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Promoting an integrated and intersectoral approach to water management at all levels: water-food-energy-ecosystems nexus in transboundary basins

SOLUTIONS AND INVESTMENTS IN THE WATER-FOOD ENERGY-ECOSYSTEMS NEXUS: A SYNTHESIS OF EXPERIENCES IN TRANSBOUNDARY BASINS

Prepared by the secretariat in cooperation with Finland

Background and introduction

1. The sixth session of the Meeting of the Parties (2012) 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. The Meeting of the Parties also decided to establish the Task Force on the Water-Food-Energy-Ecosystems Nexus[1], to oversee the thematic "nexus" assessments in 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. 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. This resulted in the publication *Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins and experiences from its application: synthesis* (2018).

3. The eight session of the meeting of the Parties (2018) requested the secretariat, as part of the programme of work for 2019–2021, to undertake the preparation of a synthesis document to fill gaps related to the experience of nexus solutions of transboundary relevance. The synthesis document should demonstrate the value of applying a nexus approach to natural resource management in transboundary basins.

4. Following this request, a stocktaking exercise to gather experience about nexus solutions and investments was carried out by the secretariat in cooperation with the International Union for the Conservation of Nature (IUCN) in 2020-20212. The stocktaking draws from the experience of the stakeholders involved in the participatory

[1] The Task Force consists of representatives of Governments (mainly water, energy, agriculture and environment protection authorities) – notably from countries that have experience in nexus or integrated assessments – river basin organizations, specialized agencies and international, regional and non-governmental organizations, as well as experts/academics. Finland chairs the Task Force as the lead Party for programme area 3.2 *Supporting intersectoral dialogues and assessments through the application of the water-food- energy-ecosystems nexus approach* in the Programme of Work 2019-2021.

2 The IUCN contributed to the stocktaking by co-supervising the development of the analytical framework and the questionnaire presented in this report, by disseminating the questionnaire and by providing input to the report. Finland provided in-kind support for the stocktaking.

nexus assessments carried out under the Water Convention and the dialogues facilitated through BRIDGE project (by IUCN). Both programs focus on transboundary basins. The stocktaking exercise included case studies with a broad geographical distribution.

5. This present document contains the draft of the synthesis document. This draft synthesis document presents the draft findings from the stocktaking exercise, expanding on the approach and the succinct preliminary findings reported in the document *Solutions and investments in the water-food-energy-ecosystems nexus: preliminary findings from a synthesis of experiences in transboundary basins* (ECE/MP.WAT/WG.1/2021/6−ECE/MP.WAT/WG.2/2021/6), giving more elements when it comes to the regional relevance of the findings, particularly regarding financing opportunities. The report also considers further experience emerging from consultations with experts and nexus dialogues in different regions of the world. The synthesis, the content of which is to be finalized by June 2021, is due to be published in time for the ninth session of the Meeting of the Parties (29 September–1 October 2021).

6. The stocktaking exercise and the development of this report are overseen by the Conventions Task Force on the Water-Food-Energy-Ecosystems nexus under the leadership of Finland. The sixth meeting of the Task Force (22-23 October 2021) discussed the preliminary results, the main factors of success and obstacles to implementation of nexus solutions and investments. In the meeting, regional experiences of advancement in applying nexus solutions and facilitating nexus dialogues were also discussed. Opportunities that exist to finance projects and measures of integrated or multi-sectoral character (nexus solutions) with transboundary benefits were presented to the Task Force and related experiences shared.

7. The main audience of this report are national and basin institutions with water and environment mandate, who requested the stocktaking. However, the findings are also relevant for policy makers and stakeholders from ”productive” sectors (notably energy, agriculture), non-line ministries (notably financing and economy) .

8. The Working Groups are invited to:

(a) Review the draft synthesis report, provide any additional comments and entrust the secretariat, in cooperation with the lead country, with integrating the comments received by the deadline 15 May and subsequently editing the synthesis report into a publication, taking into account the comments made and elaborating as necessary;

(b) Entrust the secretariat with submitting the publication “Solutions and investments in the water-food-energy-ecosystems nexus: a synthesis of experiences in transboundary basins”, in English, to the Meeting of the Parties at its ninth session (29 September–1 October 2021), printing it and translating it into French, Russian and Spanish.

Contents

1. Introduction

1.1 Nexus dynamics in transboundary settings

Transboundary water resources constitute more than 60 per cent of global freshwater resources. Water, energy, food, and environmental security depend on these waters. Demographic, economic, social, and climatic changes, are all exerting increasing pressure on natural resources, including through a seemingly ever-growing global demand of energy, food, and water that threatens the well-being of the ecosystems we rely upon. The key to shift towards sustainable development lies in the strategic decisions we will take regarding natural resources, which need to be better valued and more responsibly managed.

Today, choices related to management and use of energy, land, and water are typically taken in isolation and without adequate consideration of the inter-sectoral implications of planned developments, which may be positive or negative. This can result in painful inter-sectoral trade-offs and makes it more difficult to find collaborative solutions. Both developing and developed countries are faced with this challenge.

In transboundary settings, not addressing trade-offs and externalities may result in friction between countries and reduced trust, at best hindering regional development and at worst generating conflict. Conversely, a nexus (or cross-sectoral) approach to managing common resources could greatly enhance water, energy and food security in riparian countries, including by increasing resource use efficiency, capitalizing on regional complementarities, and improving natural resource governance.

The “nexus” concept is rooted in the idea that there is an urgent need for sectoral and national policies to be made more coherent to reduce resource management trade-offs and reconcile multiple uses of resources, including transboundary waters. Policy coherence can be achieved through intersectoral exchange or communication, active coordination and due consideration of different interests, and negotiation of trade-offs, all the way to synergy and cooperation towards common objectives. Notably, policy coherence is a necessary condition for effective climate action, water and food security, ecosystem preservation and development in general, all of which requires acting across sectors (energy, food, biodiversity, etc.) and across scales (global to local, and transboundary). The 2030 Agenda for Sustainable Development itself requires coordination across sectors, coherent policies, and integrated planning – essentially a “nexus approach”.

Policy coherence could bring economic benefits by facilitating the development of synergies and partnerships, and in turn facilitate the co-financing of investments: public-private, multisectoral and multi-country. In transboundary settings, increased trust and cooperation, including agreements among riparian countries is essential to reduce political risks for investors. Climate action, green economy and sustainable development provide valuable cross-sectoral policy frameworks for coordinated, integrated projects and can support water authorities in establishing strategic partnerships and finding financing.

Multiplying benefits from a single project (for example, multipurpose infrastructure; combining innovative solutions to attain the efficient use of different resources) is the most practical way of contributing to different objectives at the same time. However, without a coherent policy framework, consultative processes and planning frameworks that support integration, the upscaling or replication of this type of investments is difficult. Transboundary cooperation frameworks, such as transboundary water agreements and respective institutional arrangements, or strategic action plans for basins, could increasingly play a positive role, provided that they effectively provide a basis for engaging with relevant economic sectors (for example, industry, energy production, agriculture or tourism).

1.2 The need for a synthesis report on nexus solutions and investments

To date, various Governments and institutions have been involved in nexus dialogues and/or assessments around the world. These efforts make up a significant body of knowledge and practical experience.

Yet, despite this experience, there is still a lack of convincing examples demonstrating the real added value of nexus approaches in policymaking and investment planning, compared to traditional, sectoral approaches. The nexus approach should lead to "nexus solutions" that increase resource efficiency and reconcile different interests, while protecting the environment and maximizing the social value of investments. However, there is no blueprint for the design and implementation of nexus solutions, and experience of cross-sectoral cooperation may or may not be labelled as "nexus". Taking stock of nexus solutions means considering a broad spectrum of experience and ultimately clarifying the following questions:

- What are the most common problems in transboundary basins that are being tackled with a "nexus", i.e., cross-sectoral, approach?
- What are the most common categories/typologies of solutions and related investments?
- What are common trade-offs and synergies across sectors and countries?
- What are the benefits of cooperation that can motivate cooperation (and that can be used for communication and advocacy)?
- What are the enabling factors for the implementation of solutions, notably institutional arrangements and financing frameworks?

In 2018, the Meeting of the Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) at its eighth session[3] requested the secretariat to undertake the preparation of a synthesis document to fill these important gaps through a stocktaking of "nexus solutions"[4].

1.3 The Water Convention's nexus assessments and IUCN's BRIDGE project

This report draws from the experience of UNECE and IUCN as well as that of key partner institutions involved in similar exercises of cross-sectoral character and regional/transboundary relevance.

The nexus assessments carried out under the Water Convention include five transboundary river basins (the Alazani/Ganykh, the Sava, the Syr Darya, the Drina, the Drin) and one shared aquifer (the North West Saharan Aquifer System (NWSAS)), all of which were developed through a participatory process involving the concerned sector authorities and other key stakeholders, e.g. from regional coordination bodies, non-governmental organizations, academia[5]. The methodology developed under the Water Convention includes the analysis of the both the technical and the governance aspects of the nexus[6].

While the first assessments (Alazani/Ganykh, Sava, and Syr Darya) focused mostly on the joint identification of cross-sectoral issues, the most recent ones (Drina, Drin, and NWSAS) looked more into "nexus solutions". Notably, the nexus assessment of the NWSAS, for example, included the joint definition of a package of nexus solutions" as part of the participatory process, also considering the past experience of implementing cross-sectoral action in the riparian countries. The assessment of the Drin River Basin (still ongoing) is supporting the implementation of some of the cross-sectoral actions included in the Strategic Action Program of the basin.

[3] Nur-Sultan, 10–12 October 2018. Meeting of the Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes,

[4] Report of the Meeting of the Parties on its eighth session (ECE/MP.WAT/54)

[5] All assessment reports are available on the website of UNECE at: https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus

[6] ECE. Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins and experiences from its application: synthesis ((United Nations, New York and Geneva, 2015)

IUCN's project Building River Dialogues and Governance (BRIDGE) supports the capacities of countries sharing river or lake basins to implement effective water management arrangements through a shared vision, benefit-sharing principles and transparent and coherent institutional frameworks. Its goal is to enhance cooperation among riparian countries by applying water diplomacy at multiple levels. BRIDGE works through five key implementation strategies: demonstration of the value of cooperation, learning (training and capacity building), dialogue, leadership (empowering champions), advice and support (on demand to governments and stakeholders). The BRIDGE projects encourage cross-sectoral cooperation, in one case specifically through an assessment of nexus trade-offs (the Sekong, Sesan and Srepok (3S) basin). The BRIDGE project supports dialogue in Africa, Asia, and Latin America[7].

The regional experience from partners reflected in this report also draws from other initiatives promoting transboundary and regional cooperation across sectors, notably: the "Nexus Regional Dialogues Programme" (supported by the European Commission and the German Agency for International Cooperation (GIZ)) and the several projects supported by the Global Environment Facility (GEF) International Water that included the development of "Transboundary Diagnostic Analyses" and "Strategic Action Programmes" (TDA and SAP)[8].

2. The framework developed to analyse nexus solutions

In the terminology developed under the Water Convention - a "nexus solution" is "an intervention that would benefit more than one sector, in this context including interventions that reduce the pressure on ecosystems (or the environment at large)". Accordingly, "nexus investments" are those investments that support the implementation of nexus solutions. In transboundary contexts – which is in focus in this synthesis report - these solutions have an impact, direct or indirect, on shared water resources.

The analytical framework was built to capture the *implementation* of "nexus solutions" and related "nexus investments" of transboundary relevance, where: "Nexus solutions and investments arise from silo-breaking action and directly or indirectly produce sustainable transboundary benefits in multiple, diverse water-using or water-dependent sectors in the riparian States". Annex 4 includes a tabular representation of the two-axis framework. The framework should support the investigation of the questions presented in section 1.2 (see Annex 1).

The first axis of the analytical framework includes the most typical problems that affect transboundary basins in terms of water quantity, water quality or environmental aspects. The second axis includes the underlying factors of success for four large clusters of nexus solutions: international/transboundary cooperation; governance; economic and policy instruments; infrastructure (both grey and green); and innovation. This type of framework allows not only to link certain typologies of problems with certain categories of solutions, but also to establish the factors of success that characterized their implementation.

This type of framework is simple and straightforward to use, as experience shows that ease of framework use is determined by the aptness and focus of the axes, especially where this comprises typologies[9].

It is important to note that nexus solutions typically address compound problems (for example, concerning both water quality and quantity) and/or combine two or more categories of solutions (for example, governance and infrastructure), see Section 2.3. Drawing conclusions from the experience collected requires unpacking these different elements and recombining them according to common characteristics. The characteristics investigated (through an ad-hoc questionnaire, see Section 2.4) were:

[7] The BRIDGE project description and the map of the basins is available at: https://www.iucn.org/theme/water/our-work/current-projects/bridge
[8] Information on the GEF International Waters available at: https://www.thegef.org/topics/international-waters
[9] Phil Riddell (2020), Taking stock of nexus solutions and investments in transboundary basins: a synthesis. This report includes the framework and the analysis of the replies to the questionnaire of the under the Water Convention.

- Problems in transboundary basins, and their root causes
- Categories of solutions, and factors of success in implementation
- The financing architecture of the solution
- The perceived added value of a nexus solution (or the missed opportunity in case the solution was not successfully implemented)
- Challenges related to the implementation of nexus solutions
- Enabling factors for the implementation of nexus solutions, notably institutional arrangements and financing frameworks
- Trade-offs and synergies across sectors and countries
- Benefits of cooperation across sectors and countries

2.1 The water-related problems addressed

The typical problems have been derived through literature, specifically from the experience of transboundary diagnostic analyses (TDA) carried out using the Global Environment Facility's (GEF) methodology[10] around the world between 1999 to 2018[11]. Most importantly, this choice allows to "anchor" the nexus solutions to the actual problems experienced by water institutions in transboundary basins. The process that followed is described in Annex 2, and the results are captured in Table 1.

Table 1 Design of the Problems Typology

PROBLEM CLUSTERS				
Primary	Secondary	Tertiary	Quaternary	Notes
Water quantity	Permanent	Too much water	Natural	Not all floods are bad and not all flood prevention is good. The same is true of waterlogging. Ecosystems in seasonable rivers sometimes depend on dry conditions at certain times of the year.
			Anthropogenic	
		Insufficient water	Natural	Water scarcity is not necessarily a result of hydrological drought or climate change. It can also result from over allocation; unproductive use and limited economic mobility of water.
			Anthropogenic	
		Excessive variability	Natural	If it is due to natural causes, variability is only excessive in terms of water resource exploitation and management.
			Anthropogenic	
	Time based	Too much water	Natural	As above, but the related solutions may be different. Seasonal flooding may be crucial for basin welfare, and perhaps needs to be restored
			Anthropogenic	
		Insufficient water	Natural	
			Anthropogenic	
		Excessive variability	Natural	As above.
			Anthropogenic	
Water quality	Permanent	Pollution	Natural	Pollution is not just a problem of effluent disposal or farm run-off. For instance, the adequacy of pristine adsorptive capacity may be compromised by anthropogenic means, in which case it is a quantitative issue. Or it may have resulted from the drainage of wetlands. Natural pollution tends to accrue to intermittent events of a geological nature, but is nonetheless included just in case.
			Anthropogenic	
		Salinity	Natural	Not all salinity is bad. The productivity of coastal wetlands and some terrestrial lakes can depend on
			Anthropogenic	

[10] GEF's TDA-SAP methodology available on the website of GEF International Waters Learning Exchange and Resource Network (IW:LEARN): https://iwlearn.net/manuals/tda-sap-methodology

[11] Input from the GEF secretariat and in particular from the GEF International Waters Learning Exchange and Resource Network (IW:LEARN).

PROBLEM CLUSTERS				Notes
Primary	Secondary	Tertiary	Quaternary	
				high levels of salinity which can be compromised by anthropogenic means.
		Turbidity	Natural	Some rivers should be permanently turbid but no longer are because of dams. Equally, other rivers are supposed to have permanently low turbidity but do not because of poor land management in their catchments. Permanent changes in turbidity can have catastrophic effects on stream bed stability; healthy deltas and indeed marine food chains beginning in sediment rich estuaries and economic infrastructure etc.
			Anthropogenic	
	Seasonal/time based	Pollution	Natural	This is unlikely to be relevant.
			Anthropogenic	Some pollution varies diurnally and not seasonally.
		Salinity	Natural	As above.
			Anthropogenic	
		Turbidity	Natural	Natural turbidity cycles are essential for stream bed stability; healthy deltas and marine food chains.
			Anthropogenic	
Environment	biodiversity loss or compromise			Although these could be thought of as being caused by problems already listed above, they are included as stand-alone items because they are substantive and may have nexus solutions of their own.
	habitat loss or compromise			
	Sediment or erosion			
	morphological change			
	compromised human health			

2.2 Categories of solutions and factors of success in their implementation

The categories of solutions were derived from the "5 Is" framework of nexus solutions developed in ECE (Annex 3) and applied in nexus assessments under the Water Convention, with the aim of capturing all "nexus solutions" that tackle a problem of transboundary relevance by applying the "nexus approach". This includes when the problem is solved indirectly (for instance, improved energy efficiency that indirectly – but not incidentally – contributes to water resource management by reducing water demand). This required building a process-oriented analysis of how the solutions were achieved, to establish the factor or factors that facilitated its design and/or implementation.

To allow for this type of analysis, the 5I's were rearticulated as more discrete factors of success and regrouped into four clusters: international/transboundary cooperation, governance, economic and policy instruments, infrastructure[12] and innovation[13].

The factors of success are described in table 2 below. For more clarity on the success factors see Annex 3 – Table 13.

Table 2: Categories of solutions and success factors

Categories (or clusters) of solutions	**Success factors**
International cooperation	• Stronger transboundary cooperation

[12] For the purpose of this study infrastructure could mean natural or built. Natural infrastructure comprises investments in the conservation, adaptation or beneficial modification of natural landscape features – examples could be natural or man-made and include wetlands; reforestation; restored floodplains; catchment stabilisation etc. Built infrastructure is the multi-purpose, civil works infrastructure needed to attenuate or otherwise manage flooding and/or increase water security and water supplies for energy and food security (both production and livelihood based) and for the environment. It may comprise dams, reservoirs, water harvesting facilities, facilities needed to increase the physical efficiency of water use, drains, re-use-recycling facilities and even inter-basin transfers.

13 The factors of success related to "Information" are included in the other categories.

	• Increased awareness of the benefits accruable to cross sector transboundary trade-offs, compromise and synergies • Increased awareness of options for cross-sector, transboundary trade-offs, compromise and synergies • New, multi-purpose "basin" level infrastructure[14] • Multi-purpose use of existing infrastructure[15]
Governance	• Shared data and information • Common metrics • Standardised social and environmental impact assessments between sectors and between riparians • Functional, transparent incentive structure • Appropriate, well enforced regulations
Economic and policy instruments	• Demand management policies • Legal arrangements[16] • Institutional arrangements[17] • Economically mobile water • Transparent and equitable terms of transboundary trade between the riparians
Infrastructure and Innovation	• Multi-purpose infrastructure • Innovative infrastructure • Innovative financing • Innovative infrastructure operating rules • Natural infrastructure • Small scale conservation agriculture • Large scale conservation agribusiness • Renewable energy • Smart energy strategies • Decentralised service delivery concepts • Decentralised service infrastructure

2.3 Use of the framework

The analytical framework was populated with case studies of nexus solutions (and related investments) coming from literature and a dedicated survey (Section 2.4). Any nexus solution typically occupies more than one "cell" in the framework because problems are often compound (e.g., concerning both water quality and quantity) and the categories of solutions are not mutually exclusive (e.g., combining governance and infrastructure). Drawing conclusions on the experience collected requires unpacking these different elements and re-combining them according to common characteristics. Visually, this means appreciating which cells get the highest number of "hits". See a hypothetical case study below (Table 3).

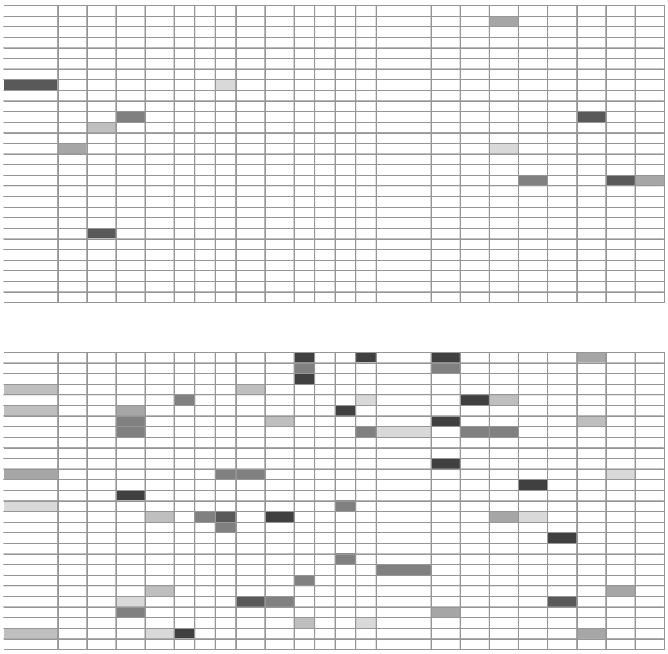
[14] Here intended in the sense of cooperative development of infrastructure.
[15] Here intended in the sense of coordinating across border.
[16] Here intended in the sense of legal arrangements for demand management.
[17] Here intended in the sense of institutional arrangements for demand management.

