



**Convention on the Protection and Use of Transboundary
Watercourses and International Lakes**

**Second Joint meeting of the Working Groups on Monitoring and Assessment and on Integrated
Water Resources Management**

**Working Group on Integrated Water Resources Management
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The Water-Food-Energy-Ecosystems Nexus in transboundary basins

**SYNTHESIS DOCUMENT ON ASSESSING THE WATER-FOOD-
ENERGY-ECOSYSTEMS NEXUS**

Prepared by the secretariat with experts¹

Background and introduction

1. The sixth session of the Meeting of the Parties decided to include in the Water Convention's work programme for 2013–2015 an assessment of the water-food-energy-ecosystems nexus in a representative set of transboundary basins. After development of a methodology for participatory assessment of the nexus in transboundary basins, the methodology was piloted and applied in the first basin assessments. In practice this involved an analysis and an intersectoral transboundary dialogue about trade-offs and synergies in managing water and related resources.
2. The seventh session of the Meeting of the Parties decided in 2015 that the methodology developed in 2013–2015 would be promoted for application by partners in other basins worldwide, including by preparing a synthesis brochure. The Parties also decided that the conclusions and recommendations from the basin assessments would be further disseminated.

* Second joint meeting of the two working groups.

¹ The draft of the document was produced by Mario Roidt with input from Lucia de Strasser, Annukka Lippinen, Roberto Martin-Hurtado, Stephen Stec and Youssef Almulla.

3. From 2016 to 2018, further basin assessments, including assessment of an aquifer, have been worked on, providing further insights into assessing intersectoral issues. In parallel, the methodology has been refined further, especially regarding the governance aspects and use of the participatory methods. Furthermore, a global stock-taking workshop was organized together with partners in December 2016. These developments made it timely to synthesize and take stock of the work done, even if activities were on-going.
4. The present Synthesis Document contains lessons focusing on the methodology, the assessment process and taking the process forward. These have been drawn from the collective experiences of Parties to the Water Convention and other States, joint bodies, as well as other stakeholders who participated in the nexus assessments. Consolidating the experience responds also to the demand for sharing experience on various fora and processes of sectoral or cross-cutting natures at the regional and global levels.
5. The Working Groups are invited:
 - a. To discuss application of the nexus assessment experience, its further use in developing work under the Water Convention, implementation of solutions as well as promotion and dissemination.
 - b. To review the Summary (ECE/MP.WAT/WG1/2018/INF.12-ECE/MP.WAT/WG2/2018/INF.12) and the Synthesis Document, provide any additional comments and entrust the secretariat in cooperation with the lead country to edit into two publications the key content of the Summary and the Synthesis Document, taking into account the comments made and elaborating as necessary;
 - c. To entrust the secretariat to submit a publication synthesizing the methodology and experience in assessing the water-food-energy-ecosystems nexus in transboundary basins, in English for the Meeting of the Parties at its eighth session (Astana, 10-12 October 2018), print and translate it into Arabic, French, Russian and Spanish;
 - d. To entrust the secretariat to submit, publish and print a publication, the Synthesis of solutions to the water-food-energy-ecosystems nexus, in Arabic, English, French, Russian, Spanish in 2019-2020.

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1 INTRODUCTION

1.1 Work under the Water Convention on the water-food-energy-ecosystem nexus in 2018

1. **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 in many basins there is friction between different sectors over water resources, and weak policy integration and coherence between these sectors. To tackle these issues, the Meeting of the Parties to the Water Convention decided in its sixth session (Rome, 2012) that the Water-Energy-Food-Ecosystems Nexus should be assessed in a representative set of transboundary basins. This work is guided and overseen by the Task Force on the Water-Food-Energy-Ecosystems Nexus.²
2. The objective of the work on the intersectoral links, trade-offs and synergies in the water-food-energy-ecosystems nexus carried out under the Water Convention is to foster transboundary cooperation. Assisting countries in optimizing resource use and building capacity to assess and address intersectoral impacts are also among the objectives. The assessment methodology was developed and piloted on the Alazani/Ganykh River Basin under the Programme of Work 2013-2015. The Nexus Assessments on the Sava and the Syr Darya were also carried out, and the one on the Isonzo/Soča was initiated but not completed.
3. Under the Programme of Work 2016-2018, the methodology was further developed and refined, an assessment in the Drina River basin was carried out as a detailed extension to the previous Sava River basin assessment, and the methodology was applied on a transboundary aquifer in the Nexus Assessment of the North-West Sahara Aquifer System. In addition, a global workshop on assessments of the water-food-energy-ecosystems nexus was held to take stock of nexus activities from past years, review approaches and tools to assessing nexus issues, but also to discuss possible management responses.³
4. **These developments made it timely to synthesize and take stock of the work done, even if activities are on-going.**

² Since 2013, the Task Force has met annually and has gradually experienced an increasing participation of non-water actors. The Task Force provides a forum for the Governments involved in the assessments to shape them, to review them and to discuss the findings. It has also been used by partner organizations, experts, development partners and civil society groups to exchange experience in tackling nexus issues.

³ The documents and presentations from the stock-taking workshop are available at: <http://www.unece.org/index.php?id=41736>

1.2 The Synthesis Document on Assessing the Water-Food-Energy-Ecosystems Nexus in Transboundary Basins

This synthesis report has three objectives:

1. Complete the documentation about the use of the methodology;
 2. Promote the application of the methodology;
 3. Foster up action to the Nexus Assessments.
5. **There are an increasing number of partners which have a role in the Nexus Assessment and its methodology.** It is time to summarize the latest developments on the methodology, combined with experiences from its application. Thus, this document compiles all relevant aspects of the methodology and offers all past developments in a comprehensive format. References to details are given for those interested readers who aim to apply the methodology.
6. **The report further summarizes the experiences that are relevant for organisations involved in transboundary resources management.** While the Nexus Assessments can be considered as scoping level, which revealed many lessons learned and nexus solutions, governments now need to further analyse the situation, develop policy and continue to cooperate. This document aims to assist countries in addressing meaningful next steps.

The main target audiences of this synthesis report are:

1. Sectoral authorities of riparian countries within a process of transboundary cooperation;
2. Regional organizations and joint bodies;
3. International organisations which are supporting development and cooperation;
4. Bilateral development partners.

The synthesis document is structured in four main parts.

7. Chapter 2 provides insight into how the nexus has emerged and why it is important for the different sectors and for transboundary cooperation.
8. Chapter 3 focuses on the Nexus Assessment methodology and its specific parts. It also gives a brief overview of the Nexus Assessments that have been carried out under the Water Convention.
9. Chapter 4 describes the lessons that have been learned in the past years of working with the Nexus under the Water Convention. It describes what is important when such a process is designed, which synergies this can have with other, similar, processes and why the engagement of other sectors is so important. Limitations and recommendations on how Nexus Assessments can be improved are also given.
10. Chapter 5 summarizes the manifold solutions that have been developed over the years with the aim to inspire countries and sectors to discuss implementing them.

2 THE IMPORTANCE OF THE NEXUS

2.1 The Rise of the Nexus Notion

11. **Policy fragmentation remains a challenge.** Governments are often organized along sectoral lines which results in a siloed management of environmental resources. While a given administration

may lack interlinkages, the real world is strongly interwoven. From the water perspective, it becomes evident that many factors have impacts on water resources which are outside the strict influence of water management. One may look at the issue from the energy, food, climate, waste, or many other perspectives. The principles remain the same: one sector is influenced by many factors outside its own.

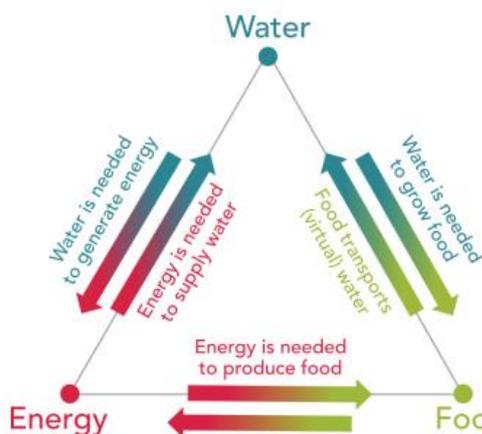


Figure 1: Nexus Interlinkages.
(Source: UNU-FLORES)

2. The interlinkages between water, food and energy have gained attention in the past years. Figure 1 shows an example of how the three sectors are inter-linked. Under the concept of the Water-Energy-Food Nexus, these interlinkages have come into focus with the aim of achieving greater policy coherence as well as higher resource use efficiency through reducing trade-offs and increasing synergies between the sectors. This is well described in Hoff (2011),⁴ the background paper to the 2011 Bonn Nexus Conference.

3. The Nexus concept provides a new way of thinking that is not only limited to the water, food and energy sectors. Other approaches have been described in the recent past, such as the water-soil-waste nexus or the

water-energy-food-ecosystems nexus, both developed under the UN umbrella.

14. **While discussions and research on the nexus have heavily intensified in the past decade, the emergence of the nexus notion can be traced back over several more years.** Beginning in the 1980s, a Food-Energy Nexus Programme was launched. In 2002 the UN World Summit in Johannesburg implicitly recognized the nexus by placing water and sanitation, agricultural productivity and energy among the priority areas. Furthermore, the concept of virtual water and the description that the increasing scarcity of water, food and energy would result in the perfect storm in 2030 inspired the thinking about the nexus. The launch of the World Economic Forum's report *Water Security: The Water-Energy-Food-Climate Nexus* in 2008 and the background document to the Bonn Nexus conference in 2011 then marked the emergence of the nexus as we know it today.
15. **The Nexus is an area of work under the Water Convention.** Water that often flows across national borders is the connecting resource between food and energy. Combined with regional energy markets and international food trade, the Nexus has a transboundary dimension. The Nexus concept was thus incorporated into the work carried out under the Water Convention after 2012. Figure 2a shows some milestones in the Nexus concept's development, figure 2b the timeline of the activities under the Water Convention.

⁴Hoff, Holger. 2011. Understanding the Nexus. Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus. Stockholm: Stockholm Environment Institute (SEI).

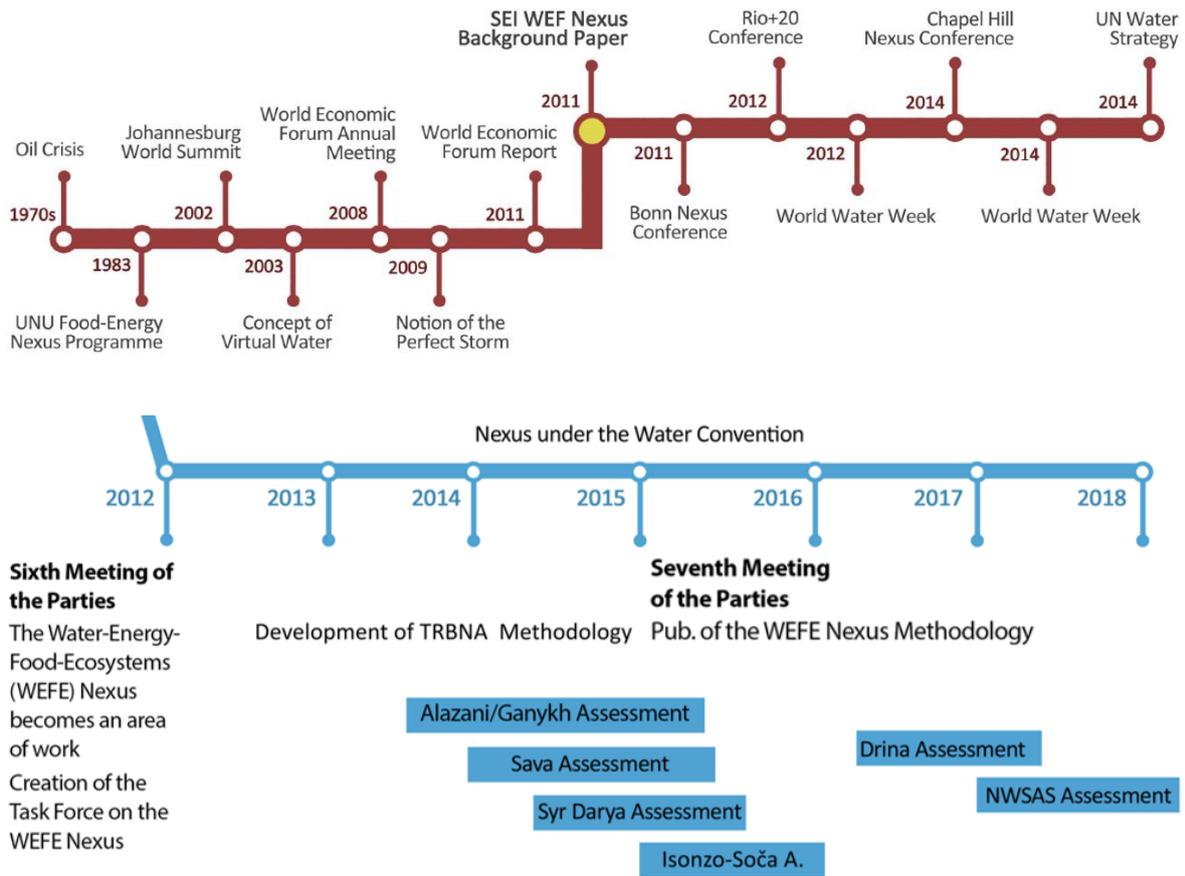


Figure 2: The rise of the Nexus concept (a, above; (modified from Roidt, 2017⁵)) and the timeline of work on the Water-Food-Energy-Ecosystems Nexus under the Water Convention (b). In 2011, various nexus approaches appeared.

16. **Water is commonly a key entry point into the Nexus**, even if the nexus approach is not tied to a basin and seeks to consider the different sectors on a more equal footing. This fact often sparks discussions on the dynamic between the Nexus and Integrated Water Resources Management. These characteristics and differences are well described in scientific literature and have also been reviewed under the Convention, with consideration of national governments and transboundary cooperation, in the publication below.

Pages 2 – 4 in UNECE (2015): Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus. United Nations. New York and Geneva.

⁵ Roidt, Mario. Comparing Integrated Management Approaches to Advance the Water-Soil-Waste Nexus. Master Thesis, TU Dresden, 2017.

2.2 The SDGs explicitly call for the Nexus Approach

17. **The Agenda 2030** for Sustainable Development, adopted by the UN General Assembly, **includes 17 sustainable development goals (SDGs) with a total of 169 targets.** The goals and targets are designed to stimulate concrete action from 2015-2030. The aim is to achieve a fairer, more just, peaceful and prosperous society, balancing the three inseparable dimensions of sustainable development: economy, society and environment.
18. **The SDGs span across a wide spectrum of topics and issues, which inevitably creates interlinkages between different goals.** No one goal can be attained in isolation, but rather only in conjunction with other goals. The interlinked nature of the SDGs requires a holistic, multi-sectoral and multidimensional implementation approach. Given current administrative structures, based on divided sectoral policies, this approach challenges conventional processes and requires different sectors to seek synergies among their individual sectoral development plans and to simultaneously deal with the trade-offs that will inevitably occur as a result. Thus, the Nexus concept is well-positioned to inform and support achievement of the SDGs. Strategizing and planning achievement of the 2030 Agenda for Sustainable Development, including in key resource management sectors such as energy and agriculture, hence would benefit from the application of a nexus approach.
19. **Four SDGs are particularly relevant for the Nexus under the Water Convention:** The water and sanitation goal (SDG 6), including sustainable water management and improving transboundary cooperation beyond the river; the goal to end hunger (SDG 2), including achieving food security and promotion of sustainable agriculture; the goal on affordable and clean energy (SDG 7), including access to sustainable energy for all; and the goal regarding life on earth (SDG 15), including the protection, restoration and sustainable management of ecosystems.
20. **Although each of the 17 goals is linked to an array of other goals and targets, there is a strong connection between these four goals.** Actions taken on one on of the goals is likely to have direct implications for one or all of the other goals. Figure 3 shows some examples of interlinkages that can be found between these goals which can be understood as an implicit call for a Nexus approach to advancing sustainable development. Table 1 explains in more detail the drawn interlinkages.

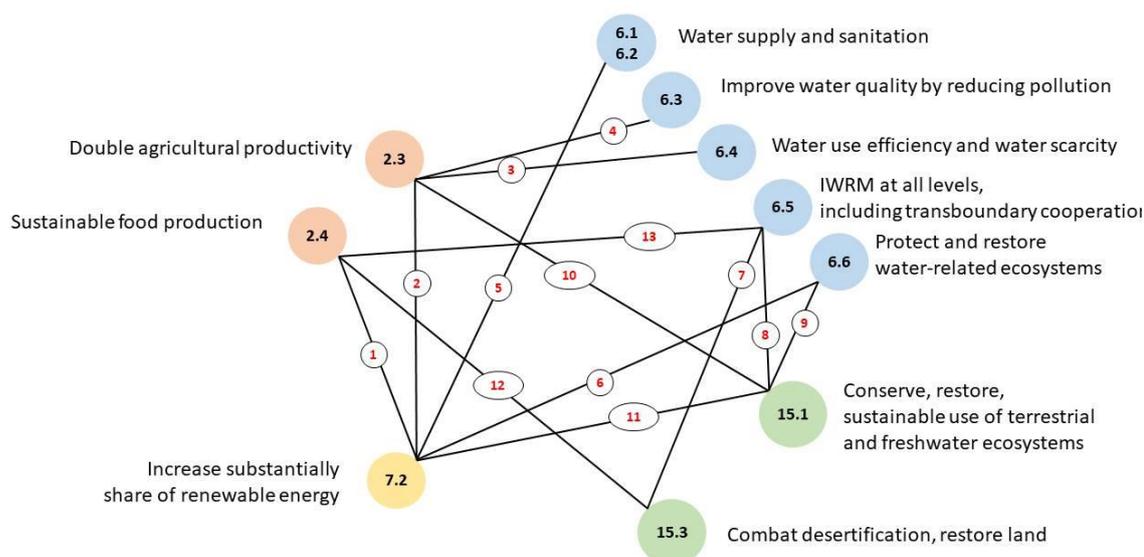


Figure 3: Nexus interlinkages between SDG Goals for food, water, energy and environment.

Table 1: Explanation of the interlinkages.

Nr.	Examples of nexus interlinkages in the SDGs
1	Products and waste from agriculture 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	Increasing water and sanitation requires energy (pumping).
6	Energy production (hydropower, cooling) influences water related ecosystems.
7	Water management can have influences on desertification.
8	Water management has direct influences on freshwater ecosystems.
9	Both goals aim at protecting water-related ecosystems.
10	Increased agriculture (land use) impacts ecosystems and at the same time depends on functioning ecosystem services.
11	Energy production (all resources and technology) have major impacts on ecosystems.
12	Sustainable agriculture conserves ecosystems and restores land.
13	Sustainable agriculture influences water management.

21. Several sources describe very well the SDGs and the impossibility of addressing them in isolation.

While UN-Water (2016) focuses on SDG6 and how it is connected across the SDGs, ICSU (2017) chose to focus on the interlinkages between four goals, namely those on health, food, energy and oceans. UNECE (2017) tackles the implementation of all SDGs. While not explicitly described, these documents in sum give an important insight into the consideration of the interlinkages between the SDGs. The Nexus theory offers an approach to achieve this.

ICSU (2017). *A Guide to SDG Interactions: From Science to Implementation*. Paris

UNECE (2017) *Building more inclusive, sustainable and prosperous societies in Europe and Central Asia*. Regional Advocacy Paper.

UN-Water, 2016: *Water and Sanitation Interlinkages across the 2030 Agenda for Sustainable Development*. Geneva

22. Some explicit mentions about the potential value of the Nexus approach to the achievement of Agenda 2030 are already available. On the occasion of the UNECE Regional Forum on Sustainable Development in March 2018, the value of a nexus approach to implementing the SDGs and experience from the Nexus Assessments was highlighted.⁶ This nexus experience has also been brought up in the preparatory reflection on SDG interlinkages leading to the High-Level Political Forum on Sustainable Development which in July 2018 will review progress towards SDG 6 and SDG 7, among others.

⁶ More information about the roundtable titled *Sharing Water: Balancing Competing Needs in a Context of Declining Resources* and the country cases is available at: <https://www.unece.org/rfsd2018.html>.

2.3 Nexus Approaches are increasingly recognized and applied

23. **Since 2010, the idea of the nexus is increasingly being investigated.** On the one hand, the nexus that exists between sectors and resources is being described, and on the other hand, different tools are created to specifically analyse the nexus-relevant interlinkages. The nexus approach is further used in environmental governance and policy making.
24. **The sectors or components which are mostly relevant for the nexus as scoped under the Water Convention are the energy-, water- and food sectors as well as environmental protection.** Hence, the Nexus Approach advocated for in the Nexus Assessment implies consideration of the interlinkages between them. By looking at these connections, one can understand and provide evidence that shows how all sectors can benefit from Nexus Approaches, and how sustainability is seen from these different perspectives. It is also possible to demonstrate that the different sectors increasingly incorporate Nexus thinking into the exercise of their mandates.

2.3.1 Water

25. **Water is the natural connector in the nexus.** Food and energy can be viewed as the outputs of different underlying resources, which include water, soil, and nutrients.
26. **Water has had a prominent role in the nexus since its rise, and thus the nexus is well embedded in the water community.** The majority of the academic community describes the rationale for the nexus as a critique of the IWRM approach and its shortcomings (Roidt 2017). The debate over IWRM and the need for a nexus approach are thus often linked together, granting water a more prominent role in the debate than other sectors. Some descriptions of the nexus explicitly place water in the centre (Hoff 2011).
27. **The Nexus Assessments under the Water Convention have recognized that water is not only the connector between sectors, but also between countries.** Hence, water is used as the entry point to transboundary Nexus Assessments. However, the nexus is not only applied within the water community. Other sectors have also developed the nexus approach and embedded it in their respective sectors.

