriculture, and efforts to step up food production will require improvements to irrigation systems, both in terms of efficiency and net-

5 GEF. International Waters Focal Area Strategy. (Extract from GEF Assembly Document GEF/A.5/07/Rev.01, May 22, 2014).Available at: https://www.thegef.org/sites/default/files/documents/GEF-6%20Programming%20Directions.pdf

6 GEF-7 Replenishment: Programming directions. Fourth Meeting for the Seventh Replenishment of the GEF Trust Fund. (Stockholm, 2018). Available at: www.thegef.org/sites/default/files/council-meeting-documents/GEF-7%20Programming%20Directions%20-%20GEF_R.7_19.pdf

work extension. Cooperation between sectors and countries can increase the availability of water for agriculture through smarter allocation, and multipurpose dams can supply water for a variety of sectors and purposes, including irrigation. In terms of providing energy, electrical power is best suited to support intensive groundwater irrigation, and also serves to meet multiple energy demands, including food processing and water desalination. International agreements on energy and food trade could significantly reduce pressure on local resources, and trade can help to better align food production with specific agroecological conditions in different countries.

At the same time, food production also affects water quality and the surrounding environment through the discharge of agricultural effluents and land-use modifications. In turn, environmental degradation can seriously compromise agricultural production – through soil degradation or loss of biodiversity, for example. Degradation, loss and poor management of forested areas can also bring significant pressure to other sectors, most notably by affecting sedimentation and compromising water retention in flood-prone basins.

4.4.2 Energy

SECTOR INTERESTS AND BENEFITS

One obvious nexus-derived benefit for the energy sector is the coordination of hydropower activities. In a hydropower cascade, overall electricity production can be increased by coordinating plant operations according to a common schedule of water discharge. By altering natural flows, hydropower always has some level of influence on the environment and river ecosystems, as well as on water availability for other uses. This being the case, its operation must be closely coordinated with other sectors in river basin planning and management to reduce trade-offs and to increase synergies. A crucial coordination need is to effectively improve system readiness to respond to floods or droughts. As with international food trading, energy trading introduces possibilities for improved energy supply and efficiency by making different sources available in different countries, and the energy sector more widely acknowledges the nexus as a platform for doing this.

Energy production from thermal power plants can be highly water-intensive and also requires close coordination with other water-using sectors in the basin. Water services play a crucial role in energy demand management, as water utilities (water distribution networks, wastewater treatment plants) are often a municipality's major electricity user and thus harbour untapped potentials for energy efficiency. Bioenergy is also an important part of the nexus.

The fact that the aforementioned aspects can be brought together under a nexus approach can benefit the energy sector as a whole, and this is becoming more widely recognized.

INVOLVED ORGANIZATIONS AND WAYS OF INVOLVEMENT

The Group of Renewable Energies (GERE) is involved in nexus activities under the Water Convention. In 2017, GERE and the Task Force on the Water-Food-Energy-Ecosystems Nexus jointly produced a publication to address the energy sector. The publication brings experience gained from the nexus assessments to the attention of a diverse range of renewable energy stakeholders. It also describes the role of renewable energy in the nexus, reviews some related opportunities and provides some helpful examples.

There are other notable examples within the framework of cooperation with GERE. For example, nexus issues in a renewable energy context were discussed with energy sector representatives on the occasion of the "International Fora on Energy for Sustainable Development" in Baku (2016) and in Astana (2017). Both events helped to raise the visibility of assessment results within the energy sector.

Renewable Energy Policy "Hard Talks", organized by ECE, have taken place in Azerbaijan, Ukraine, and Georgia. The nexus perspective is finding its way into these events in more explicit detail through discussions on renewable energy investment. Recommendations made during the talks in Azerbaijan refer to taking a nexus approach on issues related to energy efficiency and environmental protection. Forthcoming State-level "Hard Talks" in three Drina River Basin countries will be devoted in part to the nexus theme, and the exchange of experience and cross-border coordination will be promoted through a three-country follow-up workshop.

Other energy stakeholders have been reached out to as well, including the Energy Community. Through its platform, the Drina assessment not only sparked discussion with energy companies on cooperation in the Drina River Basin, but also triggered the need to revisit estimates of hydropower potential in the Western Balkans region, notably taking into account the environmental needs and links to water management (table 7). Further outreach has been made to IRENA, for example.