Table 3: Diversity of Problems and Solutions (a hypothetical case study for illustration purposes)

<table>
<tr><th rowspan="2"></th><th colspan="2">PROBLEM</th><th colspan="3">POSSIBLE SOLUTIONS</th></tr>
<tr><th>Too much water</th><th>Too little water</th><th>governance</th><th>policy</th><th>infrastructure</th></tr>
<tr><td>Natural</td><td>Intense rainfall events</td><td>Seasonality</td><td rowspan="4">New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure optimised as a result of trans-sector governance and international cooperation.</td><td rowspan="4">New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure optimised as a result of appropriate economic policies, incentive structures and well enforced regulations</td><td rowspan="4">Water, energy, agriculture and environmental security enhanced, basin-wide as a result of landscapes restored or transformed by appropriate agribusiness operations (natural infrastructure)</td></tr>
<tr><td rowspan="3">Anthropogenic</td><td>Watershed degradation</td><td>Overallocation</td></tr>
<tr><td>Dam cascades with uncoordinated operating rules</td><td rowspan="2">Inefficient use</td></tr>
<tr><td>Upstream flood defences that simply send concentrated flood downstream</td></tr>
</table>

To show how the framework is used to draw conclusions from the stocktaking of several case studies, we can consider the two extreme stories that could emerge (Figure 1). If the populated framework looks like the upper table, the story would be that 1) there is a limited number of successful nexus approaches and 2) although only a limited number of different problems have benefitted from a nexus approach, in one case there is a noticeable success rate accruable to nexus (indicated by the darker colour of the cell). Alternatively, if the populated framework looks like the lower table, the story would be that 1) many solutions can solve a wide range of problems and 2) many problems potentially have several nexus solutions.

Figure 1 Extreme framework stories



Note: The X axis includes the factors of success and the Y axis includes the problems (See Annex 4)

2.4 The questionnaire

In addition to the framework, a questionnaire was built not only to gather common problems and solutions (analysed though the framework), but also to answer the other questions laid out in Section 1.2 related the types of investment and financing pathways, and the perceived benefits of applying a nexus approach compared to conventional siloed sectoral planning. The full questionnaire is presented in Annex 5.

3. The stocktaking process and the emerging trends

3.1 The process

The first phase of the stocktaking exercise was carried out in 2020, using the questionnaire to collect the experience of countries and basins' stakeholders[18] and the analytical framework presented in Section 2 to process the case studies[19]. This allowed to collect a total of 36 case studies, 21 of which were submitted in response to the questionnaire[20], and the other 15 coming from a review of the literature. It should be noted that the case studies emerging from the literature review provided much less information, and as such were only considered in the analytical framework (to draw common problems and solutions) but were not useful for further analysis (on root causes, factors of success, financing schemes, added value, etc).

This stock of experience allowed to draw preliminary conclusions on the most common problems in transboundary basins that are being tackled with a nexus approach, the most common categories/typologies of solutions and related investments, and the enabling factors for the implementation of solutions, notably institutional arrangements and financing frameworks. To a lesser extent, the analysis allowed to make some considerations on common trade-offs and synergies across sectors and countries and the benefits of cooperation[21].

Overall, the case studies collected focus on all continents Africa (11) Americas (4) Asia (9), and Europe[22] (12) (Table 4). The case studies have different cross-sectoral reaches. Some of them include the broad "sectors" of water, food, energy and ecosystems, but others also extend beyond (notably industry, tourism, navigation).

Table 4: Summary of case studies analysed

REF	BASIN, CONTINENT	CASE STUDY
1	Mekrou[23], Africa	From the on-line survey
2	Drina, Europe	From the on-line survey[24]
3	Aral Sea[25], Asia	From the on-line survey
4	Parana, Americas	From the on-line survey
5	Zambesi, Africa	From the on-line survey
6	Lake Titicaca, Americas	From the on-line survey
7	Sekong, Sesan, and Srepok (3S), Asia	From the on-line survey
8	Lower Syr Darya, Asia	From the on-line survey
9	Mekong -1, Asia	From the on-line survey
10	NWSAS – 1, Africa	From the on-line survey[26]
11	Dneister, Europe	From the on-line survey
12	NWSAS – 2, Africa	From the on-line survey
13	Mekong – 2, Asia	From the on-line survey

[18] The questionnaire was established online and disseminated by ECE

[19] Phil Riddell (2020) Taking stock of nexus solutions and investments in transboundary basins: a synthesis.

[20] Some replies to the survey were excluded because they comprised multiple river basins, or concerned single sectors, and were excluded.

[21] Solutions and investments in the water-food-energye-cosystems nexus: preliminary findings from a synthesis of experiences in transboundary basins (ECE/MP.WAT/WG.1/2021/6–ECE/MP.WAT/WG.2/2021/6)

[22] Europe region includes both Eastern and Western Europe.

[23] The respondent only cited agriculture as the affected sector. But in the narrative, environmental problems were also mentioned, so this has been included as the second nexus element

[24] See also UNECE. Assessment of the water-food-energy-ecosystem nexus and benefits of transboundary cooperation in the Drina River Basin (2017) Available at: https://unece.org/environment-policy/publications/assessment-water-food-energy-ecosystem-nexus-and-benefits

[25] The respondent only cited environment as the affected sector. But in the narrative, agriculture and energy problems were also mentioned, so these have been included as additional nexus elements.

[26] See also: Reconciling resource uses: Assessment of the water-food-energy-ecosystems nexus in the North Western Sahara Aquifer System (UNECE, GWP-Med, OSS, 2020) Available at: https://unece.org/environment-policy/publications/reconciling-resource-uses-assessment-water-food-energy-ecosystems

14	Niger, Africa	From the on-line survey
15	Mekong – 3, Asia	From the on-line survey
16	Kura, Asia	From the on-line survey
17	Drin, Europe	From the on-line survey[27]
18	Lake Atitlan[28], Americas	From the on-line survey
19	Danube, Europe	From the on-line survey
20	Limpopo, Africa	From the on-line survey
21	Incomati, Africa	From the on-line survey
22	Zambesi, Africa	*World Bank Multi Sector Investment Opportunity Assessment for the Zambezi. A study of options*[29]
23	Kafue[30], Africa	Itexi-Itexi and Kafue Gorge Dams. *A combination of joint operating rules and remote hydrological sensing could restore annual floods to the socially, economically and environmentally important Kafue Flats in Zambia*[31]
24	Orange-Senqu, Africa	Stabilisation of the Southern African Water Tower aka the Lesotho Highlands. *Two studies (EU and IUCN) suggested that appropriate large-scale agribusiness could contribute to water, food and energy security, watershed rehabilitation and economic growth*[32]
25	Rhine, Europe	Multi-stakeholder cooperation in the Rhine Basin. *A real case of institutional cooperation solving problems arising from pollution and competition for water*[33]
26	Lake Geneva, Europe	*Transboundary water cooperation in a "benefit cluster" – the case of the Canton of Geneva, Switzerland and France*[34]
27	Pripyat, Europe	*Identifying benefits to boost cooperation in the upper Pripyat River basin*[35]
28	Alazani/Ganykh, Asia	*An assessment of the intersectoral linkages to complement a benefit assessment in the Alazani/Ganykh River Basin*[36]
29	Lake Peipsi, Europe	*Identifying a variety of beneficiaries of an economically and environmentally sustainable Lake Peipsi area*[37]
30	Elbe, Europe	*Transboundary cooperation responses to catastrophic flooding in the Elbe Basin*[38]
31	Rhine, Europe	*Environmental benefits of transboundary water cooperation on the Rhine*[39]
32	Sava, Europe	*Cooperation in the Sava River Basin: post-conflict cooperation and confidence building-related benefits*[40]
33	Teesta, Asia	*Water-for-peace deals in the Teesta Basin*[41]
34	Great Lakes, Americas	*Governance benefits of transboundary water cooperation – the case of the North American Great Lakes*[42]
35	Danube, Europe	*The Danube's transnational monitoring system: harmonized data for joint planning*[43]
36	Senegal, Africa	*Economic benefits in the Senegal River Basin*[44]

[27] See also: Phase I and II (ongoing) of the Drin Nexus Assessment https://www.gwp.org/en/GWP-Mediterranean/WE-ACT/Programmes-per-theme/Water-Food-Energy-Nexus/seenexus/

[28] The case of Lake Atitlan (Guatemala) is not transboundary but was considered a good example of nexus approach and was therefore included in the analysis.

[29] IUCN. Increasing returns on investment opportunities by applying a nexus approach. Best practice nexus case studies (Belgrade, Serbia: IUCN 2019)

[30] The case of Kafue river basin (Zambia) is not transboundary but was considered a good example of nexus approach and was therefore included in the analysis.

[31] ICA, IUCN, and IWA. Nexus trade-offs and strategies for addressing the water, agriculture and energy security nexus in Africa (Geneva 2015). Available at: https://www.icafrica.org/fileadmin/documents/Publications/Nexus_Trade-off_and_Strategies__ICA_Report__June2016_2_1_.pdf

[32] IUCN. Increasing returns on investment opportunities by applying a nexus approach. Best practice nexus case studies (Belgrade, Serbia: IUCN 2019)

[33] Ibid.

[34] UNECE. Policy Guidance Note on the Benefits of Transboundary Water Cooperation, 2015. Available at: https://unece.org/environment-policy/publications/policy-guidance-note-benefits-transboundary-water-cooperation

[35] Ibid.

[36] Ibid. See also: UNECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus (2015). Available at: https://unece.org/environment-policy/publications/reconciling-resource-uses-transboundary-basins-assessment-water

[37] Ibid.

[38] Ibid.

[39] Ibid.

[40] Ibid. See also: UNECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin (2015). Available at: https://unece.org/environment-policy/publications/reconciling-resource-uses-transboundary-basins-assessment-water-3

[41] Ibid.

[42] Ibid.

[43] Ibid.

[44] Ibid.

A second phase of the stocktaking included a global Task Force meeting with regional reporting, regional consultations (the one on Latin America and the Caribbean[45] has been held while others are to be confirmed) and individual interviews with experts.

The sixth meeting of the Task Force (22-23 October 2020)[46] provided for discussing the preliminary results, the main factors of success and obstacles to implementation of nexus solutions and investments. In this meeting, regional experiences of advancement in applying nexus solutions and facilitating nexus dialogues were also presented and discussed. The regional overview included notably Central Asia, South-East Europe and the Mediterranean as well as Middle East and North Africa.

All the above-mentioned components of the second phase allowed to enrich the preliminary conclusion with further case studies, deepening some key aspects that emerged and clarifying regional trends (Sections 4, 5, and 6).

3.2 Emerging trends from the survey

Going back to the stories that can emerge from an analytical framework like the one developed from this exercise (Section 2.3), the reality seems to be closer to the second extreme. From the stocktaking exercise it emerges that the nexus approach is being applied to tackle a variety of problems. Nevertheless, it is possible to highlight those problems that are more consistently tackled with a nexus approach in the survey, as well as the success factors that have considerably more "weight" than others.

Common problems and root causes

Simply stated, these analyses suggested that, at least as far as the case studies were concerned, the problems addressed by nexus-oriented factors of success were more concerned with environmental and qualitative issues than with quantitative issues of water variability, for example. This does not indicate that quantitative issues are not present, but that most of the solutions collected in the study tackle qualitative and environmental problems, revealing that quantitative issues are more rarely tackled through a nexus approach. However, as discussed later, there are many examples where regional nexus dialogues aimed specifically at the coordination of water infrastructure to tackle water quantity issues.

Nonetheless, there is remarkable consistency between the case studies with respect to the fact that anthropogenic hydrological changes are the highest-ranking root cause of the problems tackled, all around the world. Climate change is the second-ranking root cause outside the European region.

Common typologies of solutions and factors of success in implementation

The data indicate that, to a very significant level, institutional solutions predominated over infrastructural approaches and that, as far as infrastructure was concerned, green infrastructure was slightly more prevalent than built infrastructure. However, this type of approaches may reflect the specific stakeholder constituency involved in the survey, which does not include for example energy companies, agribusinesses, industrial stakeholders.

The typologies of solutions and underlying factors of success span a broad range. All the 26 factors of success (see table 5 below) fall into the four big clusters of international cooperation, governance, economic and policy instruments, and infrastructure and innovation appeared in at least one case study.

[45] Virtual event organized by UNECE in cooperation with the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the Inter-American Development Bank (IDB) on 22 February 2021. More information at : https://www.water-energy-food.org//news/nexus-blog-virtual-meeting-of-experts-on-policies-of-the-water-food-energy-ecosystems-nexus-and-projects-of-transboundary-relevance-in-latin-america-and-the-caribbean-lac

46 The presentations at and documentation for the meeting is available at https://unece.org/environmental-policy/events/task-force-water-food-energy-ecosystems-nexus

Two more factors of success were indicated in two of the case studies (marked as “other” in the table). A clear conclusion is that the wide-ranging suite of “institutional” factors of success predominate over the others, i.e., there is very limited mobilization of green infrastructure approaches (green) and even less of built infrastructure (grey). In other words, the most common factors of success relate to the action of institutions and do not require the mobilization of resources for new infrastructural investments.

Table 5 Factors of success (institutional, green and grey infrastructure-related) ranked from the most to the least common.

Factor of success	*Type*
1. Stronger transboundary cooperation	Institutional
2. Shared data and information	Institutional
3. Increased awareness of options for cross-sector, transboundary trade-offs, compromise and synergies	Institutional
4. Innovative infrastructure operating rules	Institutional
5. Increased awareness of the benefits accruable to cross-sector transboundary trade-offs, compromise and synergies	Institutional
6. Institutional arrangements	Institutional
7. Renewable energy	Infrastructural (green)
8. Natural infrastructure	Infrastructural (green)
9. Standardized social and environmental impact assessments between sectors and between riparians	Institutional
10. Legal arrangements	Institutional
11. Demand management policies	Institutional
12. Appropriate, well-enforced regulations	Institutional
13. Multipurpose use of existing infrastructure	Institutional
14. Innovative infrastructure	Infrastructural (grey)
15. Decentralized service delivery concepts	Institutional
16. Economically mobile water	Institutional
17. Functional, transparent incentive structure	Institutional
18. Small-scale conservation agriculture	Infrastructural (green)
19. Smart energy strategies	Institutional
20. New, multipurpose “basin”-level infrastructure and/or the planning thereof	Infrastructural (grey)
21. Large-scale conservation agribusiness	Infrastructural (green)
22. Innovative financing	Institutional
23. Common metrics	Institutional

Factor of success	*Type*
24. Decentralized service infrastructure	Infrastructural (grey)
25. Transparent and equitable terms of transboundary trade between the riparians	Institutional
26. (Other) Investment prioritization based on hydrological and other analyses	Institutional
27. Awareness-raising	Institutional
28. (Other) Application and monitoring of measures to control erosion, creation of erosion maps	Institutional

Common trade-offs and synergies

The survey did not provide clear insights into the trade-offs and synergies associated with nexus solutions. However, looking at the factors of success, two conclusions can be tentatively drawn. Firstly, at least five of the factors imply a trade-off related to water resource allocation (new, multipurpose "basin"-level infrastructure; multipurpose use of existing infrastructure; demand management policies; innovative infrastructure; innovative infrastructure operating rules). Secondly, some of the "institutional" factors may involve other types of trade-off in terms of political economy or hegemony.

Constraints to implementation and enabling factors

The data set revealed a suite of eight constraints encountered by stakeholders when trying to implement nexus solutions. These are: politics; data and information shortcomings; inadequate institutions; financial constraints; persistent policy/sector silos; limited technical capacity; limited time frames; and limited options for benefit-sharing.

Fortunately, the data also identified three possible ways in which such constraints could be, and in some cases were, obviated. "Well-focused programme-based support", "mainstreaming of national and sectoral plans into high-level development planning" and "common understanding and mutual trust" emerged as strategic enabling factors of nexus solutions in transboundary basins. A further enabler that clearly emerged during the sixth meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus, as well as at a recent virtual global Workshop on Financing Transboundary Cooperation and Basin Development (16 and 17 December 2020) under the Water Convention[47], was the involvement of high-level decision-makers and ministries of finance in transboundary (nexus) dialogues. The lack of involvement of high-level decision-makers is often a major obstacle that prevents riparians from implementing concrete solutions (with or without a nexus approach). If transboundary dialogues lead to the identification of bankable projects, they can attract the attention of non-line ministries. Crucially, the cooperative nature of transboundary nexus dialogues has the potential to reduce political and financial risk for investors.

Perceived added value of nexus solutions

In this context, and due to the difficulty of drawing clear conclusions regarding trade-offs and synergies, the "added value" of nexus solutions corresponds to the benefits that they generate beyond the direct (sectoral) resolution of the problem in question, in qualitative terms. According to the survey (see table 6 below), perceptions of added value were predominantly institutional in nature, trending through resource and regional security, with economic and financial added value coming last.

[47] More information available at: https://unece.org/environmental-policy/water/events/virtual-workshop-financing-transboundary-water-cooperation-and-basin

Table 6: Elements of added value of nexus solutions

Element	*Percentage*
Enhanced intersectoral cooperation	65
Enhanced transboundary cooperation	65
Better resilience or reduced risks	58
Establishment of improved planning practices and paradigms	52
Improved ecosystem services	52
Greater transparency	48
Improved infrastructural functionality	42
Improved resource security (water, energy or food) (R)	42
Reduced tension	42
Increased returns on investment (F)	30
Regional peace or stability	28
Decentralized/devolved financing opportunities (F)	19
Increased returns on the factors of production (especially land and water) (R)	19
Reduced demands on line budgets (F)	16
Increased returns on sunk costs (F)	10

Abbreviations: R, resource and regional security added value; F, economic and financial added value.

The role of river basin organizations

SECTION TO BE DEVELEOPED

Some regions more than others lack legal and/or institutional frameworks for transboundary cooperation among riparians. The question of how this affects the opportunity of countries to design and implement nexus solutions in these basins arises. Some examples of how RBOs supported or participated in nexus solutions and investments are reported in section 6.2.

Regional differences

The analysis of the case studies collected through the questionnaire allowed to make a first comparison between different regions of the world, for instance whether the most common challenges in transboundary basins (and their root causes) vary from one region to another. The only meaningful comparison allowed by the survey, due to the geographical distribution of cases, was between the root causes reported in the Europe region case studies and those reported in case studies from other regions (table 7 below).

Table 7: Common root causes emerging from the survey

Outside the European region	In the European region
• Anthropogenic change in hydrology	• Anthropogenic change in hydrology

• Climate change • Data and information limitations • Poor land use and management • Poor intersectoral coordination • Poor water resource management	• Inadequate finances • Inadequate institutional capacity • Land use change

A surprising finding from the survey is that case studies from the Europe region cited "inadequate finances" as a challenge more consistently than case studies from other regions. This might be due to the fact that, in the other regions, cross-sectoral cooperation is increasingly supported by development partner support (even though it may be project-specific or limited to the basin region). However, it should be noted that, independently from the region, the perception on the availability of financial resources may vary greatly depending on the stakeholders (e.g. governmental or non-governmental actors.)

3.3 Sources of nexus investments and financing delivery pathways emerging from the survey

The aspect of financing is rarely present in literature and the responses to the questionnaire included solutions that were not effectively implemented though dedicated investments. Hence, these aspects were initially reviewed based on the experience of the consultant carrying out the analysis of case studies[48], and the preliminary findings were discussed with experts and through regional consultations (different regions have different sources of financing available).

The fact that, from the point of view of respondents (mostly coming from the fields of water and the environment) economic and financial types of added value ranked so low may be one important barrier to establishing a concrete dialogue between water and water-using sectors. In general, within water institutions there seems to be little understanding of how the financing of nexus/multisectoral projects works in practice and this is a major capacity gap that prevents them from finding (or coordinating) bankable cross-sectoral projects. In the end, water-using sectors (for example, energy, industry) find solutions to their water problems faster by themselves, thereby reinforcing silos.

The analysis of investments and financing focused on the overall data emerging from the questionnaire survey (the literature review was effectively silent on the subject), also considering a data set provided by a complementary study into the financing of transboundary institutions.

The types/sources of financing considered were:

• By the State (including credits from development partners)

- By the State, with development partner grant support
- By development partner grants
- By blended finance
- By the private sector

The financing delivery pathways considered were:

- Project specific funding (funding for a single, discrete investment (infrastructural or institutional)
- Specific programme financing (for example, climate funds) (funding for a predetermined suite of investments (infrastructural and/or institutional))
- Adaptable programme financing (funding for a suite of investments (infrastructural and/or institutional) that are not predetermined but have a common cascade of objectives and outputs)

[48] Phil Riddell (2020) Taking stock of nexus solutions and investments in transboundary basins: a synthesis. This report includes the framework and the analysis of the replies to the questionnaire of the under the Water Convention.

- Sector budget support (funding made available to line ministries or their decentralized/devolved authorities to be disbursed at their discretion)
- Central budget support (funding made available to non-line ministries and/or decentralized/devolved authorities to be disbursed at their discretion)

Examination of the data available suggests that project-specific delivery pathways (financed by the State, with or without development partner support) were the most common. With minor exceptions, this trend appears even when the study data set is broken down by region, meaning that the trend applies almost equally to the entire world.

The analysis also included the search for a correlation between the financing delivery pathway and the type (and source) of investment. This is an interesting question, particularly when it comes to consideration of infrastructural solutions and private sector financing because programmatic funding is an efficient way to mobilize public finance and certain kinds of private financing (specifically bonds) for a series of infrastructural investments (especially if basket funding modalities are possible), circumventing the hazards cited by both the public and private sectors with respect to financing water sector infrastructure.