2.3.2 Agriculture

28. **A prominent example of recognizing the Water-Energy-Food Nexus in the agricultural sector is the work of FAO.** The organisation's general goal is to achieve food security, and food production has vast nexus interlinkages to the environment, water resources and the energy sector. FAO's mandate thus marks an important entry point to the nexus through the food and agriculture sector, including land management. In 2014, FAO's Committee on Agriculture approved the "Water Governance for Agriculture and Food Security" programme, including the mandate for FAO to define the nexus for the food and agricultural sector and to develop a conceptual approach.
29. **FAO developed a WEF Nexus Approach, including a Nexus Assessment methodology.** The FAO Nexus Approach is described in the following publications. A short insight shall be given below.

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

FAO (2017) *Walking the Nexus Talk: Assessing the Water-Energy-Food Nexus in the Context of the Sustainable Energy for All Initiative*. Environment and Natural Resources Management Working Paper 58. United Nations. Rome.

FAO (2013). *An Innovative Accounting Framework for the Food-Energy-Water Nexus. Application of the MuSIASEM approach to three case studies*. Environment and Natural Resources Management Working Paper 56. United Nations. Rome.

FAO *Water-Energy-Food Nexus Rapid Appraisal*. www.fao.org/energy/water-food-energy-nexus/water-energy-food-nexus-ra/en/

30. **The FAO Nexus Approach recognizes the different goals and interests of the water, energy and food sectors and their interlinkages with the resource bases of those sectors.** Capital and labour are included in the resource bases alongside land, energy and water. Managing the nexus in this approach refers to three working areas, which are i) to provide evidence of the nexus interlinkages, ii) to contribute to scenario development by also including drivers that impact the nexus and iii) to prepare response options through a process of stakeholder dialogue. Response options range from governance solutions to technical interventions.
31. **The concept is underpinned by a methodological approach on how to carry out a Nexus Assessment.** This includes the upper areas of work and the MuSIASEM tool (Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism) to analyse the nexus. The description of the methodology was developed in close collaboration with the energy sector through the Sustainable Energy for All initiative. Based on this methodology, FAO developed the WEF Nexus Rapid Appraisal. This online tool 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 the sectors to be used for communication and awareness raising.
32. The food component of the nexus, as relevant for the work under the Water Convention, includes the agriculture sector (essentially agricultural practices), trade of agricultural products and land management. Among the motivations of the food component applied to a Nexus Approach are the development of more sustainable and “green” agriculture; ensuring water needs for growing food, fodder and fibre; managing competing land uses; and meeting the agro-sector’s energy needs in a sustainable manner, to mention a few.

2.3.3 Energy

33. **The Water-Energy-Food Nexus perspective has also been introduced to the agenda of the energy sector.** Two examples of how the energy sector discusses the nexus are given by the International Renewable Energy Agency and the UNECE Group of Experts on Renewable Energy (GERE) in the sources below. The World Energy Outlook also recognizes the manifold interlinkages that exist between water and energy. Furthermore, the UNECE Regional Global Tracking Framework (GTF) report highlights the need to track progress toward sustainable energy across the energy system and in a holistic manner, thereby making explicit the energy sector’s linkages with other areas, including climate, water, and food.

IRENA (2015). Renewable Energy in the Water, Energy & Food Nexus. IRENA. Abu Dhabi

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

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

REN21 UNECE Renewable Energy Status Report 2017, REN21/UNECE, Paris

UNECE (2017): Global Tracking Framework: UNECE Progress in Sustainable Energy. United Nations. Geneva.

34. **IRENA (2015) provides evidence of the nexus interlinkages from an energy perspective and delivers an analysis of the opportunities that renewable energies can offer in addressing these interlinkages.** Key opportunities include integrating renewable energies within the food chain to contribute to food security and using renewables to provide sustainable energy for irrigation. Renewables themselves can be less water extensive and can, in addition, contribute to improved accessibility, affordability and safety of water. On a preliminary basis, IRENA (2015) proposes a conceptual framework for a tool, which is based on the energy balance, giving an energy-specific view on analysing the WEF Nexus. In a first step, a baseline energy balance would be provided, which could then be adapted to an alternative balance by including renewable energy policy. The tool (to be developed) could then calculate the implications for water, land, emissions and costs of this adapted energy balance.
35. **The Water-Energy Nexus excerpt from the World Energy Outlook analyses the interlinkages between water and energy.** The report explains on the one hand the significance of the interlinkages to economic growth, life and well-being, and on the other hand it describes the water-energy interlinkages themselves.
36. Directed towards the energy community, the UNECE document referred to above, titled *Deployment of Renewable Energy: The Water-Energy-Food Nexus Approach to Support the Sustainable Development Goals (2017)*, describes the strong role that renewable energies can play when addressing the nexus. Renewable energies are further described in the context of the Nexus Assessments under the Water Convention, highlighting both opportunities and also trade-offs. The process of developing the document involved review by the UNECE Group of Experts on Renewable Energy (GERE) at its annual session as well as within ad hoc workshops. The GERE is mandated to carry out action-oriented, practical activities to increase the uptake of renewable energies in the Member States. The Group functions as a neutral platform for policy-makers and stakeholders to discuss, analyse and exchange information in the development of their national policies with the aim of significantly increasing the uptake of renewable energy in the region. Nexus issues (including experience from the assessments under the Water Convention) were also discussed at the International Forum on Energy for Sustainable Development in Baku (2016) and in Astana (2017).
37. **The transition to sustainable energy set as the ambition in Agenda 2030** poses requirements and risks that will impact water resources, but which could also result in positive impacts on the environment and in mitigating climate change (through reduced greenhouse gas emissions). Part of the added value of a Nexus Approach is that it brings together climate change mitigation and adaptation, different targets under SDG 7 (including access, renewable energy in the energy mix and energy efficiency) and links to other SDGs. Lower energy demand through improved energy efficiency commonly translates into less water demand and fewer impacts on water.

38. **More consultative and integrated approaches can win wider support for developing energy generation more sustainably.** A nexus can approach be particularly interesting for this sector due to the possibility of discussing specific sectoral development with a wider range of stakeholders for evaluation of trade-offs with the environment and for addressing those trade-offs (e.g. for hydro-power development). Renewable energies more broadly could further address several trade-offs between the water, energy, food and ecosystems although the development of renewable energy also entails trade-offs.
39. **An opportunity in the nexus: discussions on renewable energies and the possibilities that they can bring to tackle intersectoral issues.** The Nexus Approach can help to increase sustainable development of renewable energy and enable discussions on energy efficiency and access to contribute to SDG 7. In the assessments under the Water Convention, and with insights from GERE, it is recognized that the development of renewable energy overall could benefit from broader development and from exploring synergy opportunities with other sectors. For example, in agricultural reform, renovation of the irrigation systems offers possibilities for integrating renewable energy sources to provide power for agricultural uses, including pumping. Investments in renewable energy would require an investigation of funding options and mechanisms. Linking development of renewable energy to rural development and sustainable tourism could help deliver some intersectoral synergies in the nexus.
40. **A regional or a multi-country approach is also valuable for the energy sector.** For energy security, a diversity of energy sources, good connectivity and a well-functioning electricity market are among the factors that create a positive impact. On the other hand, investments that are not coordinated with neighbouring countries may lead to inefficiency, negative impacts (some through water) and political friction, and a lack of harmonization of environmental standards may add to this. For these reasons, the Nexus Assessments carried out under the Water Convention can also enrich the debate on nexus issues in energy frameworks.
41. **A country-level consideration and action.** The water-energy nexus has been considered in specific country level investment meetings (“Hard Talks”) in Georgia, Ukraine, Azerbaijan and Kazakhstan. In support of the achievement of the energy-related Sustainable Development Goals, notably SDG7, and based on key findings from the REN21 UNECE Renewable Energy Status Report 2017, Hard Talks in UNECE countries are bringing together major players in the energy field from public and private sector to discuss key issues, identify priorities and propose concrete recommendations. Such policy changes 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 being planned in three riparian countries of the Drina River Basin: Bosnia and Herzegovina, Montenegro and Serbia.
42. **A dialogue and assessment on how energy supports achievement of the 2030 Agenda for Sustainable Development is required.** Energy is a key aspect in achieving many of the SDGs. To explore the synergies and trade-offs between the three pillars of sustainable energy (“energy security”, “environmental protection” and “energy for quality of life”), UNECE has implemented the “Pathways to Sustainable Energy” project. This country-driven initiative seeks to provide answers to how countries can attain sustainable energy by combining scenario modelling with stakeholder policy workshops. Nexus perspectives are at the heart of formulating holistic, cross-cutting and adaptive policy solutions to achieve the set targets until 2050.

2.3.4 Ecosystems

43. **Ecosystems are heavily involved in the nexus.** All means of energy production influence ecosystems either as a source of energy resources (e.g. wood, bioenergy, fossil fuels), a sink for pollution (e.g. cooling water, air pollution) or through structural changes (e.g. in rivers for hydropower generation). Agriculture profits from ecosystems and influences them heavily through land use changes. The water sector uses ecosystems as a source for freshwater and as a sink for pollution from domestic and industrial use.
44. **In comparison to the WEF Nexus sectors, ecosystems are not directly considered as an economic sector.** Ecosystems are indirectly considered as relevant in decision-making through sectors such as tourism, through valuing ecosystem services, or through the voices of environmental stakeholders.
45. **An example of how the nexus has entered the activities of environmental stakeholders is the work of the International Union for the Conservation of Nature (IUCN).** Through the entry point of water and ecosystems, the International Water Association and IUCN have joined forces to facilitate the discussion on ecosystem-based solutions to nexus problems. Since 2012, the two organisations serve as the secretariat of the Nexus Dialogue on Water Infrastructure Solutions. The dialogue aims to facilitate transformations in water infrastructure planning, financing and operation. Through the platform, new partnerships shall be formed and new ways to operationalise the nexus will be identified.

IWA/IUCN: Nexus Dialogue on Water Infrastructure Solutions. <http://waternexussolutions.org/>

3 THE TRANSBOUNDARY BASIN NEXUS ASSESSMENT (TBNA) METHODOLOGY

3.1 The concept of the TBNA Methodology

3.1.1 A brief overview of the TBNA methodology

46. **It has been the aim to apply a pragmatic Nexus Approach to dealing with the strong complexities that occur when several sectors are analysed.** This complexity arises in the context due to the involvement of the water, energy, food and ecosystem, resulting in a high diversity of stakeholders and a multiplicity of institutional settings. This complexity is amplified in a transboundary context where several countries are involved.
47. The first generation of methodology is described in a UNECE publication and a peer-reviewed scientific article, where detailed descriptions are available:

Pages 13 – 26 in UNECE (2015): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus*. United Nations. New York and Geneva.

de Strasser et al.: *A Methodology to Assess the Water Energy Food Ecosystems Nexus in Transboundary River Basins*. *Water* 2016, 8, 59.

48. **The methodology enables stakeholders to identify positive and negative linkages, benefits and trade-offs between the concerned sectors with the possibility to account for changes in the future, be they climatic or socioeconomic.** These linkages are identified in a qualitative way and in a participatory manner, where experts and officials from concerned sectors and countries jointly identify and map the linkages. This sets the basis for then quantifying the linkages which are of priority and for which data and analysis tools are available. The methodology further allows for governance assessments, aiming to increase the understanding of how coherent integration of sectors could be achieved.
49. **The methodology is based on six basic principles and is carried out in six consecutive steps.** Both are means to the end of identifying solutions and concrete actions to reduce tensions between sectors and countries.

Participatory Process – The view of stakeholders from concerned sectors is considered through joint identification of intersectoral linkages and dialogues in workshops and beyond. In line with the collaborative spirit of the Water Convention, the methodology ensures ownership.

Knowledge Mobilization – To utilize all information that exist in a basin, the methodology aims to access local knowledge, data and previous experiences, and combines them in the Nexus Assessment.

Sound Scientific Analysis – The process of a Nexus Assessment is in parallel informed by scientific research based on available knowledge to ensure objective information for decision-making.

Capacity Building – By applying the methodology, the parties' understanding of the interlinked nature within their river basin increases and experiences show how natural resources may be managed in a more sustainable way.

Collective Effort – The methodology, due the focus on participation, produces Nexus Assessments which reflect a broad range views and expertise.

Benefits and opportunities – The focus on the benefits of cooperation allows for a constructive and solution-oriented discussion aimed at mobilizing wide support.

50. **Based on these principles, the methodology provides six steps with detailed descriptions of how actions are carried out and by whom.** The first three steps aim to increase the knowledge of a river basin and its governance, while the last three steps aim to provide solutions and actions.

Step 1 – In a desk study, analysts identify the socioeconomic context and the general conditions of the basin. This includes information on i) the state of energy, food, water and environmental security, ii) the relations that exist within the region, the basin and its riparian countries and iii) the main strategic goals, development policies and challenges.

Step 2 – Together with the authorities, the analysts prepare a second desk study in which the key sectors and stakeholders are assessed. Here, it is identified which stakeholders ought to be included in the further assessment process.

Step 3 – Analysts and authorities begin to analyse the identified key sectors. In a first workshop, informed by the desk study, the stakeholders tackle key sectors in more depth. This includes the analysis of resources flows and governance setups. Resources flows are jointly identified and wherever possible supported by quantitative indications to grasp the orders of magnitude. The governance analysis aims to understand strategies and policies, rules and regulations as well as mandates, responsibilities and administration in the basin.

The results of these steps inform the discussions in the following steps.

Step 4 – In the first workshop, the participants jointly identify intersectoral issues. Interlinkages are discussed from a sectoral perspective, resulting in nexus diagrams where basin-specific interlinkages are presented (e.g. water is used to produce energy, biofuels are used to produce energy etc.).

Step 5 – Still within the first workshop, the nexus dialogue takes place. In a round table, all stakeholders agree on prioritizing the identified interlinkages, including how they are expected to change. An opinion-based questionnaire, handed out to the workshop participants, informs this process.

Step 6 – The jointly-identified issues and solutions are investigated in depth by the analysts, with quantification wherever possible. The analysis aims to reveal possible solutions to increase synergies in water resources management, both through technical solutions and policy interventions. The in-depth analysis informs the second workshop. In this workshop, the participants discuss the solutions and translate them into feasible actions, which are ideally linked to actual policies or projects on the agenda of national governments or basin organizations.

Figure 4 shows how the TBNA methodology aims to exchange information throughout the Nexus Assessment to reach a level at which stakeholders can jointly identify actions.

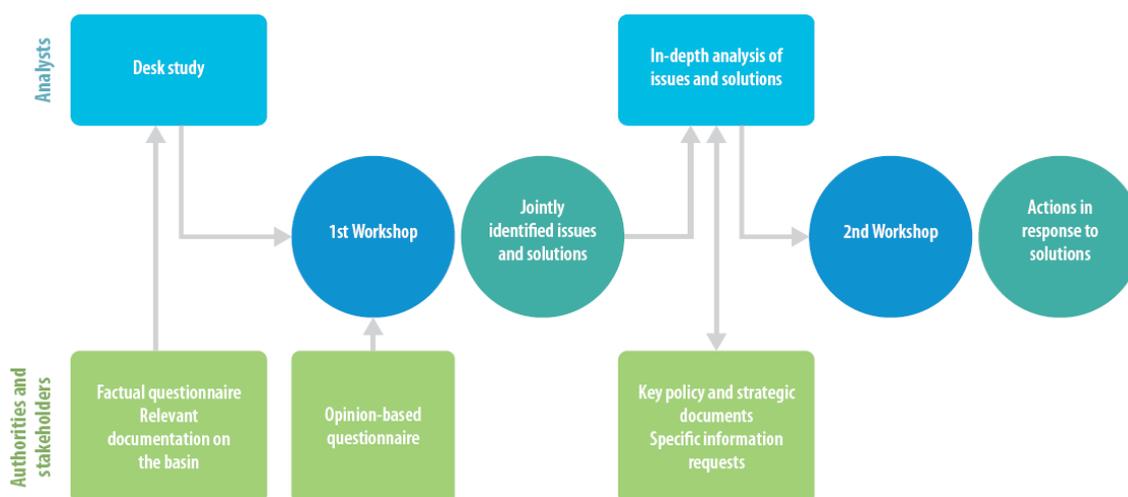


Figure 4: Process of a Nexus Assessment and information exchange.

51. **This process is a general description of the methodology, which varies from case to case.** While two workshops are the default case, the Drina Assessment allowed for a third workshop. There, it was in possible to validate all findings by the stakeholders.
52. **This methodology has evolved throughout its application.** The following chapter describes how this methodology has been developed and how it is still under the process of constant adaptation and change according to new experiences or local conditions.

3.1.2 The development of the TNBA Methodology

53. **As part of the Programme of Work 2013 - 2015 of the Water Convention, the methodology was developed by scholars, experts and partners from Member States.** By design, the methodology

was developed in an iterative manner, allowing for improvement through experience. The development and improvement of the first generation was carried out in three phases, as shown in the figure below.

- 54. **While phase A focused on the initial development of a broad methodology, it was phase B where experience was gained.** The six steps of the methodology were carried out in a basin-specific context in the pilot project of the Alazani/Ganykh basin. The feedback from this pilot then led to refining the methodology for application in other basins. In phase C, conclusions were drawn, and the methodology was revised into the first generation TBNA methodology.
- 55. **The methodology was improved through lessons learned from the basins.** At the same time, it was changed and tailored to meet the specific requirements of each basin. Thus, each adaptation did not necessarily result in a permanent change or general improvement of the methodology.

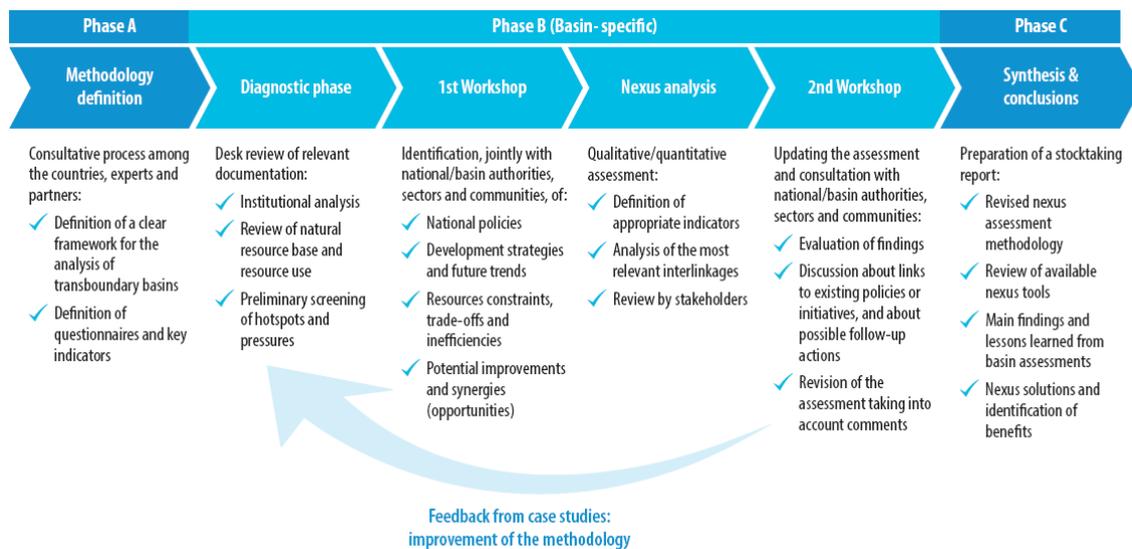


Figure 5: Development of the TBNA methodology between 2013 – 2015.

- 56. **Under the Programme of Work 2016 – 2018, more Nexus Assessments were carried out and the methodology was further adapted.** Within these years, three processes were crucial to the further development of the methodology. First, was the Assessment of the Drina River Basin - a sub-basin of the Sava Basin – in which the Nexus Assessment zoomed in on a previously assessed basin, thus increasing the level of detail (see chapter 3.2.5). Second, the first application of the methodology to a groundwater aquifer, rather than a river basin, was carried out as the Nexus Assessment on the North-Western-Sahara-Aquifer-System (NWSAS) (see chapter 3.2.6). Third, a global stock-taking workshop on the Nexus was held in December 2016. The objectives of the workshop were, inter alia, to review key methodologies and initiatives of relevance for assessing nexus issues in transboundary basins, to draw lessons learned and to gain an overview of tools applied to carry out Nexus Assessments. These processes influenced how the methodology was further developed through considerations of scale (see chapter 3.3), a revised governance methodology (see chapter 3.4), the further development and improvement of participatory methods (see chapter 3.5), and a range of discussions and developments on information needs, indicators and tools to assess the Nexus (see chapter 3.7). Especially the latter was informed by the global stocktaking workshop.
- 57. **Figure 6 shows how the three phases of development have evolved into a wider circle of feedback and development.** The role of the partners in the Nexus Assessments has increased over the years

and the emphasis has shifted to experience sharing on application on the methodology and providing advice. The Nexus Assessment work on the NWSAS and in the Drin is carried out as part of larger projects in which the Global Water Partnership has the lead role on the implementation.

58. **The iterative character of the development of the TBNA methodology has thus continued over the past three years into what can now be summarized as the second generation of the methodology.** The following sections synthesise these developments.