The involvement of local utilities and experts with knowledge of the energy sector in the basin region being assessed is also instrumental in terms of recognizing existing opportunities. In the Syr Darya assessment, for example, it was possible to estimate the impact of energy efficiency measures to reduce dependency of hydropower production in the basin. Attention to specific sectoral goals adds to the weight of messages being discussed among representatives of the Governments. For instance, the Syr Darya assessment informed the Central Asian countries in the Thematic Working Group under the UN Special Programme for the Economies of Central Asia (SPECA) in Baku in October 2016 to acknowledge that SDG 6 and SDG 7 are very closely interlinked, and that an intersectoral approach is needed to implement the SDGs – and also that such an approach should also be considered in the course of developing the respective National Action Plans.

4.4.3 Ecosystems

SECTOR INTERESTS AND BENEFITS

The term "ecosystems", here as a component of the nexus, is understood in a broad sense and extends to the natural environment. In a "resource" sense, it refers to ecosystem services within the sector environmental protection. Despite their important role in a nexus, ecosystems too often receive little attention in assessments and in debates.

The nexus sectors all profit from intact ecosystems through the multiple services they provide (provisioning, regulating, habitat-supporting, and cultural-recreational). At the same time, the economic sectors always have some sort of impact on ecosystems, and the sum of all human activities has an increasingly damaging effect on their proper functioning. Energy production depends on ecosystems, both as sources of energy (hydro, solar, wind, bioenergy, fossil fuels) and as sinks for pollution (water, land, and air). Agriculture needs healthy ecosystems, and at the same time influences them through utilization and land-use changes. The water sector uses ecosystems as sources for freshwater and as sinks for pollution from domestic, municipal, agricultural and industrial effluents.

Concrete actions can improve sector sustainability, including agricultural orientations that help to preserve nature, the environment and biodiversity. An emphasis on high-quality traditional or organic products can increase the value of agricultural production, and can also contribute to greater biodiversity conservation and environmental protection. Environmental flow regulation can help ensure adequate water flows during dry seasons, which has positive effects on biodiversity, fisheries and agriculture. Local communities looking to generate income from ecotourism can strike a balance with nature-conservation objectives through, for example, the construction of minimal-impact paths in biodiversity-rich areas. Green infrastructure can be a smart alternative to grey infrastructure: wetlands, for example, can help lower flood risks, while at the same time restoring the capability of natural systems to filter and depurate water.

At present, it is clear that environmental and ecosystem concerns remain in the background. The introduction of "ecosystems" as a fourth nexus component was, in fact, a way of signalling that environmental needs should be put forward together with those of energy, food, and water security. Ensuring integrity of ecosystems and their sustainable use is necessary for continued enjoyment of their services. In fact,

ecosystem preservation is very often perceived as a long-term problem, and environmental protection is too often considered in juxtaposition to economic development; and putting the ecosystems at the centre of the nexus dialogue, including in the identification of solutions, has often proved challenging as a result. It is also clear, however, that many countries and regions are demonstrating a palpable will to shift towards a greener, more circular economy, and that there is a need for more platforms to allow for the elaboration of policies, plans and projects to forge this will into action. Regarding environmental flows and food production, more attention needs to be given to approaches and methodologies available to assess the values of ecosystem services and nature-based solutions.

INVOLVED ORGANIZATIONS AND WAYS OF INVOLVEMENT

The International Union for Conservation of Nature (IUCN) is involved in the nexus by having undertaken joint work on infrastructure with the International Water Association (IWA) – notably on hydropower. Through the entry point of the Aral Sea Basin Program, the Regional Environmental Centre for Central Asia (CAREC) and IUCN are helping Central Asian countries to identify opportunities for multisectoral investments for increased water, energy and food security that promote socioeconomic development while maintaining ecosystem integrity and sustainability. IUCN is also involved in sharing experiences related to its nexus activities – during the global stocktaking workshop, for instance.

Recent efforts under the Convention on Biological Diversity (CBD) have been devoted to tackling the "mainstreaming of biodiversity within and across sectors and other strategic actions to enhance implementation", targeting, among others, the energy and infrastructure sectors. Nexus experiences under the Water Convention have been shared on this topic as well: the importance of the value of ecosystems and the protection of biodiversity was illustrated with the conclusions of the Drina assessment. These are crucial assets for sustainable development, and efforts to strengthen the agriculture sector through expanded organic farming and the development of ecosystem-friendly tourism will be beneficial.