Within the limits of the data available, it is reasonable to say that there is a correlation between infrastructural measures and adaptable programmatic financing. Programmatic financing means that funds are allocated to a programme (for example, modernization of irrigations systems in a river basin) without connection to a specific project. Funds can come from public or private entities, or both. While in principle they are possible, transboundary programmatic financing schemes are not common.

One important limit of programmatic funding schemes is that they are typically designed by one sector and, in less-developed regions, with strict requirements from a donor. To be effectively “nexus”, these schemes should be more adaptable and “smarter”, meaning that they should stimulate competition between eligible projects. In parallel, “basket funding” is typically associated with specific projects while it may be more effective in support of programmes and, in general, at a higher level of politics where countries have more leverage to decide and more “space” across sectors.

When it comes to private financing, the case studies show an important gap, as responses reveal an overwhelming preponderance of state financing of one form or another. This observation may be biased by the fact that most of the questionnaire responses came from public institutions and the fact that the solutions relate to water and environment issues.

In fact, solutions in agriculture and energy (for example, landscape agriculture, improved agribusiness, sustainable agricultural value chains, renewable energy, or energy efficiency) are more likely entry points for private investments that could directly or indirectly tackle water and environment issues. For example, large-scale agribusinesses are typically private sector investments, and even though public funds may be allocated to cross cutting research into sustainable agriculture, these might contribute to large-scale agribusiness development just indirectly (e.g., through tax incentives, leases of public land and blended capital). Private-led solutions were not adequately represented in the set of case studies considered for the analysis.

Going back to the relevance for high-level ministries and decision-makers, if nexus dialogues manage to align with multisectoral programmes (for example, climate- or green economy-oriented programmes), this may enable the necessary high-level support or decisions. Agreeable integrated packages of solutions, when supported by different sectors, should also better convince finance ministries. This might be an important step for water authorities in countries where water ranks low in national priorities for investment.

4. The experience of regional nexus dialogues

Since the nexus approach was first conceptualized in 2011[49], there have been several efforts to stir regional cooperation and sustainable development at regional level. Some of these dialogues were specifically focused on transboundary basins (e.g. the nexus assessments under the Water Convention and the dialogues organized in the framework of the project Building River Dialogue and Governance BRIDGE[50]), in other cases they targeted other geographic scales (e.g., the Nexus Dialogue Programme supported dialogues in Middle East and North Africa (MENA), Latin America and the Caribbean (LAC), Central Asia, Niger River Basin, and Southern Africa)[51]), but included considerations on the management of, and cooperation on, shared water resources. These multi-country dialogues provide an important source of information on how the nexus approach is applied in different regions.

The following sections illustrate some of these dialogues, highlighting their relevance from the perspective of transboundary cooperation. The choice of regions (non-comprehensive of all regions of the world) reflects this perspective. It should be noted that the variety of objectives that these different dialogues aimed at achieving, and the different ways in which the dialogues were structured, makes it difficult to compare them. These dialogues do not refer to a common methodology or even to a common glossary, including on what a "nexus solution" is.

However, nexus dialogues always aim at the same type of impact (facilitate sustainable development, improving policy coherence, improving efficiency of resource use, support the design, evaluation, implementation of sustainable projects). Also, they all have an important element of awareness raising and capacity building on how to deal with nexus trade-offs and how to exploit nexus synergies. Furthermore, as they progressed over time, they all "evolved" from a dialogue focusing on trade-offs to one that aims at finding solutions of some kind[52] .

4.1. South-East Europe

South-East Europe (Albania, Bosnia and Herzegovina, North Macedonia, Kosovo[53], Montenegro and Serbia) is a region that is largely covered by forests, where hydropower is a key energy source and many rivers are naturally prone to flooding. The region includes several transboundary basins: Tisza, Sava and the broader Danube River Basins that flow to the Black Sea, and the Krka, Drin, Aoos/Vijosa, Vardar/Axios and Struma/Stymonas that flow to the Mediterranean Sea. They all have associated aquifers[54].

The region is characterized by several biodiversity hotspots and pristine natural areas which conservation is sometimes threatened by infrastructural development (hydropower in particular). The impact of climate change is felt through decreased precipitations and increased temperatures, and the frequency of flood and drought episodes is increasing[55].

The use of wood biomass for heating in households is widespread. Even though this traditional use is supported by large stock of forests, it severely affects ecosystems through erosion and sedimentation, and in turn worsening water quality, changing hydromorphology and reduced water retention capacity. This has

[49] Holger Hoff. Understanding the Nexus – Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus (Stockholm, Stockholm Environment Institute, 2011)
[50] More information on the BRIDGE project available at: https://www.iucn.org/theme/water/our-work/current-projects/bridge
[51] More information on the Nexus Dialogue Programme available at: https://www.water-energy-food.org/resources/fact-sheet-nexus-regional-dialogues-programme-phase-ii
[52] One of the goals of the Phase II of the NDR is to "foster interest, awareness and engagement of investors for WEF NEXUS projects"
[53] UN Security Council Resolution 1244
[54] GWP-Med. Draft Nexus Mapping Study in South East Europe, Background Study to support the Nexus Policy Dialogue Process in the SEE2020 Region. Available at: ttps://www.umweltbundesamt.de/en/topics/sustainability-strategies-international/cooperation-eeca-centraleastern-european-states/project-database-advisory-assistance-programme/water-food-energy-environment-nexus-policy-dialogue
[55] UNECE. Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin (2015). Available at: https://unece.org/environment-policy/publications/reconciling-resource-uses-transboundary-basins-assessment-water-3

in some cases this led to bans to logging practices. Sanitation coverage and wastewater treatment need improvement in some areas.

So far, recent advancements in cross-sectoral coordination are happening mainly at national level and mainly at the level of institutional settings (not so much concretely in policy integration). However, in the South East Europe region several countries have embarked in nexus dialogues at transboundary level. Notably, the Sava, Drina, and Drin nexus assessments[56] carried out by UNECE, the latter two currently in partnership with Global Water Partnership Mediterranean-GWP-Med.

In the case of the Drina for example, the transboundary dialogues were enriched by energy perspectives through dedicated energy-focused dialogues (carried out at national level with basin focused discussion). These multi-stakeholder dialogues on renewable energy with a special focus on nexus[57] contributed to the development of a dedicated toolkit publication to renewable energy policy makers to consider transboundary synergies and trade-offs early on in the energy planning process[58]. The process in the Drin and Drina River Basins is leading to the development of a nexus roadmap/strategy for the basin to 1) ensure establishment of the necessary cross-sectoral coordination and institutional arrangements to support integrated policy and management for flow regulation, and 2) facilitate the mobilising of actions and investments across sectors, notably for nexus priority projects.[59]

Transboundary nexus dialogues in the South East Europe region reached a point of maturity where countries started discussing transboundary nexus solutions and investments (for instance in the Drin and Drina)[60]. These dialogues are a place for sharing experience of implementing technical solutions that the countries may be already implementing to optimize resource use (e.g., floating photovoltaic in reservoirs[61]) and discuss transboundary implications and potential.

Regional cooperation initiatives and political processes that combine and complement transboundary nexus dialogues include, for instance, the “Task Force on the Nexus Approach” in the context of the Water Agenda of the Union for the Mediterranean (UfM), the GEF Nexus project under the UNEP/MAP Med Programme, the Growth Strategy 2020 (Regional Nexus Policy Dialogue Process 2017-2019) led by the Regional Cooperation Council (RCC).

4.2 Latin America and the Caribbean

Much of the water resources in the Latin America region are shared. Of the 33 countries in Latin America and the Caribbean 22 share transboundary rivers, lakes and aquifers. Transboundary cooperation frameworks are largely lacking[62], however some exceptions may be found in the Amazon and La Plata basins, the Sixaola river between Costa Rica and Panama, and the Trifinio in Northern Central America or the Guaraní Aquifer.

[56] All assessment reports are available on the website of UNECE at: https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus

[57] Serbia and Bosnia and Herzegovina. More information on the Renewable Energy Hard Talks in: https://unece.org/sustainable-energyrenewable-energy/unece-renewable-energy-hard-talks-unece-countries

[58] UNECE, 2020. Towards sustainable renewable energy investment and deployment: Trade-offs and opportunities with water resources and the environment. Available at : https://unece.org/environment-policy/publications/towards-sustainable-renewable-energy-investment-and-deployment

[59] “Promoting the Sustainable Management of Natural Resources in South-eastern Europe, through the use of the Nexus approach” (2016-2021) is a project. funded by the Austrian Development Agency (ADA), implemented by GWP-Med and UNECE. Information on the project available at: https://www.gwp.org/en/GWP-Mediterranean/WE-ACT/Programmes-per-theme/Water-Food-Energy-Nexus/seenexus/

[60] The identification of nexus projects of transboundary value in the Drin and Drina is part of the project “Promoting the Sustainable Management of Natural Resources in Southeastern Europe, through the use of the Nexus approach.” (UNECE and GWP-Med)

[61] https://energyindustryreview.com/renewables/keshs-first-floating-solar-photovoltaic-plant-in-albania/

[62] UNECE & UNESCO, 2018. Progress on transboundary water cooperation: Global baseline for SDG indicator 6.5.2.

A recent IUCN study on nexus trade-offs in the region[63] highlights that natural resources are abundant, economic development has brought important results but there is a high level of inequality and shares of the population still lack access to water, energy, and food. Environment degradation brought by pollution and deforestation is compromising important ecosystems (including ecosystems of global importance as rainforest) and climate change is adding pressure through changing rainfalls patterns and extreme events. As a result, some regions that are naturally water rich have recently experienced water insecurity.

The study highlights the following strategic priorities for nexus in the region: coherent landscape planning (beyond single projects), strengthen water governance (reducing fragmentation and improving coordination of actors), improve monitoring systems (reducing pollution and improving efficiency of use), quantify trade-offs (scenarios support for decision making), decouple agriculture from deforestation, adjust price signal (in water, agriculture, considering payment from ecosystem service).

A consultation with experts from the region[64] brought up the fact that the application of the nexus approach to policy making and transboundary contexts is hampered by a lack of convincing examples where the approach added value. However, it also emerged that there are many opportunities to advance the nexus approach in the region because several countries have experience of improving nexus coordination at country level,[65] for instance in Bolivia (National Irrigation Development Plan and Agenda 2025 which contemplate in their design of irrigation infrastructure a more efficient use of water and land), and Chile (Irrigation Law which considers the use of renewable energies in irrigation systems)[66] and, at the same time, there are examples of experience of shared infrastructure (see Box 1). The countries in the region are increasingly recognizing that ecosystems should be better protected and appropriately valued in development plans, including in transboundary basins, an approach that is supported by the strategies of donors and financing institutions (see Box 14).

4.3 Middle East and North Africa

The Middle East and North Africa region is one the most water scarce in the world. 18 out of 22 Arab countries are below the renewable water resources scarcity annual threshold of 1,000 m^3 per capita, and 13 are below the absolute water scarcity threshold of 500 m^3 per capita per year[67]. Desalinization of seawater and highly mineralized groundwater is employed extensively in the region. Several states in the region have resorted to the reuse of treated wastewater to fill the gap between conventional water resources supply and demand. Nearly half of the collected wastewater that is safely treated is reused in the region, approximately one-fourth is used for irrigation and groundwater recharge. The Gulf Cooperation Council Member States use 90 to 100 per cent of their safely treated wastewater[68].The main concern for wastewater treatment and reuse has been the associated cost and the high energy demand. The energy demand may be offset by energy efficiency measures during design and operation. Renewable energy may also be used to offset the energy demand of wastewater treatment. Recovered biogas may be used for

[63] Bellfield, H. 2015. Water, Energy and Food Security Nexus in Latin America and the Caribbean. Global Canopy Programme. Available at: https://portals.iucn.org/library/sites/library/files/documents/2015-022.pdf

[64] Virtual event organized by UNECE in cooperation with the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the Inter-American Development Bank (IDB) on 22 February 2021. More information at : https://www.water-energy-food.org//news/nexus-blog-virtual-meeting-of-experts-on-policies-of-the-water-food-energy-ecosystems-nexus-and-projects-of-transboundary-relevance-in-latin-america-and-the-caribbean-lac

[65] ECLAC notably has supported national level work on the nexus, including in cooperation with GIZ. This support includes development of a national level guidance: ECLAC Guía Metodológica: diseño de acciones con enfoque del Nexo entre agua, energía y alimentación para países de América Latina y el Caribe

[66] Presentation by United Nations Economic Commission for Latin America and the Caribbean (ECLAC) at the 6th Meeting of the Water-Food-Energy-Ecosystems nexus under the Water Convention

[67] FAO, AQUASTAT database. Available at http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en.

[68] United Nations Economic and Social Commission for Western Asia (2017). Wastewater: An Arab Perspective. Beirut. E/ESCWA/SDPD/2017/BOOKLET.1 available at https://www.unescwa.org/sites/www.unescwa.org/files/page_attachments/l1700174_web_-_waste_water_-_march_2017_0.pdf.

generation of heat and electricity. Involvement of the private sector can help alleviate the initial capital cost.

Food security is deeply linked to the management of the scarce water resources, which has in many cases led countries to aim at food self-sufficiency to reduce vulnerability to imports and price volatility.[69]

There is little experience in implementing nexus solutions in transboundary contexts and transboundary cooperation frameworks are largely lacking[70], however some countries are highly committed to improve resource efficiency strategically, notably when it comes to water (e.g., the FAO project "Water efficiency, productivity and sustainability in the Near East and North Africa regions (WEPS-NENA)"[71]). As the high solar potential is also characteristic of the region, innovative solutions in water and energy are very promising (e.g., solar powered desalination). Beyond technical solutions, opportunities exist to apply the same logic of resource use optimization at regional level, indirectly improving the management of scarce resources (see Box 5). There is also the experience of the North West Saharan Aquifer System[72] (the first nexus assessment under the Water Convention carried out on an aquifer), where a transboundary nexus assessment led to the joint identification of a "package of solutions" was developed considering trade-offs, synergies, and past experiences of implementing similar solutions in the countries (see Box 17).

4.4 Central Asia

In Central Asia the use of water, energy, and land resources are highly interrelated because of the natural geography of the region. Once part of a unified union, the countries of Central Asia are now independent but remain strongly inter-dependent because most of their water comes from the same source. Two main large transboundary rivers (the Amu Darya and the Syr Darya) cross the region and discharge into the water bodies remaining of the former Aral Sea, a once thriving salty lake that has now largely dried up due to the exploitation of water resources from the rivers. In this context, upstream-downstream cooperation is necessary to ensure water and food security as well as energy security.

The transboundary dimension of the nexus in Central Asia is therefore prominent, and this is reflected in the focus of the nexus dialogue facilitated by CAREC and IUCN, which focused largely on water infrastructure, and the nexus assessment in the Syr Darya which identified the main intersectoral issues in this river basin as well as intersectoral solutions. There are prospects for optimizing resource use at regional level though trade agreements (e.g. on food and energy), also drawing from past experiences in the region itself. Notably, Kazakhstan is promoting the initiative to create an International Water and Energy Consortium, a sustainable regional mechanism for the use of water and energy resources of the region taking into account the economic interests of all stakeholders and corresponding to the current economic realities[73]. The region has a long history of transboundary nexus cooperation, but current schemes are in need of review, in some cases being reviewed.

Under the United Nations Special Programme for the Economies of Central Asia (SPECA), the SPECA countries agreed that the Working Group on Water, Energy and the Environment will provide a platform for supporting progress on strategic issues related to water, energy and the environment, and towards achieving the respective SDGs, taking into account interlinkages between them; promote consideration of energy and water cooperation opportunities, including inter-sectoral and transboundary cooperation; act as a platform for identification, development and coordination of technical programmes and projects; identify countries' priorities and emerging issues and consult on regional and collaborative approaches to

[69] A review of the evidence. Discussion paper on irrigation and sustainable water resources management in the Near East and North Africa. Cairo, 2017. Available at: http://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/897549/

[70] UNECE & UNESCO, 2018. Progress on transboundary water cooperation: Global baseline for SDG indicator 6.5.2.

[71] The proejct is implemented in Algeria, Egypt, Jordan, Iran, Lebanon, Morocco, Tunisia, Palestine.

[72] UNECE, 2020. Reconciling resource uses: Assessment of the water-food-energy-ecosystems nexus in the North Western Sahara Aquifer System, Part A - "Nexus Challenges and Solutions.

[73] https://astanatimes.com/2018/08/central-asian-leaders-hold-first-aral-sea-summit-since-2009-agree-to-develop-action-plan/

address them. In the Concept of the SPECA Strategy on Water, Energy and Environment (2019), the Working Group specifically recommended the following priority areas: identify economic, investment and policy development opportunities in the water-food-energy-ecosystem nexus to coherently achieve SDGs 6 and 7 targets (e.g. in application of renewable energy technologies, agro-sector resilience measures); capacity building for sustainable management of natural resources (water, energy, agro/forestry sectors) at national and regional level; feasibility study of water-energy consortium; improved availability of information and exchange of experience on inter-sectoral solutions.

According to the experience from the Central Asia Nexus Dialogue Program (implemented by the Regional Environmental Centre for Central Asia (CAREC), in the first phase in cooperation with IUCN), there is a high level of awareness of nexus issues, but the design and operationalization of nexus solutions remains slow, hampered mainly by capacity and financing gaps[74].For this reason, the programme moved from trade-offs to solutions and also to investments (making the case for nexus cooperation as a means to increase returns on investments)[75]. The following outputs of the programme are therefore the core elements of its second phase:

- Nexus Investment Portfolio, which includes eight project ideas of regional importance and covers a wide range of transboundary natural resources management issues, including water allocation, dam safety, upgrade of technical systems, eco-tourism, combating desertification and other environmental issues of the Aral Sea, confirmed relevant by all project countries
- Proposals for nexus investments in two transboundary water facilities, the Farkhad dam and reservoir in Tajikistan and the Tuyamuyun hydroelectric complex bordering Uzbekistan and Turkmenistan. The latter is worked on as a demonstration project and a Technical Working Group has been formed.

4.5 South-East Asia

Southeast Asia is home to major transboundary river systems such as the Mekong, the Red River and the Salween. The river systems are being developed at a rapid rate to promote economic growth in the region. Different sectors such as hydropower, irrigation, fisheries and navigation face challenges due to variable hydrological regimes, flood, drought, rapid development, land use change and climate change. Ensuring that planned development guarantees long term ecological and economic sustainability will require integrated approaches that look beyond national borders and considers the watershed dimension of planning.

The transboundary dimension of these developments is important. In 2010, a strategic environmental assessment prepared for the Mekong River Commission was published outlining the benefits, costs and risks of the planned construction of 88 new hydropower dams in the Lower Mekong Basin (LMB) by 2030.[76] While the proposed developments would increase hydroelectric power generation by nine-folds, it would diminish wild fish catch by 24%–40%.[77] Wild fish are a significant source of protein and micronutrients for the sixty million people living the LMB, so the diminution of this fish supply will require the development of alternative sources of protein through trade or local production.[78] In these complex systems, trade-offs exist between water, food and energy in other areas such as production alternative crops, making cross-sectoral decisions between different variables is increasingly important.

[74] CAREC, Presentation at the sixth meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus (22-23 October 2020)
[75] Increasing returns on investment opportunities by applying a nexus approach Best practice nexus case studies https://portals.iucn.org/library/sites/library/files/documents/2019-047-En.pdf
[76] https://www.mrcmekong.org/assets/Publications/Consultations/SEA-Hydropower/SEA-FR-summary-13oct.pdf
[77] http://livesproject21.org/wp-content/uploads/2018/01/water-08-00425.pdf
[78] https://link.springer.com/article/10.1007/s10113-017-1175-8

The Mekong River Commission, for instance, has emphasized the importance of the nexus approach under changing climate for improved cooperation for Water, Energy and Food security (see Box 19)[79].

Some nexus projects and dialogues in the region (with actual or potential transboundary relevance):

- Assessment of nexus trade-offs in the 3S River Basins (see Box 4)
- Sustainable Hydropower and Multipurpose Storage to meet the Water food and energy SDGs by IHE-Delft that integrates both green and grey water storage. (Myanmar)[80]
- Urban nexus dialogue on wastewater treatment in Korat, (Thailand) [81]

4.6 Sub-Saharan Africa

Africa is home to most of the world's major transboundary watercourses (the Congo, Incomati, Limpopo, Niger, Nile, Okavango, Orange, Senegal, Volta, and Zambezi) which account for some 90 percent of the continent's surface water resources. Various shared river basins in the region and a few aquifers are covered by bilateral or multi-lateral agreements[82].

Sub-Saharan Africa [83] is the region with the highest level of food insecurity in the world, affecting almost 30% of the population.[84] According to the World Bank calculations, only half of the total population has access to electricity[85]. When it comes to water, hundreds of million people in the region still lack safe water services (only 27% and 18% have access to drinking water and sanitation, respectively), which makes water sector development truly central to the socio-economic development of the region.

Issues of natural resource insecurity are exacerbated by climate change, drought and land degradation. Hence, future developments of infrastructure must tackle food security, renewable energy generation and clean water supply, also taking into account future climate trends, all of that with a basin level approach to planning to enhance resilience[86]. Where infrastructure is under-developed there are opportunities to "leapfrog" the problems brought by development in other regions, by using the latest technology and new planning approaches, including the nexus approach[87].