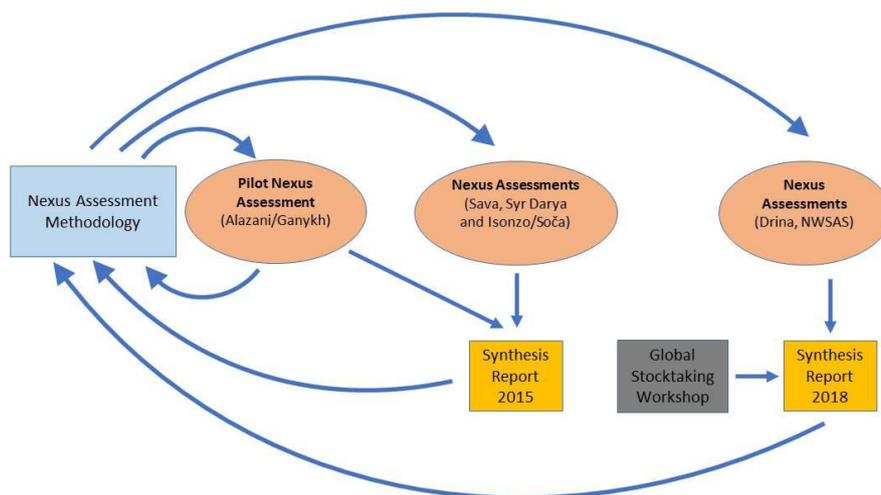


Figure 6: Phases of developing the TBNA methodology.

3.2 The basins are assessed using the methodology

59. **The work on the Nexus under the Water Convention consists of a number of Nexus Assessments that haven been or are being carried out in transboundary basins** in different regions of the world. This synthesis report draws on examples and experiences made so far within these assessments. Thus, a brief overview of the Nexus Assessments carried out and their most important characteristics is provided below and in table 2.
60. **A short description provides text in two categories.** First, *the cooperation setting* which existed between the riparians at the time of the assessment, showing the level of transboundary cooperation embedded in the basin. Second, some *process details and uniqueness* in the assessment process. Some process details shall be highlighted here to give an insight into carrying out such tailored assessments. Each assessment had specific adaptations of the methodology which will be described. Table 2 lists very succinctly the main interlinkages and the thematic.

Table 2: Basin Assessment summary

	Alazani/Ganykh (2013 – 2015)	Sava (2014 – 2015)	Syr Darya (2014 – 2015)	Isonzo/Soca (2015 – 2016)	Drina (2016 – 2017)	NWSAS
Basin Size	11,700 [km ²]	97,700 [km ²]	410,000 [km ²]	3,400 [km ²]	20,320 [km ²]	1,000,000 [km ²]
River Length	391 [km]	945 [km]	3,019 [km]	140 [km]	346 [km]	---
Countries Sharing	Georgia, Azerbaijan	Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, (Albania)	Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan	Italy, Slovenia	Bosnia and Herzegovina, Montenegro, Serbia, (Albania)	Tunisia, Algeria, Libya
Climate	Warm temperate climate	Warm temperate climate	Arid/semi-arid climate	Mediterranean influenced partly humid climate	Warm temperate climate	Arid/hyper-arid climate
Main Nexus Storyline	<ul style="list-style-type: none"> - Lack of access to affordable energy aggravates deforestation, which increases the exposure to flash floods, erosion and landslides. - A poor state and inadequate maintenance of irrigation systems aggravates the impact of flash floods on the loss of fertile soil and damage to settlements. 	<ul style="list-style-type: none"> - Energy production in the countries depends on water availability in the Sava Basin. - Targets for renewables and climate mitigation push countries to develop more hydropower. - There are environmental concerns about dam construction in environmentally sensitive areas. 	<ul style="list-style-type: none"> - Energy and food insecurity are drivers for conflicting seasonal water uses and make countries prioritize self-sufficiency over cooperation. - This aggravates the current situation of sub-optimal use of resources. 	<ul style="list-style-type: none"> - Diverse ecosystem services need protection. - Hydropeaking affects biodiversity and water availability for irrigation. Irrigation is reduced with water efficient technology. - Groundwater abstraction for irrigation needs energy and may cause seawater intrusion. 	<ul style="list-style-type: none"> - Water flow regulation for power generation is sub-optimal and has impacts on flood and drought risks. Application of environmental flows. - Rural development is hampered by low agricultural productivity and a lack of infrastructure. - Water quality is declining because pressures go unchecked (solid waste, wastewaters). 	<ul style="list-style-type: none"> - Heavy and unsustainable exploitation of the aquifer. - Heavy use of irrigation with high losses. - Water and soil salinization from irrigation and inadequate management of drainage. - Water management (pumping from higher depth, treatment etc.) requires sustainable energy solutions.
Main Nexus Interlinkages	<ul style="list-style-type: none"> - Water-Energy (hydropower) - Land-Energy-Water (biomass use, erosion/sedimentation, environmental flow). 	<ul style="list-style-type: none"> - Water-Energy (hydropower) - Land-Water (sediment management). 	<ul style="list-style-type: none"> - Water-Land-Ecosystems (irrigation, salinization) - Water-Energy (hydropower) - Land-Water-Ecosystems (unsustainable agriculture, insufficient environmental flow) 	<ul style="list-style-type: none"> - Water-Energy-Ecosystems (river flow continuity, hydropeaking) - Water-Energy-Food (irrigation) - Water-Energy (groundwater pumping, hydropower, cooling of thermal power plants). 	<ul style="list-style-type: none"> - Water-Energy (flood risk, cooling, uncoordinated hydropower operation) - Water-Food (irrigation, flood risk) - Water-Food-Ecosystems (water quality degradation from mainly wastewater & waste) 	<ul style="list-style-type: none"> - Water-Energy (groundwater pumping, water use for solar power, desalination) - Water-Ecosystems salinization, desertification) Water-Food (irrigation)

3.2.1 Pilot project in Alazani/Ganykh Basin

Cooperation setting

61. While there is a cooperation framework for energy trade between the riparian countries, Azerbaijan and Georgia, no joint cooperation body for the management of transboundary waters exists to date. However, a draft bilateral agreement on the Kura River is under negotiation with the support of UNECE and the Organization on Security and Cooperation Europe (OSCE).

Process details and specificity The Assessment was carried out with one participatory workshop where it was possible to describe a clear nexus storyline (see Table 2). There was synergy in the organization of the workshop with the GEF project on the Kura River, also in terms of expert support, the European Union Water Initiative's National Policy Dialogues (NPD) on IWRM provided an occasion for presenting and further elaborating on the Nexus Assessment results in both countries.

62. This assessment was the first of its kind where the methodology was tested. It served as a scoping-level assessment of relevant issues and some possible synergetic actions or nexus solutions to put in place in response to them.

3.2.2 Assessment of the Sava River Basin

Cooperation setting

63. The Sava has a good governance basis for integrated management of the basins resources. The International Sava River Basin Commission (ISRBC), established for the implementation of the Framework Agreement on the Sava River Basin (FASRB), to which Bosnia and Herzegovina, Croatia, Serbia and Slovenia are Parties⁷, is thematically broad in support of water management. The implementation strategy of the FASRB also includes the objective to integrate water policy with other sectoral policies. Agreements on the Danube also apply.

Process details and specificity

The assessment was carried out in a similar manner to the pilot project. However, the project was given more visibility after the workshop on regional fora, which allowed for a wider reach, particularly towards the energy sector. Compared to the Alazani/Ganykh, Nexus issues and solutions were developed (see Table 2) and prioritized, but did not come together to form a specific storyline. The findings were circulated for review and comments to the stakeholders, including a consultation through the website of the International Sava River Basin Commission (ISRBC). In addition to the transboundary Nexus Assessment workshop, at the request of the countries, national-level meetings were organized to discuss the findings.

It was specific here that in the Sava assessment, the availability of data and resources as well as synergy with the European Commission's Joint Research Centre (JRC) in the analytical work provided for a quantitative analysis of the water-energy nexus through a multi-country energy model (including hydropower) and a spatial analysis of land use and related water demand for irrigation. Moreover, the presence of a well-functioning and proactive basin authority (the ISRBC) allowed for

⁷ Montenegro, also a riparian country, has signed a memorandum of understanding (MoU) on cooperation with ISRBC and in practice already cooperates on matters such as hydro-meteorological issues, flood management, and river basin management

a broad and diverse participation of stakeholders by providing a convening framework for some of the discussions.

3.2.3 Assessment of the Syr Darya River Basin

Cooperation setting

64. The existing institutional frameworks and capacity for transboundary cooperation is not used due to the lack of trust between the riparians, reflecting on engagement and participation in institutions. The assessment adapted to this situation and to an incomplete participation in the assessment⁸. It was not convened in a regional framework, and outlined a progression of solutions (see below).

Process details and specificity

65. On top of the transboundary Nexus Assessment workshop, a focused discussion on the nexus was organized as part of the EU Water Initiative's National Policy Dialogue 12th NPD Steering Committee meeting. Inputs from local experts and officials from the participating countries were also gathered during the third meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus in April 2015 and through consultations held in the countries linked to the NPDs on IWRM. The findings were also presented and discussed in meetings of the energy sector, notably the Forum on Energy for Sustainable Development (in 2016 in Baku and in 2017 in Astana) and in the Thematic Working Group on Water-Energy-Environment of the UN Special Programme for the Economies of Central Asia (SPECA).
66. 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 issues. Furthermore, given the challenges in cooperation in the region, nexus solutions for the Syr Darya were structured according to a logic where the action could progress from no-regret measures to be taken at the national level to solve domestic issues. These would also reduce transboundary impacts, help increase trust and restore cooperation in the long term.

3.2.4 Assessment of the Isonzo/Soča River Basin

Cooperation setting

67. The bilateral Italian-Slovenian Hydro-Economic Commission provides the institutional framework for the countries' cooperation in water management. A water allocation agreement between the countries dates from 1957, the so-called Osimo Agreement. Technical cooperation is reported to be good, and river basin development plans are coordinated between the riparian countries.

Process details and specificity

68. Due to human resources constraints in Slovenia, only one workshop was held in Italy with no participation from Slovenia.
69. The specificity was that the assessment focused largely on the downstream part of the basin (Italian part). This was because of the different levels of engagement between the countries. While this severely limited the transboundary relevance of the assessment, it allowed for a fruitful discussion

⁸ Uzbekistan did not associate itself with the assessment beyond commenting, while regional organizations and the civil society participated.

on how to enhance inter-sectoral cooperation at a more local level. Subsequent bilateral projects in other frameworks have touched upon some of the issues and provided channels for cooperation.

3.2.5 Assessment of the Drina River Basin

Cooperation setting

70. There is no permanent separate legal and institutional cooperation framework at the Drina level. However, since the Drina is part of the Sava River basin, water management issues related to the Drina are discussed in the framework of the ISRBC (as well as in the framework of the International Commission for the Protection of the Danube River). The governance structure is also very similar, with the ISRBC being the body allowing for cooperation in resources management in the basin.

Process details and specificity

71. The Drina assessment was a zoom into the results of the Sava Nexus Assessment, with a focus on Drina-specific issues and potential solutions.
72. The assessment was carried out based on the previous experiences of the methodology, including new adaptations, such as a second and a third workshop.
73. It was specific to this assessment was that it allowed for more workshops and that the project benefited from the active involvement of the energy sector, including a link to cooperation with the UNECE Group of Experts on Renewable Energy (GERE). As the process allowed for three workshops entirely devoted to discussing the nexus (as opposed to previous basins where one workshop was followed by shorter meetings back-to-back with other workshops), it was possible to explore solutions more in detail. In particular, time was allotted to carry out a Benefits of Cooperation Assessment, where the participants discussed the benefits that the identified solutions would bring to riparian countries and how these should be communicated to decision-makers.
74. After the Drina, the benefits of cooperation perspective became an integral part of the Nexus Assessment.

3.2.6 Assessment of the North-Western Sahara Aquifer System

Cooperation setting

75. The three aquifer-sharing countries, Algeria, Libya and Tunisia established in 2002 a Consultation Mechanism for the North-Western Sahara Aquifer System (NWSAS), called the Observatory for Sahara and Sahel (OSS) - a regional organization – which provides technical support through projects on water management and offers a platform for international cooperation efforts. The OSS administers and hosts the coordination mechanism.

Process details and uniqueness

76. The Nexus Assessment is part of a broader project on the Middle East and North Africa region, led by the Global Water Partnership Mediterranean (GWP-Med). The Coordination mechanism provides the framework for the Nexus Assessment which is implemented in cooperation with GWP-Med and OSS. Political instability in Libya limits the possibility of stakeholder engagement from the country. One participatory workshop was held in Algeria. Instead of a second workshop, the countries asked the discussion on solutions to take place at the national level. Therefore, national workshops will be carried.

77. Unique to this project is that the methodology is tailored to be used on an aquifer, and, in addition, is complemented by GWP-Med's tools and approaches such as a detailed stakeholder analysis (see chapter 3.5). The approach involves also a study of the benefits of transboundary cooperation.

3.3 The issue of scale when applying the TBNA Methodology

78. **One key aspect that differentiates the Nexus 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 to natural settings or artificial, administrative boundaries. Sometimes these overlap, but most times they do not, requiring the analyst to understand how different scales interact.⁹ A description of the multi-scale relevance of the Nexus summarizing relevant and current literature is further given in Avellán et al. (2017)¹⁰.
79. **Also, the Nexus Assessments under the Water Convention recognized the importance of working at several scales.** The focus on finding solutions to foster transboundary cooperation does not necessarily call for a strict assessment of all aspects only at the transboundary scale. The methodology instead calls for analysing each aspect at the most appropriate scale.
80. **The technical analysis considers different scales.** Key indicators are mostly provided at the national scale for the riparian countries. They are then also described for the basin if possible and where relevant. This is, for instance, possible for water resources or agricultural land. The regional character of the energy market often does not allow for an exact description of energy indicators at the basin scale. On the local scale, however, analysts aim to describe single power plants and installed capacity, an important factor for the identification of local nexus interlinkages but also relevant for modelling the energy system.
81. **Also, the governance analysis takes place at various scales and across sectors.** The overview of institutions relevant to managing basin resources is provided at the transboundary scale (basin commission, regional and sub-regional institutions), the national scale (central government, state agencies and enterprises), the sub-regional scale (regional watershed agencies, regional government), and at the local scale (municipalities, associations). Also, inter- and multi-sectoral state bodies are mapped out, e.g. the Nation Energy and Water Supply Regulatory Commission in Georgia or mechanisms related to Sustainable Development or climate change related coordination.
82. **Nexus issues and proposed solutions are not limited to one scale.** Governance solutions such as facilitating access to energy through regional energy trade, establishing basin commissions, and advancing policy coherence at the national level, or technical solutions such as enhancing wastewater treatment at the municipal scale or reducing inefficiencies in the energy system, show the various levels at which the nexus can provide options. It is important that when nexus interlinkages are identified, the respective scale is clearly described and understood to formulate the solutions accordingly.

⁹J. Liu, H. Yang, C. Cudennec, A.K. Gain, H. Hoff, R. Lawford, J. Qi, L. de Strasser, P.T. Yillia & C. Zheng (2017) Challenges in operationalizing the water–energy–food nexus, *Hydrological Sciences Journal*, 62:11, 1714-1720.

¹⁰Avellán, T.; Roidt, M.; Emmer, A.; von Koerber, J.; Schneider, P.; Raber, W. Making the Water–Soil–Waste Nexus Work: Framing the Boundaries of Resource Flows. *Sustainability* 2017, 9, 1881.

83. **Nexus projects may be carried out at various scales.** While the Nexus Assessment under the Water Convention has a clear focus on a transboundary basin (river or aquifer), other Nexus initiatives have shown that a multi-scale approach is possible – the Nexus is applied and relevant at various scales. At the global stocktaking workshop assessments of the water-food-energy-ecosystems nexus in transboundary basins (Geneva, December 2016), several Nexus projects were presented and described, ranging from the city scale to a large transboundary basin. The following, non-exhaustive list was described in the workshops report.

Box 1: Examples from nexus studies at different scales¹¹

Transboundary - Alazani/Ganykh Basin¹²

Ecosystem services as 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 due to a lack of clean and affordable alternatives to wood fuel. As reforestation becomes important not only at national level (improving health in households), but also at basin level (to limit floods downstream), the assessment under the Water Convention identifies room for knowledge sharing.

Continent/Country - Africa/Uganda¹³

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 under- or over-sized. The World Bank supports countries in developing the capacity of planning under uncertainty.

Island - Mauritius¹⁴

Sugar or biofuels? By investing in cogeneration, it is possible to move away from sugarcane production and increase the production of biofuels. This leads to reduced imports of fossil fuels, reduced CO₂ emissions, and reduced expenditures. However - counterintuitively - as water will become scarcer, the country, which relies heavily on hydropower, needs to invest in desalination, which in turn could result in higher coal consumption. As these considerations would not be grasped without a nexus approach, country authorities recognized its importance for the island's development planning.

State - Punjab (India)¹⁵

Long term effects of cheap energy for irrigation. With generous subsidies for irrigation, groundwater has been withdrawn faster than it was naturally replenished. Agricultural land turned into a

¹¹ Elaborated from: Mark Howells, Keynote presentation at the global stock-taking workshop on assessing the nexus in transboundary basins. Available from: <https://www.unece.org/index.php?id=41736#/>

¹² UNECE (2015): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus*. United Nations. New York and Geneva.

¹³ KTH (2017). Country level CLEWs. www.kth.se/en/itm/inst/energiteknik/forskning/desa/projects/country-level-clews-1.663650

¹⁴ Welsch, M., Hermann, S., Howells, M., Rogner, H. H., Young, C., Ramma, I., ... & Le Blanc, D. (2014). Adding value with CLEWS—Modelling the energy system and its interdependencies for Mauritius. *Applied energy*, 113, 1434-1445.

¹⁵ Gulati, M., & Pahuja, S. (2015). Direct delivery of power subsidy to manage energy-groundwater-agriculture nexus. *Aquatic Procedia*, 5, 22-30.

desert, deeply compromising local food production. Moreover, this affected the state's energy consumption: as aquifer depths increase, more energy is needed for irrigation.

City - New York City¹⁶

A study on bathroom appliances showed that improving efficiency in water use reduces energy consumption, e.g. lower flow shower heads means less energy to warm water up, and low-flow flushes means less energy to pump it and treat it. If utilities work together, efficiency is mutually improved. On a large scale like that of New York City, this can have a significant impact.

3.4 The Revised Governance Methodology

84. **It is one of the key purposes of the Nexus Assessments to identify potential conflicts and synergies across national boundaries and sectors.** This does not only involve the technical analysis of resource flows. Governance aspects must also be understood in order to fully grasp the uncertainties, difficulties or opportunities when solutions are being implemented. The 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. Thus, from its inception, the TBNA methodology has incorporated this thinking. The methodology was thus developed as a two-track approach, both of which are fully complementary.
85. **The first track is a technical analysis of resource availability and quality, as well as mechanisms that link their use.** This track is well described in UNECE (2015) and de Strasser et al. (2016), and has been applied in the Nexus Assessments from their early days through the use of indicators and modelling (see chapter 3.7).
86. **The second track is the governance track, which aims to understand how rules and actors determine the management of environmental resources.** This track is only initially described in UNECE (2015) and de Strasser et al. (2016) and has in 2017 emerged into a fully developed part of the TBNA methodology.

3.4.1 The initial governance analysis and its development

87. 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 includes a four-step analysis. First, the analysis of main uses of resources; second, the analysis of main regulations; third, the analysis of actors' configuration; and fourth, the identification of specific hot spots. The fourth step analyses salient characteristics of the institutional framework by using the four variables: extent, coherence, robustness and flexibility of the governance system.
88. This method was later further developed and described as the draft methodology for the Nexus Assessments under the Water Convention in the informal paper shown below. The focus of this

¹⁶Engström, R. E., Howells, M., Destouni, G., Bhatt, V., Bazilian, M., & Rogner, H. H. (2017). Connecting the resource nexus to basic urban service provision—with a focus on water-energy interactions in New York City. *Sustainable cities and society*, 31, 83-94.

analysis was policy coherence as well as identifying overlaps, gaps and complementarities of responsibilities.

Bréthaut (2014): *A draft methodology for assessing governance aspects of the water-food-energy-ecosystems nexus*. An informal paper prepared by Dr. Christian Bréthaut, University of Geneva.

89. The Assessments of the Sava, Syr Darya, Isonzo/Soča and the Alazani/Ganykh were carried out based on this draft methodology. A short description of how the governance analysis can be applied in the Nexus Assessments is given in the sources below. There, the method is loosely defined and accompanied by a set of questions guiding the analysis.

Pages 15 & 101 in UNECE (2015): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus*. United Nations. New York and Geneva.

Pages 8f in de Strasser et al. *A Methodology to Assess the Water Energy Food Ecosystems Nexus in Transboundary River Basins*. Water 2016, 8, 59.

90. better consider the other sectors. It was also unrelated to the TBNA, which was a problem particularly at the workshops, where the technical aspects would immediately take a central place in the discussion. When applying the methodology in the Sava River Basin, modifications were made to the governance methodology, which were partly reflected in de Strasser et al. (2016).

91. Therefore, the need to consolidate the governance analysis into a firm approach became clear. The sources described above incorporated the governance methodology to varying degrees. By consolidating them, the pieces of the puzzle were brought together into what is now described as the Revised Governance Methodology (RGM).

3.4.2 The Revised Governance Methodology

92. The RGM 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 RGM was consolidated and described in the publication below, on which also this chapter is based.

TFWFEEN/2017/5. *Revised Governance Methodology for Assessing the Water-Food-Energy-Ecosystems Nexus. Report to the 5th meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus. Prepared by Stephen Stec.*

93. The RGM is an approach that describes in a comprehensive and detailed way how governance analysis is to be applied throughout the six steps of a Nexus Assessment. Before the RGM is summarized here, some overall key aspects shall show how the governance methodology has evolved.
- From giving an overall picture of the issues to be tackled, the RGM gives a detailed description of the part that governance analysts play during the entire assessment. All six steps of the methodology are taken up, and it is illustrated how governance analysts approach the assessment in desk studies and workshops.
 - From providing an overall list of questions that need to be clarified during an assessment, the RGM provides a list of questions for each task to be fulfilled by the analysts. These lists are, when necessary, thematically split into the analysed sectors.