Finally, the engagement of local environmental NGOs can ensure that the specificity of environmental issues and singular opportunities to develop environment-friendly initiatives will be captured in each assessment. Guidelines that synthesize good experience and help harmonize approaches can provide direction for local efforts. In the Sava assessment, where a need for simultaneously sustaining or improving the ecology and enhancing the quality of life for rural communities was recognized, the Guidelines for Transboundary Ecotourism, developed in the ISRBC framework, was highlighted as a reference for concrete possibilities for sustainable development of tourism.

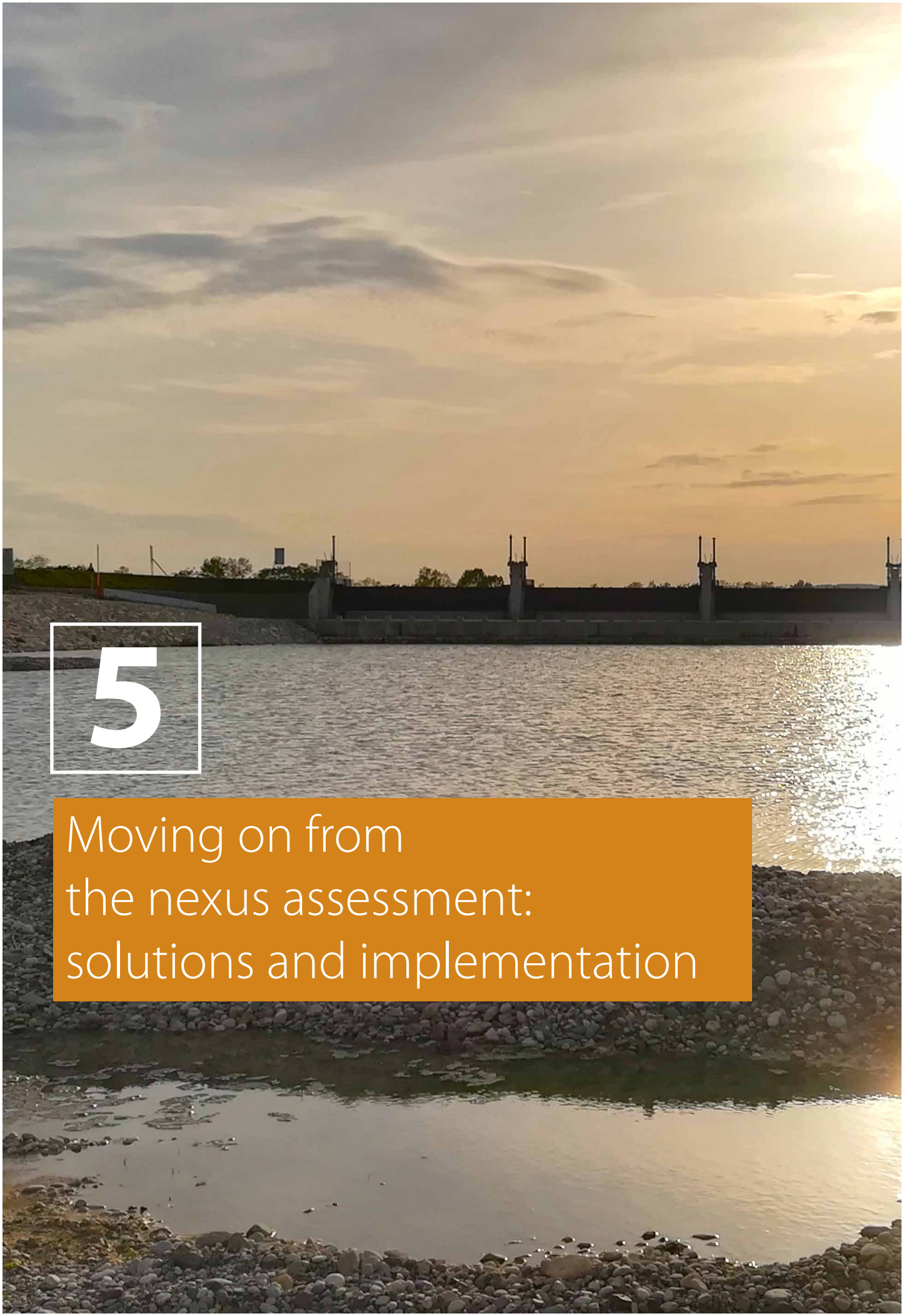
4.5 Transparency about information and tools used is crucial