The nexus trade-offs at stake in the development of water infrastructure in Sub-Saharan Africa was the focus of a research by IUCN, the Infrastructure Consortium for Africa (ICA) and the International Water Association (IWA). In fact, water is a cross cutting resource for development and water sector infrastructure provides the best opportunities for multi-functionality. The study highlights that the nexus approach is not commonly applied and operationalized. A more coordinated effort is required by stakeholders at all levels, and moving away from silo thinking within regional and national authorities as well as development partners, knowing that there is no "one-size-fits-all" nexus solution to water issues[88]OBJ

Water is also key for energy development in Sub-Saharan Africa. Almost 100% of electricity production in many countries (e.g. Democratic Republic of Congo, Lesotho, Malawi and Zambia) is generated by means of hydropower. The continent is divided into five regional "power pools" that allow countries to export and import electric power from each other to meet their local demand. Regional and transboundary cooperation can help countries sharing the benefits of investments by optimizing the use of resources at

[79] https://www.mrcmekong.org/assets/Publications/conference/MRC-intl-conf-publ-2014.pdf
[80] https://www.un-ihe.org/projects/sustainable-hydropower-and-multipurpose-storage-meet-water-food-and-energy-sdgs
[81] https://www.water-energy-food.org/ru/news/third-national-dialogue-on-the-urban-nexus-in-thailand-strengthening-collaboration-and-access-to-financing-to-support-integrated-resource-management-in-thai-cities
[82] UNECE & UNESCO, 2018. Progress on transboundary water cooperation: Global baseline for SDG indicator 6.5.2.
[83] The whole African continent excluding North African countries: Morocco, Algeria, Tunisia, Libya, Egypt.
[84] https://www.unwater.org/publications/highlights-sdg-6-synthesis-report-2018-on-water-and-sanitation-2/
[85] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZG
[86] https://www.worldbank.org/content/dam/Worldbank/Feature%20Story/Africa/Conference%20Edition%20Enhancing%20Africas%20Infrastructure.pdf
[87] https://www.feem.it/m/publications_pages/ndl2017-039.pdf
[88] https://www.icafrica.org/fileadmin/documents/Publications/Nexus_Trade-off_and_Strategies__ICA_Report__June2016_2_1_.pdf

regional level. In fact, the availability of resources within the region is not evenly distributed and cooperation means shared benefits.

Looking at the region of Southern Africa Development Community (SADC), which was one of the region in focus under the Nexus Dialogue Programme implemented by SADC and GWP-Southern Africa, 85% of the region's water resources are transboundary in nature.[89] SADC coordinates transboundary water cooperation in fifteen basins across Southern Africa.[90] These shared basins present opportunities for cooperation to enhance socioeconomic security and ensure further progress with achieving the SDGs. The dialogue (2017-2019) resulted in the development of a "Water Energy Food (WEF) Regional Governance Framework" to strengthen WEF Nexus governance in the region and to attract high-level political buy-in and interest. The framework was validated by SADC member states and approved by ministers of water and energy in 2020.The programme will also deliver a web-based regional investment project screening and appraisal tool to decide upon nexus investments[91].

Another example of transboundary cooperation for climate resilient water infrastructure planning (green and grey) is the Volta River Basin (Ghana, Burkina Faso, Mali, Côte d'Ivoire, Togo and Benin). The project Water Infrastructure Solutions from Ecosystem Services (WISE-UP) fosters cooperation on this matter to achieve poverty reduction, ecosystem management, growth and climate resilience while assessing trade-offs across sectors is in the basin. Critical water resource challenges in the basin can be addressed through better mechanisms for coordination amongst riparian States, through increased water storage for subsistence farmers, by reducing waterborne disease, and supporting biodiversity, and deriving maximum benefits from hydropower through existing and planned hydropower plants.[92]

5. Selected examples of nexus solutions and investments

This section includes examples of nexus solutions and investments that have been implemented (or at least designed) through a nexus approach and that bring (or would bring) clear transboundary benefits. These are presented according to the typologies of solutions, highlighting the key factor(s) of success that supported their implementation (see Section 2.2). The aim is to illustrate the variety of possible solutions and investments.

5.1 International cooperation

This section includes one case study that illustrates the benefits that can be generated by applying a coordinated and cross-sectoral approach to the management of shared infrastructure taking into account the surrounding territory with its ecosystems and variety of stakeholders (Box 1); one case that shows the potential benefits of future energy policy actions (related to renewable energy and energy efficiency) on the use of shared water resources (Box 2).

Box 1. Multi-purpose, shared infrastructure (The Parana River)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

- Sectors: Water; Agriculture; Energy; Industry
- Problems: Water quantity, Water quality, Environment
- Success factor in focus: Multi-purpose use of existing infrastructure
- Source of financing: Itaipu Binacional (binational Entity)
- Financing delivery pathways: Project specific funding; Specific programme financing (e.g., climate funds); Adaptable programme financing.

[89] https://www.mdpi.com/2073-4441/8/6/235/html
[90] https://www.unwater.org/publications/water-security-global-water-agenda/
[91] https://aipwater.org/2021/02/wef-nexus-framework-to-strengthen-coordination-of-water-energy-and-food-sectors-in-the-sadc-region/
[92] https://www.iucn.org/sites/dev/files/content/documents/wise_up_brochure_en.pdf

- Transboundary cooperation framework and/or project: Treaty of Itaipu 1973 (legal instrument for the exploitation of the hydroelectric potential of the Parana river)

Itaipu Binacional is a binational entity created in 1974 by the Governments of Paraguay and Brazil in order to utilize the water from the shared Parana river to generate hydropower. The hydropower plant - the world's second largest by installed capacity (14,000 MW), and the largest in terms of effective generated output (103.1 TWh in 2016) - is located in the Paraná River on the border between the two countries.

Hydropower production requires a secure, high quality (low sediment), continuous water flow to maintain generation and supply both countries. Moreover, the reservoir serves not only for electricity generation but also for agriculture, fishing, aquaculture, touristic and leisure purposes, as a municipal water source, and for maintaining wildlife and ecosystem services. Ongoing efforts of modernization of Itaipu aim to improve the energy efficiency of the system, and in turn water use efficiency[93].

Itaipu leads a range of activities to conserve and maintain the quality and conditions of all these water-related ecosystems at optimum levels. "*In relation to terrestrial ecosystems, about 101,000 hectares of forests surround the Itaipu reservoir. This area represents the protected belt for the reservoir along the Brazilian and Paraguayan margins. Itaipu manages within this area a total of 10 protected areas including biological sanctuaries and reserves that protect native flora and fauna and advance research and conservation initiatives. These areas and the reservoir provide valuable connections among important remnants of the Atlantic Forest located in Paraguay, Brazil and Argentina*"[94].

As agriculture (mainly soy, corn, poultry, swine and milk production) is the main economic activity in the region, agricultural activities must be well managed to avoid soil erosion and to reduce pollution. To manage these risks, Itaipu takes a watershed approach to the restoration of ecosystems by investing in forest restoration, the conservation of biodiversity, management of protected areas, recovery and protection of springs, and practices for water and soil conservation (including activities to mitigate impacts of agrochemicals from rural areas).

The implementation of an integrated approach to resource management is not trivial, as stakeholders in municipalities and other institutions tend to keep sectoral perspectives on common issues. Hence, Itaipu's activities on environment protection are carried out with the active participation of the communities near the reservoir and by establishing partnerships with various groups of stakeholders (municipalities, farmers and their organizations, such as associations and cooperatives, federal, state and city institutions of research and technical support, schools and universities, NGOs).

Itaipu has permanent funding in some areas, such as water quality and quantity monitoring, forest restoration and others. Education programs and capacity building activities are implemented in partnership with other national and international institutions and/or government.

Box 2. Renewables and energy efficiency to reduce pressure on shared waters (Syr Darya)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

- Sectors: Water, Energy
- Problems: Water quantity

[93] Sustainable Water & Energy Solutions Network. Generating Hydropower through Sustainable Management of Natural Resources https://www.un.org/sites/un2.un.org/files/itaipu_generating_hydropower_through_sustainable_management_of_natural_resources.pdf

[94] Sustainable Water & Energy Solutions Network. Generating Hydropower through Sustainable Management of Natural Resources https://www.un.org/sites/un2.un.org/files/itaipu_generating_hydropower_through_sustainable_management_of_natural_resources.pdf

- Success factor in focus: Increased awareness of the benefits accruable to cross sector transboundary trade-offs, compromise and synergies
- Source of financing: N/A
- Financing delivery pathways: N/A
- Transboundary cooperation framework and/or project: Agreement between the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan, Turkmenistan and the Republic of Uzbekistan on Cooperation in the Field of Joint Management on Utilization and Protection of Water Resources from Interstate Sources (1992); The International Fund for Saving the Aral Sea

The Syr Darya's water resources are central to hydropower generation in upstream countries (Kyrgyzstan and Tajikistan) as well as agricultural production in densely populated parts of the basin downstream (Uzbekistan and Kazakhstan). There is a clear trade-off as demand for energy, particularly electric power, in upstream countries peaks during winter, while irrigated agriculture requires water release in summertime. These demands and dependencies could be reduced.

Investing in renewable energy and energy efficiency as a solution to reduce stress on shared water was a proposal, backed by water-energy modelling - from the Syr Darya nexus assessment carried out under the Water Convention[95]. The assessment aimed to foster transboundary cooperation by identifying intersectoral synergies and determining measures that could alleviate tensions related to the multiple needs of the riparian countries for common resources. The participatory assessment process for the Syr Darya involved an intersectoral workshop for identification of the main intersectoral issues and possible solutions, detailed by a subsequent analysis, and followed by consultations of the various sectoral authorities concerned. The assessment helped to identify measures and actions to optimize the use of the resources and identify benefits of transboundary intersectoral cooperation. Among these measures were, firstly in the energy sector, an increased diversification of energy sources, improving the functioning of the regional power system and revitalizing the power trade and improved energy efficiency, and, secondly in the field of agricultural water use, furthering the ongoing transformation of agriculture involving improved efficiency of water use, crop switching and land reform, among others.

In order to investigate the dependencies between the Syr Darya 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 Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. A dynamic response of electricity trade and changes in electricity generation profiles were then analyzed. While there are many 'potential futures', the analysis was limited to three scenarios.

A reference scenario was developed to represent business-as-usual conditions (BAU scenario). Another scenario was dedicated to exploring the potential benefits of stated efforts in the implementation of energy efficiency measures, targeting both the supply and demand sides (EE scenario). This included measures investigated in the Power Sector Development Regional Master Plan. A third scenario investigated the impacts of diversifying the power generation mix via the increased deployment of renewable energy technologies (RET scenario), such as wind power and solar photovoltaic power. Electricity trade was analysed across the three scenarios in order to assess how different conditions impact the dynamics of power flows in the region and the generation mix of the countries. Of particular interest is what this would imply for the patterns of hydropower generation in the upstream countries of Kyrgyzstan and Tajikistan.

Investment needs in the modernization of existing infrastructure to ensure higher efficiency of the use and protection of the basin's resources are high. Among the relevant lines of action were identified

[95] https://unece.org/DAM/env/water/publications/GUIDELINES/2017/nexus_in_the_Syr_Darya_River_Basin/Syr-Daria-FINAL-WEB-.pdf

further development of the regional energy market and trade as well as exploring opportunities for energy-water exchanges on the basis of coordinated strategic planning of the development of electric power systems and water use. Greater involvement from the energy sector within the basin-wide frameworks of institutional cooperation would improve opportunities to pursue nexus opportunities.

FIGURE 13
Change in hydropower generation in the Syr Darya River Basin (%)

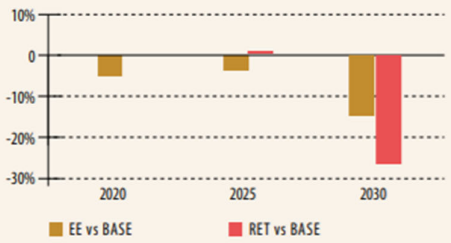
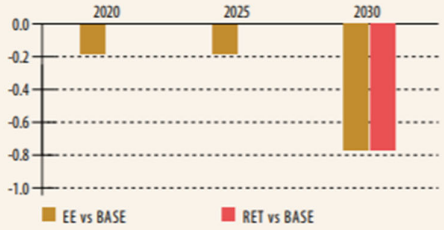


FIGURE 14
Difference in hydropower installed capacity in the Syr Darya Basin in Kyrgyzstan between scenarios (GW)



5.2 Governance

This section includes one case study related to shared data and information and common metrics to coordinate decisions on multiple sectoral water uses based on the suitability of water (Box 3).

Box 3. Coordinated and aligned decisions in hydropower, fishery, fishing and bathing based on the suitability of water course and riparian areas (Isonzo/Soča River Basin)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

- Sectors: Water-Energy -Environment-Tourism
- Problems: Water quantity, Environment
- Success factors in focus: Shared data and information, Common metrics (standardised river corridor suitability analyses)
- Source of financing: co-funded by the European Regional Development Fund and national funds
- Financing delivery pathways: Project specific
- Transboundary cooperation framework and/or project: Coordinated Activities for Management of Isonzo – Soča (CAMIS Project)

The Isonzo/Soča River Basin is shared by Slovenia and Italy.

The Institute for Water of the Republic of Slovenia developed a method for determining the suitability of water courses and riparian areas for various water uses and coordination, using knowledge of 1) water and spatial planning, spatial, landscape and ecological as well as hydrological and hydraulic modelling, hydromorphological assessments and 2) administrative procedures, sectoral interests, cross-sectoral solutions. The method is used to develop sustainable solutions for the use of water courses and their riparian areas (i.e. river corridors) [96].

Within the CAMIS project (Coordinated Activities for Management of Isonzo - Soča), the method was applied to the upper part of the Soča river basin in Slovenia to four types of use, which have been identified as relevant in the area in question: hydropower use, bathing sites, fish farming and fishing. The method is universal and can be applied to any water uses and implemented on any rivers, river basins or catchment areas. The CAMIS project involved partners from both riparian countries.

[96] http://www.camisproject.eu/modules/uploader/uploads/system_menu/files_sys/camis_zlozenka-izvrs_angl_low.pdf

The coordination of solutions through active stakeholder involvement forms an integral part of the entire process, e.g. from the records of environmental status and data register, analyses and model development to synthesis work and final coordinated decision-making and proposal of solutions. Taking stakeholder competence, expertise and interests into account significantly contributes to the process efficiency and an enhanced understanding and support of decisions and implementation of solutions.

The project was co-funded by the European Regional Development Fund and national funds.

5.3 Economic and policy instruments

This section includes: one case that illustrates national-level policy actions and legal arrangements in the field of energy that originated from the nexus assessment (and other multi-sectoral studies) in a basin, which highlighted the benefits of cross-sector transboundary cooperation (Box 4); one case study on a proposal that indicates how international cooperation on water-energy nexus might bring economic benefits by optimizing the use of scarce resources (Box 5) though major water and energy decisions are commonly political in nature. National level intersectoral coordination is a pre-condition for finding and implementing transboundary nexus solutions. Then the section includes one case study on how national sectoral and cross-sectoral planning were influenced by the outcomes of a transboundary nexus project (Box 6) and one case study on advancements in legal arrangements on the operations of a dam taking into account environmental needs (Box 7).

Box 4. Making the best use of water through transboundary cooperation (Sekong, Sesan, and Srepok 3S)[97]

- Sectors: Water; Energy; Agriculture; Fisheries.
- Problems: Environment (Biodiversity loss or compromise ; Habitat loss or compromise ;Sediment or erosion ;Compromised human health)
- Success factors in focus: Increased awareness of the benefits accruable to cross sector transboundary trade-offs, compromise and synergies;
- Source of financing: By the state with development partner grant support;
- Financing delivery pathways: Sector budget support; Project specific funding;
- Transboundary cooperation framework and/or project: Regional Technical Advisory Group

Covering 10% of the Mekong river basin, the transboundary Sekong, Sesan, and Srepok (3S) river basin provides 20% of its water and sediment. The 3S basin (shared by Cambodia, Lao PDR, Vietam) is rich in land, forest, and hydropower potential, which the three countries are seeking to harness for national development. Transboundary cooperation can optimize the value of water across the 3S.

The nexus assessment[98] of the 3S basin, carried out as part of the BRIDGE project, identified three areas of transboundary cooperation: joint energy planning and investment to maximize river connectivity; transforming coffee production in Vietnam to a higher value and less water-consuming mix to increase dry season water flow into Cambodia; and keeping the mainstream of the Sekong free flowing to sustain regional fisheries and food security. Coordinated transboundary investments can deliver energy security, meet export targets, and minimize impacts on fisheries[99]. The agricultural (coffee) transformation will cost $300 million over 30 years, increase crop value by 2.5, and save 200 million m3 of water in dry

[97] 3S Nexus assessment in Cambodia, Lao PDR, Vietnam. Presentation by Mr. Jake Brunner, International Union for Conservation of Nature IUCN https://unece.org/environmental-policy/events/task-force-water-food-energy-ecosystems-nexus

[98] IUCN, Measuring, understanding and adapting to nexus trade-offs in the Sekong, Sesan and Srepok Transboundary River Basins Available at: https://portals.iucn.org/library/sites/library/files/documents/2019-024-En.pdf

[99] IUCN, 2020. Sekong, Sesan and Srepok River Basin energy profile. Available at : https://www.iucn.org/news/viet-nam/202005/sekong-sesan-and-srepok-river-basin-energy-profile

season[100].The energy implications are considered in the Cumulative Impact Assessment of Renewable Energy in the Sekong, that IFC is carrying out for the Government of Lao PDR to identify the best balance between renewable energy development, and the sustainable use and protection of the river.

The main challenge to implement the assessment recommendations is the lack of an institutional counterpart with the authority to lead transboundary cooperation in the 3S basin, considering also the relevant sectors. A regional Technical Advisory Group was therefore set up to provide technical input and help disseminate the results of the assessment by engaging with high influence/low-interest organizations such as IFC, World Bank, the Communist Party of Vietnam, and ministries of energy and by framing the key recommendations in economic rather than biodiversity terms.

The nexus assessment, which builds on previous wok by IUCN, WWF, Natural Heritage Institute and others, had an important impact on national energy policy and regional energy development. In 2020, Cambodia issued a 10-year moratorium on Mekong mainstream dams[101]. In Vietnam, "Resolution 55" [102] issued in 2020 broke with the coal-first paradigm by prioritizing renewables, and the new Power Development Plan (PDP 8), which is based on the resolution, includes substantial cross-border energy trade, which is one of the assessment recommendations[103]. Furthermore, IFC is now linking financing for power transmission to keeping the Sekong mainstream dam-free.

Box 5. Synergic transboundary solutions on water-energy (Middle East)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

- Sectors: Water; Energy
- Problems: N/A (the case does not refer to a transboundary basin)
- Success factor in focus: Transparent and equitable terms of transboundary trade between the riparians
- Source of financing: N/A (solution at the stage of proposal)
- Financing delivery pathways: (solution at the stage of proposal)
- Transboundary cooperation framework and/or project: N/A

EcoPeace Middle East is an environmental NGO that brings together Jordanian, Palestinian, and Israeli environmentalists. The Water-Energy Nexus (WEN) is EcoPeace's flagship project for climate change adaptation and mitigation, designed to create a regional desalinated water - solar energy community between Jordan, Israel and the State of Palestine that would optimize the use of resources and support healthy and sustainable regional interdependencies.

The potential to transfer desalinated water from Israel and the State of Palestine (which have access to the Sea) in exchange for solar energy produced in Jordan (abundance of available space for photovoltaic) was evaluated through a pre-feasibility study (2017). The study showed that "*the proposed idea of international cooperation and water-energy exchanges, while facing political obstacles, could provide numerous economic, environmental and geopolitical benefits to all parties involved*"[104] A cooperative arrangement could be a more efficient way of using the available resources than to develop desalination and renewable energy in different territories in isolation.

[100] IUCN, 2020. Transforming coffee and water use in the Central Highlands of Vietnam: case study from Dak Lak Province. Available at : https://www.iucn.org/news/viet-nam/202008/transforming-coffee-and-water-use-central-highlands-vietnam-case-study-dak-lak-province

[101] https://www.reuters.com/article/us-mekong-river-cambodia-idUSKBN215187

[102] Vietnam's Politburo Issues Resolution on Orientation of New National Energy Development Strategy to 2030 with a vision to 2045. https://www.bakermckenzie.com/en/insight/publications/2020/02/vietnam-national-energy-development-strategy

[103] https://globalcompliancenews.com/vietnam-key-highlights-of-new-draft-of-national-power-development-plan-draft-pdp8-04032021-2/

[104] Katz, D. and Shafran, A. Transboundary Exchanges of Renewable Energy and Desalinated Water in the Middle East. Energies 2019, 12(8), 1455. Available at: https://www.mdpi.com/1996-1073/12/8/1455

Any such type of synergetic water-energy solution would also require cooperation to be strengthened between the two sectors at the national level. A recent study discusses how Jordan's water and energy sectors are increasingly connected though cooperation focuses mostly on technical solutions and resource allocation decisions [105].

Box 6. Considering nexus in national, regional, and basin planning (Alazani/Ganykh, experience from Georgia)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

- Sectors: Water, Agriculture, Energy, Environment
- Problems: Water quantity, Water quality, Environment (Biodiversity loss or compromise, Sediment and erosion).
- Success factor in focus: Increased awareness of benefits accruable to cross-sector, transboundary trade-offs, compromise and synergies
- Source of financing: By the state (including credits from development partners), By the state with development partner grant support, By blended finance, by the private sector.
- Financing delivery pathways: Project specific funding, Specific programme financing (e.g. climate funds), Sector budget support, Central budget support
- Transboundary cooperation framework and/or project: UNDP-GEF Kura Project[106] (which supported the nexus assessment by facilitating the transboundary dialogue)

The Alazani/Ganykh River is of great social and economic importance for both Georgia and Azerbaijan. The two countries participated in a number of regional projects on the management, monitoring and assessment of transboundary water resources, including the Alazani/Ganykh participatory assessment of the nexus (2013-2014, facilitated by UNECE and UNDP)[107].