- From a loosely defined concept of the coexistence of the governance and technical tracks, the RGM lays out how and where governance and technical analysts directly work together, inform each other and exchange knowledge. This is graphically described in Figure 7.
- An important improvement to the initial governance methodology was the integration of the consideration of planning cycles and geographic scales of decision-making in different sectors into the RGM.
- From a general idea of what has to be done during a governance analysis, the RGM developed a detailed idea on how it will be reported. A template shows the chapters and sub-chapters to be filled with descriptions of the information to be gathered and analysed at each stage.

94. A summary of the RGM is provided below, giving full acknowledgement to the above-mentioned document.
95. The RGM cannot be seen as one exercise which is performed at one point of the TBNA methodology. It is a continuous process which is part of the TBNA methodology along all six steps. In each step, a specific part of the RGM is applied alongside the technical component of the methodology. These steps are:

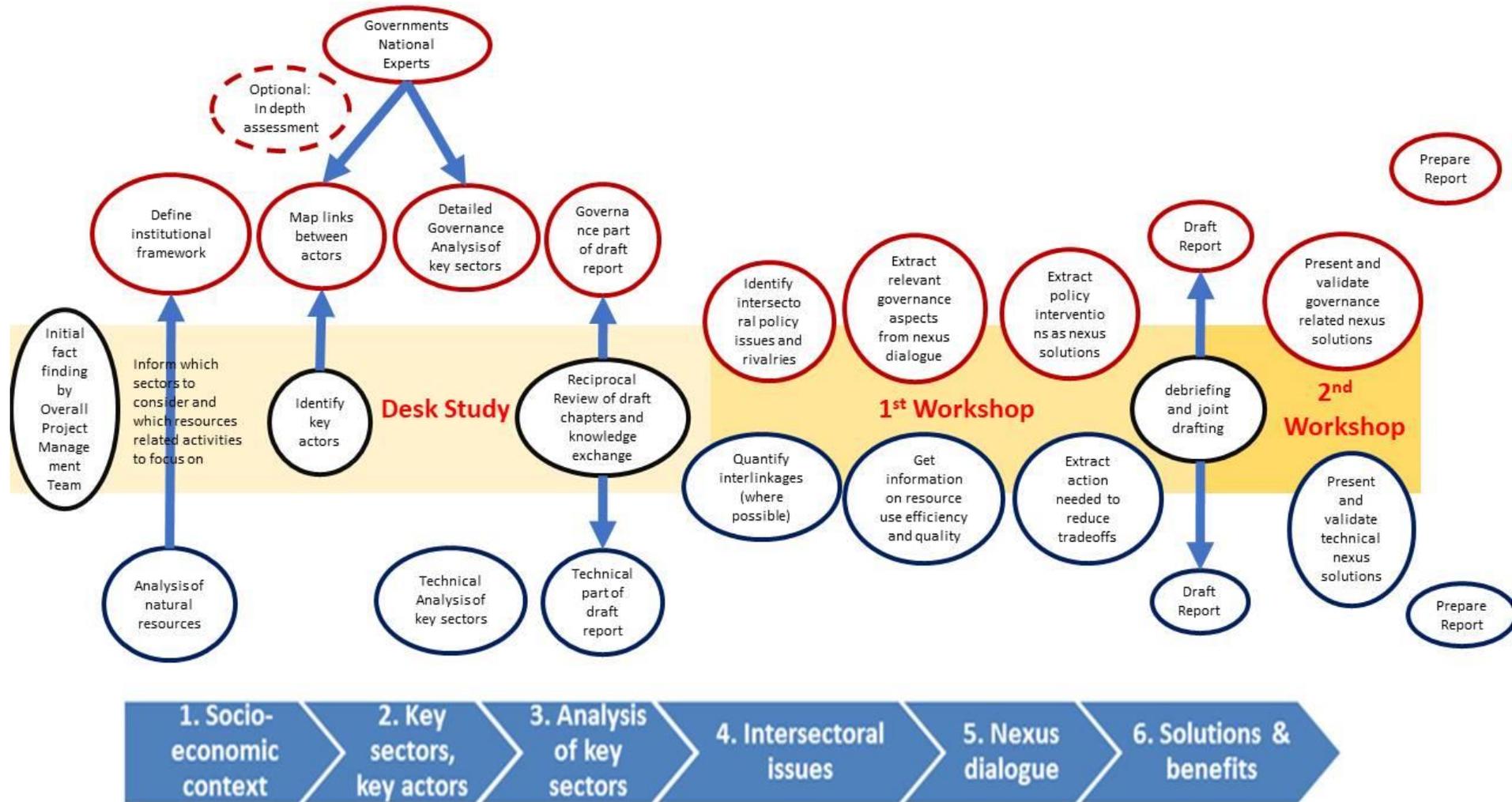


Figure 7: Responsibilities of the governance and technical experts throughout the Assessment

Define institutional framework

96. Step 1 includes the scoping of the existing uses, identification of key actors, macroeconomic factors and broad political setup, all in light of 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 conflicting sectoral policy objectives. Simultaneously, the technical experts inform the governance analyst which sector to consider and which resource-related activities to focus on, and vice versa. Key to this step is mapping out the scale of decision-making for each sector; processes, milestones and planning cycles at each level; and governance mechanisms for each transboundary process.

Identify key actors and map links between them

97. In step 2, the technical and governance analysts jointly identify the key actors and sectors supported by national governments and experts. The governance analysts then commence a deeper study of the policymaking processes at different geographical and political levels, and their governance aspects. This includes mapping the nature of links between the identified actors through agreements (private or public), the institutional level of the 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.
98. During this phase, the governance-factual questionnaire is prepared to collect further details on the national levels.
99. This mapping becomes part of the nexus report, presenting the results in either simple maps or in more complex tables if different sectors, countries and levels are included.
100. Depending on resources, the RGM offers an in-depth assessment which examines the functions, mandates and responsibilities of each identified sector. The Sava and Drina Assessments (for example) were quite detailed in this sense.

Detailed governance analysis of key sectors

101. While in step three, both technical and governance experts analyse the key sector, it is the responsibility of the governance analysis to gain an understanding of the relevant policy documents and legislation for that sector. This includes transboundary agreements, as well as national and subnational levels. The RGM provides an extensive list of questions which must 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 regulation, iii) robustness, as capacity of the regulatory framework to effectively control the different uses, and iv) flexibility as room to manoeuvre and self-organise. For each of these variables, the RGM provides a list of questions and components which support the analysts.
102. Once there is a clear picture of policy, regulations and institutions, the analysis digs deeper into the governance culture. This includes the question of 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 RGM provides a list of questions to be tackled during the analysis of the governance culture.

Identify intersectoral policy issues and rivalries

103. In step 4, the governance analyses are further carried out in the workshops of the Nexus Assessment. During the workshop, the participants jointly identify intersectoral issues, as described in chapters 3.1. and 3.4. The inquiry of the governance methodology is to identify policies that may target objectives which conflict with the objectives of other policies in other sectors, within the

country or in the transboundary context. This is closely connected to the identification of physical resource flows (e.g. identification of upstream-downstream disputes).

104. In contrast to the desk study, in which governance analysts focus on policy coherence within a sector, the coherence between sectors is the focus of the workshops. Differences in geographical and political scales, timeframes for planning and decision-making, and governance cultures are taken into account. The RGM again provides a list of questions that should be answered to successfully carry out the identification of nexus issues. Most of step 4 is conducted through participatory exercises within workshops (see chapter 3.4).

Extract relevant governance aspects from nexus dialogue

105. Step 5 – the nexus dialogue – is carried out with both technical and governance perspectives. One element of the exercise is that participants develop a shared understanding of nexus issues. On the governance side, rivalries between sectors and countries are discussed. The governance analysts provide explanations of how specific rivalries emerged and the potential causalities for these rivalries. The discussions then reveal the strengths and weaknesses of institutional frameworks in this regard. This is often accompanied by a case study in which the analytical variables (extent, coherence, robustness, flexibility) are examined.
106. Governance experts take note of the discussions with specific focus on the governance concerns raised during the discussions, which they will then include in the last step of the Nexus Assessment.

Extract policy interventions as nexus solutions

107. In the last step, participants discuss nexus solutions and the benefits of cooperation (both technical and governmental). The last two steps provide the necessary input for the governance analysts to continue to draft the assessment report on the governance side in preparation of the second workshop.
108. Technical and governance analysts hold consultations to debrief on the outcome of the first workshop. In this debriefing a joint drafting plan for the report is prepared. The draft report with technical and governance components is sketched out and circulated as preparation for the second workshop. Again, the focus lies mainly on providing potentially beneficial actions to be discussed in the second workshop.

Present and validate governance-related nexus solutions

109. In the second workshop the focus of the governance analysts is on those solutions which are practical, implementable and considerate of existing governance contexts. Two forms of solutions are offered on the governance side. 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.
110. The focus therefore lies on i) technical solutions which are examined with attention to governance aspects, or ii) examination of gaps in frameworks for transboundary cooperation, with the aim of proposing a way forward.
111. The ecosystems and energy aspects are still underrepresented in the governance methodology in comparison to water and agriculture. The reason often lies in the fact that analysts inevitably focus on what they know best. The focus for the future, therefore, is to incorporate cooperation with experts from all sectors into the analysis.
112. Experience from the workshops showed that there is room for improvement in the way the newly-aligned methodology is applied in practice. The recommendation is to go a step further and have a

common schedule, working meetings and clear inputs and outputs to facilitate the group of experts working cohesively as a team.

3.5 Participatory Methods

113. **Cooperation is the backbone of the Water Convention, and also of the Nexus Assessments.** Participation is one of the basic principles of the Convention and thus, broad participation is crucial to jointly identify the main nexus issues, to ensure ownership for the process, to increase the accuracy of the assessment due to local expert knowledge, and for brainstorming about nexus solutions that are relevant locally and regionally.
114. **The Nexus Assessments are prepared in close cooperation with the national authorities of the riparian countries, in response to a request from countries or joint bodies for transboundary cooperation.** The approach under the Water Convention is to include all countries of a given basin in the Assessment through official processes. UNECE requests the main counterpart ministries to nominate a focal point from the national administration. In addition, local experts and other stakeholders are invited to participate.
115. **Compared to earlier Assessments, the methodology now provides more consultation opportunities.** Because of its commitment to stakeholder engagement, and to representing a broad range of views and reconciling different interests, the assessment provides a solid basis for improvement of resource management and policy, as well as future cooperation and support. The workshops in particular are the keys to participation. Several methods have been developed over time to gather input and views. These methods are shown below alongside the lessons learned over the past years.

3.5.1 Factual Questionnaires – Gathering information

116. **To support the desk study, two factual questionnaires are prepared by analysts.** The questionnaires are handed out to the focal points of 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.
117. **The first questionnaire is of a technical nature.** It aims to identify, in a preliminary manner, which main pressures and hotspots exist in the basin. Questions screen the different sectors and collect important information on availability of resources, socioeconomic conditions and economic activities.
118. **The second questionnaire was developed as part of the Revised Governance Methodology.** 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 successfully applied in more recent assessments.
119. **The use of these questionnaires informs the desk study with relevant information gathered directly from the stakeholders.** This guarantees that all existing information and earlier studies are taken into account. The participatory aspect is particularly emphasised by ensuring that documentation provided by the participating authorities is used.

3.5.2 Opinion-Based Questionnaire – Revealing different views

120. **At the first workshop, a second questionnaire is handed out, which – in contrast to the other questionnaires – aims to gather opinions rather than facts.** Before discussions begin, the questionnaire is handed out to the participants, filled out and collected. This exercise captures the differences in perspective by country and 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. These comparisons reveal the different perceptions of the sectors and countries. It may be the case that water is described as “scarce” by the water sector participants, while this view is not shared by the energy sector. The overall purpose of this first exercise is to reveal to which extent the groups agree or disagree, and to show how each country and sector has a different viewpoint on the issue.
121. **There is a need to refine this tool from a generic questionnaire, and to tailor it to each case as necessary.** This would require a new questionnaire design, or would require changing the questions for each Nexus Assessment, which would result in deeper insights gained.

3.5.3 Overview Presentations – Setting the stage

122. **To set the stage for the workshop and to get familiar with the assessed basin and its characteristics, different thematic or regional overview presentations, as well as an overview of the sectors and national policy developments, are given.** The sectoral and national presentations in particular are not given by external experts, but by the respective authorities or national representatives. In order to ensure a streamlined quality of the presentations, a template was developed with the TBNA methodology. This template includes the main topics to be addressed, such as: i) the national development plans and sectoral goals of a country in the river basin, ii) regional development programmes involving the key sectors in the basin, and iii) the respective implementation measures. The full template is displayed in UNECE (2015) Annex IV.
123. **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 ensure that some known issues relevant to the basin are discussed. Presenting the previous work is important for 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.

3.5.4 Brainstorming Exercise - Identifying Nexus Issues

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

125. **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.
126. **Experience from the workshops shows that the decision on which sectors were considered “key sectors” was often made at the workshops together with the participants, rather than being presented as a predefined criteria of including the water, energy, agriculture and ecosystems sectors.** 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 (e.g. in the Drina Assessment). In other cases, the issues were scattered, and it would have been difficult to move directly to the nexus dialogue phase. In these situation, breaking the discussion down into the sectoral perspectives could potentially help resolve a stalemate (e.g. in the Syr Darya Assessment).
127. **The brainstorming on the interlinkages so far has focused on the status quo and has not included future scenarios.** However, if reliable data and scenarios for the future are available, it may be possible to include future developments of the sectors into this brainstorming exercise.

3.5.5 Nexus Dialogue – Developing a shared understanding

128. **The first workshop brings together all sectoral views and identified interlinkages into one single nexus picture.** A nexus understanding is developed which is shared by all participants. While in the brainstorming exercise, small groups of participants examined the nexus from one sector’s perspective, this exercise brings all of these views together. All participants agree on the most important interlinkages and draw them on the nexus dialogue template, in which all sectors are equally represented. 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 going to change with future developments.
129. **This exercise, especially, was prone to several methodological changes.** Sometimes it proved useful to discuss it in the plenary sessions; other times, smaller, sectorally mixed groups developed the shared understanding. Some stakeholders emphasized that problems are typically known already (e.g. conflicts arising from the operation of a certain dam), and that the workshops should give much more space to the nexus dialogue and to developing solutions. It is true that, if stakeholders are active in their participation, the nexus dialogue on may uncover important sectoral perspectives that can serve as basis for solutions. In the Alazani/Ganykh Assessment, for instance, the topic of forest degradation would not have emerged without the sectoral phases.

3.5.6 Stakeholder Mapping and Analysis (by GWP-Med in NWSAS)

130. **One participatory method, which has been used only recently in the Nexus Assessment of the NWSAS, is the joint stakeholder mapping and analysis.** During the first workshop, participants are asked to identify stakeholders to the Nexus Assessment, and to provide new information about stakeholders such as importance, interest and influence on the management of the aquifer.
131. **A list of previously identified stakeholders from the desk study is handed out and participants are asked to add missing stakeholders to the list.** Participants are then split into country groups where they are asked to prioritize which stakeholders they see as the most important to the management of the aquifer system. In a third step, an interest/influence grid is used, in which participants place

the name of each stakeholder into the appropriate cell of the grid. Figure 8 shows the grid 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).

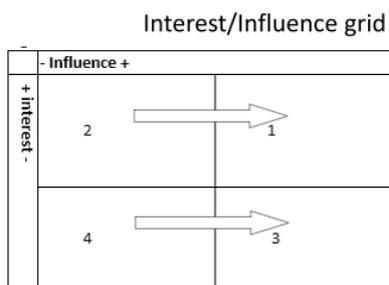


Figure 8: The interest/influence grid of network analysis.

3.5.7 Identification of solutions

132. **The identification of solutions is the main focus of the second workshop.** Solutions may be of a technical nature, or they may consist of policy interventions, changes in governance, and so forth. The goal is to jointly develop a set of solutions with a cross-sectoral and transboundary dimension. They can be considered “nexus solutions” (i.e. actions to be taken to tackle nexus and/or transboundary issues). Participants are asked to write such solutions on post-its and stick them on a board, the content of which is then jointly discussed in the plenary. Solutions are considered in terms of their applicability, beneficial impact, and so on. The link between solutions and benefits of cooperation is particularly relevant in the evaluation of solutions. If applicable, short presentations of good measures and relevant projects from the region can add to the discussion of solutions.
133. **This exercise is one of the key moments of the Nexus Assessment because the solutions are starting to emerge.** However, follow-up analysis is necessary to investigate the feasibility of the solutions in more detail. To some extent, such follow-up workshops have been organised as part of basin assessments.
134. **Since both local and international experts are involved in the development of solutions, it is very important to create a strong link between them.** It is crucial that they work closely with each other and interact as much as is needed. Hence, they should be actively encouraged to do so, and their exchange facilitated.

Table 3: Summary of participatory methods and application considerations.

Method	Stage used	Purpose	Key tool	Application Experience	Need for further development
Factual Questionnaires	Stage 1 Desk Study	- Inform the desk study. - Include information from participating authorities.	Questionnaire	Good to gather information on key issues and literature on the basin. Can help orient the desk study.	- Prepare a joint technical and governance factual questionnaire. - Send the questionnaire to focal points (or national experts if involved or identified at that stage) prior to the workshop.
Stakeholder mapping and Analysis	Stage 2 Workshop 1	- Identify and prioritize the importance of stakeholders. - Understand the interests and influence of stakeholders.	- Stakeholder lists - Influence/interest grid	The transboundary nexus workshop provides an occasion to getting input to the mapping from the stakeholders. An existing river basin management related stakeholder identification has in some cases provided the basis.	Can be merged into the Factual Questionnaire.
Opinion Based Questionnaire	Stage 4 1. Workshop	Measure to which extend the groups agree or disagree.	Questionnaire & presentation of results to the plenary	Has allowed to identify issues that are widely agreed about among the authorities and stakeholder.	
Overview Presentations	Stage 4 1. Workshop	- Setting the stage. - Overview on the basin.	Guidance template for presentation	Has been used variably by stakeholders. Coordination related to preparing the presentations may be useful for connecting different sectors nationally.	
Brainstorming exercise	Stage 4 1. Workshop	- Identify nexus issues. - Show integrated nature sectors and resources.	Sector-centred nexus diagram templates	-Emphasis on physical aspects of resources flows over other aspects but points also at impacts and externalities. -The simple and intuitive template can easily be modified and allows for an open dialogue.	Future trends of each sectors could be better taken into account in forthcoming assessments.

Nexus dialogue	Stage 4 1. Workshop	<ul style="list-style-type: none"> - Agree on and prioritize nexus interlinkages. - Develop a shared understanding of the nexus issues. - Identify and develop nexus storylines of causes and effects as well as solutions. 	Nexus diagram template	<ul style="list-style-type: none"> - Flexible design of the discussion in plenary or mixed groups is necessary, taking into account the representation of different sectors and interests, as well as the local culture. - The process benefits from sequencing more occasions for the dialogue, combining national and transboundary level. 	Sufficient time needs to be allocated for the nexus dialogue.
Identification of solutions	Stage 6 2. Workshop	Identify nexus solutions.	Post-its	Brainstorming with a diverse set of local stakeholders in groups mobilizes a lot of ideas. Invited presentations by local stakeholder can be made.	Elaboration and evaluation of the solutions would be good to take further with the authorities and stakeholders, considering outlook for implementation (feasibility, capacity, resources etc.).

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

3.6.1 The Water Convention's work on the benefits of transboundary water cooperation

135. **Since 2013, the Water Convention has been working on the benefits of transboundary water cooperation.** *The Policy Guidance Note on the Benefits of Transboundary Water Cooperation: Identification, Assessment and Communication* was published in 2015.

UNECE (2015): Policy Guidance Note on the Benefits of Transboundary Water Cooperation. Identification, Assessment and Communication. United Nations. New York and Geneva.

136. **Between 2016 and 2017 three pilot projects to apply the Policy Guidance Note were carried out.** The took place in the Okavango basin (Angola, Botswana, Namibia), the Sio-Malaba-Malakisi basin (Kenya, Uganda) and the Drina basin (Bosnia-Herzegovina, Montenegro, Serbia). In February 2018, a Global Workshop to exchange experiences was organised.

3.6.2 The Benefits of Cooperation Approach

137. A Benefits Assessment is carried out in three steps.

Step 1 – Identification of benefits and beneficiaries. Together with a broad range of stakeholders, benefits are identified and categorized into a benefits typology. The benefits are then screened to select the most relevant ones for an assessment with respect to their magnitude and other policy related criteria.

Step 2 – Assessment of benefits. Benefits undergo a qualitative assessment, which is in some cases extended to a quantitative analysis including the monetary value of water cooperation. The level of the assessment is flexible, and it is thus possible to vary it according to the cooperation stage and political will of the countries.

Step 3 - Communication of benefits. Key to the entire exercise is the communication of the assessed benefits to decision makers. From the beginning of the assessment, the communication is planned in order to effectively use internal and external communication channels. The focus lies in moving from perception to facts.

3.6.3 The Benefits of Cooperation Approach in the Nexus Assessments

138. **One of the key messages of the *Policy Guidance Note* is that a benefits assessment exercise could and should be linked to other basin-level analytical processes.** Examples are a Transboundary Diagnostic Analysis or a Transboundary Nexus Assessment.
139. **An initial effort to incorporate a Benefits Assessment into a Nexus Assessment took place in 2015.** There, the first batch of Nexus Assessments (Alazani/Ganykh, Sava, Syr Darya) included a rapid, desk-based identification of the benefits of transboundary cooperation in each of those three basins.

140. **The first fully-fledged effort to integrate a Benefits Assessment into a Nexus Assessment took place in 2016/17 in the Nexus Assessment of the Drina basin.** A new effort is being made in the development of the Nexus Assessment of the North West Sahara Aquifer.
141. **The Benefits Assessment consists of a coherent methodology of its own.** It is therefore important to note that it was not included into the TBNA methodology. Rather, it should be seen as a complementary method which can be integrated into the Nexus Assessment, not as an additional step in the TBNA methodology.