Resource management action is impeded if salient information is not available to all concerned sectors or to relevant government ministries. Obtaining the necessary information basis and forming a holistic picture of a situation is, however, particularly complicated in a transboundary context. Here, harmonized indicators, information and data are needed from all the relevant riparian parties, and having a database in place can catalyse information exchange within a variety of fields.

Data gaps do not prevent joint identification of intersectoral issues. Data gaps will always exist, but they do not necessarily impede analysis of nexus issues and solutions, nor do they prevent authorities and other actors from addressing problems through resource management decisions and policy. Typically, some kinds of data are available to start with. Resource-sharing countries that agree on a qualitative basis about priority issues bring a value that should not be underestimated. At the same time, while the flexible approach of the nexus assessment allows for adaptation based on the availability of data, it is important to understand the limits that data gaps can bring to the analysis and to call for better information, particularly when the elaboration of appropriate solutions depends on its availability. Reasonable assumptions, estimates and expert opinions can fill some gaps, but caution must be exercised in their use and transparency is necessary.

Despite the progress in the analysis of interlinkages across sectors, there remains a need for advanced models and tools that are able to provide analysis that better serves evidence-based policy development and helps to answer questions related to topical resource management. The list of available nexus tools in this *Synthesis* publication shows the advances that have been made thus far (section 3.9).

Decision-making in the realm of resource policy would benefit from reliable tools that draw a somewhat realistic picture of reality. However, it is important to acknowledge that there are still significant obstacles to the creation and use of nexus tools, such as the availability and accessibility of specific data sets, or the lack of a robust list of indicators.



5

Moving on from the nexus assessment: solutions and implementation

5 Moving on from the nexus assessment: solutions and implementation

5.1 Nexus solutions and packages for implementation

The nexus assessments of each basin considered in this publication conclude with the identification of possible "nexus solutions" that national and regional authorities and decision-makers, as well as other concerned stakeholders, can implement. A "nexus solution" can be defined broadly as "an intervention that would benefit more than one sector, in this context including also interventions that reduce the pressure on ecosystems (or the environment at large)." This means that nexus solutions can materialize not only as the concerted action of multiple parties but also as the action of one sector that brings cross-sectoral benefits.

The primary focus of nexus solutions is on governance, and their purpose is to assist decision-makers (and the Governments of riparian countries in particular) in moving ahead to create an environment that will enable solutions to be implemented which can reduce negative intersectoral impacts and improve sustainability in managing basin resources. While not all solutions are blueprints for any given basin, they can serve as sources of general inspiration. Transboundary coordination can assist in the implementation of solutions that bring the most optimal effects. At the same time, some specific solutions might be most pertinent for a particular riparian country, and a national action might be capable of delivering intersectoral and transboundary benefits.

When developing the TBNA methodology, five categories of solutions (the "5 I's") were defined: (i) Institutions, (ii) Information, (iii) Instruments, (iv) Infrastructure (and investment), and (v) International coordination and cooperation (Table 11). This categorization into groups helps to facilitate the participatory process of identifying solutions (see section 3.6). It also helps in terms of communicating solutions to groups with different areas of interest. Naturally, the categorized solutions are often connected to a high degree, and sometimes even overlap.

The added value of the nexus approach – as opposed to sectoral approaches – is not in so much in the identification of individual solutions, but rather in their combination and coordination. Hence, nexus assessment solutions are typically presented in the form of packages to be implemented in response to a specific issue. For instance, if a priority issue is the occurrence of flash floods and vulnerability to their effects (as in the case of the Alazani/Ganykh), the package of nexus solutions may include multisectoral action, the beneficial impacts of which can be direct or indirect. If, on the other hand, cooperation-related challenges stand to make transboundary solutions more difficult to achieve (as in the Syr Darya River Basin), the package can be designed as a series of progressively cooperative actions to be implemented over time (see table 12).