The assessment found multiple linkages between the different basin resources, including some chains of indirect impacts across sectors, for example between household use of fuelwood, deforestation, erosion and sedimentation, loss of ecosystem services and degradation of the hydrological regime. Potential solutions to increase the benefits from the basins' resources were also explored, which could be achieved through more coordinated policies and actions and through transboundary cooperation. Such potential measures include facilitating access to modern fuels (such as gas) and energy trade; introducing economic instruments; making hydropower generation more sustainable; as well as developing the agriculture and agro-industrial sector, for example by improving practices like the maintenance of irrigation infrastructure.

These results are being considered by the Government of Georgia in a number of measures that it is taking at national and basin level, notably: the adoption of a number of resolutions, plans for socio-economic development for the country and, for the Kakheti region, the development of new legislation. For basin-level strategies, the objective is to improve living conditions and ensure sustainable access to sufficient food, water, energy, and environmental resources. Notably, actions were taken to switch away from fuelwood: since the time of the nexus assessment, 178 villages in 8 municipalities have been connected to the gas network in Kakheti, with works financed from the government and implemented by Georgian Gas Transportation Company.

[105] Chenoweth, J. and A.Al-Masri, R. The impact of adopting a water-energy nexus approach in Jordan on transboundary management. Environmental Science & Policy. Volume 118, April 2021, Pages 49-55. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1462901121000265

[106] More information on the project "Advancing Integrated Water Resource Management (IWRM) across the Kura river basin through implementation of the transboundary agreed actions and national plans" is available at: www.kura-river.org

[107] The findings from the assessment are included in UNECE (2015), *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus.* Available at: https://unece.org/environment-policy/publications/reconciling-resource-uses-transboundary-basins-assessment-water

The nexus assessment informed sectoral and cross-sectoral strategies: “Strategy of socio-economic development of Georgia (Georgia 2020)”,“Strategy of socio-economic development of Kakheti for the period 2014-2021”,“The third program of environmental activities of Georgia for 2017-2021 (NEAP-3)",“National Action Plan for Environment and Health for 2018-2022 (NEHAP-2)"," Strategy for the Development of Agriculture for 2015-2020","Strategy for the Development of Georgia's Villages for 2017-2020",”Action Plan for Renewable Energy Sources for 2019-2020", and others such as the "Action Plan for Renewable Energy Sources for 2021-2030", under development. All these documents are the result of intersectoral coordinated and comprehensive work of ministries.

Box 7. Optimizing the ecological flows of a hydropower plant (Dniester)

- Sectors: Energy; Environment
- Problems: Water quantity (natural shortages), Environment (Biodiversity loss or compromise; Habitat loss or compromise; Sediment or erosion)
- Success factors in focus: Institutional arrangements
- Source of financing: Development partner grants (GEF)
- Financing delivery pathways: Project specific
- Transboundary cooperation framework and/or project: The Commission on Sustainable Use and Protection of the Dniester River Basin (the Dniester Treaty 2012)

The Dniester is shared by Ukraine and Moldova. The release of so-called “spring ecological water” from the Dniester reservoir started in 1988, right after the commissioning of the Dniester hydropower plant (which has significantly changed the hydrological regime of the river) in Ukraine. The spring ecological water release is established in the Rules of operation of the Dniester HPP reservoirs. An objective of the release is to provide water for:

- fish spawning areas in flood plains, particularly for phytophilous fish species,
- animals and plants of the Lower Dniester floodplains (including 3 Ramsar sites and a national nature park).

The release is conducted every April, for a duration of 30 days. The volume and duration of the release depend on the spring flood in the Dniester basin. An Intersectoral Commission under the auspices of the State Agency for Water Resources (SAWRU) of Ukraine is responsible for convening a broad-based discussion and approval of the release. During the release, the Dniester plant reduces power production, hence other power producers take over to ensure balance in the country’s power system.

In 2020, an “analysis of the goals, limitations, and opportunities for optimizing the regime of spring ecological reproductive release from the Dniester reservoir” was done upon the joint request of the governments of the Republic of Moldova and Ukraine, providing several scenarios and models of the spring ecological water release. Hydrobiological studies and modelling have also been completed[108].

The study highlights that the following joint actions on the spring ecological water release are needed:

- development of tools for monitoring of effectiveness of the release
- more analysis to understand objectives, limitations and efficacy of the release,

[108] The GEF / UNDP/ OSCE/ UNECE project “Enabling transboundary co-operation and integrated water resources management in the Dniester River Basin” has provided the requested expertise and funds. Document and interactive tool for release flow scenarios available at : https://dniester-commission.com/en/news/the-experts-examined-optimization-options-for-spring-ecological-reproductive-release-from-the-dniester-reservoir/ (ENG) https://dniester-commission.com/novosti/eksperty-izuchili-varianty-optimizacii-vesennego-ekologo-reprodukcionnogo-popuska-iz-dnestrovskogo-vodoxranilishha/. (RUC)

- change of a procedure for submitting proposals to the Intersectoral Commission considering exclusively realistic scenarios based on agreed long-term requirements and limitations,
- strengthening a mechanisms for transboundary agreement of the parameters of the release in the frame of the Commission on Sustainable Use and Protection of the Dniester River Basin (the Dniester Treaty 2012) and the Institute of the Plenipotentiaries (the Dniester Agreement of 1994).

This means that more needs to be done to optimize ecological flows, also because environmental needs are the only element of the "water balance" of the basin that is still unclear (the different needs of all sectors are known). This requires new resources and capacity as water authorities in Ukraine and Moldova are often overloaded and underfunded to carry out this type of research. However, there is political momentum as the countries are committed to reviewed flow release parameters at transboundary level beyond the spring release (all year operations).

The example demonstrates that with a water-energy-environment dialogue at the transboundary level, it is possible to agree about measures that that better reconcile different flow related needs and reduce environmental impact from economic activity.

5.4 Infrastructure and innovation

This section includes: one case study that illustrates how a (small-scale) renewable energy nexus solution can contribute to the implementation of both national and transboundary plans (Box 8); one case study about the assessment (and estimated investment) needed to tackle the problem of erosion through multiple sectoral actions (Box 9); and one case that illustrates the potential to finance watershed conservation through payments from nexus sectors (Box 10).

The implementation of infrastructural nexus solutions is increasingly common, though they are rarely designed to as transboundary projects. Basin plans and programs could well include infrastructural nexus solutions (green and grey) and possibly implement them across the borders. The importance of nature-based solutions for climate change adaptation is a point in case[109]. Renewable energy solutions to reduce the environmental impact on rivers is another one[110].

The implementation of land-based infrastructure solutions for the benefit of water and the environment requires coordinating with the forestry or agriculture sectors. Various examples of innovative soil engineering as green-infrastructure solutions for the sustainable management and use of nature (tackling socio-environmental challenges including climate change, water security, water pollution, food security, human health, and disaster risk management) are illustrated in a recent paper[111]. The importance of these solutions in transboundary basins is clear, however these projects are typically implemented at local level. The study suggests that the impact of these solutions would be strengthened perhaps through the integration of the engineering components (e.g., standards, best practice, etc.) in the existing policy instruments at national and transnational levels.

Box 8. Energy recovery from biomass removed from protected areas in a shared lake (Skadar/Shkoder Lake, Drin)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

[109]UNECE, Advancing ecosystem-based adaptation to climate change in transboundary basins (news, 2019). Available at: https://unece.org/environment/news/advancing-ecosystem-based-adaptation-climate-change-transboundary-basins

[110] World Wildlife Foundation (WWF) and The Nature Conservancy (TNC). Connected and Flowing (2019) Available at: http://d2ouvy59p0dg6k.cloudfront.net/downloads/connected_and_flowing__wwf_tnc_report_.pdf; UNECE, Towards sustainable renewable energy investment and deployment: Trade-offs and opportunities with water resources and the environment (2020). Available at: https://unece.org/environment-policy/publications/towards-sustainable-renewable-energy-investment-and-deployment;

[111] Mickovski, S., *Re-Thinking Soil Bioengineering to Address Climate Change Challenges*, 2021.Sustainability13(6). https://www.mdpi.com/2071-1050/13/6/3338/htm

- Sectors: Water, Energy, Environment
- Problems: Water quality, Environment
- Success factors in focus: Renewable energy, innovative financing
- Source of financing: Development partner grants (GEF)
- Financing delivery pathways: Project specific
- Transboundary cooperation framework and/or project: Memorandum of understanding for the management of the extended transboundary Drin Basin (Drin MOU)[112]

A small-scale nexus solution was implemented as a pilot activity "Reduction of nutrient load and forest preservation through biomass collection and production of fuel briquettes in Montenegrin part of the Skadar/Shkoder Lake", in the framework of a GEF Drin Project[113]. The transboundary Skadar/Shkodra Lake is shared by Albania and Montenegro.

The solution tackles problems of water quality (eutrophication) and environment (invasive species) while generating new benefits (biomass) that make the solution economically self-sustainable. The biomass collected to clean-up the lake is used to produce fuel-briquettes: a valuable alternative source of energy to fuel-wood, which use is widespread and unsustainable in the region. The pilot is implemented with the National Park Authorities and informs their approach to managing invasive species in the future[114]. The project:

- Improves knowledge regarding specific ecosystem changes caused by extensive nutrient load;
- Implement targeted vegetation control measures (wetland management);
- Reduces nutrient load from the lake (primarily phosphorous and nitrates) through removal of biomass (reed and *Amorpha fruticose* (Indigo bush) – an invasive species locally known as 'Bagremac');
- Reduces pressure on degraded natural forest on the lakeshore by reducing logging; the latter will be fostered by testing possibilities for use of fuel-briquettes produced from harvested biomass as an alternative -to wood- fuel;
- Contributes to the improvement of socio-economic conditions at local level by exploring and creating potential for additional employment opportunities (thought biomass to fuel scheme) and supporting tourism (boat cruising, recreational activities); and
- Contributes to the improvement of understanding of the local population regarding the sustainable management of the Lake.

This solution contributes to the improvement of the state of the ecosystem in the lake by establishing a replicable, low-cost action that provides multiple benefits without generating negative impact. When scaled up, this type of solution contributes to CO2 emission reduction and job creation. Importantly, the pilot is designed to be financially self-sustainable allowing mitigation measures for the benefit of community, nature, and natural park management at no additional costs.

The pilot – and its potential for upscaling/replication - contributes to the implementation of the following policies and plans:

- At national level (Montenegro) [115]:

[112] http://drincorda.iwlearn.org/drin-coordinated-action/drin-memorandum-of-understanding

[113] The project is implemented by UNDP and executed by Global Water Partnership-Mediterranean also in partnership with UNECE http://drincorda.iwlearn.org/library-main/meetings/inaugurations/biomass-pilot-activity-in-national-park-of-skadar-lake-reaches-second-phase-following-equipment-donation

[114] http://drincorda.iwlearn.org/library-main/meetings/inaugurations/biomass-pilot-activity-in-national-park-of-skadar-lake-reaches-second-phase-following-equipment-donation

[115] CNVP, "Strengthening the value chain of energy biomass in the Drin River Basin for a more sustainable management of forests, and related nexus implications" (Drin Nexus Assessment)

  - the National Forest Strategy, which promotes investments sustainable forest management of private and State forests;
  - the National Renewable Energy Strategy Montenegro, which promotes the use of energy efficient technology such as biomass boilers;
  - the forestry policy, which indicates the need for research on the role of forests in mitigating climate changes, functioning of forest eco-system, protection of biodiversity, use of timber and biomass, relation between forests and water, competitiveness, rural development.
- At transboundary level:
  - The Strategic Action Programme the Drin River Basin[116], which includes energy and forest-related actions because it was developed including recommendations from the Nexus Assessment of the Drin[117].

Box 9. Coordinated actions to manage sedimentation and control erosion (Drina)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

- Sectors: Water, Agriculture, Energy, Environment, Industry, Navigation, Tourism
- Problems: Environment (Sedimentation and Erosion)
- Success factor in focus: Natural infrastructure
- Source of financing: Actions not yet funded; study funded by the state including development partners (UNECE)
- Financing delivery pathways: N/A (actions not yet funded)
- Transboundary cooperation framework and/or project: International Sava River Basin Commission and the Drina Nexus Assessment[118] and follow-up project under the Water Convention[119]

The Drina River Basin (shared by Serbia, Bosnia and Herzegovina, Montenegro) is a river naturally prone to erosion, which is a problem that affects different sectors (energy, water, agriculture, etc.).

The Jaroslav Cerni Institute in Serbia developed a "Scoping study on erosion and sedimentation in the Drina River Basin"[120] providing a consistent picture of the occurrence of sedimentation and erosion in the basin and related problems (sedimentation of reservoirs, sedimentation of river mouths, problems with erosion deposition/flooding in downstream areas, etc.), using data available in the three basin-sharing countries.

The recommendations from the study are cross-sectoral, in particular when it comes to: apply and monitor appropriate erosion control measures; apply measures to reduce erosion and torrent impact in a coordinated fashion; apply biological and biotechnical measures, exploring synergies, e.g. with flood control, forestry actions and biomass production, where appropriate. Based on this study, the investments in anti-erosion and torrent control is estimated at EUR 113 million.

[116] https://www.gwp.org/globalassets/global/gwp-med-files/list-of-programmes/gef-drin-project/drin-docs/drin_sap_v15_spreads_010220.pdf
[117] https://www.gwp.org/en/GWP-Mediterranean/WE-ACT/Programmes-per-theme/Water-Food-Energy-Nexus/seenexus/drin-II/
118 UNECE (2017). Assessment of the water-food-energy-ecosystem nexus and benefits of transboundary cooperation in the Drina River Basin (available at: https://unece.org/environment-policy/publications/assessment-water-food-energy-ecosystem-nexus-and-benefits)
[119] Background on the work on the water-food-energy-ecosystems nexus on the Sava and the Drina, and the Drina River Basin Concept Note of the Phase II Nexus Assessment Report, presentation by Annukka Lipponen (2021) https://www.gwp.org/globalassets/global/gwp-med-files/list-of-programmes/see-nexus/phase-ii-ada-nexus/unece--nexus-on-the-sava-and-the-drina-and-cn-phase-ii_mne.pdf
[120] One of the components of UNECE Drina River Basin Nexus follow-up project (https://unece.org/environmental-policy/events/launch-workshop-follow-project-water-food-energy-ecosystems-nexus)

In this case, the nexus approach helped connecting different countries in the basin, but the communication between countries and sectors is still insufficient. There are financial constraints that seem to require substantial help from international financial institutions and other organizations to implement the results of the study.

Box 10. Innovative financing for watershed conservation (Trifinio water fund)

The Trifinio river basin is shared by Guatemala, Honduras, and El Salvador. The basin is an "indivisible ecological unit" that is home to about 1 million people and that has significant naturalistic and cultural/archaeological touristic potential. This biosphere is a shared, and jointly managed, natural reserve. The three countries cooperate on the management of shared resources through the Trinational Commission, established in 1997, which role is to implements the development plan for the basin (Plan Trifinio)[121].

A "water fund" is a financial mechanism for watershed conservation activities and projects, as well as a governance mechanism for watershed planning. Water funds apply the principle of Payments for Ecosystem Services (PES) in a watershed to direct payments from downstream users and beneficiaries of watershed services to sustain upstream communities and ecosystems.

The Trifinio Water Fund (at the stage of design by the Commission with the support of the Inter-American Development Bank (IADB)) would be the first example of a transboundary water fund, where the users of water include domestic water supply as well as agriculture (irrigation and fishery), energy (hydropower), and industry[122]. The water fund would direct the payments for water (tariffs and permits) to the sustainment of the shared water and forest ecosystems in the biosphere.

6. Enabling and upscaling nexus solutions in transboundary basins

Enabling nexus solutions means tackling the constraints commonly experienced by stakeholders who are trying to implement them, as described in section 3.2. The mobilization of new financial resources can provide an important stimulus to cooperation, directly overcoming the issues of financial constraints and indirectly improving the technical capacity of institutions to plan "bankable" solutions involving different sectors. However, no nexus solution can be found or implemented without greater coherence in policy action and plans, which passes through political dialogue, better information, and the search for common objectives, synergies, and possibilities for benefit sharing. This is the key to build a common understanding and mutual trust.

6.1 Mobilizing finances for nexus projects

Nexus projects are multi-sectoral and need cross-sectoral cooperation to unlock investments. Therefore, for the countries to identify opportunities it is important, first of all, to have an overview of the planned investments, the type of projects, the type of financing, at all levels (international, national, local). This allows to maximise opportunities and minimize risks. The level of investments in the various components of the nexus varies, notably energy tends to receive more financing compared for instance to sanitation.

Because of these differences between sectors, multisectoral projects can provide for new and additional financing opportunities to water management and contribute to conservation or environment protection objectives through economic sectors' action. This clearly requires strengthening the capacity of institutions

[121] http://www.plantrifinio.int/quienes-somos/marco-juridico

[122] https://unece.org/fileadmin/DAM/env/documents/2020/WATER/10Oct22-23_TF_Nexus/Presentations/Item_5_Raul_Munoz_Castillo_IADB.pdf; https://www.fondosdeagua.org/en/

at national and local level to design and manage cross-sectoral projects, including development of necessary partnerships, and enhance the implementation of IWRM.[123]

The survey (section 2.4) shows that while the nexus approach opens up opportunities for more private and blended finance, this potential is largely unutilized in transboundary basins. In general, the diversification of financial sources for financing transboundary cooperation can be hampered by risks often associated to cooperation arrangements and institutional set-up, which is deeply linked to the capacity of institutions to provide an enabling environment.

Water- and environment-related problems need to be effectively tackled across sectors, and this may require significant financial resources. Without effective cooperation, there is a high risk of economic sectors finding their own solutions to solve the immediate problems without a common vision of sustainable basin development, which is a missed opportunity for water management and environment protection to receive concrete benefits from these interventions. By designing solutions and planning investments together (across sectors), water institutions at national and basin level can catalyse the implementation of well-integrated solutions that are both environmentally sustainable and bankable.

Financing institutions are increasingly concerned with the cross-sectoral coherence of projects when it comes to transboundary basins. For example, in Africa the World Bank supported the identification of projects with multi-sectoral benefit potential (see Box 11) and in South East Europe the implementation of investments across different sectors and countries under a coherent water cooperation framework (Box 12). In Latin America and the Caribbean, the IADB strategy for transboundary waters[124] includes knowledge, science and technical assistance to catalyze nexus (cross-cutting/multisector) investment portfolios, policy and planning that can be funded by IADB itself or through blended resources with other IFIs or private sector. It can be noted that in order to promote nexus projects, the IADB leans more towards programmatic approaches rather than stand-alone at project level (confirming the findings from the survey).

Experience from Latin America and the Caribbean suggests that adopting a nexus approach to basin planning can be strategic to access funding (Box 14). In Central Asia, IFC proposes a landscape approach to the evaluation of projects in a view to de-risking investments (see Box 13). The OECD also promotes a similar approach to water investment planning for regional water, food, energy security (Box15). In the Mediterranean region, the Union for the Mediterranean takes a nexus approach to financing water investments to identify and leverage resources in nexus sectors (energy, agriculture) and in the private sector, and to establish partnerships to mobilize climate financing in the region[125]. One example from the Middle East (implemented at national level) illustrates the practical implementation of a nexus solutions and investment project (Box 16).

Finally, there are perspectives for climate funding to support nexus projects in transboundary basins, for instance through the Green Climate Fund. This is the largest fund for climate finance, established to support climate change adaptation and mitigation for developing countries and implementation of their National Determined Contributions NDC. So far, there have been only a few nexus and/or transboundary GCF project proposals. One example of transboundary GCF project (under preparation) is Lake Chad & Adaptation to Climate Change (LACC). The project includes adaptation and mitigation measures in agriculture and forestry through improved management of water and soil resources and where possible using solar energy [126]. Transboundary partnership discussions and dialogue are crucial both for the

[123] Virtual event organized by UNECE in cooperation with the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the Inter-American Development Bank (IDB) on 22 February 2021. More information at : https://www.water-energy-food.org//news/nexus-blog-virtual-meeting-of-experts-on-policies-of-the-water-food-energy-ecosystems-nexus-and-projects-of-transboundary-relevance-in-latin-america-and-the-caribbean-lac

[124] https://publications.iadb.org/en/joined-water-jbw-idbs-transboundary-waters-program

[125] https://ufmsecretariat.org/wp-content/uploads/2019/04/UfM-Financial-Strategy-for-Water_for-web-paginas.pdf

[126] https://www.greenclimate.fund/sites/default/files/document/23120-lacc-project-lake-chad-adaptation-climate-change.pdf

determination of the beneficiaries' needs and for the formulation of appropriate adaptation measures. Nexus analysis can be useful to study the impact of climate change and investigate policy measures to adapt and mitigate. There are many ways of financing nexus solutions/actions, from traditional to innovative finance mechanisms. These different sources can represent decisive co-funding opportunities for GCF projects.