3.6.4 The Benefits of Cooperation Approach in the Drina Assessment

142. **The methodology applied included four steps.** As a first step, in the first multi-stakeholder workshop the Benefits of Cooperation Approach was introduced and explained, after which a rapid identification of the benefits of cooperation in the Drina basin was carried out. The specifics of the rapid identification are shown in table 4. The first workshop also included a participatory exercise to identify the target audience of the benefits component of the Drina assessment.
143. **Rapid identification is a necessary step to raise awareness among the participants.** However, it needs to be tackled in more depth by analysts before revisiting it in discussion with the participants. Such an expert analysis was carried out as a second step, in which several benefits of cooperation were investigated and described based on the nexus analysts' description of the nexus-related challenges and the options to address them. In addition, a modelling exercise was carried by the experts working on the topic of co-optimising flow regulation, which quantified some of the potential benefits of cooperating on hydropower development.
144. **As a third step, during the second multi-stakeholder workshop, the participants identified and discussed in one session the past benefits of cooperation in the Drina basin from the perspective of each country.** They also discussed in a different session a number of possible actions that could be adopted on each key theme (which had been previously identified by the experts carrying out the Nexus Assessment) and rated their benefits on a four-point qualitative scale, ranging from very high to low. Finally, the findings of the different strands were put together in a dedicated chapter in the final Drina Nexus Assessment report.
145. **Valuable experiences were made.** In view of the experience in the Drina Nexus Assessments, implementing the following recommendations would help to carry out a more effective and efficient integration of a Benefits Assessment in a Nexus Assessment:
1. Include the discussion on past benefits of transboundary water cooperation in the first workshop.
 2. Include in the Terms of Reference of the nexus analyst the identification and qualitative assessment of the benefits of the measures proposed.
 3. Ensure that time is allocated between the drafting of the technical nexus chapters and the second workshop to complement the work on benefits carried out by the nexus analysts and to design the benefit sessions for the second workshop.

Table 4: How to carry out a rapid assessment of the benefits of transboundary water cooperation assessment.

Step	Method
<p>Introduction of the Benefits of Cooperation</p> <ul style="list-style-type: none"> - Contents: <ul style="list-style-type: none"> Background Previous Examples Rationale - Explanation of the Approach Benefits Assessment Exercise. 	Presentation
<p>Identification of benefits</p> <ul style="list-style-type: none"> - Name 10 historical and potential benefits of transboundary cooperation in the basin. - Are these outcome benefits or process benefits? 	<ul style="list-style-type: none"> - Each participant writes down two benefits (on two post-its). - Roundtable, each participant is invited to share one of the two benefits that they have identified. - Facilitator clarifies whether that benefit is an intermediate benefit or an outcome benefit.
<p>Classification of Benefits</p> <p>Classify the list of benefits according to the matrix.</p>	<ul style="list-style-type: none"> - Facilitator builds up an empty matrix. - The participants are invited to place their post-its on the matrix. - Required material: Typology of benefits matrix. (Table 2 in UNECE (2015b) p. 9).
<p>Overview of Benefits</p> <p>Can you think of any benefits from the table which are missing on the matrix?</p>	<ul style="list-style-type: none"> - Reading table and discussion. Clarification of any misunderstandings. Addition of benefits to the matrix if required. - Required material: Table 16 in UNECE (2015a) p.77f
<p>Benefits of Specific Solutions</p> <ul style="list-style-type: none"> - Which solutions require international cooperation? - What are the benefits of those solutions? - What is the qualitative importance of those benefits? 	<ul style="list-style-type: none"> - Group work (one group for each theme) - Starting with the list of nexus solutions for that theme previously identified by the nexus analysts, participants discuss and agree which ones require cooperation. - Participants are asked to individually write down the benefits of each solution, then to report them 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, Low). They are 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.
<p>Communication of Benefits</p> <ul style="list-style-type: none"> - Who do we need to convince to promote further cooperation in the basin. - What is the rationale for the answer? - Prioritize the answers. - How can we convince the actors? - What level of Benefits Assessment would be more appropriate in the basin. General overview or Specific Solutions? - Prioritize the answer. 	<ul style="list-style-type: none"> - Ask participants to write down one key actor. Roundtable inviting participants to report their key actor, thus compiling a list of key actors. - Every participant is given two votes (two post-it notes). They can vote for two actors, or they can give two votes to one actor. - Facilitator adds up the voting and presents the results. - Plenary discussion on what types of communication efforts are required to influence the top key actors.
<p>Benefits of past cooperation in the basin</p>	Group work

<ul style="list-style-type: none"> - 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? 	
<p>Potential benefits of nexus solutions in the basin.</p> <ul style="list-style-type: none"> - Who will be the main beneficiaries of the nexus solutions? - What will be the main benefits of the nexus solutions? - What is the importance of those benefits? 	Group work
<p>Sharing of country perspectives</p>	Presentations of group work results followed by Q&A
<p>Communicating the benefits of past cooperation and nexus solutions in the basin</p> <ul style="list-style-type: none"> - Who are the target audiences? Which existing processes are important to inform and to influence? - What are the key messages and information to be communicated? - What communication tools could be used? 	Discussion

3.7 Information, indicators and Nexus tools

146. **Each stage in the Nexus Assessment requires its own kind of information and data.** Several types of data are necessary throughout the Nexus Assessments. During the first stages, in the desk study, mostly non-spatial indicators and thematic maps on the country and basins are used. 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 dynamic and to predict changes in the future.¹⁷ Here, the data requirements have a time dimension as well.
147. What has been learned in the past years regarding data, their utilization through indicators and their use in nexus modelling tools is described below.

3.7.1 Information and data are necessary for Nexus Assessments

148. **Policy development and decision-making depend on sound information and data.** Transboundary dialogue is already a value in itself. However, decisions on basin management, policy adjustments

¹⁷ For example, in the Syr Darya Basin the model examined the effect of improving energy efficiency and integrating more non-hydro renewable energy into the energy system. In the Drina River Basin, energy system benefits of a 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.

or strategic shifts that follow such dialogues must be based on salient information and meaningful analysis, which in turn requires adequate data.

149. **Governments are the preferred source of information and data.** During the Nexus Assessments it proved valuable to utilize as much as possible the official data provided by national authorities, and to complement this with other data from international organisations, etc. Countries trust their official data, and Nexus Assessments are validated by the governments. Using databases with an official source (e.g. FAO, OECD, World Bank, UNECE) can save time, however, and can simplify the request for data into a request for validation. The information and data needs for Nexus Assessments are so broad and, in the case of quantification, even extensive, but a validation process helps to provide for acceptance of a wider range of information sources.
150. **There is a need for information sharing across borders.** Basin-wide monitoring, data verification and exchange, and knowledge-sharing are key for a meaningful analysis of the transboundary nexus, and no matter the starting point of cooperation, these elements always need improvement. In the past Nexus Assessments, this point is often one of the first identified solutions (see also Chapter 5.1.2)¹⁸.
151. **Information on the different sectors and their interactions is needed.** In contrast to sectoral management, application of a nexus approach calls for integrated analysis. This requires information and data covering different sectors. Lack of data from the different sectors is critical, as it, firstly, limits the ability to understand dynamics between sectors and resources in their complexity. Secondly, it then limits the opportunity to use the nexus approach as a means to reduce negative intersectoral impacts and to improve cooperation. For example, consideration of intersectoral impacts of plans and policies would benefit from substantiation by analysis of appropriate data. Moving beyond sectoral silo approaches requires the development of new databases and data processing methods (or better linking and integration of existing sectoral databases), and better facilitation of access to these databases and methods. Different planning cycles and shortcomings in consultation and evaluation procedures may influence how information about intersectoral synergies and impacts is taken into account.
152. **The availability of good data remains a challenge.** The availability of good, accurate, harmonized and up-to-date data and information often hinders the desired level of analysis throughout the projects. Even where data is available, there can be challenges in processing and analysing it due to obstacles in using different indicators in collection and measuring methods across countries or regions. Furthermore, there can be large temporal or geographical data gaps.

3.7.2 The Use and Categorization of Indicators

153. **The Nexus community agrees that data are not enough for Nexus Assessments.** To effectively describe nexus interlinkages and to fully grasp its interlinked nature, different indicators can be utilized. The conclusions of the Global Stocktaking Workshop stress that indicators which are comparable across countries are necessary. Clear indicators are also important to determine the impact

¹⁸ 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. An example is that coherent and transparent mapping of water pollution sources, including determination and quantification of the type of pollution and its effect on water quality, is missing in the Drina basin.

of proposed solutions across sectors. And, as Roidt et al (2017) describe, the Nexus Approach would profit from nexus-specific indicators.

154. **Nexus indicators as such are not yet widely used and are still under development in the scientific community.** However, the use of several indicators from water, food, energy and ecosystems have successfully been used in the past years in the Nexus Assessments under the Convention.
155. **As each basin is the subject of a unique and tailored exercise, it has proven most effective not to limit the assessment to one rigid set of indicators.** The concept of a fixed set of indicators resulting in the possibility to compare each country and each assessment is an ideal case. It is, however, impractical. The assessments under the Convention include a set of indicators which are used – tailored to each case - during the several stages of the assessment. All indicators are listed in the publication below, where source information can also be found.

Pages 104 – 106 in UNECE (2015): Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus. United Nations. New York and Geneva.

156. **In the past years, several possible categorisations these indicators have been put forward, with the aim of meaningfully integrating them into the Nexus Assessments methodology.** In the early stages of development of the methodology in 2014, the indicators were categorised either by group or by source.

Indicators by group

- National Indicators
- Basin Indicators
- Nexus FAO indicators
- Opinions of countries & sectors
- Specific indicators

Indicators by source

- Country Experts
- Country and Basin Statistics (FAO, World Bank etc.)
- Spatial information
- Opinion based questionnaire

157. **Both types of categorisation show that different indicators have different natures.** Some are qualitative and some quantitative, some geospatial and some statistical. There are data which are provided at the country or basin scale. Some indicators are from experts and national governments, while others are provided through international statistical services. Some information depends more on perspective and are thus provided through the opinions of the participants. Both types of categorisations informed the use of the TBNA methodology but were not explicitly integrated into the methodology.
158. **As the methodology developed, the indicators were adapted to fit closer to the process of the assessments.** They were categorised by methodological use and are presented as follows in UNECE (2015) and de Strasser et al. 2016.

Indicators by methodological use

Non-Spatial Indicators

- Screening indicators
- Perspective indicators
- Assessment specific indicators

Geospatial Indicators

159. **This categorisation was used to carry out the assessments and is also reflected in the Nexus Reports.** The first set (screening indicators) is used to describe the basin and its context, and is based on information from experts, governments and international statistical services (see Table 5). In general, official data was prioritized. The second set of indicators is used in the opinion-based questionnaire and includes different kinds of information on the resources and socio-economic circumstances. The third set is comprised of the nexus interlinkages and solutions that are identified, and highly depends on the dynamics of the assessment. The geospatial indicators are needed for modelling and further quantitative analyses by the experts but are also used to show the distribution of different factors relevant to the nexus on maps.
160. **The screening indicators have so far not been categorized into a Nexus-specific grouping; however, it is the aim to provide this here.** As the resource base of each of the concerned sectors is of particular interest during the technical parts of the analysis, the availability of resources as well as their use(s) are 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 UNECE (2015)¹⁹ and the indicators used in the Sava and Drina Assessment were included in Table 5. Most indicators are presented in UNECE (2015) and used in the assessments. The indicators which were given in UNECE (2015) but were not used in the Assessments are marked with an asterisk.
161. **Key indicators help to distinguish the differences in the resource base, uses and issues in the different basins assessed.** The overview of categorisations and how they are used in the Nexus Assessments confirms the experience. There is no indicators template or categorisation which can be used in the exact same way for each Nexus Assessment. One set of indicators which comes close to this goal is the group of “key indicators”. The key indicators are presented in a very similar way in each Nexus Assessment and allow the participants to see the importance of resources in each basin. Basin-level information was not always available, and sub-national administrative units often did not correspond with basin boundaries.

Key indicators

- Total Renewable Freshwater Resources
- Installed Electricity Generating Capacity (by sources)
- Agricultural Land
- Gross Domestic Product
- Population

¹⁹UNECE (2015): Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus. United Nations. New York and Geneva.

162. **These indicators have mainly been presented visually.** Figures 9 and 10 below show how the key indicators can be presented in alternative ways in the different Nexus Assessments. Figure 11 gives an example of how indicators (here with the example of water) were used in the opinion-based questionnaire (see section 3.5.2).

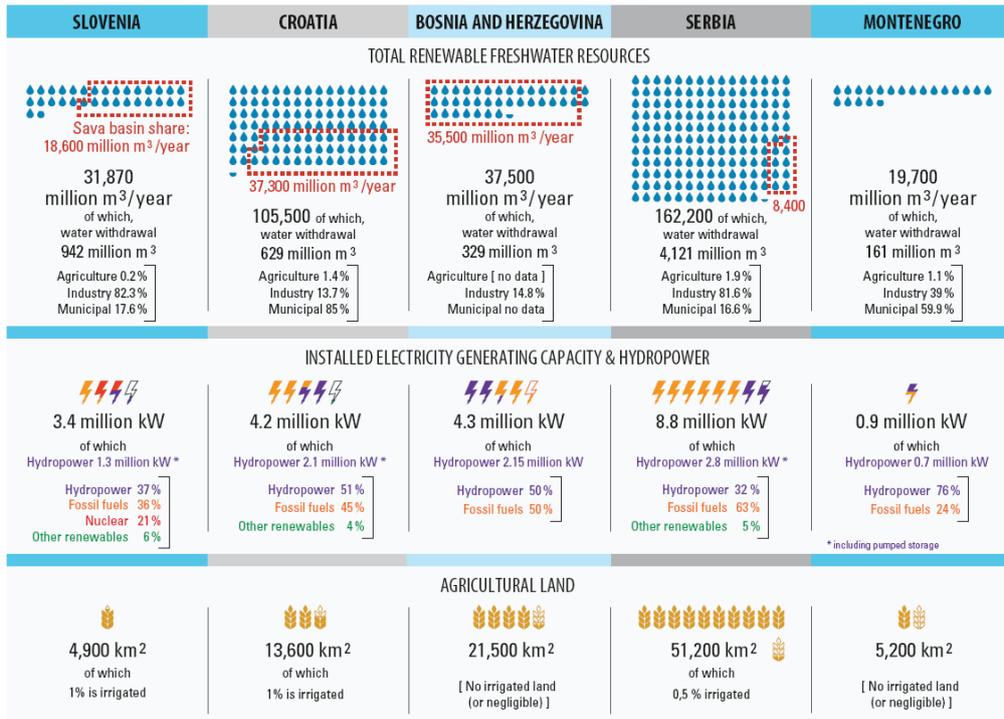


Figure9: Key indicators as presented in the Sava Assessment. This visualization was used in most basins assessed so far.

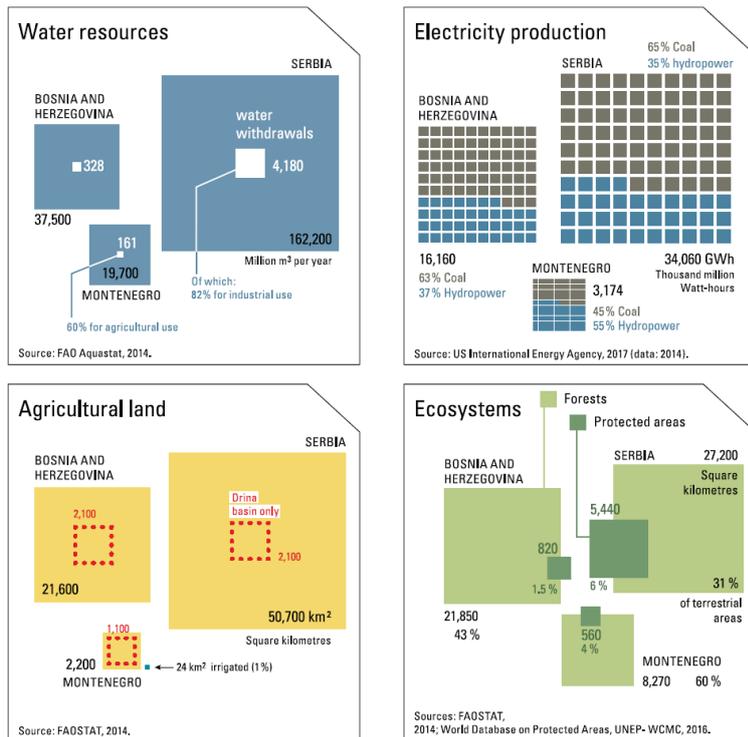


Figure 9: Key indicators as presented in the Drina Assessment. Because of the smaller size of the basin and the fact that this assessment detailed further the nexus issue on the basis of the Sava Assessment, a different presentation format was selected.

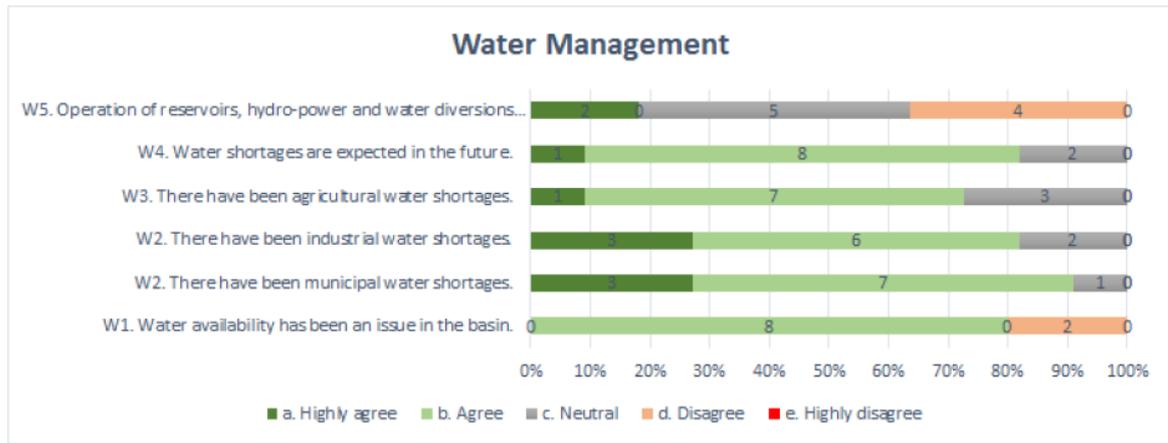


Figure 10: use of indicators in the opinion-based questionnaires.

Table 5: Nexus Indicators

		Basin Indicator	Country Indicator
Basin information		River Length Basin Area Basin shares by country (relative presence)	Country Area Shares of each country in the basin area (dependency)
Socio-economic		GDP share in basin (Possible to receive if the basin region overlaps with an economically valuable region. 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, iii) 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, ii) Mean annual precipitation Groundwater Balance Wastewater i) Generated, ii) Treated (primary, secondary, tertiary).	Renewable Water Resources i) Actual-, ii) Internal-, iii) External renewable resources total and per capita i) 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) Agricultural, 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 renewable and waste Alternative and nuclear (incl. 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 From i) Coal, ii) Natural gas, iii) Oil, iv) Hydropower, v) Renewables, v) 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 By different types (Data are often available at country level and not at basin level)	Logging harvest* i) official, ii) illegal Agricultural irrigated Land Land under cereal production 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

3.7.3 Analytical frameworks and tools

163. The nexus issues vary by basin and by context, and therefore the analytical tools that are applicable and indeed most appropriate also vary. In the nexus assessments under the Water Convention, although application of tools is broadening, several quantifications were made using OSeMOSYS open source cost optimization tool (see table 7) to link energy sector benefits to water management trade-offs, notably related to hydropower.

The following examples of quantifications from the Nexus Assessments are illustrative:

- a) **In the Sava River Basin**, each country has set long-term renewable energy (RE) targets, have energy security concerns and greenhouse gas (GHG) mitigation goals. The quantification exercise performed by the Royal Institute of Technology (KTH) with input from JRC indicates that, taking the Sava River Basin countries as a whole, the RES targets are within reach and can even be surpassed, reaching 55% in 2020. Hydropower plants located in the Sava River basin play a decisive role in meeting the RE targets: the electricity generation from hydropower could represent 33% of the total contribution of the RE sources. In light of such renewable energy generation opportunities, transboundary cooperation between Sava countries can therefore prove to be advantageous in providing energy security, decreasing energy dependency and contribute to the decarbonisation of the energy system.²⁰
- b) 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% of the dam capacity for flood control would have a cost, through a change in the energy mix, of about 4% 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% of the combined emissions of the three countries in 2015.²¹
- c) In order to investigate the dependencies between **the Syr Darya River Basin's** water resources and the power systems sector, a multi-region model of the electricity systems of the riparian countries was developed. With this system, causes and effects of changes in upstream hydropower generation can be simulated. To identify opportunities for cooperation, scenarios were developed for the operation of integrated power systems of the four riparian countries. A dynamic response of electricity trade and changes in electricity generation profiles were then analyzed. The scenarios included stated efforts in the implementation of energy efficiency measures, targeting both the supply and demand side, and

²⁰ Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus (UNECE, 2015) (box 13, p. 71) Available at: http://www.unece.org/fileadmin/DAM/env/water/publications/WAT_Nexus/ece_mp.wat_46_eng.pdf

²¹ Assessment of the water-food-energy-ecosystem nexus and benefits of transboundary cooperation in the Drina River Basin (UNECE, 2017). Available at: <http://www.unece.org/index.php?id=47750>

increased deployment of renewable energy. The comparative analysis allowed for the identification of key implications, demonstrating the value of energy sector action on water.²²

164. **Since the nexus concept is being formulated, the respective tools and methods to assess its interlinkages are continuously being developed.** To this end tools such as i) nexus dialogues, ii) nexus mapping, iii) scenarios, iv) extended systems analysis and v) institutional analysis have been developed and still are being developed. This is further described in UNECE (2015).
165. **The tools available to help analyse nexus issues differ in the level of integration.** Some tools have been created as fully integrated multi-resource models in which nexus interlinkages can be investigated using only a single software. Other models are extended system models, or single models which are combined through soft-linking. Soft-linked models allow different levels of automation between tools, and thus provide for a more flexible approach.
166. **The frameworks are based on a quantitative approach and consider several nexus interlinkages.** While almost all frameworks tackle the water, energy or food perspectives, some include wider aspects such as climate, environment or socio-economic indicators.
167. **A framework to analyse the nexus often includes the application different types of tools (modelling software).** Some of these frameworks that include a transboundary perspective on the nexus are presented below, including a reference to their transboundary application(s).
168. **The frameworks are often built around free software.** To allow a wider community of nexus stakeholder to work with these analytical frameworks, most of the underlying software is free of charge either through public domain or open source licenses. While access to technical support may then not be easily available, flexibility is a major advantage.
169. **While analytical frameworks aim to grasp the nexus as a whole, underlying software tools tend to have a sectoral focus.** This is often due to the fact that tools have been developed with a specific area of emphasis and have then been combined with other tools or extended. Thus, tools often show a clear, water, energy or land/soil/agriculture focus. Combining and extending tools provides for assembling an appropriate toolkit for different settings and sets of issues.
170. Table 6 shows analytical frameworks with transboundary relevance, with the attention on the considered interlinkages. Table 7 describes the frameworks with their underlying modelling software tools.

²² Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Syr Darya River Basin (UNECE, 2017). Available at: <http://www.unece.org/index.php?id=45042>.

Table 6: Analytical Frameworks to analyse transboundary nexus issues

ANALYTICAL FRAMEWORK	Scale	Considered Nexus interlinkages	References	Transboundary Application
MuSIASEM Multi-Scale Integrated Assessment of Society and Ecosystem Metabolism	Transboundary (Trade) Global Regional National Sub-National	Water Energy Food Land Human activity GHG GDP	Giampietro et al. (2013) ²³	Nexus Security using Quantitative Story-Telling. http://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 http://magic-nexus.eu/sites/default/files/%20files_case_studies/musiasem_global-case.pdf
CLEWs Climate, land-use, Energy and Water strategies	Transboundary basins Global Regional, National	Climate, Environment ↓ Energy, Water, Land/ Food	Alfstad et al. (2016) ²⁴ Howells et al. (2013) ²⁵	Nexus Assessments under the Water Convention - Alazani/Ganykh, Sava, Syr Darya and Drina River Basins www.unece.org/fileadmin/DAM/env/water/publications/WAT_Nexus/ece_mp.wat_46_eng.pdf www.unece.org/fileadmin/DAM/env/water/publications/WAT_Nexus/ECE_MP.WAT_NONE_9/Drina-FINAL-EN-WEB_final-correct.pdf
OnSSET	Transboundary basins	Energy ↔ Water Energy ↔ Food/Land	Mentis et al (2017) ²⁶	Nexus Assessment under the Water Convention – North Western Sahara Aquifer

²³Mario Giampietro, Richard J. Aspinall, Sandra G.F. Bukkens, Juan Cadillo Benalcazar, François Diaz-Maurin, Alessandro Flammini, Tiziano Gomiero, Zora Kovacic, Cristina Madrid, Jesús Ramos-Martín, Tarik Serrano-Tovar (FAO, 2013): “An Innovative Accounting Framework for the Food-Energy-Water Nexus”.

²⁴Alfstad, T., Howells, M., Rogner, H., Ramos, E., & Zepeda, E. (2016). Climate, Land-, Energy-, Water-use simulations (CLEWs) in Mauritius-an integrated optimisation approach. In EGU General Assembly Conference Abstracts (Vol. 18, p. 15765).

²⁵Howells, M, et al. (2013). Integrated analysis of climate change, land-use, energy and water strategies. Nature Climate Change, 3(7), 621.

²⁶Mentis, D., et al. (2017). Lighting the World: the first application of an open source, spatial electrification tool (OnSSET) on Sub-Saharan Africa. Environmental Research Letters, 12(8), 085003.

Open Source Spatial Electrification Tool	Continental Regional National Regional	Climate ↔ Energy		Forthcoming
WEAP-LEAP	Transboundary Global National	Water↔Energy Water ↔Food Water ↔Environment Energy↔Food Energy↔Land Energy↔ Environment Food↔Energy Land↔Food; Land↔ Environment	Stockholm Environment Institute Heaps (2016) ²⁷ Sieber & Purkey (2015) ²⁸	Upper Blue Nile Basin www.water-alternatives.org/index.php/all-abs/273-a8-1-6/file
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/science-update/mekrou-project-promoting-sustainability-m-krou-basin Udias et al., Submitted
WHAT-IF Water-Hydropower-Agriculture Tool for Investments and Financing	Transboundary Regional National Basin (single, multi)	Food Water Energy Welfare economics Financing	COWI AS in co-operation with OECD OECD (2018) ²⁹	Lower Syr-Darya basin (Asia) www.oecd.org/environment/outreach/MPWI_Perspectives_Final_WEB.pdf Zambezi river basin (Africa) -

²⁷ Heaps, C.G., 2016. Long-range Energy Alternatives Planning (LEAP) system. [Software version: 2018.1.8] Stockholm Environment Institute. Somerville, MA, USA. <https://www.energycommunity.org>.

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

²⁹ OECD (2018), Strengthening Sharda Multi-Purpose Water Infrastructure in Kazakhstan, OECD Studies on Water, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264289628-en>.

WEF Nexus Tool	National	Water ↔ Energy, Water ↔ Food, Energy ↔ Food Water, Energy, Food ↓ Land, Financing, Car- bon, Environment	WEF Nexus Re- search Group (Daher and Moh- tar, 2015) ³⁰	Security, climate change, and the resource nexus www.taylorfrancis.com/books/e/9781317198826/chapters/10.4324%2F9781315560625-4
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³⁰Bassel Daher and Rabi H. Mohtar (2015). Water–energy–food (WEF) Nexus Tool 2.0: guiding integrative resource planning and decision-making, Water International, DOI:/02508060.2015.1074148.

Table 7: Software information on analytical frameworks

ANALYTICAL FRAMEWORK	Category	Main Modelling Softwares used	Focus Sector	Availability	Access
MuSIASEM	QL/QN	Currently internal	Socio-Ecological Systems	Planned to be public	-
CLEWs	QN	OSeMOSYS	Energy	Open source	www.osemosys.org
		LEAP	Energy	Free for users in developing countries. Priced licenses to all others	www.sei.org
		WEAP	Water		www.weap21.org/
		GAEZ	Land use	Free	www.gaez.iiasa.ac.at
OnSSET	QN	OnSSET	Energy	Open source	www.onsset.org
WEAP-LEAP	QN	WEAP	Water	Free for users in developing countries. Priced licenses to all others	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 & optimisation language	WHAT-IF: Public Domain GAMS: Proprietary MS Excel/Access: 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://wefnexusool.org

4 PASSING ON THE EXPERIENCE - WHAT HAS BEEN LEARNED IN THE PAST YEARS ABOUT NEXUS ASSESSMENTS

171. **The learning curve in the Nexus Assessments is still steep and new experiences are constantly made.** Among these insights is that it is important to tailor the scope and focus of each assessment to the specific issues in the basin. Every assessment again proves that the different sectors that are in the focus of the nexus play out at different scales, with effects at multiple levels. The existing cooperation and other specifics of the basin, the region and the countries then further influence how the Nexus Assessment can be carried out as well as the perspectives of follow up. Improving resource management in a basin requires improvements in the governance setting, for instance, through more coherent national policies. These and several other conclusions and recommendations of the Nexus Assessment under the working programme of 2012 – 2015 remain valid and appreciated. They are summarized in the publication below.

Pages 99 – 102 in UNECE (2015): Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus. United Nations. New York and Geneva.

172. This chapter will focus on additional experiences made during the past three years.
173. **There is a growing body of knowledge of nexus dynamics and tools.** The attention that the nexus has sparked in 2011 is still ongoing. This has resulted in increased activity under the nexus notion in science and policy. That the developed tools and knowledge are also beneficial in a transboundary context was shown during the Global Stocktaking Workshop. Also discussed at this workshop was that international agencies and donors play a significant role in promoting regional planning and transboundary cooperation.
174. **While each Assessment is a unique exercise, experience shows that transboundary basins share common issues related to water allocation and environmental impact.** In this regard, the Assessments provide useful entry points to motivate examinations of international cooperation across sectors to better allocate water and consider environmental impacts. 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 designing the assessments, as described in the chapters below.
175. **Compared to IWRM, the Nexus Assessments consider sectors more broadly.** This is done with the intention of explicitly including sectoral perspectives, looking also beyond the basin, and considering a wider range of opportunities for cooperation.
176. **There are several key lessons learned in the past years.** Some of them consider the design of the Nexus Assessments (chapter 4.1.), how the Assessments created synergies with other processes (chapter 4.2) and how energy and agriculture sectors are also exploring the value of nexus approaches in the nexus (chapters 4.3). Further challenges and need for improvements are described in chapter 4.4.

4.1 Design of the process

4.1.1 Official engagement of countries provides for ownership

177. **The result of the Assessments may be controversial to a sector or a country and therefore during the design of the process it is important to ensure acceptance and ownership of the participating countries and sectors.** The Assessments aim to facilitate the creation of leadership and ownership of the involved countries throughout the process. In the design of the assessments it proved useful to increase ownership by carrying out the assessments as official processes. All basin (or aquifer) riparians with a non-negligible share should agree to and engage in the process from the start, confirmed by official correspondence. UNECE therefore first reaches out to the focal points of the Water Convention to establish engagement from the countries. In detail, the approach and considerations were specific to each Nexus Assessment.
178. **National focal points (ideally from different sectors, or perhaps from an inter-ministerial group) have a key role in the overall process.** Local experts proved invaluable to support the focal points in answering technical questions. Furthermore, it was important to define clear roles of focal points and local experts to ensure more support from the project.
179. **An official process enables the Assessment to develop common understandings which are officially shared by the riparian countries.** This commitment allows for the integration of the nexus approach into strategic documents and development plans of the riparian countries, which were called for by participants of past Assessments.
180. **By aiming to include all relevant sectors and participants from several levels of the national administration as well as other stakeholders, ownership can be consolidated.** That the participants are actively involved through the process, especially in the workshops, is necessary to shape the Assessment into a valuable exercise for the participants themselves.

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

181. **Creating ownership does not stop at officially including countries in the Nexus Assessment.** The above section argued, and the participatory methods (chapter 3.5) showed, that much of the thinking is done by country officials during the workshops. The process is designed to foster participation. This begins with the inclusion of focal points and local expert in the desk studies, continues throughout the workshops and extends beyond the workshops with commenting and joint publication of results. An example is that the results from the Drina assessment were validated by stakeholders, who also provided further details and views on implementation of the proposed actions. Compared to earlier applications of the Assessment methodology, even more consultation opportunities were provided for input. The facilitation of participation that represented a broad range of views provided a solid basis for improvement of resource management and policy, and future assistance.
182. **Experience showed that such a participatory process is challenging.** The complexity of multiple level interdisciplinary work requires time and learning.
183. **The WEF Nexus aims to equally consider the water, energy and food sectors as well as ecosystem concerns; however, the entry point to the nexus here is water.** As the Assessments are carried out under the Water Convention, water is the element that connects the countries and the basin is the

level at which the 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. This introduces a “water bias”. This bias must be carefully considered and balanced to the degree possible. However, continuously reaching out to other sectors and including them to the highest degree possible increases the quality and relevance of the assessments, adding value expanding beyond pure water management perspectives as well as enhancing outreach within the countries.

184. In order to ensure that all relevant sectors and interests are reached in the Nexus activities, **the process must be designed to achieve broad participation**, which increases the uptake of the nexus in different sectors. Attention must be paid to identify and reach out to the various stakeholders that may be relevant to or affected by management of basin resources considered in the Nexus Assessments. The approach to the identification of stakeholders and establishment of contacts differed somewhat depending on the basin (some examples are given in table 8).

Table 8: Different approaches to identification of and establishment of contact with countries (examples).

Nexus Assessments	Approach	Considerations
Alazani/Ganykh, Sava	Stakeholder identification in basin management-related work was used as the basis and then complemented.	There was a good synergy with the GEF project, but the dialogue with the energy sector developed with a delay.
Syr Darya	Focal point (water) ministries together with the foreign ministries were contacted about forming the national delegations.	Representative local participation was difficult to ensure, and diversity of participation could have been better (e.g. from a gender point of view).
Drina	The contacts/network established in the Sava provided the basis; the involvement of SED/GERE provided for identification.	The focal points effectively involved local administrations and utilities. Collaboration with the UNECE Group of Experts on Renewable Energy helped to involve the energy sector.

185. **Partners with different sectoral mandates are invaluable.** The Assessments are carried out under the Water Convention, which implies an emphasis on water resources. Yet, partners from other sectors need to be involved. FAO, for instance, facilitated the outreach to the agriculture and land management sector, and the UNECE Sustainable Energy Division helped to involve the energy sector and promoted discussion about water issues through the nexus in energy sector fora.
186. **For the participatory process to be effective, experience has also shown that the workshop should be limited to key stakeholders.** A high number of stakeholders hinders the flow during the workshops without guaranteeing a better outcome.

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

187. **Communication is an important aspect throughout the assessments.** Before the process, communication motivates involvement. During the process, it forms valuable networks and reinforces mutual understandings of the different interests, and afterwards it is important to communicate the outcomes to add to the impact of other processes. Including the benefits perspective into this communication advances the Nexus Assessments as a whole. It must also be considered that scoping-level Nexus Assessments only lay out possible directions for solutions, and that the dialogues must be continued to move towards implementation of nexus solutions. Assessing the feasibility (technical, financial) and acceptability of priority measures could be logical next steps in that direction. Further guidance on implementation and application of the nexus approach has been called for by some countries.
188. **Defining a glossary to communicate the Nexus concept before an assessment has begun is beneficial.** Defined terms help to develop a common language, clarify the task at hand and help to prevent possible misunderstandings when each sector uses its specific jargon. Such a glossary would not only advance the work under Convention, but for the entire nexus community.
189. **An Assessment should also include a consultation of stakeholders to determine the target audiences and thus refine communication efforts.** This helps in adjusting messages to the audience and focusing on the most pertinent findings. The participants of the Drina Assessment, for instance, identified national governments as the key stakeholder to be convinced of the benefits of managing the Drina resources together. A number of other specific stakeholders were also identified as needing to be targeted, in particular the ministries of finance, relevant ministerial representatives, mayors, local populations, and project financiers.
190. **A factor that added to the importance of communication is the evolution and extension of the assessments over time.** Due to the complexity of the issues and, consequently, the thematic breadth of the studies, as well as limited human resources, the assessments in many cases took longer than foreseen. In some cases, the longer assessment period occurred alongside changes in ministries and agencies. This underlines the importance of regular communication.
191. **Developing stronger cooperation after the assessments requires convincing key decision-makers and stakeholders.** Hence, an effective communication strategy is an important component in designing the nexus process. Ensuring communication, especially of the outcomes, has proven to be one of the key challenges in past years.
192. **It is one of the objectives of a Nexus Assessment to raise awareness among authorities about policy actions, instruments and tools.** Therefore, designing the process must include the dissemination of material to relevant decision-makers. Experience has shown that different audiences should be the target of information on the nexus results. Therefore, under the different Assessments, policy briefs, policy summaries, larger policy documents, summaries of assessment reports as well as full technical reports have been published. Promotion of the past Assessments' findings is regularly carried out to ensure that the messages reach the concerned authorities, inform regional water management and development agendas, and are taken up in salient intergovernmental processes. For instance, the International Sava River Basin Commission translated the findings of the Sava assessment into local languages and disseminated them, ensuring visibility in the basin countries.

193. **Apart from project-specific communication, a need became apparent for general awareness-raising about the nexus approach at different levels.** This includes at the local level, among government authorities and in civil society organizations. Involving junior experts in any follow-up projects proved valuable for capacity building about the nexus. Such a general promotion of the assessments' results was done, for instance, at international events, such as the World Water Week in August 2016 and the Regional Forum for Sustainable Development in 2016, or the Batumi Environment for Europe Ministerial Conference in 2016, where a side event on the Nexus Assessment was organised.
194. **Many of the intersectoral impacts could be most effectively addressed by the policies and practices of certain economic sectors, notably energy and agriculture.** The importance of creating synergies with these sectors is described in chapter 4.2. To raise awareness and encourage cooperation with other sectors, communication must be directly targeted at these sectors and its stakeholders, highlighting concerns and opportunities. For example, different perspectives to the benefits of cooperating emerge from linking discussions about water management and about transition to sustainable energy.

4.2 Scoping and complementing the methodological approach

4.2.1 The benefits perspective strengthens the Nexus Assessments

195. **Previous experience described that enhanced cooperation between countries brings significant benefits, such as making the countries less vulnerable to external shocks and decreasing the cost of infrastructure use.** To strengthen this aspect and to take up previous experiences with benefits under the Convention, the benefit perspective was thus explicitly included in the Nexus Assessments. Similar to the Water Convention's policy guidance on benefits, the Nexus Approach invites the audience to consider broader cooperation, rather than just allocating water.
196. **Beyond identifying the benefits of cooperation across sectors and countries, it is important to communicate them,** both to the participants of the workshop and in the final recommendations to policy-makers in the basin report. This aspect gained increasing importance during the workshops, and ultimately became an integral part of the agenda as described in this report.

4.2.2 A scoping-level Nexus Assessment is only a start

197. **When designing and carrying out an Assessment at the scoping level, one must keep in mind that this is only the start.** The uptake of the findings must be ensured if solutions are to be implemented. During past activities, it was recognized that the Assessment should be an initial step in a continuous process. Once countries have gained a common understanding of the issue and have formulated actions for solutions, it is then time to continue dialogue between the countries on implementing these steps. Local and sub-regional cooperation organizations will be important for using and sustaining the results from the assessments, and for continuing the dialogues about resource management trade-offs.
198. **Many key measures to address the nexus are such that they need to be taken beyond water management.** Promotion of dialogue in the key sectors and among the key actors is therefore very important after the Assessments. Existing intergovernmental structures can be used to foster follow-up. The momentum gained in the Drina nexus project, for instance, could be built on, to continue

the dialogue among the countries and sectors on the assessment's findings. It could be explored how existing structures with multi-sectoral characters, e.g. the International Sava River Basin Commission, can be built on to promote intersectoral coordination. It is, however, important that officials and stakeholders have the will to progress to a next step in nexus activities, such as focusing on the proposed solutions and assessing them in detail, as with a cost-benefit-analysis.

4.2.3 Synchronized technical and governance methods enhance the outcomes of the Assessments

199. **A major lesson from previous years is that the technical and governance parts of the Assessments must be better synchronized and progress hand-in-hand.** This synthesis report focuses on how this has been done (see chapter 3.4). Experience has shown that this indeed enhanced the quality of the assessments. It is now increasingly important to apply this in practice, and to encourage experts to form a close-knit team of analysts that feel "obliged" to talk to each other and collaborate.

4.2.4 Flexibility and learning in applying the TBNA methodology is necessary

200. **Already at the time of the first description of the TBNA methodology it was stated that the Assessments will be carried out under varying circumstances considering a wide range of conditions and interlinkages.** Thus, the method was designed as a simple and consistent framework which, due to its simplicity, allows for flexibility in application. The lessons learned throughout the years are that this flexibility is necessary, as each Assessment is a unique case.
201. **The Nexus Assessment can be carried in a progressive way, building on earlier work.** Because it was based on the Sava Assessment, the first part of the Drina assessment did not start from scratch, but rather built directly upon the outcomes of the Sava Assessment. The method was used to zoom in on the previous work. During the participatory phase it was possible to hold three workshops, instead of the two foreseen in the default methodology. Having more workshops allowed for the inclusion of the perspective of benefits of cooperation, and created more time for discussing the nexus solution in the second workshop, while still allowing sufficient time to validate all results in the third workshop.
202. **Is the Assessment in an Aquifer System (NWSAS) the methods are adapted and complemented to suit the groundwater focus and the issues at stake.** An example is stakeholder mapping. While previous lessons learned revealed that it is a limitation to the methodology and that stakeholder mapping must be carried out early in the process, the NWSAS Assessment has developed just that. As a participatory exercise (see chapter 3.5) stakeholders are mapped and their relationships and power balances described in the beginning of the assessment.
203. **Regardless of the aquifer or river basin, such participatory processes are challenging.** The complexity of this kind of multi-level interdisciplinary work and participation requires time and learning throughout the process. Being able to adapt to these circumstances is crucial to achieve the best possible results. This flexibility in the method thus proved very useful and will be retained in the future. In addition, it was an invaluable benefit when funding agencies and participating organisations allowed for the necessary flexibility throughout the assessment.