5.2 Prerequisites for implementing nexus solutions and the importance of governance

Nexus assessments aim to bring stakeholders together, to increase the knowledge base to support decision-making, to promote dialogue between the countries and sectors, and to identify nexus issues and solutions. The implementation of identified solutions, however, goes beyond the aims of the assessment: implementation is about achieving enhanced coordination and cooperation between countries and sectors to manage basin resources, to reduce trade-offs and increase synergies, and to eventually achieve a more efficient use of resources through enhanced governance structures and technical measures.

The willingness of Governments, along with their decisions to respond to the jointly developed conclusions and recommendations, are vital for the formulation and implementation of concrete policy and management responses. While international organizations can provide support, political willingness, informed decision-making and effective coordination of response measures are necessary to reap the benefits from the identified nexus solutions in order to improve the quality of transboundary resources management. The integrated and intersectoral nature of packages of solutions makes it more complicated to champion their implementation, making it necessary to form partnerships that extend beyond water management.

Nexus implementation will truly take off when identified nexus solutions and their related targets and instruments are included in national and sectoral strategies and plans. Strong multisectoral planning enhances the effectiveness of implementing nexus solutions. This applies also to transboundary planning, and to national-scale coordination efforts. For such action to materialize, as illustrated by some categories of solutions below, some preconditions are necessary in terms of governing the nexus.

TABLE 11

The five categories of nexus solutions, as used in the nexus assessments under the Water Convention

SOLUTION CATEGORIES	EXAMPLES
Institutions Spanning from institutional reforms to improved institutional cooperation and governance culture.	• Clarify **roles and responsibilities** (e.g. regarding the involvement of national and local governments in rural development, or in the management and financing of irrigation schemes • Set up or improve existing **mechanisms for coordinating across sectors** at the national and/or transboundary level (e.g. climate change adaptation planning and sustainable development strategy development). • Set up or ensure **coherence between sectoral strategies**: that is, by seeking complementarity and avoiding counter-productivity (e.g. across strategies for energy sector development, climate action and/or environmental protection).
Information Improving collection, accessibility and communication of data, information and knowledge related to basin resources and their dynamics.	• Improve **monitoring** of resource availability, quality, uses etc. (e.g. to ensure resilience of energy generation and agricultural production), as well as weather forecasting and predicting consumption patterns etc. • Identify **policy implementation barriers** (and cross-sectoral actions in particular). • Introduce and improve **standards** (e.g. for buildings) and develop and apply integrated planning principles and guidelines. • **Share data** across borders (e.g. for flood preparedness) and with users (e.g. through appropriate extension services in agriculture).
Instruments Defining and implementing various instruments to address trade-offs and promote synergies in the management of natural resources and environmental protection.	• **Policy instruments** (e.g. implementation of the Strategic Environment Assessment, setting up detailed targets for renewables and energy efficiency etc.) • **Economic instruments** to provide incentives for rational and sustainable resource use (e.g. tariff-setting on water, cross-subsidization of energy, application of "user pays" and "polluter pays" principles etc.) • **Legal instruments** (e.g. defining minimum environmental flows, agreements and protocols)
Infrastructure (and investments) Planning (i.e. designing, siting, financing) and modernizing or modifying existing infrastructure.	• Direct investments towards **multi-purpose and environmentally sound** infrastructure projects (both "grey" and "green"). • Improve resource **efficiency** in transmission and conveyance networks on the user side as well, taking into account indirect and cross-sectoral impacts (reducing water leaks in irrigation networks, for example, may save electricity; at the same time, improving a farm's efficiency may result in higher energy consumption). • Account for different needs (including environmental needs) in **optimizing the use of existing structures.**
International coordination and cooperation The most cross-cutting category: solutions of this type are aimed at broadening the scope of transboundary cooperation and identifying common priorities.	• Improve **basin-wide** monitoring, data verification and exchange, as well as knowledge-sharing (particularly on the development of tools to quantitatively analyse resource flows, impacts and benefits at the basin level or the regional level). • Define areas of **common interest** for regional development and potential **complementarities** of resources (e.g. agricultural land and forests) and policy goals (e.g. environmental protection and tourism development). • **Facilitate trade** (e.g. agricultural goods, electricity) to boost local economies; improve water, energy or food security; and/or optimize the use of resources and infrastructure at the regional level (e.g. addressing obstacles to trade to cut the need to produce water-intensive crops on national territory under unfavourable conditions). • Develop **common rules** and joint guidelines for key sectors (e.g. navigation, hydropower, ecotourism).