Box 11. Multi-sector investment opportunity analysis (Zambesi)

****THIS CASE STUDY TEXT IS STILL UNDER REVIEW****

The Zambesi River Basin (Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe) is a vital source of water and a critical ecosystem for the riparians and beyond. The economies of riparians are tightly linked to its water and for energy (hydropower production, a key resource that represents very high shares of total power production) and food security. The climate variability can have devastating effects.

In 2010, the World Bank carried out a River Multi-Sector Investment Opportunity Analysis (MSIOA) *"to illustrate the benefits of cooperation among the riparian countries in the ZRB through a multi-sectoral economic evaluation of water resources development, management options and scenarios from both national and basin-wide perspectives."* This MSIOA points at how cooperative basin development (within the wider Southern Africa Development Community (SADC)) has the potential to accelerate regional economic growth and stability[127].

The MSIOA looks at how to better manage development in the basin through cooperation to *increase agricultural yields, hydropower outputs, and economic opportunities,* knowing that, cooperation can *increase the efficiency of water use, strengthen environmental sustainability, improve regulation of the demands made on natural resources, and enable greater mitigation of the impact of droughts and floods.*

By comparing several different scenarios, *the analysis assessed the strengths and weaknesses of different combinations of investment concepts for hydropower, irrigation and floodplain restoration in the river basins, with domestic water supply and environmental stream flows prioritised as unaffected benefits/options in almost every case.* The most preferable combinations (nexus solutions) are considered in the "desirable development zone" by the World Bank[128].

One of the lessons emerging from this study is that *changes in the operational rules of hydropower dams can increase benefits in other sectors, in this case irrigation and flood control, but may therefore create challenges to secure energy generation during dry periods. This can create opportunities for other renewable energy investments that can help stimulate economic diversification, new business opportunities, low carbon development and access to investment and modular systems that put less strain on ageing transmission networks*[129]*.*

Box 12. The Sava and Drina Rivers Corridors Integrated Development Program (Sava-Drina)

****THIS CASE STUDY TEXT IS UNDER REVIEW ****

The Sava and Drina Rivers Corridors Integrated Development Program (SDIP) is a programme financed by GEF and the International Bank for Reconstruction and Development (IBRD, World Bank Group). The programme aims at improving flood protection and enhancing transboundary water cooperation in the Sava and Drina Rivers Corridors. The World Bank took a regional/multi-country approach because

[127] https://openknowledge.worldbank.org/handle/10986/2960?show=full
[128] https://portals.iucn.org/library/sites/library/files/documents/2019-047-En.pdf
[129] https://portals.iucn.org/library/sites/library/files/documents/2019-047-En.pdf

regional action will reduce costs, that is, bring economies of scale, and enhance benefits from investments (win-win solutions), and also because country-level activities tend to have a narrower focus, have different prioritization and can create risk of dispute[130].

The sectors involved are: sectors of navigation environment (protection and revitalization), flood protection and drought preparedness, tourism, agriculture, and hydropower. The first phase of SDIP (2020-2026) includes investments in flood protection and the preparation of integrated investments. In the second phase, the integrated investments (2023-2030) will be implemented in navigation and flood protection (core items), but also investments in hydropower optimization, environmental improvements, recreation, and tourism are included[131]. Both phases will support water cooperation at different levels, including through a regional plan for eco-tourism.

Box 13. Landscape Advisory for basin planning and facilitating private sector investments (various river basins in Asia)

****THIS CASE STUDY TEXT IS UNDER REVIEW***

The International Finance Corporation (IFC) deploys Landscape Advisory initiatives in various river basins including the Trishuli River Basin in Nepal (transboundary with the Tibet Autonomous Region in China) [132], Sekong River Basin in Lao PDR (transboundary with Cambodia and Vietnam); Myitgne River Basin in Myanmar and Jhelum Poonch River basin in Pakistan (transboundary with India).

Sectors that depend on the presence of natural resources tend to be geographically concentrated (e.g., hydropower, wind and solar power, agribusinesses), collectively affecting the same environmental and social receptors (e.g., communities, biodiversity, human rights, water, security). The standard approach of assessing risks and impacts through a project lens is inherently limited when companies are operating in proximity. Moreover, companies may not readily share data or collaborate on assessments, leading to a duplication of efforts and difficulties in monitoring (as data collection methods are often variable). Addressing key environmental and social issues at the stage of environmental and social impact assessment, is often too late for effective management, especially when operating in sensitive environments. Instead, acting earlier in the developmental process, these risks can be identified earlier and addressed before decisions are made and difficult to change (e.g., the siting and location of infrastructure). This helps to avoid impacts and the need for high-risk, costly mitigations (e.g., offsets) and may also reduce the chances of unexpected delays arising from stakeholder concerns.

When operating in complex environments such as across landscapes within a river basin, environmental, social and corporate governance challenges go often beyond the ability of one company to tackle them by itself. IFC's tries to define what the private sector can do better and cooperate with the government/public sector, other developers in the landscape and with NGOs to coordinate these efforts.

In many cases, there is a barrier to investment when no single entity has the ability, leverage and technical know-how to convene multiple stakeholders to collectively address risks and impacts and define solutions. In Landscape Advisories, the IFC been moving to not only assessing risks but trying to develop 'joint management ' options.

Box 14. Integrating the nexus approach in GEF-IW projects (Latin America)

[130] https://www.iawd.at/files/File/dwp/media/Events/2018/EC_WB_Water_Day/11._Javier_Zuleta_and_Igor_Palandzic_the_Sava-Drina_corridor_initiative.pdf

[131] https://www.thegef.org/sites/default/files/web-documents/10553_IW_WB_PID.pdf

[132] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_report_cia-trishuli

****THIS CASE STUDY TEXT IS UNDER REVIEW****

Global Environment Facility (GEF) proposes a two-steps process to address environmental issues in shared freshwater bodies, the Transboundary Diagnostic Analysis (TDA) and the Strategic Action Programme (SAP). TDA is a rigorous diagnostic of the issues aimed at mapping the root causes that needs to be addressed. The SAP contains those actions. It is a document that gets adopted at ministerial level. The GEF projects typically involves the establishment of inter-ministerial committees.

The GEF promotes the use of the nexus approach in its strategy, without prescribing a specific methodology. However, the GEF-IWLEARN platform offers services and access to tools. In the TDA, the use of a nexus approach means complex analysis of interlinkages. The scientific and policy-related information may be available from different sources, but it is crucial to analyse the interlinkages, e.g. through integrated modelling.

The SAP provides a relevant cooperation framework of implementing nexus solutions through concrete projects, as it constitutes a solid commitment from the countries in a comprehensive framework that includes monitoring, policy reform and investments. What can be achieved in practice is influenced by how and to what degree the relevant economic sectors are engaged in the process.

The three following examples of GEF IW projects in Latin America integrate the nexus approach in their design[133]:

Amazon (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela)
SAP formulation was participative, with technical authorities but also representatives from the countries, including the Ministries of Foreign Affairs. Relating to infrastructure in the TDA and the scope turned out divisive, because there are issues of competing uses. This required more resources to organize inter-ministerial dialogues to discuss nexus, to solve these issues and to address critical aspects of climate action SDG 15 and resilient infrastructure SDG 9. The process is starting soon and is led by the Amazon Cooperation Treaty Organization (ACTO).

Pantanal (Brazil, Bolivia, Paraguay)
The TDA and SAP documents had initially developed only for Brazil, in 2004. Today they are being revised expanding the scope to cover the three countries. The use of the nexus approach is seen as critical to untangle complex cross-sectoral and upstream-downstream issues in the basin, and to make the SAP a solid portfolio of cross-sectoral projects. While there was initial hesitation from the side of the countries to use the nexus approach because of its complexity, its adoption was also a way to align to the GEF strategy and therefore access GEF funding.

Trifinio (El salvador, Guatemala, Honduras)
Many data available from previous studies. Tackling environment problems requires complex analysis of interactions and UNEP suggests using the nexus approach for TDA and SAP formulation in a view to switch from science to policy across sectors.

Box 15. Prioritizing water sector investments looking at impact and returns (Lower Syr Darya)

[133] Virtual event organized by UNECE in cooperation with the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the Inter-American Development Bank (IDB) on 22 February 2021. More information at : https://www.water-energy-food.org//news/nexus-blog-virtual-meeting-of-experts-on-policies-of-the-water-food-energy-ecosystems-nexus-and-projects-of-transboundary-relevance-in-latin-america-and-the-caribbean-lac

In planning for water investments, the challenge is to allocate limited resources so that to get maximum net benefits for the country and the broader region. IWRM needs to include, or be complemented by, an integrated investment planning and a benefit-sharing mechanism across sectors and potentially riparian countries. Furthermore, investment planning for water infrastructure should be based on bold hydro-economic analysis, including the assessment of net benefits, losers and winners between and within affected sectors (argi-food, energy, water) and countries, and of affordability issues.

The Organisation for Economic Co-operation and Development (OECD) supported the government of Kazakhstan in planning for Multi-Purpose Water Infrastructure (MPWI), starting from the Shardara reservoir as a pilot case study. This reservoir was initially built for irrigation, and later upgraded to provide hydroelectricity generation, flood control, commercial fisheries and support to livestock. In the future, it should support recreational activities too. The site area, like the Lower Syr Darya as a whole, suffer lack of irrigation water in dry years. Agriculture is characterized by low water efficiency and salinity problems due to the lack of collector-drainage systems. OECD considered the impact of several possible interventions in the Shardara MPWI to improve water productivity (with the final goal to improve water, energy, food security in the country and region)[134]. The key recommendations was that investing in agriculture productivity (improving drainage and refurbishing canals) as a priority compared to on-farm water efficiency measures (drip irrigation) that, for the moment, have a small impact and lower return on investment.

Box 16. Innovative financing for water-energy nexus solutions (Jordan)

Jordan's As-Samra Waste Water Treatment Plant (WWTP)[135] is an example of public-private partnership (PPP) for a project providing benefits to water, energy, agriculture, and environment. It is the first WWTP in the Middle East that is using a combination of private, donor, and local government financing. This is true for both phases of the plant and is proof of the advantages of simultaneously using both private sector financing with grant funding in a scheme known as Viability Gap Funding. The As-Samra Wastewater Treatment Plant is therefore an example not only in terms of the technology/knowledge transfer it has achieved but also in terms of the financing options it has used to achieve them. This unique financing system has also led to an affordable tariff for the community and the country.

The PPP was established to finance the construction and operation of a public infrastructure based on a Build Operate Transfer (BOT) approach, over a period of 25 years. The WWTP brings the following benefits:

- 80 per cent of the energy required for the plant's operations is generated by the plant itself (biogas from sludge, hydropower at the outlet of the plant);
- the treated water is used for agricultural purposes (in the country, it represents about 10 per cent of the water consumption). The entities which reuse this water are thus farmers who irrigate their crops using water from King Talal Reservoir and other farmers located along Wadi Zarqa. Water pollution has also been reduced in Jordan due to the plant.

By making WWTPs self-sufficient when it comes to their energy supply, countries can help make their water supplies more secure, as treated water can be used for more applications, reducing the demand on fresh potable water for some of those applications.

[134] https://www.oecd-ilibrary.org/environment/strengthening-multi-purpose-water-infrastructure-in-shardara-mpwi-kazakhstan_9789264289628-en

[135] United Nations Economic and Social Commission for Western Asia (2017). Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals: Water-Energy Nexus Operational Toolkit, Technology Transfer Module. Beirut. E/ESCWA/SDPD/2017/Toolkit.3. Available at https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/water-energy-nexus-technology-transfer-module-english_0.pdf.

Jordan is one of the leading countries in the region to utilize treated wastewater, reporting that 100 per cent of its safely treated wastewater is being used. The treated wastewater is mainly used by the agriculture sector for irrigation in the Jordan valley and to a lesser extent by the industry. This allows for re-allocation of the freshwater resources that would have been used in agriculture to the domestic sector, without impacting the available irrigation water[136].

6.2 Enhancing basin level coherence of policy actions and plans

The nexus approach to transboundary water management and cooperation can help detect inconsistencies in sectoral and national development plans and redefine priorities[137]. For instance, it can be used to define packages of nexus solutions that are coherent across sectors (reduced trade-offs and improved synergies), as done through participatory process involving the three riparian countries (see Box 17). Similarly, it can help to develop decision-making frameworks to evaluate multi-dimensional trade-offs and benefits with different stakeholder groups, as in the case of the DAFNE project (Box 18 and Box 19). In general, the nexus approach led to several technical assessments and exercises of integrated modelling and co-optimization of nexus resources with a transboundary basin focus, all around the world. These assessments are extremely valuable to support transboundary dialogue, however their impact ultimately depends on policy makers actively engaging in these exercises and considering their results in national policy and planning.

RBOs have an important role to play in coordinating, or participating to, this type of dialogue depending on their mandate (the level of multi-sectoral integration largely depends on the specific mission of the RBO[138]), and influence[139]. To do so, RBOs can coordinate with other regional organizations (e.g. economic commissions or energy regional organizations) for a more effective cross-sectoral outreach and assessment of cumulative impacts of infrastructure projects (green and grey), which is crucial for project sustainability and climate resilience. For instance, an RBO can offer a platform for nexus assessment (Box 20); provide a space for countries to discuss and coordinate on the implications of different-sector developments (notably energy and agriculture) on water and ecosystems (Box 21), support countries to evaluate projects based on the multi-sectoral benefits they provide (Box 22), support countries in mainstreaming sustainable agriculture for the purpose of improved water quality (Box 23) and in developing common guidelines for e.g. hydropower (ICPDR). Clearly, a lot depends on the availability of resources and capacity, as well as on the willingness of countries to use these platforms to discuss strategic policies and investment plans.

These initiatives are crucial for capacity building at different levels (see Box 24). Since problems may have their root causes beyond hydrological changes and climate change (e.g. data limitation, poor management, political economy, poor disaster planning, inadequate institutional arrangements, etc.) it is crucial that local, national, and inter-governmental institutions build the necessary capacity to deal with the complexity of nexus dynamics beyond the prioritization of projects[140].

Box 17. A "package" of nexus solutions (North Western Saharan Aquifer System)

[136] United Nations Economic and Social Commission for Western Asia (2015). ESCWA Water Development Report 6: The Water, Energy and Food Security Nexus in the Arab Region. Beirut. E/ESCWA/SDPD/2015/2. Available at https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/l1500339.pdf

[137] Virtual workshop on financing transboundary cooperation and basin development https://unece.org/environmental-policy/water/events/virtual-workshop-financing-transboundary-water-cooperation-and-basin

[138] See for instance: https://www.water-energy-food.org/resources/a-nexus-for-basin-organisations-in-the-sahel-multisectoral-comparison-omvs-lcbc-nb

[139] Domborowsky, I. and Hensengerth, O. Governing the Water-Energy-Food Nexus Related to Hydropower on Shared Rivers—The Role of Regional Organizations. Front. Environ. Sci., 2018. Available at : https://www.frontiersin.org/articles/10.3389/fenvs.2018.00153/full

[140] Virtual event organized by UNECE in cooperation with the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the Inter-American Development Bank (IDB) on 22 February 2021. More information at : https://www.water-energy-food.org//news/nexus-blog-virtual-meeting-of-experts-on-policies-of-the-water-food-energy-ecosystems-nexus-and-projects-of-transboundary-relevance-in-latin-america-and-the-caribbean-lac

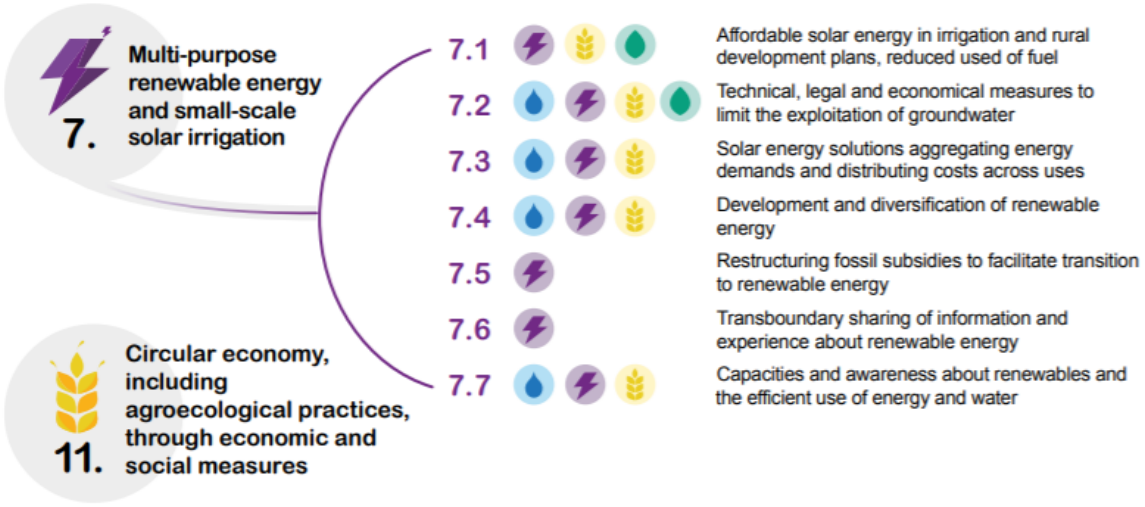
The North Western Sahara Aquifer System, NWSAS (1 million km2) is shared by Algeria, Libya and Tunisia. The aquifer is a critical source of water that supports all economic activities of local populations including agriculture, which is the main source of income for many. The basin is threatened by the degradation and depletion of groundwater resources due to increasing demands and increasing infiltration of pollution from various sources.

The NWSAS nexus assessment (2017-2019) was facilitated by UNECE, Global Water Partnership Mediterranean (GWP-Med), and the Observatory for Sahara and the Sahel (OSS)[141]. The NWSAS Coordination Mechanism, which provides an institutional framework of cooperation between the countries, supported the process. The main output of the participatory process was a "package of solutions", jointly developed with the countries, to be implemented through cross-sectoral cooperation. The objective of implementing the solutions in synergy is to enhance the impact of sectoral actions and ensure their overall coherence towards common objectives of sustainability and development in the basin. Implementing a nexus approach in the NWSAS can realize a broader range of benefits of cooperation across different sectors and through regional economic cooperation[142].

The package of solutions includes several actions, some of which have already at least partially been implemented, and in fact the experience of the countries influenced the development of the package. The example below illustrates the synergy between an energy-sector led and an agriculture-led solution (nr 7 and 11 of the "package" illustrated below), which implementation at the level of actions requires coordination with the water and environment sectors.

Because of the policy coherence embedded in the coordination of sectoral actions, and the way they can be 'packaged', the nexus solutions can be used by the countries to:

- draft proposals to international donors interested in financing sustainable development or environmental and climate funds;
- better coordinate the implementation of water, energy, and agricultural policies and projects that have intersectoral impacts.



[141] UNECE, 2020. Reconciling resource uses: Assessment of the water-food-energy-ecosystems nexus in the North Western Sahara Aquifer System. *Policy brief* Available at : https://unece.org/DAM/env/water/publications/WAT_NONE_16_NWSAS_Nexus/NWSAS-UNECE_EN_Web.pdf

[142] UNECE, 2020. Benefits of strengthening transboundary water cooperation in North Western Sahara Aquifer System shared by Algeria, Libya and Tunisia. Policy Brief. Available at: https://unece.org/environment/press/policy-brief-highlights-benefits-strengthening-transboundary-water-cooperation

	Water	Energy	Food	Environment
Governance and international cooperation	1. Enhance local water management, including revitalising participatory models in oases and enhancing the enforcement of existing laws on water conservation. 2. Reinforce transboundary cooperation for sustainable groundwater resource management.	6. Enhance mechanisms for the coordination of energy development with other sectoral plans, to anticipate trade-offs and build on intersectoral synergies.	9. Set up agricultural policies oriented towards rational, sustainable, and productive agriculture. 10. Valorise local products and strengthen programmes for a more balanced diet while involving young people and women in the economic and social development of the oases.	13. Increase awareness of the trade-offs and synergies between different sectors in public institutions.
Economic and policy instruments	3. Set up dedicated policies and related incentives for wastewater reuse in agriculture and urban areas. 4. Strengthen water demand management, including through water-saving programmes.	7. Develop a sustainable programme for diversified, multipurpose renewable energy and sustainably upscale small-scale solar irrigation.	11. Promote the circular economy including agroecological practices, through ad hoc economic measures and social instruments.	14. Consider environmental needs in the water balance of the aquifer.
Infrastructure and innovation	5. Upscale the use of non-conventional water resources through desalination and wastewater and drainage treatment.	8. Improve the reliability of the electricity grid in rural areas, thereby enhancing the integration of renewable energies for remote and multiple uses.	12. Enhance innovative practices and techniques for sustainable soil and crop management and invest in their upscaling and dissemination.	15. Systematise environmental and social impact assessment for all new infrastructure (large and small scale).

Box 18. Multi-stakeholder dialogue at transboundary level (Zambesi)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

The Zambezi River Basin (Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe) is the largest river basin in the Southern African Development Community (SADC).

The DAFNE research project was established to explore the water-energy-food Nexus in complex transboundary water resource systems of fast developing countries[143]. By taking a multi- and inter-disciplinary approach to the formation of a decision analytical framework (DAF) for participatory and integrated planning, the project aimed at the evaluation of decisions based on social, economic and environmental needs.