4.3 Synergies with other processes

204. **In the past decade, the nexus concept has influenced the work of many research institutes, development organisations and international donor agencies.** The work under the Water Convention has also cooperated with other organisations and contributed to synergies between different nexus activities. Table 9 shows different synergies which have emerged over the past years. It shows how different activities under the Water Convention have related with other processes.. Assessments have, for instance, contributed to sparking more activities in the regions. Yet, not only a specific Assessment itself but the nexus work under the Convention in general has led to synergies with other partners and activities. Some such partners and activities are located within the UNECE, such as other MEAs or the Benefits of Cooperation (see chapter 3.6). Several other synergies emerged related to the Global Environment Facility (GEF) funded projects (described below).
205. **Three different kinds of synergies can be distinguished.**
- **Process synergies** which, for instance, 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 to regional nexus work.
 - **Raising awareness** in regional and sectoral processes to continuously consider the nexus in future activities.
206. **The Regional Nexus Dialogues (RNDs) provide one example of a process synergy, demonstrating how the nexus work done under the water convention in general informs other processes** The RND Programme is implemented by the European Commission and GIZ, and has run since 2016. The aim 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.”³¹. This activity shall help to continuously implement the nexus approach at the regional and the national levels. Thus, it has a transboundary implication. The Nexus Assessments have informed the shaping of the RNDs mainly through their experience, conclusions and recommendations. This has in particular informed the RNDs in the Niger Basin and Central Asia, but has also contributed to the Dialogue in Latin America.
207. **The coordination with other UN Regional Economic Commissions serves an example about complementarity and sharing of experience between regions.** The Economic Commission for Latin America and the Caribbean’s (ECLAC) case study work highlights in particular water-food-energy nexus in water and wastewater services. The Water Convention’s nexus experience provides insights to the public policy guidance work of ECLAC. ESCWA’s capacity building and work on good practices provides useful references in the Middle East and North Africa region.
208. 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 of the Aral Sea Basin: The Water Convention's Syr Darya Nexus Assessment provided input and orientation regarding the issues and possible solutions, and had raised awareness, facilitating further nexus work.

³¹<https://www.nexus-dialogue-programme.eu/about/nexus-regional-dialogue-programme/>

209. **The assessment in the Drina 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, for example, contributed to the debate on trade-offs related to development of the hydropower potential and raised awareness about the related environmental considerations, in the Energy Community, among others. The regional roundtable on *Operationalizing the Water, Food, Energy and Environment Nexus in South-Eastern Europe (SEE)* in June 2017 used the key inputs from the Drina assessment. The project *Promoting the Sustainable Management of Natural Resources in South-eastern Europe, through the use of Nexus approach*, in cooperation with GWP-Med, contributes to the South-East Europe 2020 Strategy which includes “advancing water, energy and food nexus approach approach at national and transboundary levels” as one of its objectives.

Table 9: Synergies with other processes

Activity under the Water Convention	Category	Organisation	Project/Activity	Synergies
Water Convention Activities (Nexus Assessments)	Global	UNECE	Espoo Convention Protocol on Strategic Environmental Assessment (SEA)	The Nexus Assessments have promoted SEAs in particular, but also EIAs as instruments for promoting the kind of intersectoral coordination that the nexus approach calls for.
		UN	High-Level Political Forum (HLPF) on Sustainable Development	Nexus experience was shared to inform sustainable development debate and the implementation of the Agenda 2030. HLPF Issue Brief 5: From silos to integrated policy making (2014) quoted emerging insights from Nexus Assessments. The transboundary dimension of the nexus and this experience was highlighted also in the HLPF 2018 preparatory Expert Group reflection on the SDG interlinkages.
		UNECE	Benefits of Cooperation	Since 2016, Nexus Assessments include a Benefits of Cooperation perspective.
		IIASA	Integrated Solutions for Water, Energy, and Land (ISWEL)	Exchange of experience.
		GEF	GEF IW:LEARN	- In the framework of IW:LEARN, the Water Convention secretariat provides training and programmatic support on the Nexus approach to address the WEF Nexus in IW portfolio of projects. - Experience from Nexus Assessment can inform the reflection about mainstreaming the Nexus into GEF IW projects.
		UN-DESA	Global Modelling Tools for sustainable development	Exchange of experience, support to countries in analysis to inform policy.
		European Commission and GIZ	Regional Nexus Dialogues (RND)	In the RND, experience, conclusions and recommendations from the Nexus Assessments have informed shaping of the Regional Dialogues, in particular in the Niger Basin and Central Asia, but have also contributed to the Dialogue in Latin America.
	Regional	European Commission	European Water Initiative's (EUWI) National Policy Dialogues (NPDs)	Parallels in implementation through process that allows for discussing nexus findings, notably the NPDs provided for a platform for discussing.

		UNECE Group of Experts on Renewable Energy (GERE)		Contributing to initiating discussion in the framework of GERE on the value of intersectoral synergies for development and generation of renewable energy (RE). An output is a joint policy document on the nexus and RE. This interaction has progressed to positioning of the nexus work to inform renewable energy investment talks about water resource considerations.
		Sustainable Energy for All (SE4All)	Progress towards sustainable energy in the UNECE region	Providing spaces for broadening stakeholder dialogue beyond energy (“Pathways to Sustainable Energy”) and the UNECE Regional Report for the Global Tracking Framework – Progress toward Sustainable Energy.
	Sectoral	IUCN IWA	Natural Infrastructure in the Nexus	
Alazani/Ganykh Assessment	Regional		GEF Project: <i>Reducing Transboundary Degradation in the Kura Ara(k)s River Basin</i>	Pilot Study was a collaboration with the GEF project, providing for synergy and mutual learning.
Syr Darya Assessment		European Commission	EU Nexus Dialogue in Central Asia.	The Nexus Assessment provided input to the scoping and contributed to the identification of issues for Nexus Dialogues implemented by Central Asia Regional Environmental Centre (CAREC) and IUCN. The Assessment also raised awareness about the nexus concept in the region, benefitting such subsequent initiatives.
		OECD		Exchange of experience, e.g. on tools. Input from OECD on economic instruments into the Nexus Assessment. Promoting discussion about the conclusions 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 with the Central Asian Governments the conclusions a possible follow up action. The nexus conclusions lay out a broad set of optional subjects for the TWG to consider.
	Sectoral	FAO	Aral Sea Basin Initiative	Nexus Assessment could draw on experiences 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 in the ESCWA region serve as input for discussing solutions for the NWSAS

Sava Assessment		International Sava River Basin Commission	Implementation of the Framework Agreement on	The Nexus Assessment contributed to the Strategy for implementing the Framework Agreement on the Sava River Basin (FASRB), by strengthening coordination with sectoral stakeholders, in the energy and agriculture sectors in particular.
		Austrian Development Agency GWP-MED	Western Balkan Sub-Regional Nexus Project <i>Promoting the Sustainable Management of Natural Resources in Southeastern Europe</i>	- 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 providing for a broader set of tools and consequently a broader range of issues analysed.
		Western Balkan Countries, EU	2017 Western Balkans Summit (Trieste Summit)	Input on infrastructure to the Trieste Summit from the International Sava River Basin Commission inspired by the Nexus.
Drina Assessment			Regional initiatives including hydropower	The nexus approach has gained momentum in 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 hydropower master plan project (WBIF) was prepared in parallel.
		Regional Cooperation Council		Contribution to regional processes: SEE 2020 Strategy's implementation on the nexus topic, the Environment pillar, which includes "advancing water, energy and food nexus approach at the national and transboundary level".
			GEF/World Bank West Balkans Drina River Basin Management Project	Drina Assessment contributed to the information basis making up for the Transboundary Diagnostic Analysis.
	Sectoral	Energy Community	Using its platform	Drina Assessment drew attention to the need to revisit hydropower potential estimates and environmental needs in the Western Balkans .

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

The GEF as a large funding mechanism for multi-country collaboration and in the area of International Waters (IW) the investments also aim to facilitate integrated cross-sectoral approaches to ensure sustainable use and maintenance of ecosystem services. The strategy of the Sixth replenishment of GEF envisaged to support initiatives addressing the water-energy-food nexus. Regarding International Waters, trade-offs in the water-food-energy-ecosystem security nexus were recognized among the challenges that implementation of Strategic Action Plan.³² GEF:IW projects have traditionally tackled intersectoral issues, and the methodology for the Transboundary Diagnostic Analysis is well-established approaching issues affecting on transboundary waters 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 the nexus work under the Water Convention with the Global Environment Facility (GEF) funded International Waters (GEF: IW) projects (notably on the Kura, Drina and Drin Rivers)(table 10) as well as the insights beyond water management and environmental protection obtained in the course of the Nexus Assessment. On-going work in the Drin Basin in cooperation with GWP-Mediterranean explores opportunities for the Nexus assessment contributing to identification of a broader spectrum of root causes of transboundary issues deriving from the energy and agriculture sectors, including from beyond the basin geographically.

A Nexus Assessment, or elements of it could complement GEF:IW (and perhaps other Focal Area projects) in different ways:

- Contributing to broadening the diagnostic and understanding better the sectoral and economic drivers of impacts on waters (energy policy, trade dynamics);
- Providing analytical tools that integrate multiple resources and consider also complex feedbacks, broader and more comprehensive issue diagnoses;
- Identifying and motivating beneficial action from the side of economic sectors; and
- Revisiting water cooperation on a wider basis.

Extended dialogue with economic sectors about scenarios and, eventually, about synergic action leading to environmental benefits would be beneficial. The GEF 7th Replenishment investments to address the nexus include integrated watershed management and land management as well as supply chain approaches but generally have a water management and water services focus.³³

Through GEF: IW Learning Exchange and Resource Network (GEF IW:LEARN 4), the nexus work under the Convention supports training and the provision of programmatic support to the GEF International Waters portfolio of projects. The IW:LEARN can mobilise the experience and insights of GEF agencies and provide a channel for knowledge mobilization to support GEF's programming. In parallel, increased awareness in the Governments about the nexus issues is expected to add to identification of opportunities where investigation and action across sectors can add value.

³² GEF International Waters Focal Area Strategy in. (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>

³³ GEF-7 Replenishment: Programming directions. Fourth Meeting for the Seventh Replenishment of the GEF Trust Fund (Stockholm, 25 April 2018). Available at: https://www.thegef.org/sites/default/files/council-meeting-documents/GEF-7%20Programming%20Directions%20-%20GEF_R.7_19.pdf

Table 10. Interaction of the Nexus Assessments under the Water Convention with the GEF International Waters projects.

Basin	Nature of synergy and interaction	Experienced value added	Further opportunities
<i>Alazani/Ganykh</i>	The GEF Kura project (phase 1) co-organized the nexus assessment workshop, supported identification of stakeholders and liaison. The GEF project's studies provided useful sources of information on some aspects.	Due to several reasons, the nexus issues were not taken on as much as they could have been: the Nexus Assessment approach was still in early development, there were no resources and adequate data for substantive quantitative analysis to be carried out, and the GEF project's stage of SAP preparation was advanced already then. The action that the Nexus Assessment calls for, for example regarding the energy sector, extends beyond the GEF project's scope.	The new bilateral Kura GEF project for Azerbaijan and Georgia can potentially address some of the nexus issues identified. The bilateral agreement on waters shared by Azerbaijan and Georgia in the Kura River Basin, under negotiation, would provide a framework also for some intersectoral action.
<i>Syr Darya</i>	There was no interaction because there was no active GEF project at the time. ³⁴	The Nexus Assessment is contributing to conditions in the Central Asia region to better enable cooperation on water resources and benefits for different sectors from their use. The Nexus Assessment and demonstrated the value of a number of sectoral and inter-sectoral actions, including in the field of energy and some of them regional. Such actions would not be identified with water management focus and considering the basin only.	The actions outlined in the Nexus Assessment the hopefully creates more fertile ground also for GEF: IW projects to be initiated. If the sustainable energy transition picks up the nexus, this can be very complementary to any GEF supported action.

³⁴ The GEF project on groundwaters in the Syr Darya Basin developed by UNESCO-IHP did not proceed into implementation.

<i>Sava and its tributary the Drina</i>	The Nexus Assessment was coordinated with the GEF project on the Drina River Basin which was under preparation at the time (end its fore-runner projects) and efforts were made to mutually use the information gathered and developed.	A full-fledged GEF TDA was not done on the Drina because there were several projects that contributed to forming the necessary information basis about transboundary issues. One of them was the Drina Nexus Assessment. The energy system modelling for optimizing the operation of hydropower plants through cooperation in the Nexus Assessment contributed energy sector insights to flow regulation.	Spin-off projects to the Drina Nexus Assessment could complement with some actions that the GEF project which devotes significant attention to flooding, and climate change. The energy system model developed could complement any flow regime optimization investigation by broadening the substantiation of benefits.
<i>Drin</i>	In cooperation with GWP Mediterranean and UNDP, the GEF TDA is complemented with a thematic report on the water-food-energy-ecosystems nexus.	The nexus approach is recognized to add value regarding a more comprehensive understanding of the drivers of impacts on waters, especially from the energy sector's development and operation. ³⁵ While building on the diagnostic work done during the preparation of the Drin GEF project, the Nexus Assessment (desk study and analysis) can point at possible gaps and complements related to e.g. energy policy, forestry and trade in agricultural products.	Potentially complementary quantification of selected nexus issues and solutions can be done with the Nexus Assessment's spin-off project in the Western Balkans, led by GWP Mediterranean.
<i>North-West Sahara Aquifer System (NWSAS)</i>	Some of the earlier technical diagnostic work and tool development, notably models on the aquifer, can be built upon in the Nexus Assessment.	The Nexus Assessment allows to revisit – on a broader basis - the legacy of the GEF supported work on the NWSAS. The Nexus Assessment has synergies, notably with some of	Once the countries review the implications of nexus issues for the aquifer and possible response actions from the Nexus Assessment, as well as review the scope of work of the NWSAS Coordination Mechanism and institutional options

³⁵ 1) Hydropower flow regulation, and flood management and 2) Biomass production, forest management, and ecosystem services. Impact of energy policy on water resources

		<p>GWP Mediterranean’s parallel contributing efforts: a study of institutional options and development of a Shared Vision for the NWSAS.</p>	<p>outlined with GWP Mediterranean’s assistance, support from GEF and/or other development partners will be needed, including in the form of investments.</p>
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4.4 Engagement of other sectors

210. **Involving all sectors in the Assessments is a key part of the exercise.** An outstanding example is the first workshop of the Drina Assessment, where all sectors were involved: energy, water management, agriculture and rural development as well as environmental protection. The Assessment contributed to gaining a common understanding, and has served to establish links between the sector administrations as a starting point to overcoming sectoral silos.
211. **The Nexus Assessments use the Water Convention as an entry point.** On the one hand, this is an important factor to ensure official engagement; on the other hand, this implies an emphasis on water resources (see chapter 4.1). To keep the balances and to fulfil the aim of the Nexus concept to equally consider the sectors, it is important to strategically seek partners within other sectoral mandates and to involve them into the work under the nexus. Therefore, it is not only the aim to include all sectors to the assessment, but to also use the work of the Convention as a conversation opener towards potential partners who will engage in the nexus through their sectors. What has been achieved is provided below.
212. **The increasing engagement of other sectors in recent years resulted in a higher awareness about intersectoral issues and possible solutions.** The Drina and NWSAS Assessments have been especially effective at including sectors other than the water sector in their dialogues.

4.4.1 Food and land management

Interest of and benefit for the sector

213. **The definition of the sector of food and land management was purposely broad.** While there is an evident relation between increasing food demand and the use of natural resources, there are other aspects of the agricultural sector (e.g. production of biofuels, modernization of agri-food value chains, food trade) that could find in the Nexus Assessment a good platform for intersectoral and international dialogue. At the same time, there are also land management issues in the forestry sector (and potentially in fisheries) that should not be forgotten when looking at the nexus.
214. **Agriculture is closely interlinked with water, energy and the environment.** The globally increasing need for food in the coming decades places large burdens on agriculture, and increasing food production requires improvements (in extension and efficiency) of irrigation systems. Cooperation between sectors and countries can increase the availability of water for agriculture through smarter allocation. Multi-purpose dams are meant to supply water for a variety of sectors and purposes, including irrigation. Energy – and electrical power in particular - can support intensive groundwater irrigation and serves multiple energy demands from the sector, including food processing and water desalination. International agreements on energy and food trade can significantly reduce pressure on local resources by making food production better aligned to the specific agroecological conditions of different countries. Taking the nexus into consideration from the food perspective will support achieving these goals.
215. **At the same time, food production also affects water quality and the surrounding environment through the discharge of agricultural effluents and the modification of land use.** In turn, environmental degradation can seriously compromise agricultural production, for instance through soil degradation or loss of biodiversity. The loss and degradation of forests, as well as poor management

of forested areas, can also bring significant pressure on other sectors, most notably by affecting sedimentation and compromising water retention in flood-prone basins.

216. **All of these issues can have transboundary implications for setting up a long-term strategy for the sector.** It is particularly valuable to discuss solutions that have a clear intersectoral dimension – like biofuels and biomass production, eco-tourism, or organic agriculture.

Involved organizations and channels of involvement

217. **The UN Food and Agricultural Organisation (FAO) is engaging in the Nexus Assessments.** The cooperation with FAO facilitated the outreach to the agricultural sector and strengthened the ties between the agricultural sector and water sector under the nexus concept. FAO is a member of the Nexus Task Force under the Water Convention and as such it has provided guidance in the development of the TBNA methodology and has taken an active role in some of the Nexus Assessments under the Convention (most notably in the Syr Darya Assessment). FAO also participated in the Global Stocktaking workshop and shared its work on the Nexus.
218. **Beyond the international community, the engagement of food and land management sectors from the countries has always been challenging during the past Nexus Assessments, in part because of the breadth of potential issues to be discussed.** However, it was precisely the contribution of local experts in agriculture that allowed for the development of concrete solutions for the basin (like in the case of the Drina, where solutions encompassed the whole spectrum of sustainable rural development opportunities, taking inspiration from existing project in the basin and surrounding region). It should be noted that for the agricultural sector it is particularly important to involve stakeholders among farmers (or cooperatives of farmers), because it is at farm level that the pressure is most evident, and it is only at that scale that rural development initiatives can actually be implemented.

4.4.2 Energy

Interest of and benefit for the sector

219. **An obvious benefit for the energy sector from the nexus is the coordination of hydropower activities.** In a hydropower cascade, the overall electricity production can be increased by coordinating all plants' operations according to a common schedule of water discharge, thereby also increasing the system readiness to respond to floods or droughts. By altering natural flows, hydropower always has some level of influence on the environment and the ecosystems of the river, as well as on the availability of water for other uses. For this reason, its operation must be closely coordinated with other sectors in river basin planning to ensure reduced trade-offs and increased synergies. In a similar way to food trade, energy trade can make energy production more efficient by utilizing the use of different sources available in different countries. The energy sector increasingly acknowledges the nexus as a platform to do so.
220. **The benefits for the energy sector, however, do not stop with coordination of hydropower activities.** Energy production from thermal power plants is water-intensive and needs close coordination with the other water-using sectors in the basin. The water sector plays a crucial role in energy demand management, as water utilities (e.g. water distribution networks, wastewater treatment plants) are often a municipality's major electricity user and thus contain untapped potentials for energy efficiency. The already-mentioned sector of bioenergy is also an important part of the nexus.

221. **The energy sector as a whole can profit from a nexus approach, which is increasingly being recognised.** Thus, within the energy sector, new successful efforts have been made and new cooperation has been developed with different actors in the energy sector.

Involved organizations and ways of involvement

222. **The Group of Renewable Energies (GERE) is involved in the nexus activities under the Water Convention.** A joint publication of the Water Convention and the Group of Renewable Energies (GERE) was issued in 2017. Addressed to the energy sector, the publication brings the experience from the Nexus Assessments to the attention of a diverse range of renewable energy stakeholders. It describes the role of renewable energy in the nexus and some related opportunities, as well as some examples.

UNECE (2017): Deployment of Renewable Energy: The Water-Energy-Food-Ecosystem Nexus Approach. United Nations. New York and Geneva.

223. **The GERE has continued to raise awareness about the Nexus in the energy sectors.** For instance, GERE has been discussing nexus issues from the angle of renewable energy on the *Fora on Energy for Sustainable Development*, e.g. in Baku 2016 with a presentation on the Syr Darya Assessments and its implications on the energy sectors, or in Astana 2017 with discussions facilitated by the UNECE Energy Division. Both events were helpful for visibility of the results from the Assessments towards the energy sector.
224. **The Renewable Energy Hard Talks in UNECE countries have been organised in Azerbaijan, Ukraine, Georgia.** The nexus perspective is promoted there through the discussions on investments in renewable energies. In the talks with Azerbaijan, the recommendations refer to a nexus approach when considering energy efficiency and environmental protection.

UNECE and Azerbaijan (2017): RECOMMENDATION PAPER. Outcome of the Hard Talk 2017. New Opportunities for Developing Renewable Energy in Azerbaijan.

225. **While good cooperation was established within UNECE, the Water Convention has also started further cooperation with other energy stakeholders, such as the Energy Community.** Through its platform, the Drina Assessment triggered the need to revisit the hydropower potential estimates in the Western Balkans (see also Table 7). Further outreach was made to IRENA and to energy utilities which are showing interest in the nexus. Exemplarily for the latter is the Drina Assessment, which triggered a discussion with energy companies in the Western Balkans about cooperation.
226. **The involvement of local utilities and experts with knowledge of the energy sector in the region is also instrumental to the recognition of existing opportunities.** In the Syr Darya, for example, it was possible to estimate the impact of energy efficiency measures on hydropower production in the basin.