TABLE 12

Examples of nexus solution packages from the basin assessments that require multisectoral response actions

NEXUS ASSESSMENT	EXAMPLES OF SOLUTION PACKAGES
Alazani/Ganykh	**Addressing the effects of flash floods and sedimentation** **Instruments –** Facilitate access to modern energy sources: reducing biomass use (wood) would reduce forest degradation, thereby limiting erosion and sedimentation of the watercourse, which has negative downstream impacts (deformation of the river channel, siltation of infrastructure). **Institutions –** Clarify the responsibility of riverbank maintenance, and strengthen the capacity of institutions working in forest conservation and management. **Infrastructure and International coordination and cooperation –** Improve crossborder trade of fuels that can be substitutes for biomass (e.g. natural gas), and apply good international practices and guidelines in the development of renewable energy sources.
Sava	**Improving intersectoral coordination in the basin by improving existing mechanisms of cooperation** **Institutions and International coordination and cooperation** – Assess options for extending and strengthening the mandate of the International Sava River Basin Commission (ISRBC) to more effectively reconcile different water and development needs in the basin. With a broad water management and navigation mandate and experience from coordinating plans concerning multiple sectors, ISRBC is in a good position to: (i) engage stakeholders from economic sectors in the dialogue over basin management, and (ii) provide a platform for consultation and assessment of basin-level impacts of sectoral development plans.
Syr Darya	**Taking progressive, cooperative action to reduce pressure on the basin's resources from water-intensive agriculture and a high dependency on hydropower for electricity generation** **Instruments, Infrastructure, Information, and International coordination and cooperation –** National governments can take "no regret" actions that can reduce transboundary impact and pave the way to restoring transboundary dialogue. These actions include: improving energy and water efficiency and diversifying energy sources (short term: national policy); facilitating trade of agricultural products, re-establishing regional power interconnections and vitalizing the energy market (medium term: non-water, international cooperation); improving intersectoral coordination through greater representation of relevant ministries and enhanced sharing of information at the basin level (long term: restored water cooperation).
Drina	**Improving cooperation among dam operators to minimize flood risk, while optimizing hydropower production at the basin level (co-optimizing flow regulation)** **Institutions –** Develop a formal agreement on coordinating the operation of hydropower plants (set up a contact group for discussing flow regulation); take advantage of existing platforms to achieve better dialogue between the hydropower sector and other sectors at the international level (i.e ISRBC and the Energy Community). **Information –** Improve the operation of hydrometeorological monitoring and early-warning systems, and develop integrated forecasting models; share information on hydropower operations. **Instruments –** Harmonize legislation on hydropower; carry out transboundary Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) of programmes and projects requiring infrastructure in the basin, including for energy projects; apply guidelines for sustainable hydropower. **Infrastructure –** Revise or update feasibility plans of new power plants; develop non-hydro renewable energy infrastructure to reduce dependence on coal and on water resources from the basin. **International coordination and cooperation –** Develop an agreement on flow regulation between the riparian countries; harmonize approaches to environmental flow; improve cooperation in the operation of hydropower plants in event of floods and extreme weather events (through better emergency preparedness and response planning); establish a unified and modern hydrometeorological system.

At present, national and transboundary governance structures are often not well-enough set up to favour intersectoral action. Countries aiming to implement nexus solutions are not required to set up a nexus-governance apparatus. While this situation can be improved, there is first the need to share possible options. One option among many is, concretely, to identify benefits of joint action that can motivate improvements, for instance, through joint investments or transboundary agreements that are developed with a nexus mindset and include a broader range of benefits.

Existing transboundary cooperation and intersectoral coordination frameworks can be built on as well: for example, joint bodies for cooperation could convene discussions on basin-level impacts of sectoral plans, or reinforce dialogue among sectoral actors. When these organizations already have a multisectoral scope, a good basis is set for evaluating, consulting or negotiating about intersectoral activities. National-level arrangements for monitoring and coordinating the implementation of SDGs can provide another framework where nexus solutions would add value. In the same vein, an elaboration of the potential impacts of these solutions in terms of progress towards meeting SDG targets would also be beneficial.