There are challenges with optimally integrating diverse water uses (hydro, environment, agriculture) in a climate-variable and transboundary context. The project delivered recommendations to the countries,

[143] DAFNE is an EU funded "Horizon 2020" project implemented in the Zambesi and the Omo-Turkana Basin (Ethiopia) -Information available at: https://dafne.ethz.ch/

drawing from the principles of international water law and WEF Nexus as pathways to achieve the SDGs. The study illustrates how using the lens of multiple sectors can give greater 'substance' and clarity to legal provisions and SDG integration.[144]

Box 19. e-Nexus integrated decision support tool (Mekrou, Senegal)

****THIS CASE STUDY TEXT IS UNDER DEVELOPMENT****

- The Mekrou River a tributary of the Niger River; shared by Benin, Burkina Faso and Niger.
  - Hydro-agro-meteorological models developed by the JRC in the frame of the project in collaboration with the technical services and national research institutions.[145]
  - Supported by a Cooperation Framework Agreement of cooperation for the promotion of political dialogue and sustainable development of the Mékrou basin signed by the riparians (2016)[146]
- The Senegal River (Guinea, Mali, Mauritania, Senegal)
  - Analysis to assess the availability of agricultural residues to help meet energy demand from a WEFE Nexus perspective; Optimization of bioenergy productivity taking into account Food demands for households, Energy demand, Livestock demands, irrigation demand.

Box 20. RBO facilitating a nexus dialogue across countries (Sava)

****THIS CASE STUDY TEXT IS UNDER DEVELOPMENT****

- This case study refers to the Sava nexus assessment under the Water Convention[147], which was implemented with the support of the International Sava River Basin Commission.
- The ISRBC is an RBO with a well-established network.

Box 21. RBO advising on the positive and negative impacts of basin development pathways (Mekong)

The Nexus assessment approach has been applied in the Mekong for many years. The latest example is the design and implementation of the major Study on Sustainable Development and Management of the Mekong river basin[148], including the impacts of hydropower project (5 years, 5 million US dollars, completed in 2018). The study looked at all water related sectors of the Mekong - irrigation, hydropower, navigation, flood, drought, water supply - and assessed their possible development impacts across a range of indicators in the environmental, social, economic and climate areas. The result is that there were synergies as well as trade-offs in the national plans of the countries.

The study's findings as well as other studies were extensively discussed and provided inputs to the update of the Mekong Basin Development Strategy 2021-2030[149], which has been endorsed by the Mekong governments. The Strategy takes into account the current developments in the various sectors, illustrates the implications of development options (including notably energy and agriculture), and suggests possible nexus solutions. The MRC actively participates with other regional organizations in the identification of such solutions, both at technical and policy level through more regional integration. For instance, as part of the "Strategic Priority 3: Enhance optimal and sustainable development by increasing

[144] https://uploads.water-energy-food.org/resources/ZRB_Policy-Brief_Aberdeen-University_2020.pdf
[145] https://ec.europa.eu/jrc/en/science-update/mekrou-project-promoting-sustainability-m-krou-basin
[146] https://www.gwp.org/en/GWP-West-Africa/WE-ACT/themes2/PROJET-MEKROU/Activites--Actualites/Mekrou-Basin-the-three-countries-sign-the-cooperation-framework/
[147] https://unece.org/environment-policy/publications/reconciling-resource-uses-transboundary-basins-assessment-water-3
[149] https://www.mrcmekong.org/assets/Publications/BDP-2021-2030-SP-2021-2025_Final.pdf

regional benefits and decreasing regional costs", there are activities on "proactive regional planning" which aims to come up with basin-wide and joint investment projects with multiple purposes (energy, flood, drought, navigation) and "Assess alternative cost-effective regional energy/water system integration options (e.g. floating solar with hydropower, seasonal storage, etc.) within the context of broader energy sector plans including solar and wind and as informed by comprehensive regional options assessment(s) by countries and other regional actors (ASEAN, GMS, etc)." It can be noted that innovative technologies like floating solar already exist in the different countries (applied in Thailand, considered in Cambodia and Lao PDR) and basin coordination can enhance their sustainable upscale.

Despite this effort, there are challenges in the implementation of this cross-sectoral strategy. On the one hand, there is some resistance to new ideas, and on the other the water and environment sector sometimes lack the necessary influence (compared to the energy sector, industry, etc.) to affect political economy decisions at high-level. Strategic support to the MRC and riparian countries from trusted partners can make a difference in successfully contribute to the implementation of the Strategy.

Box 22. RBO applying a nexus criteria for development projects (Niger river basin)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

Resource security in the Niger River Basins (Guinea, Mali, Niger, Côte d'Ivoire, Burkina Faso, Benin, Nigeria, Chad and Cameroon) is a concern for the riparian countries. Of the 160 million people living in the basin area, 60% do not have access to safe water and only 20% have access to energy. 70% of agriculture is rainfed and only 20% of the estimated hydroelectric potential is exploited. On this basis, the Shared Vision of the NBA (ratified by the heads of state) is to apply integrated management of water resources and associated ecosystems to improve living conditions and prosperity by 2025.

A major challenge for the Niger Basin Authority (NBA) and its 9 Member States is the overall coherence of the basin development and management of infrastructures. Planned projects include very large multipurpose dams (> 1billion m3) supporting irrigation, hydropower, low flow support. There are 6 existing ones (Mali, Nigeria, Cameroon), 1 under construction (Niger) and 2 future ones (Guinea, Mali). Even if each project proposal, taken by itself, is multi-purpose, it is not clear how do they relate to each other and if they compromise each other.

To fill this gap, the NBA is integrating the nexus approach into its Operational Plan (OP) and investment portfolio. This is done through participative mainstreaming covering 350 projects and 250 climate actions (among green and grey infrastructure on water and land, and ecosystem-based adaptation, including in humid zones and forest areas), multi-sectoral planning, standards and indicators, and fundraising. This "nexus criteria" for the selection of projects is applied at three different levels:

- Conception of projects in national context (inter-ministerial consultation)
- At project implementation level (with local communities)
- Pre-feasibility studies for attracting financial support.

The Plan as a whole for a total cost of US$ 7,2 Billion over the period 2016-2024[150].

The NBA is confronted with challenges related to the geopolitical and economic context in the basin, which is complex, and water regulation, poorly applied in the countries (inadequate institutional arrangements and mechanisms, and inadequate institutional capacity). A Permanent Technical

[150] https://unece.org/fileadmin/DAM/env/documents/2020/WATER/10Oct22-23_TF_Nexus/Presentations/Item_5_Mr_Guero_NBA__Eng_.pdf

Committee within NBA could be established to overview the coordination of water management and regulations.

Box 23. Sustainable agriculture for improving transboundary water quality (Danube)

****THIS CASE STUDY TEXT IS UNDER REVIEW****

Sustainable nutrient and drought management are highly challenging issues in the Danube River Basin (DRB) and need to be addressed. Agriculture is an important component of the economy in many Danube countries since the geographical and climatic conditions in large parts of the Danube River Basin (DRB) are favourable for agriculture. Although agriculture is substantially subsidized by the EU and the national governments, the sector is facing socio-economic challenges. In many regions the intensity of agricultural production is low due to the less favourable economic situation. In areas where land productivity is low, farmers are often facing difficulties, as agriculture in these regions may not be competitive at all. In many Danube countries, there is a significant number of small farms working on a few hectares, which are highly depending on EU or national subsidies and often subsistence farms and have limited capacity to comply with strict and ambitious cultivation provisions.

Water-related environmental concerns are also related to agriculture. Nutrient pressure from agricultural diffuse sources could increase and affect the status of surface waters, groundwater and the Black Sea. In the context of climate change, the duration and magnitude of drought events are forecast to be increasing in summer months. Such extreme weather conditions could trigger serious water scarcity issues. The International Commission for the Protection of the Danube River (ICPDR) as the coordinating body for transboundary water management in the DRB is committed to assist Danube countries with addressing these challenges.

In line with the EU-initiative of aligning water and agricultural policies in the new Common Agricultural Policy (CAP), the European Green Deal and its relevant strategies and ambitions, the ICPDR launched a dialogue with the agricultural sector aiming at the development of a guidance document on sustainable agriculture. The guidance will offer Danube countries support for the preparation and implementation of the national agro-environmental policies, CAP Strategic Plans and relevant strategies of the River Basin Management Plans. It will provide a consistent policy framework with a set of recommended instruments and tools to facilitate national water and agricultural decision making and to identify common goals, set up tailor-made policies and implement joint actions and cost-effective measures.

Box 24. Valuing shared ecosystems to benefit local communities (Lake Titicaca)

****THIS CASE STUDY TEXT IS UNDER REVIEW***

7. Conclusions and recommendations

7.1 Conclusions

The report illustrates the findings from a stock-taking of nexus solutions and investments around the world, mostly from the perspective of water institutions. There is an increasing recognition of the potential value of coordination and integrated planning across sectors, even though obstacles to practical achievement can be significant. The study has been motivated by a need to assess the experience and – despite an emerging knowledge base – by seemingly a lack of convincing examples as well as a need to address a range of related questions, some highly context-specific.

The case studies considered in the report come from a survey, a review of literature, and further input from expert consultations and a review of regional nexus dialogues. The information emerging from survey and literature was subject to a range of quantitative and qualitative analyses to find common features and trends in terms of problems and solutions (considering survey and literature), financing sources and schemes, obstacles to implementation and enabling factors, as well as perceived added value, benefits (only survey, which provided more detailed information). Despite the ambition to reach out to a greater diversity of respondents, also from economic sectors, the survey reached mostly stakeholders from the Water Convention, BRIDGE project networks and the GEF International Waters projects. The further experience collected from expert consultations and regional nexus dialogues were considered only if they had a relevance (at least potentially) for transboundary water management.

The conclusions are mostly illustrative of the experience of water institutions concerned with transboundary issues and this responds to the need of taking stock of experience that is relevant for the main audience of this report. However, it should be noted that this experience does not fully reflect the potential of initiatives from other sectors (e.g. technical solutions for water and energy efficiency in industry, nexus solutions in urban settings, small scale investments in sustainable agriculture and forestry, etc.) that can be applied and upscaled in transboundary basins. More far reaching intersectoral actions may be possible at local and national levels while indeed such actions could be extended, also in terms of impact, and shared experience about at the transboundary level. At the regional level, notably in relation to regional energy planning, there may be opportunities for basin organizations to provide a forum for discussing water needs of planned developments and potential impacts on water resource or bring a common voice to those discussions. Solutions by economic sectors and other resource management domains would certainly help to provide a more complete picture of the possibilities.

There are clear ways forward to further uptake and upscale nexus solutions and investmetns in transboundary basins: through basin level action plans (e.g. the Strategic Action Plan of the Drin, which includes energy, forestry, and agriculture related actions), through coordinated strategies and investment plans (e.g. the Mekong strategy, that promotes the upscale of non-hydro renewables, or the NBA approach to the evaluation/revision of projects using nexus criteria), or even in specific projects (e.g. the ITAIPU hydropower plant, that also provides for the protection and amelioration of land ecosystems surrounding the reservoir).

Emerging trends from the analysis

Looking at the experience gathered through the survey and literature, it emerges that where the nexus concept is understood, or where constraints on its adoption are minor, a nexus approach is useful to tackle multisectoral problems. It should be noted that intersectoral actions of relevance are not necessarily recognized as “nexus solutions” and indeed the understanding of what constitutes such a solution varies greatly. Some solutions submitted in the survey may have a conservation focus within a basin but still aspire for greater involvement of and action from the side of economic sectors.

The typical problems tackled by means of a nexus approach in the case studies analysed relate more often to water quality and environment rather than to water quantity (availability, variability), even though "anthropogenic change in hydrology" is the most common root cause reported. However, looking at experience beyond the survey it emerges that there is a strong support to the application of a nexus approach to water investment planning from the side of regional organizations (notably RBOs) and financing institutions to solve water quantity related problems. Clearly, the perspective taken in this study is that of water and environment, and to some extent energy (hydropower), however more integrated solutions and investments also come from the energy and agricultural sectors, indicating that there is a common interest in cross-sectoral coordination to reach sustainable development goals, and climate action in particular[151].

In the basins considered, problems ultimately arise from anthropogenic causes related to water and land management, with climate change in some cases adding significant pressure. Institutions often lack the resources and capacity to tackle these complex issues, ensure appropriate cross-sectoral coordination, collect adequate data and share information, and ultimately attract and channel the necessary investments. Understanding how the financing of nexus/multisectoral projects works in practice within water institutions might be limited, and indeed the attention to multisectoral solutions is rather recent. This risks being a major capacity gap that could prevent such institutions from identifying (or coordinating) bankable cross-sectoral projects. Mandates might also limit such opportunities, and an important question may therefore be what kind of partnerships and modalities would best support the implementation of cross-sectoral projects.

Success factors and added value of nexus solutions

There are examples of cross-sectoral cooperation with transboundary benefits from all regions. These "nexus solutions" are operationalized through international cooperation, governance, economic and policy instruments and infrastructure and innovation.

The highest-ranking enabling factors in the implementation of these solutions are stronger transboundary cooperation, shared data and information, increased awareness of options and benefits for cross-sector, transboundary trade-offs, compromise and synergies, and innovative infrastructure operating rules (though there are many others). These enabling factors largely depend on the institutions themselves, in the sense that it is the institutions who are best positioned to create an enabling environment for nexus solutions.

Interestingly, many of the challenges to implementation that emerge from the study also relate to institutions. These are politics, data and information shortcomings, inadequate institutions, financial constraints, persistent policy/sector silos, limited technical capacity, limited time frames and limited options for benefit-sharing.

The respondents to the survey perceive the "added value" of a nexus approach as relating to the effectiveness of institutions in managing basin issues, rather than to the delivery of benefits in terms of resource and regional security and economic efficiency. This means that the economic and non-economic benefits of nexus solutions are still unclear, and this makes it difficult to catalyse the resources necessary to operationalize solutions into concrete projects. In transboundary basins, where investments are generally associated to high risk (compared to national investments), a lack of clarity on the benefits of cooperation

[151] Nexus initiative of global relevance include International Energy Agency (https://www.iea.org/topics/energy-and-water) , the International Renewable Energy Agency (https://www.irena.org/publications/2015/Jan/Renewable-Energy-in-the-Water-Energy--Food-Nexus), the Food and Agriculture Organization of the UN (http://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/421718/).

further reduces prospect of funding opportunities[152]. More needs to be done to clarify these benefits by sharing knowledge and experience[153].

Financing nexus solutions and investments

For now, most of the financial resources used to implement "nexus solutions" come from the state (including donor financing), even though it is recognized that the nexus approach opens up clear opportunities for more private and blended finance though "green" investments in agriculture, energy, tourism, etc. The delivery pathway is also important. Based on the study, for example, there seems to be a correlation between infrastructural measures and adaptable programmatic financing, where funds are allocated to a programme (for example, modernization of irrigations systems in a river basin) without connection to a specific project.

Water- and environment-related problems need to be effectively tackled across sectors, and this may require significant financial resources. Without effective cooperation, there is a high risk of economic sectors finding their own solutions to solve the immediate problems without a common vision of sustainable basin development, which is a missed opportunity for water management and environment protection to receive concrete benefits from these interventions. By designing solutions and planning investments together (across sectors), water institutions could catalyse the implementation of well-integrated solutions that are both environmentally more sustainable and bankable.

The study shows that financing institutions are increasingly concerned with the coherence of multiple projects in transboundary basins, and there are examples where they provided technical support to countries to prioritize or review projects taking into account their cross-sectoral and transboundary impact. Coordination - not just on investment plans but also on data and monitoring, Environmental Impact Assessment and Strategic Impact Environmental Assessment processes, or other social and environmental safeguards frameworks - is particularly important to de-risk investments of regional importance. Ultimately, the political will to cooperate and coordinate on long-term sustainability (economic, environmental, social) is reassuring for investors to engage, including private ones who need structured financing schemes and can help closing financial gaps.

Regional experiences

Regional nexus dialogues focusing to transboundary water management have been organized in several regions of the world across the African, Asian, American, and European continents. In general, these dialogues are informed by technical studies that address cross-sectoral impacts and implications of development, and climate change. Despite differences, ultimately all these dialogues aim at the operationalization of nexus solutions and investments. The latest nexus assessments under the Water Convention supported the joint identification of coordinated actions (e.g., the "package of solutions in the NWSAS) and the identification of projects of transboundary benefits (South East Europe: Drin and Drina). The Nexus Dialogue Programme funded by EU and implemented by GIZ (global programme that implemented dialogues in MENA; Central Asia, LAC, Southern Africa, Niger River Basin) is now focusing on the mobilization of finance for nexus projects. In different regions, there are examples of IFIs taking the lead on the analysis of nexus dynamics (to support countries in the identification of needs and/or project prioritization, e.g., the Sava-Drina Corridor) and proposing sustainable financing schemes that involve nexus sectors (e.g., the Trifinio water fund).

[152] Blue Peace Voices. *Is finance the final frontier to ensure long-term benefits from transboundary cooperation?* Available at : https://www.thebluepeace.org/blue-peace-voices-final-frontier

[153] IUCN (2019). Increasing returns on investment opportunities by applying a nexus approach: Best practice nexus case studies. Belgrade, Serbia: IUCN.

The role of River Basin Organizations

Depending on their specific mandate and influence, RBOs have an important role to play in coordinating, or participating to, nexus dialogue. Crucially, by coordinating with other regional organizations (e.g., economic commissions, organizations for energy integration, etc) RBOs can play a key role in facilitating the cross-sectoral dialogue that is needed to develop water infrastructure (grey and green) in shared basins. This means that their contribution can be vital to develop master plans that are "nexus proofed". Examples illustrate how they can provide a platform for nexus dialogues (the ISRBC), a space to evaluate projects and their overall coherence (the MRC), and a source of common guidelines for sustainability in sectoral policies that have implications on shared waters (e.g., ICPDR on agricultural practices, sustainable hydropower). However, a lot depends on the availability of resources and capacity, as well as on the willingness of countries to use these platforms to discuss strategic policies and investment plans.

Possible use of the findings on nexus solutions and investments

The outcomes of the stocktaking exercise establish an important knowledge base that would be beneficial to further improve. In fact, some important questions that would make the stocktaking a useful "resource" for countries and basins, still require further clarity:

- Who should (or who can) develop nexus solutions and how? What are the costs and benefits associated with them (and, in particular, their economic added value)?
- What type institutional frameworks (particularly in transboundary basins) are needed to support the implementation of nexus solutions?
- What financing sources are available to support multisectoral programmes or projects of transboundary relevance?

The questionnaire and surveying

Looking beyond the synthesis report, a broader and more diverse stocktaking of nexus solutions and investments, concretely expanding the survey to include more basins and a wider range of stakeholders, would help in drawing conclusions regarding the types of solutions and cross-sectoral cooperation that have effectively tackled basin issues. The greatest benefits lie in the extension of outreach in the following directions:

- Beyond the basin scale: unlike integrated water resources management, the nexus approach is not scale-specific, and looking "beyond the basin" can help in capturing relevant nexus solutions that indirectly provide transboundary benefits.
- More towards water-using economic sectors: despite its "nexus intention", the study largely focused on watershed, rather than "cross-sectoral", issues. Although the choice of deriving the most typical problems from the experience from transboundary diagnostic analyses ensured that the solutions were relevant for institutions concerned with water management, it also meant that important issues related to other sectors were only indirectly considered (among the "root causes" and among the "factors of success in the implementation").
- Beyond the group of stakeholders concerned with institutional support: the findings so far indicate a surprising lack of case studies related to infrastructure, be it green or grey.

Further development and use of the questionnaire would help to capture more details about trade-offs, synergies and compromise and about the knowledge, attitude and perception of stakeholders with respect to nexus – especially among development partners, national Government and river basin organizations. The questionnaire could be further used, for example in different regions, for analysing in more detail how cross-sectoral solutions and investments help in addressing issues in transboundary basins. This could

support identification of specific opportunities and operationalization of nexus solutions, in the framework of transboundary or regional intersectoral strategies. In some of the regions where nexus assessments have been carried out, such documents are being developed, in some cases complementing strategic action programmes (for example Global Environment Facility International Waters).

Regional planning and strategic documents

In the framework of the Global Environment Facility International Waters, trade-offs in the "Water–Food–Energy–Ecosystem Security Nexus" have been recognized among challenges related to the implementation of strategic action programmes (SAPs). Identifying nexus investments, including to reinforce strategic action programmes, and broadening partnerships for joint action with other sectors and for investment, can consolidate and synergize efforts for a greater impact. Regional nexus dialogues supported by various organizations (for example, the European Commission, the German Agency for International Cooperation, the Global Water Partnership and the Organization for Economic Cooperation and Development), could also potentially benefit from building on the synthesis report, by considering possible application of the framework for nexus solutions and investments developed for the analysis described in the present document.

7.2 Considerations for policy action

Determining root causes of the problems in transboundary basins is key, and nexus dialogues can take policy makers a step further, helping to act upon them. Policies may need to be adjusted and regulation may need to be revised, which requires time and effort but is necessary to ensure coherence towards sustainable development. Some beneficial upgrading of capacities could come through learning by doing, exchange, sharing, and bridging the sectoral challenges.

Clearly, not enough investment in water is happening, however there are unexplored or underexplored opportunities that may come from coordination and partnering with other sectors, including across the borders. To benefit from such cross-sectoral financing opportunities, political will is crucial and high-level policy makers as well as non-line ministries (e.g., finance, economy) need to be convinced.

The review of existing programming frameworks to improve them, including in terms of jointly defined priorities, is possible and timely. The COVID-19 pandemic and recovery process -with the changes in the use of natural resources and the economic outlook; sustainable development, green and circular economy objectives; as well as climate action commitments - have already prompted some review of programming, and the space for transboundary and multisectoral actions and investments could be further enlarged.