4.4.3 Ecosystems

Interest of and benefit for the sector

227. The term *ecosystems* is here intended to indicate the whole natural environment, including environmental protection and environmental friendly initiatives. Despite the important role of ecosystems in the nexus, they often get little attention in assessments.
228. **The nexus sectors all profit from intact ecosystems through the multiple services they provide (provisioning, regulating, habitat, and cultural).** However, these 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 a source of energy (e.g. hydro, solar, wind, bioenergy, fossil fuels) and as a sink for pollution (e.g. cooling water, air pollution, CO₂). Agriculture needs healthy ecosystems and at the same time influences them through land-use changes and utilization. The water sector uses ecosystems as source for freshwater and as a sink for pollution from domestic, municipal, agricultural, and industrial effluents.
229. **Concrete actions can improve sustainability in the sectors.** Examples are strengthening of agricultural orientation to preserve nature, environment and biodiversity. An emphasis on high-quality traditional products or organic products can lead to increases in the value of agricultural production, but also to greater biodiversity conservation and environmental protection. Environmental flow regulation can lead to increased water flows in the dry season, which would have positive effects on biodiversity, fisheries and agriculture. Developing eco-tourism, for example through the establishment of minimal-impact paths for tourists to reach important biodiversity areas, can balance the needs of local communities to generate income using local assets with nature conservation objectives. Green infrastructure is often a smart choice, as opposed to grey infrastructure. For instance, wetlands can help lower the risk of floods while at the same time restoring the capability of natural systems to filter and depurate water.
230. **Currently, it is clear that the environment and ecosystem concerns are still in the background.** Keeping “ecosystem” as a fourth component of the nexus was, in fact, a way of signalling that environmental needs should be put forward together with energy, food, and water security. The full potential and the benefits of utilizing intact ecosystems in all three nexus sectors is not yet fully reached. In fact, ecosystem preservation is very often perceived as a long-term problem, and environmental protection is considered in juxtaposition to economic development. Putting the sector at the centre of the nexus dialogue, including in the identification of solutions, was often challenging because of that. However, it was also clear that in many countries and regions there is a palpable will to shift towards a greener, more circular economy, and that there is a need for more platforms to allow for elaborating policies, plans, and projects to solidify this will into action. Approaches and methodologies available to assess the value of ecosystems, their services and nature-based solutions with regards to environmental flows and food production would merit more attention.

Involved organizations and ways of involvement

231. **IUCN, as an important environmental stakeholder, has embarked on Nexus activities.** How IUCN and IWA are jointly engaged in the nexus through hydropower is described in chapter 2.3.4. Through the entry point of the Aral Sea Basin Program, Regional Environmental Centre for Central Asia (CAREC) and IUCN are helping Central Asian countries to identify opportunities for multi-sec-

toral investments for increased water, energy and food security that promote socio-economic development while maintaining the integrity and sustainability of ecosystems. IUCN was also part of the experience sharing on their nexus activities, for example in the Global Stocktaking Workshop.

232. **The Convention on Biological Diversity (CDB) is active on cross-sectoral issues.** The CDB secretariat has been reaching out to tackle the “Mainstreaming of biodiversity within and across sectors and other strategic actions to enhance implementation”. Under this topic the experiences with the nexus under the Water Convention have been shared. On the Drina assessment, the importance of the value of ecosystems and protection of biodiversity was demonstrated. It is a crucial asset for sustainable development to be maintained by strengthening the agricultural sector through expanding organic farming and developing ecosystem-friendly tourism. Thus, the interest in “nexus” approaches to look at trade-offs related to development can help to better reconcile different resource management and environmental protection objectives.

233. **Also, for ecosystems, the engagement of local environmental NGOs ensures that the specificity of environmental issues and the singular opportunities to develop environment-friendly initiatives are captured in each assessment.** In the case of the Sava, for instance, it was suggested that the Sava Commission could offer a platform to develop ecotourism in the region through its existing network of policy makers.

4.5 Information and Nexus Assessment Tools to support policy-making

234. **The lack of data can hamper transboundary governance.** If salient information is not available to all concerned sectors or to relevant ministries in a government, it can slow down harmonized action. Obtaining the necessary information basis and forming a holistic picture of the situation is, however, more complicated in a transboundary context. Here, harmonized indicators, information and data are needed from all the relevant riparian parties. Yet, once a database is in place it can catalyse information exchange in a variety of fields³⁶.
235. **Data gaps should not prevent a Nexus Assessment.** Data gaps will always exist, but they should not hold back analysis of nexus issues and solutions, or addressing the findings through resource management decisions and policy. Typically, some kind of data is available to start with. The value of countries sharing a resource agreeing on a qualitative basis about priority issues should not be underestimated. As a result, while the flexible approach of the Nexus Assessment also allows for adaptation to the availability of data, it is important to know 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 it. Reasonable assumptions, estimations and expert opinions can fill some gaps, but must be used cautiously.
236. **Nexus models must be further improved.** As the analysis of interlinkages across sectors is still a new subject, there is a need to further improve models and tools that are able to provide for the analysis that serves more evidence-based policy development and helps to respond to topical resource management questions. The compilation of some nexus tools in this Synthesis Document gives an indication about how far they have come.
237. **Decision-making in resource policy depends on reliable tools that draw a somewhat realistic picture of reality.** This is more straightforward in siloed approaches, where one sector or resource is at the centre of attention. With integrated approaches, be it integrated water management or the nexus approach, the task of providing decision-making support has become more difficult due to the increased complexity.
238. **It is reported that there is still a lack of tools to effectively apply nexus thinking.** “The currently applied tools are still largely limited to individual sectors and hence not fit for untangling these complexes inter-linkages, especially beyond the local scale”³⁷ Continuously developing tools that can help not only to understand the nexus but also to support governance is ongoing.³⁸

³⁶ A positive example is the Sava River Basin, where information exchange systems and joint planning efforts have delivered benefits beyond water management (e.g. ecotourism).

³⁷ J. Liu, H. Yang, C. Cudennec, A.K. Gain, H. Hoff, R. Lawford, J. Qi, L. de Strasser, P.T. Yillia & C. Zheng (2017) Challenges in operationalizing the water–energy–food nexus, *Hydrological Sciences Journal*, 62:11, 1714-1720

³⁸ Dai, J et al. (2018). Water-energy nexus: A review of methods and tools for macro-assessment. *Applied Energy*, 210, 393-408.

5 MOVING ON: IMPLEMENTING THE NEXUS SOLUTIONS

239. While previous chapters have shown the experiences in carrying out Nexus Assessments, this chapter looks beyond the Assessment itself.
240. **The Governments' willingness and decisions to respond to the conclusions are key to concrete policy and management responses.** . While international organizations can support, political willingness and decisions to take response measures by the countries are necessary for the nexus solutions identified and elaborated to become reality to improve transboundary resources management. The integrated and intersectoral nature of the packages of solutions complicates championing responses and requires partnerships beyond water management.
241. **Currently, national and transboundary governance structures are often not well set-up to favor intersectoral action but they can be built upon.** Thus, there is a need to share possible options to catalyse such change. One among many is that simply identifying benefits of joint action can already motivate improvements, for instance, in the form of joint investments or transboundary agreements, developed with a nexus mindset, including a broader range of benefits. Existing transboundary cooperation and intersectoral coordination frameworks can be built upon; for example joint bodies for cooperation could convene discussions about basin-level impacts of sectoral plans or reinforce dialogue with sectoral actors otherwise. The national level arrangements for monitoring and coordinating implementation of the Sustainable Development Goals could provide a framework where nexus solutions would add value and elaborating on the potential impact of these solutions in terms of progress towards the SDG targets would be beneficial.
242. **The aim of the Nexus Assessments is to bring stakeholders together, increase the knowledge base to support decision-making, promote dialogue between the countries and sectors and identify nexus issues and solutions.** Implementing the identified solutions will go beyond the aims of the assessment: Implementation is about achieving enhanced coordination and cooperation between countries and sectors in the resources management of basins, reducing trade-offs, increasing synergies and thus more efficiently using resources through enhanced governance structures and technical measures.
243. **This chapter summarizes nexus solutions from the various assessments carried out in close cooperation with Governments.** On the one hand, solutions have been formulated for each individual case; on the other hand, there are some general lessons that can be drawn from the past years for moving ahead in transboundary and cross-sectoral resources management. An overview of specific solutions for each assessment is given in table 11. It shows the concrete possibilities of technical and governance action, tailored to the nexus issues individual to each basin.
244. **A progressive application of a nexus approach or partial solutions can pave the way for more ambitious and comprehensive solutions.** Such gradual progress may be necessary, as there are many limitations to the practical application of a nexus approach, requiring new ways of thinking and working, new partnerships and difference incentive structures. The nexus action can start with national efforts, for example, to improve efficiency in the use of water and electricity on shared resources, and gradually build more favourable conditions for actions that require regional or basin-level coordination
245. **To create an enabling environment, many – more general – solutions revolved around the nexus thinking.** When developing the TBNA methodology, five categories were defined in which these solutions are grouped. The 1's of nexus solutions are i) Institutions, ii) Information, iii) Instruments,

iv) Infrastructure (and investment) and v) International Coordination and Cooperation. The focus of these solutions lies on governance, with the aim to contribute to governments in moving ahead to create a more enabling environment for the nexus to blossom. Despite that not all solutions are blueprints for any given basin, they may serve as a source of inspiration.

Table 11: Summary of specific solutions for each basin from the Nexus Assessment.

Nexus Assessment	Solutions
Alazani/ Ganykh	<ul style="list-style-type: none"> - Facilitate access to modern energy sources and energy trade. - Minimize impacts from new hydropower development. - Enhance catchment management to control erosion.
Sava	<ul style="list-style-type: none"> - Expand hydropower sustainably and integrate other renewable energies - Better coordinate energy planning and basin-level water management between riparians.
Syr Darya	<ul style="list-style-type: none"> - Promote the restoration and vitalization of the energy market. - Develop the currently minimal trade in agricultural products. - Improve efficiency in energy generation, transmission and use. - Improve efficiency in water use (in agriculture in particular).
Isonzo/Soča	<ul style="list-style-type: none"> - Explore the potential for basin-level green economic growth. - Restore river continuity and increase drought resilience - Reduce stress on riverine ecosystems (minimum discharge). - Increase the use of renewable energies in the irrigation sector (small hydropower, solar) - Link renewables to existing agriculture infrastructure (small hydropower, solar, biomass)
Drina	<ul style="list-style-type: none"> - Develop a basin-wide approach to the development of hydropower. - Strengthen cooperation on flood management beyond emergency response. - Advance towards the development of a common environmental flows standard. - Exploit the existing synergies between eco-tourism, agriculture and renewable energy production. - Support farmers to increase agricultural productivity and climate-resilience. - Invest in infrastructure that supports sustainable rural development. - Advance towards the establishment of transboundary protected areas. - Develop a common approach to effectively protect water quality.
NWSAS	<ul style="list-style-type: none"> - Modernise and increase the value and viability of agriculture. - Reorient economic activities dependent on water and improve resource efficiency.

5.1.1 Institutions (governance)

246. Institutional solutions focus on improving the legal and regulatory basis (e.g. formalization of transboundary basin management across sectors), institutional frameworks and mechanisms for coordination and consultation, and policies.

Institutions – Solutions
<ul style="list-style-type: none"> - Clarifying roles and responsibilities of organisations, e.g. management and financing of irrigation schemes, monitoring of basin resources, support of sustainable development principles and basin organizations. - Developing institutional capacities.

- Identifying opportunities related to multi-sectorality in sector-based policy making.
- Increasing institutional reforms, e.g. separating policy-making, regulation and implementing roles as well as creating decentralized institutions.
- Building on existing structures and mechanisms, and linking to on-going processes that can support operationalization of policy recommendations, e.g. climate change adaptation planning or sustainable development strategies
- Institutionalizing the engagement of resource-using sectors in the development of laws, strategies and plans.
- Reviewing the mandates of existing transboundary organisations to strengthen their role in multi-sector basin management. For instance, reviewing the ISRBC to increase its ability to discuss all relevant basin resources.
- Finalizing agreement processes, e.g. the draft bilateral agreement between Georgia and Azerbaijan on cooperation in the Kura river basin.
- Adapting basin legal frameworks to improve intersectoral coordination, e.g. in the Syr Darya basin, support implementation of intersectoral technical solutions.
- Adapting national legal frameworks to support implementation of new technologies in the countries.
- Setting basin-wide and national targets and develop actions plans to meet targets.
- Improving intersectoral coordination e.g. increasing representation of and consultation with relevant ministries.
- Creating mechanisms for participation from different sectors in planning processes.
- Raising awareness, encouraging positive action and cooperation with the energy sector and agricultural sectors, e.g. targeting renewable energy actors, as renewable energy plays key role to improve sustainability.

5.1.2 Information

247. Information solutions are necessary to improve knowledge of the basin, the activities therein and their impacts. Gathering and sharing multi-sector information as well as analysing existing policy will support policy-making across sectors.

Information – Solutions

- Improving monitoring of basin resources, data management and forecasting.
- Analysing policy implementation barriers.
- Including nexus linkages in sectoral assessments.
- Mapping policy instruments and analysing their impacts.
- Expanding agricultural and forestry extension programmes to support crop-shifting and sustainable land management.
- Ensuring that information is available for policy-making across sectors to allow for multisectoral modelling and analysis.
- Promoting research and implementation of innovative and modern approaches and best practices, e.g. new irrigation technologies.
- Developing open source databases and tools to allow relevant stakeholders to develop strategic plans.
- Increasing participation of stakeholders to gather up-to-date insights on nexus issues.
- Advancing knowledge, tool-kits and capacity to identify areas where coordinated planning is necessary.

5.1.3 Instruments

248. Economic and policy instruments, best used as a mix appropriate to the context, can in many ways support effective management of resources. For example, motivating rational use of water and electricity and supporting environmental protection.

Instruments – Solutions
<ul style="list-style-type: none"> - Increasing the systematic use of policy and economic instruments to address trade-offs and synergies, e.g. transboundary EIA and SEA legislation, minimum environmental flows, or land use planning. - Applying consultation processes between sectors to increase intersectoral coordination. - Creating an enabling environment and incentivising rational use of water, energy, land and ecosystem protection, e.g. user-pays or beneficiary pays principles. - Beyond individual instruments, facilitating coherent mixes of policy instruments, e.g. combination of energy efficiency standards, public awareness and pricing reforms. - Increasing collaborative practices and coherent policies. - Increasing the enforcement of environmental legislation. - Scaling up IWRM in river basins. - Designing and implementing performance efficiency standards, and strengthening the links to renewable energy technologies. - Reforming water and energy pricing to support rational use and generate income.

5.1.4 Infrastructure

249. Investing in infrastructure and technical measures is an important solution. On the one hand, new or rehabilitated infrastructure is often necessary; on the other hand, better investments will lead to multi-purpose use of infrastructure.

Infrastructure – Solutions
<ul style="list-style-type: none"> - Increasing investments in green infrastructure to increase ecosystem services, e.g. wetlands, or flood-plains for flood protection. - Creating an enabling environment for investments in the water sector, as there is generally little investment due to the difficulties in cost recovery. - Investing not only more, but better, and strategically coordinating investments basin-wide. - Coordinate investments of hydropower dams to multipurpose reservoirs. - Investing in diversification of energy sources and developing inter-connectivity of electricity networks to promote efficient use of capacity, and supporting the development of functioning regional markets. - Supporting agricultural extension service programmes. - Encourage diversification of crops. - Integrating a nexus approach to funding decisions of international financing institutions. - Investing in multipurpose infrastructure to allow for splitting costs and return on investments across sectors, e.g. multi-purpose dams. - Encouraging efficient use of existing infrastructure to avoid expensive duplicate infrastructures, e.g. of reservoir capacity through agreeing about operation regimes.

5.1.5 International Coordination and Cooperation

250. Increasing coordination and cooperation aims at increased partnership and between riparian countries through sharing information, development plans, or good practices aiming at benefits for all.

International Coordination and Cooperation – Solutions
<ul style="list-style-type: none"> - Improving the basis for transboundary cooperation. - Developing capacities of basin institutions regarding knowledge management and planning processes. - Improving data verification and exchange and knowledge sharing between countries, joint monitoring and forecasting. - Boosting data quality, timely sharing and adequate accessibility to key stakeholders. - Developing basin-wide inventories, e.g. of resource users or pollution sources. - Jointly identifying good practices and at the local and national levels. - Promoting and improving energy trading to increase overall energy security and facilitate gradual introduction of renewable energies. - Lowering barriers to trading food and agricultural goods to promote cost-, water- and energy efficient production and exchange. - Developing regional energy markets.

5.2 Necessities for implementation

251. When aiming to implement nexus solutions it is not required that countries have a nexus governance already set up and working. To govern the nexus, however, some preconditions are necessary.
252. **Strong multi sectoral planning enhances the effectiveness of implementing nexus solutions.** When the opportunities of nexus solutions are in the process of implementation, strong multisectoral planning is required. This applies for transboundary planning, as well as coordination at the national scale.
253. **Investing better, rather than more, advances nexus infrastructure.** Large investments are required when exploiting nexus synergies for the concerned sectors 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 in infrastructure can also reduce the need of unnecessary, redundant infrastructure investments.
254. **Using existing institutional structures helps to ignite nexus coordination.** In some contexts, existing bodies, such as river basin organisations or other joint bodies between countries ease the communication and cooperation. When these organizations already have a multisectoral scope, a good basis is set for negotiating nexus activities.
255. **Sharing information and knowledge is a must for cooperation.** Wherever possible, countries can improve decision-making at the national and the transboundary levels when a shared knowledge base exists.
256. **Exploring economic and policy instruments has great potential to exploit synergies and reduce trade-offs.** Instruments such as water and energy pricing can introduce incentives towards nexus-oriented behaviour and raise infrastructure funds. Other tools such as cost-benefit-analysis and

Strategic Environmental Assessments can help decision-makers to consider alternatives and investigate possible nexus solutions and their benefits.

257. **Nexus solutions need to be picked up in strategies and plans.** When identified nexus solutions and the necessary targets and instruments are included in national and sectoral strategies and plans, the implementation of the nexus will take off.
258. **Political will brings together countries and sectors.** Without political will at the highest level, the coordination between sectors and countries will not succeed. Thus, clear messages and communication within each sector and at the national government level is required to change policy and organisational structures towards cross sectoral and transboundary cooperation.
259. **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 including these elements their guidelines and requirements for approval of projects and related consultations. Some development partners are already increasingly adopting a nexus approach to transboundary issues and will keep on working in this direction.

5.3 Limitations and Potential Bottlenecks

260. **It is recognized that challenges related to reconciling national strategies in the different sectors and in a transboundary context still exist.** Conflicting use of common resources, water flow regulations, or environmental impacts continuously need to be tackled.
261. **While the Nexus Assessments have been carried out, adaptations have been made with the aim to continuously improve the facilitation of increased transboundary cooperation.** This process remains challenging. While some of the limitations from previous years were tackled, such as the consolidation of the governance analysis or improved communication, there are still limitations encountered. When further moving from the Nexus Assessment to embedding work on the Nexus in to the processes of the sectors and national administration, different bottlenecks still exist. This chapter reveals some critical points in this regard.

5.3.1 Limitations in the Nexus Assessment process

262. **The capacities of national focal points are not yet high enough.** Focal points who are part of the Nexus Assessment support the process in addition to their full-time responsibilities in national organisations. Focal points are often not able to allocate the time to the Nexus Assessment that would be necessary and fruitful throughout the entire process. There is thus a need for additional backing from national experts with enough time at hand to support the national focal points during the Nexus Assessments.
263. **Sufficient and broad participation can still be enhanced.** The importance of participation during the Assessments was reconfirmed in the last years. With the application of a broad range of participatory methods, the Assessments are now well equipped for participation. However, it is still challenging to ensure that the participation is sufficient and broad enough. It is sometimes the case that not all sectors or stakeholders participate. Constraints on time and resources often also limit participatory processes.

264. **The value of ecosystems remains in the background.** The ecosystems aspect in the Assessments remains in the background when compared to the other economically strong sectors of water, energy and food. The value of ecosystem services for these sectors must further be communicated and analysed to strengthen the important role that ecosystems play.
265. **The important views of sectors and countries that do not participate may not be reflected.** The risk remains that non-participation in the workshops will change the outcome of a Nexus Assessment. If a sector is not represented, its specific needs may be overlooked and thus not reflected in further activities. This can also happen within a sector. Limiting the participation of the energy sector to hydropower specialists may draw sole attention to hydropower while other benefits for the energy sector at large do not come to light.

5.3.2 Potential Bottlenecks for Implementing Nexus Solutions

266. **The transition from an external to an internal process is challenging.** The Nexus Assessments need to move beyond being an external process facilitated by international organisations. A critical step is moving from externally facilitated activities to a self-sustaining process within the concerned sectors and countries. This transition needs local champions from civil society and national administration to move forward such nexus-related processes.
267. **Without data there is less potential for proper analysis and decision-making.** Analysis can only take place when data in sufficient quantity and quality are available. Yet, there is often a lack of sufficient information and data. In order to better support decision-making and communication, the possibility of analysis must be improved. There is a need for upgrading existing tools and models, while also increasing monitoring and data to form a basis for decision-making.
268. **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. 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 which are still hard to overcome.
269. **Ensuring equally high commitment from all countries and sectors is difficult.** Authorities and stakeholders see a value in the Nexus Assessments and appreciate the exchange across sectors. Yet, the power of business-as-usual is strong, and the established policies and practices need a well-defined entry point and sufficient momentum to be changed. Despite that all countries and stakeholder might be officially involved in the process, it was found that it is challenging to engage and ensure the same level of commitment from all riparian countries. Coupling the analysis of the nexus with a benefits assessment can help generate arguments to this end.
270. **Follow-up is demanding and requires sufficient financial resources.** This report described that the Assessments are only the start. Results require follow-up, solutions must be discussed within other processes, and decision-makers must be convinced to implement solutions. To facilitate this process, it is necessary to translate the findings and recommendations into local languages, broadly communicate and share the findings and provide further possibilities to the countries to continue their discussions. Among these possibilities are the following: evaluating further and demonstrating benefits of cooperation, drawing attention to opportunities from investment (including from infrastructure), supporting targeted dialogue for political engagement and for exchanging experience, as well as exploring options for guiding or formalizing flow regulation. This process is necessary, yet

demanding, and requires sufficient financial resources. Fostering follow-up actions is an area which still requires more thinking and improvement.

271. **Changes in national administration can induce possibilities and difficulties.** National ministries, focal points and other parts of government administration may be reshuffled after political changes. This contains the possibilities of cross-sectoral integration, yet it also bears the risk of losing momentum. With changing representatives in involved institutions, priorities may also change regarding the work of transboundary and cross-sectoral cooperation.