Investing "better", rather than simply more, advances sustainable infrastructure in terms of its being more optimally located, more appropriately designed, more responsive to different needs, and bringing fewer negative impacts. Large investments are needed when exploiting nexus synergies for the sectors concerned or when reducing trade-offs between them. Carefully coordinating investments with a focus on multipurpose designs can increase benefits without necessarily increasing costs. Cross-border cooperation on infrastructure can also curb unnecessary or redundant investments in infrastructure.

Sharing information and knowledge is a "must" for cooperation. Wherever possible, countries can improve their decision-making at both the national and the transboundary level when a shared knowledge base exists.

Exploring economic and policy instruments holds great potential for exploiting synergies and reducing trade-offs. Instruments such as water and energy pricing can incentivize resource-efficient behaviour and help in raising funds for infrastructure. Other tools such as cost-benefit analysis and Strategic Environmental Assessment (SEA) can help decision-makers to consider alternatives and investigate possible nexus solutions and their benefits.

Clear messages and communication within each sector and at the national government level is required to help shift policy and organizational structures towards cross-sectoral and transboundary cooperation.

International agencies and donors need to promote regional planning and transboundary cooperation. As national interests and regional interdependencies may push in different directions, the role of global and regional institutions becomes central. This also applies for financiers of development such as multilateral banks, who not only open up opportunities for multisectoral and transboundary projects, but also require adequate environmental assessments when approving such projects. Some development partners are already applying a nexus approach to transboundary issues on a regular basis and plan to continue working in this direction.

Finally, the progressive application of a nexus approach (or even partial solutions) can pave the way for more ambitious and comprehensive solutions, though gradual progress may be necessary in some cases. There are, it should be noted, several limitations to the practical application of a nexus approach in that it requires new ways of thinking and working, new partnerships, and different incentive structures. Nexus action can start, however, with national efforts – through improved efficiency in the use of water and electricity on shared resources, for example – and then build gradually to include favourable conditions for actions that require regional-level or basin-level coordination.

5.3 Limitations and potential bottlenecks

Several challenges remain in terms of reconciling national strategies involving different sectors and a transboundary context, including: conflicting uses of common resources, different water-flow regulations, and questions on how to assess and address environmental impacts.

In carrying out the nexus assessments, continuous adaptations have been made to improve the means of facilitating transboundary cooperation. While the process remains challenging, progress has been made in different areas, notably in the communication and consolidation of governance analysis. Different types of bottlenecks exist, however, in moving beyond the assessment process to embed the work in sector-related and national administration processes. Some of the more critical points in this regard are described below.

5.3.1 Limitations encountered in the nexus assessment process

To begin with, the national focal points taking part in nexus assessments are providing their support in addition to their already full-time engagement with national organizations. As a result, they often lack the time needed to make as fruitful a contribution as they could throughout the entire nexus assessment process. There is thus a need for additional backing from national experts who can spare enough time to support the national focal points during the assessment process.

Overall participation could be broader, and is sometimes insufficient. Through the application of a wide range of participatory methods, the assessment process is now well set up to accommodate expanded participation. It remains a challenge, however, to ensure that this takes place, as it is sometimes the case that not all sectors or stakeholders participate. This problem can often be attributed to time constraints or a lack of resources.

Another problem within the assessment process is that the economically strong sectors of water supply, energy and agriculture tend to overshadow environment protection. For this dynamic to change, the values of ecosystem services need to be better communicated to and analysed within the more dominant sectors.

It is also possible to miss out on important views from sectors and countries that do not participate in the workshops, the key danger being that their non-participation can change the overall outcome of a nexus assessment. Needs that are not represented are unlikely to be reflected in further activities, and this phenomenon can also occur within individual sectors. Limiting energy-sector participation to hydropower specialists will likely draw sole attention to hydropower, while other benefits for the sector as a whole will be far less likely to emerge.

5.3.2 Potential bottlenecks to implementing nexus solutions

It is quite difficult to make the transition from an external process to an internal one, but the nexus assessment needs to move beyond being an external process facilitated by international organizations. One vital step in this direction is to move from externally facilitated activities towards a self-sustaining process within the concerned sectors and countries. Making such a transition calls for the involvement of local champions from civil society and national administrations.

A lack of data limits the potential for proper analysis and, consequently, good decision-making. It is therefore important to create conditions to ensure that data are available in sufficient quantity and quality. There is also a need to upgrade existing tools and models, as well as to increase monitoring capabilities and capacities.

National and sectoral interests are difficult to overcome. Riparian countries generally appreciate that sectors and countries are brought together to develop a shared understanding of nexus issues. However, while common understandings of necessary actions may be developed during the assessments, some actions are often not in the interest of all stakeholders. Some measures that will improve overall resource management may be unlikely to be implemented due to sectoral or national interests standing in the way.

It is also difficult to ensure an equally high commitment from all countries and sectors. Authorities and stakeholders see the value of nexus assessments and appreciate the way the process facilitates exchange across sectors. Nonetheless, the influence of business-as-usual-type thinking is strong, and well-defined entry points and sufficient momentum are needed in order to change deep-rooted policies and practices that are somehow inadequate. Even with the official involvement of all riparian countries and stakeholders in the assessment process, it remains challenging to engage and ensure roughly equal levels of commitment. One possible approach towards addressing this problem is to couple nexus analysis with a benefits assessment.

Follow-up actions are demanding and require sufficient financial resources, and indeed a main point of this publication is that nexus assessments are only the start of a longer process. The assessment results require follow-up: solutions must be discussed in relation to other processes, and decision-makers must be convinced to implement those solutions. To facilitate this process, it is necessary to translate the findings and recommendations into local languages, to broadly communicate and share findings, and to explore further possibilities for countries to continue their discussions. Among these possibilities are the following: further evaluating and demonstrating the benefits of cooperation; drawing attention to opportunities created through investment (including infrastructure investment); supporting targeted dialogue for political engagement and for exchanging experience; and exploring options for guiding and formalizing flow regulation. Such steps are necessary, albeit demanding, and require deeper thinking in addition to sufficient financial resources.

Finally, changes in national administration can introduce both difficulties and fresh possibilities. Personnel from national ministries, focal points and other parts of government administration are most often reshuffled after political changes. While such changes can open up new possibilities for cross-sectoral integration, there is also the risk of losing momentum. When such changes take place within the institutions involved in the process, it is important to be aware of the fact that priorities in terms of transboundary and cross-sectoral cooperation can change as well.

Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins and experiences from its application: synthesis

This *Synthesis* publication covers assessment-derived lessons on interlinkages, trade-offs and benefits in managing water, energy and land/agriculture, as well as on protecting the environment in transboundary basins in Southern Europe, the Caucasus, Central Asia, and North Africa. These lessons are the result of the collective experience of Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) and other States, joint bodies for transboundary cooperation, and other stakeholders who participated in carrying out assessments of the water-food-energy-ecosystems nexus in several transboundary river basins (and one aquifer system).

This publication also consolidates the methodology for assessing nexus issues and identifying solutions in transboundary basins, which was developed under the Water Convention in 2013–2015 and has been applied in seven basins to date. Its development involved a broad range of expertise, gradual refinement upon use, and an intergovernmental review process. The publication was developed in response to a decision by the Meeting of the Parties in 2015 to promote the application of the methodology in other basins worldwide through the sharing of experiences. The publication also aims to foster follow-up action to the nexus assessments.

Coherence between sectoral policies (as well as between environment and climate policies) and integrated planning are major challenges for many countries. Related shortcomings result in negative impacts causing friction between riparian countries, inefficiencies at different levels, and missed opportunities for more sustainable and cooperative development. The international community explicitly calls for a nexus approach in efforts to implement the Sustainable Development Goals (SDGs).

A participatory assessment of the nexus in applying the methodology provides a better basis from which to address these challenges: firstly, through a structured analysis, considering technical aspects and governance across sectors; and, secondly, through intersectoral transboundary dialogue. This process can assist countries seeking to initiate, broaden or revisit transboundary cooperation. Furthermore, the resulting insights can also help reinforce national efforts to optimize resource use (e.g. through improved efficiency), improve policy coherence and achieve co-management benefits.

The main audiences for this publication are authorities involved in natural resources management, regional organizations and cooperation organizations, international organizations, bilateral development partners, and technical experts.

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