The insights from the stocktaking exercise may help governmental authorities and other actors to better understand the potential of the nexus approach and to take the next steps where intersectoral solutions have been identified but their operationalization has turned out to be challenging, or where they can unlock transboundary basin issues through water authorities engaging with economic sectors.

Water management and environment policy makers

There are opportunities in applying a nexus approach to natural resource management in transboundary basins and to coordinate national policies to design and implement nexus solutions and investments using strategic documents (e.g., through SAPs). Among the major obstacles to implementation are those related to capacity and financial resource gaps, as well as political will to cooperate. Regional experiences show that international organizations and financing institutions are stepping up technical support, capacity building activities, facilitation of political dialogue and identification/nexus proofing of projects.

The nexus approach opens an opportunity to leverage finance for investments on water and environment, but this requires clarity about where these needs meet other sectors' needs and interests, and where the

common ground for scoping proposals is. Working on improving the bankability of projects and the coherence within investment portfolios (at national and international level) is also required. Climate action (e.g., NDCs, NAPs) as well as activities aimed at environmental protection, require close inter-sectoral coordination and benefit from the prospect of co-financing for multi-sectoral projects or sectoral projects within a coherent programme (across sectors, across countries).

Energy and agriculture policy makers

Energy and agriculture are the major water users and need to take a proactive role in proposing solutions and investments that integrate consideration of water and the environment. All forms of generating energy require water, agriculture is the biggest water user of all sectors. Ensuring an effective management of risks, possibly also related to other sectors' potentially competing water and land use, benefits from early stage (strategy, policy) consultation and coordination with water and environment authorities. This helps to avoid delays and controversy in later stages.

Innovative energy and agriculture/forestry solutions have a great potential to generate cross-sectoral benefits. However, they are designed at sub-national or national level, implying that their potential contribution to tackle the most pressing issues in transboundary basins or to generate transboundary benefits is often unclear. Yet, river basin organizations and regional cooperation frameworks could provide for coordinating, upscaling and exchanging experience about such solutions.

More energy and agriculture-led nexus solutions and investments in transboundary basins would significantly increase opportunities for cooperation across riparians and the potential for water-energy and water-agriculture/forestry solutions and investments (also through innovative financing solutions and/or co-financing). Even when the don't' provide immediate co-financing opportunities, efficiency and sustainability solutions in project design translate into economic benefits in the long term. Conversely, uncoordinated actions to solve specific problems (e.g., water use efficiency) may fail to solve the issues at stake at larger scales. For this reason, it is crucial that sectoral policies and investment plans are evaluated against their contribution to national and regional objectives to increase resource security, peace and stability, and sustainability. Such greater planning space can provide for more optimal placement of measures.

Sectoral strategies are more effective if they take into account development alternatives and related trade-offs, sustainability, and transboundary related issues early on in the process. There are many tools available and river basin organizations (where they exist) can play a key role in facilitating the dialogue with the water and environment sectors.

Finance and economy and other non-line ministries

Water and environment may rank low in the priority of countries compared to energy and agriculture, despite the fact that water as a resource and provider of healthy ecosystems, is fundamental to all economic activities and social wellbeing. The nexus approach can be helpful to design integrated packages of investments that make the best use economic of the financial resources available to reach multiple sustainable development objectives at the same time, and - by the virtue of their broader scope – may become eligible for more funding sources.

Programmatic funding is an efficient way to mobilize public and private financing for infrastructural investments (especially if basket funding modalities are possible), circumventing the hazards cited by both the public and private sectors with respect to financing water sector infrastructure. Furthermore, programmatic financing schemes may be better suited than project specific solutions to deliver multiple benefits from a nexus perspective (reducing trade-offs, leveraging on synergies). Particularly in transboundary settings – where sectors are interconnected through water – these schemes can allow

different sectors to co-design nexus solutions taking into account their cumulative social and environmental impact without being constrained by predefined characteristics (e.g., on siting, on the type of solution) that might have been taken previously by different sectors in an uncoordinated manner.

Today, public funding (including from donors) is the main source of nexus investments of transboundary value. However, the nexus approach opens funding opportunities from the private sector that can be leveraged through public-private partnerships, blended finance solutions, indirect support (e.g., through tax incentives), green/blue bonds, and basket funding. There are prospects for designing innovative schemes (including revenue-based models) that leverage private investments for both infrastructure and institutions. These schemes for multi-sectoral projects can be crucial to access climate funds, as well as environmental funds.

This potential is only minimally utilized in transboundary basins where there are more stakeholders to involve. However, the political commitment to coordinate on investments could reduce the perceived risk of investors and unlock new resources. Such engagements by co-riparian countries can reinforce transboundary cooperation, allowing progressively more ambitious joint projects to be negotiated and undertaken.

Actors engaged in transboundary water cooperation/ conflict prevention

Understanding the interlinkages between water, energy, land/food and environmental resources can open crucial opportunities for cooperation benefits that can reduce tension. Going further, nexus solutions might be of great help in trust building and conflict prevention.

Therefore, insights about the nexus issues and solutions can help devise actions that reduce pressure on shared water resources through acting on economic sectors using water or impacting on waters. Such actions can reduce tension in co-riparian (or aquifer sharing) relations.

Trade relations influence on how resources are used, their potential developed and related benefits shared. As production of many important agricultural goods requires land and water endowments, trade can be a strategic means for obtaining water intensive products. Nevertheless, also related vulnerabilities also need to be considered.

Engagement of economic sectors in an intersectoral transboundary dialogue about sustainable development in a transboundary basin or about other common objectives improves mutual understanding about problematic issues. It can also help uncover unconventional solutions for what water management or allocation struggles to solve. A perspective of discussing investments benefitting all the riparians and multiple sectors can provide the necessary motivation for crucial first steps in a process.

Annex 1 Questions, definitions, and criteria

Table 8 Questions, definitions and criteria

QUESTION	COMMENT/CLARIFICATION	DEFINITION ARISING	CRITERIA
What are the common problems in transboundary basins?	In the context of this study, the problem has to involve the management and/or exploitation of transboundary waters. There may be a range of root causes and these could include: • resistance to new ideas • policy silos and linear thinking • political economy(ditto) • donor-drag (ditto)	Quantitative and/or qualitative phenomena that are transboundary in cause and/or effect. The phenomena can be natural or anthropogenic in nature and could be seasonal.	For consideration by the study: • the problem must have been encountered in more than one instance and ideally in in more than one location in more than one basin/region; • more than one of the sectors must be involved either as a cause or a victim of the problem.
What are categories/typologies of solutions?	This is effectively answered by the declared wish of UNECE to work as much as is meaningful with the pre-existing "5I" concept. The adaptation of this concept for use as the Objectives Axis of the analytical framework is explained in sub-section 2.3.2.	For the purpose of the study, a solution will be understandable as an objective of some sort.	For consideration by the study, a solution will be captured by one of the following "Mezzanine[154]" objective clusters: • international cooperation • governance • economic policy and instruments • infrastructural innovation
What are common trade-offs and synergies, across sectors and countries?	In his previous nexus work, the Consultant has also included compromise as a nexus option.	For the purpose of this study: • a *trade-off* means that a preferred objective is traded for another • *a compromise* is a result which is less than perfect for one or more stakeholders, but is accepted by all involved • *synergy* occurs when one intervention covers multi-sector objectives Trade-off and compromise will always have winners and losers whereas with synergy, everyone is a winner.	For the purpose of this study, a solution must be either a trade-off, a compromise or synergistic.
What are the benefits of cooperation that can motivate it (and that can be used for communication and advocacy)?	This clearly a fundamental output of the study. But it is an interesting question. This is because the benefits as perceived by policy makers and planners may be different from the benefits as perceived by water users/water using sectors. Some of the literature suggests that benefits arise from perceptions of improved security (in a variety of ways). But to influence policy makers and planners, the benefits are likely to be political and economic in nature.	For the purpose of this study, benefits can be defined as follows: • equitable economic growth accruing to multi-sector water management and utilisation (this falls within the upper left quadrant of the UNECE typology for transboundary water cooperation) • reduced political cost of nexus solutions (relevant to the bottom left quadrant) • increased basin welfare[155] (cross cutting relevance to upper left and right quadrants)	For the purpose of this study, a solution must suggest or support a communication or advocacy campaign targeted at policy makers and planners in all water using or dependent sectors, as well as those in non-line ministers such as ministries of finance, or economic development.
What are the enabling factors for the implementation of solutions, notably institutional	This is also a fundamental output of the study, because enabling factors either reduce the political	For the purpose of this study, an enabling factor is any factor that reduces the political or	There is no need for criteria here because any nexus solution will have some sort of enabling factors. These therefore have no utility in

154 See section 2.1.2.2

155 Defined here as the ratio of the economic productivity of water to levels of competition for or conflicts over water. In other words, if economic productivity goes up and competition goes down basin welfare increases.

QUESTION	COMMENT/CLARIFICATION	DEFINITION ARISING	CRITERIA
arrangements and financing frameworks?	cost of nexus solutions; or increase the political capital available. The role of public awareness and the "sanctioned discourse[156]" may be relevant here.	institutional cost of nexus planning or decision making.	terms of filtering irrelevant from relevant solutions.

Annex 2 Derivation of the Problem Axis

The component elements of the problem axis of the analytical framework were derived as follows.

1) A list of 147 problems were derived from a list of 24 TDAs [157].Most of these were encountered in multiple TDAs.

2) The problems were categorized as:

- cause,
- effect,
- both – for instance, changing rainfall patterns could cause water scarcity, while water scarcity could be an effect of poor water resources management and wastage.
- unclear – for instance, are variable of hydrologic regimes anthropogenic or natural?
- cross-cutting – meaning that it could be cause or result from a wide range of problems.

The categorization is set out in Table 9.

3) The problems categorised as "both", "unclear" or "cross cutting" were discarded because a closer examination confirmed the issues at stake are adequately captured by other problems .

4) The remaining problems were consolidated into 13 causes and 10 effects with respect to water quantity, quality, and environment, as shown in Table 10.

Table 9: Categorisation of the GEF/TDA Problems.

TDA			
River or Basin	**Year**	**PROBLEM**	**CATEGORY**
Amazon	2015	Water Pollution;	effect
		Deforestation;	cause
		Loss of Biodiversity;	effect
		Extreme Hydroclimatic Events;	cause
		Erosion, and Sediment Transport and Sedimentation;	effect
		Changes in Soil Use;	cause
		Loss of Glaciers;	cause
		Large Infrastructure Projects;	cause
		Limited Integrated Water Resources Management	cause
Bermejo	2000	Soil degradation. Intense erosion and desertification processes	cause

[156] Defined here as the "space" within which political decisions are affordable in terms of political capital, and which for obvious reasons, is influenced by public awareness, which in turn can be influenced by communications and advocacy campaigns.

[157] The list was provided by the GEF secretariat. Marine examples of TDAs have been excluded for the purpose of the study.

TDA			
River or Basin	Year	PROBLEM	CATEGORY
		Water scarcity and availability restrictions	both
		Degradation of water quality	effect
		Destruction of habitat, loss of biodiversity and deterioration of biotic resources.	both
		Conflicts from flooding and other natural disasters	cause
		Deteriorating human living conditions and loss of cultural resources	cross-cutting
Danube	2006	Nutrient pollution;	cause
		Organic pollution;	cause
		Pollution from hazardous substances;	cause
		Hydro-morphological alterations	effect
Dinaric Karst (aquifer)	2013	Anthropogenic pollution	cause
		Possible flow reduction due to a hydropower dam	cause
		inadequate data and information	cause
		Agricultural and sanitation waste pollutions	cause
		Industrial pollutions	cause
		wastewater and industrial pollution	cause
		Inequitable allocation of water	cause
		Lack of regulation	cause
Dnipro	2003	Chemical pollution;	cause
		Loss/modification of ecosystems or ecotones, and reduced viability of biological resources due to contamination and disease;	effect
		Modification of the hydrological regime of surface waters;	cause
		Eutrophication;	effect
		Flooding events and elevated groundwater levels;	unclear
		Pollution by radionuclides	cause
	2016-2018	Deterioration of Water Quality	effect
		Variability of Hydrological Regime	unclear
		Biodiversity Degradation	effect
		Sediment Transport	effect
Guarani (aquifer)	2007	GAS pollution problems: wells and the aquifer	cause
		Quantitative problems arising from intensive over-exploitation; decline in GAS water availability	effect
		Macro strategies: challenges to the sustainable management of the GAS	cause
Lulumenden (aquifer)	2007	Change in available resources,	effect
		Degradation of water quality	effect
		Climate variability	cause
Kura	2013	Variation and reduction in hydrological flows	unclear
		Deterioration of water quality	effect
		Ecosystem degradation	effect
		Flooding	effect
Lake Baikal	2013	Degradation of Aquatic and Terrestrial Habitats	effect
		Hydrological Regime Changes	effect

TDA			
River or Basin	Year	PROBLEM	CATEGORY
		Decline of Water Quality	effect
		Unsustainable Fisheries and Wildlife Exploitation	cause
		Biological Invasions	effect
Lake Chad	2007	Variability of hydrological regime and fresh water availability;	unclear
		Water pollution;	effect
		Decreased viability of biological resources;	effect
		Loss of biodiversity;	effect
		Changes and variability in hydrological regime & fresh water availability	unclear
		Water pollution	effect
		Invasive species	effect
		Variability in Hydrological and Hydrogeological Regimes;	unclear
	2018	Biodiversity Degradation	effect
		Sedimentation	effect
		Climate Variability and Change	unclear
Lake Peilpso/Chudskoe	2005	Eutrophication of Lake Peipsi (including riverine loads)	effect
		Fishery management	cause
		Groundwater pollution and water distribution in the Narva River region	effect
		Mining pollution from oil-shale activities	cause
Lake Shkodra/Skadar	2006	Pollution (industrial, municipal, solid and liquid waste)	cause
		Hunting and fishing	cause
		Lakeshore development	cause
		Water management measures	cause
Lake Tanganyika	1999	Unsustainable Fisheries;	effect
		Increasing Pollution;	cause
		Excessive Sedimentation;	effect
		Habitat Destruction	effect
Lake Victoria	2006	Land use and land degradation;	cause
		Water quality and pollution;	effect
		Water quantity and water balance;	effect
		Fisheries decline and biodiversity;	effect
Niger	2009	Land degradation	cause
		Water resource degradation	effect
		Loss of biodiversity	effect
		Invasive species of aquatic plants	effect
Nubian (aquifer)	2010	Declining water levels	effect
		Water quality deterioration	effect
		Changes in groundwater regime	effect
		Damage or loss to ecosystems and biodiversity	effect
		Climate change	cause
Okavanga-Cubango	2011	Variation and reduction of hydrological flow	unclear
		Changes in sediment dynamics	both

TDA			
River or Basin	Year	PROBLEM	CATEGORY
		Changes in water quality	effect
		Changes in the abundance and distribution of biota	effect
Orange-Senqu	2008	Stress on surface and groundwater resources	effect
		Altered water flow regime	effect
		Deteriorating water quality	effect
		Land degradation	cause
		Spread of alien invasive plants and animals	effect
Pantanal	2003	Critical issues associated with human presence (Water pollution; Soil Degradation; Loss of Biodiversity)	cause
		Critical issues associated with the hydrological flow of the system (Critical Events; Emerging Water Use Conflicts; Economic and Social Losses)	effect
		Critical issues associated with the socio-political organization (Political-Institutional fragility and lack of implementation of Water Resources Management Instruments)	cause
Prespa	2009	Nutrient pollution;	effect
		Declining fish stocks	effect
		Loss of water level in Lake Macro Prespa;	effect
		Sediment transport;	effect
		Deforestation and changes in native forests;	cause
		Organic pollution;	cause
		Hazardous substance pollution	cause
Rio de la Plata	2010-2016	Extreme hydrological events linked to climate variability and change;	cause
		Water quality degradation;	effect
		Sedimentation of waterways and bodies of water in the Basin;	effect
		Disruption and loss of biodiversity;	effect
		Unsustainable use of fishery resources;	cause
		Unsustainable use of aquifers in critical areas;	cause
		Water use conflicts and the environmental impact of irrigated crops;	effect
		Lack of disaster contingency plans;	cause
		Poor water health and the deterioration of environmental sanitation	effect
San Juan	Date Unknown	The accelerating degradation of transboundary ecosystems	effect
		Overexploitation of valuable natural resources	cause
		Soil degradation and increasing sedimentation	both
		Pollution of water bodies	effect
		High vulnerability to natural hazards	cross-cutting
Senegal	2007	Surface water availability problems;	effect
		Groundwater availability problems;	effect
		Water quality: pollution/siltation;	effect
		Water quality: pollution/mining operations;	effect
		Change in estuarine hydrodynamics;	effect
		Land Degradation*	cause
		Degradation of fish fauna;	effect
		Wetlands degradation;	effect

TDA			
River or Basin	**Year**	**PROBLEM**	**CATEGORY**
		Invasive species;	effect
		Waterborne diseases	effect
Volta	2002 Preliminary TDA	Land degradation	cause
		Water scarcity	unclear
		Loss of biodiversity	effect
		Flooding	effect
		Water-borne diseases	effect
		Growth of aquatic weeds	effect
		Coastal erosion	effect
		Water quality degradation	effect
		Urbanization *	cause
		Increase in Industrial and Mining Activities *	cause
		Changes in water quantity and seasonal flows	effect
		Coastal erosion downstream of the Volta Basin	effect
		Invasive aquatic species	effect
		Increased sedimentation of river courses	effect
		Loss of soil and vegetative cover	cause
	2013	Agricultural, industrial and domestic pollution of waterbodies	cause

Table 10: Consolidated Causes and Effects

CAUSES used for the questionnaire	EFFECTS used for both the questionnaire and the analytical Framework	
deforestation	With respect to water quantity	Permanent or seasonal flooding due to natural causes
natural hydrology		Permanent or seasonal Flooding due to anthropogenic causes
anthropogenic changes to hydrology		Permanent or seasonal Inadequate water due to natural causes
climate change		Permanent or seasonal Inadequate water due to anthropogenic causes
land use change	With respect to water quality	Permanent pollution due to anthropogenic reasons
poor land use		Unnatural turbidity due to anthropogenic reasons
infrastructure design	With respect to the environment	biodiversity loss or compromise
infrastructure operation		habitat loss or compromise
poor WRM		morphological change
regulatory inadequacies		compromised human health
inadequate data and information		
poor disaster planning		
unregulated effluent		

Annex 3 Derivation of the Solution Axis

The component elements of the solution axis of the analytical framework were derived as follows.

1) The five categories of nexus solutions proposed by UNECE were reorganized into four mezzanine factors (Table 11);

2) The mezzanine factors were unpacked into subsidiary factors (Table 12), using the "package of solutions" proposed in the NWSAS Nexus Assessment[158][159] (Box 17);

3) The subsidiary factors were translated into component elements of the Solutions Axis (Table 13).

The component elements can be grouped into

Table 11 Derivation of mezzanine factors

Clusters of Solutions			Mezzanine Factors	
Institutions	• inter-sectoral • multiple level governance • resource users		• sharing	**International Cooperation**
Information	• multi-sector policy supporting • trans/pan sector assessments • guidelines		• inter-sectoral • multiple level governance • resource users • multi-sector policy supporting • trans/pan sector assessments •	**Governance**
Instruments	• economic • regulatory		• economic • regulatory • plans • guidelines • best practice	**Economic and Policy Instruments**
Infrastructure	• built • natural		• built • natural	**Infrastructure and Innovation**
International cooperation and governance	• sharing • plans • best practice			

[158] The choice of the NWSAS package of solutions as a reference is justified by the fact that it is the result of an extensive study and consultation on sectoral and cross-sectoral solutions to basin issues. The NWSAS is the last of a series of basin assessments under the Water Convention and as such is the most advanced in terms of coverage of nexus solutions.

[159] UNECE, GWP-Med, OSS (2020). Reconciling resource uses: Assessment of the water-food-energy-ecosystems nexus in the North Western Sahara Aquifer System Part A - "Nexus Challenges and Solutions". Available at: https://unece.org/environment-policy/publications/reconciling-resource-uses-assessment-water-food-energy-ecosystems

Table 12 Derivation of the subsidiary factors

SENIOR CLUSTER	SECTOR	ORIGINAL ACTION	DISCUSSION	SUBSIDIARY FACTORS CARRIED FORWARD FOR FRAMEWORK DESIGN	
International Cooperation	Water	Enhance local water management, including by revitalising participatory models at oases and enhancing the enforcement of existing laws on water	Not relevant because local water management is by definition not transboundary except as regard the aquifer, which might be. If so it is captured in A1 (below right)	Not applicable	
		Reinforce transboundary cooperation for sustainable groundwater resource management	Highly relevant	A1	Sustainable and productive natural resource management as a result of stronger transboundary cooperation
	Energy	Enhance mechanisms for the coordination of energy development with other sectoral plans to anticipate trade-offs and build on intersectoral synergies	Highly relevant	A2	Increased awareness concerning the benefits of and options for cross-sectoral, transboundary trade-offs, compromise and synergies
	All water using sectors			A3	New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure optimised as a result of trans-sector governance and international cooperation.
	Ecosystem	Upgrade inter-sectoral cooperation based on a detailed water balance of the aquifer that includes sectoral demands as well as environment needs	If this was articulated in terms of information exchange and management, then this would be highly relevant, but in fact it is actually about cooperation	Adequately captured by B1	
Governance	Water	Upgrade inter-sectoral cooperation based on a detailed water balance of the aquifer that includes sectoral demands as well as environment needs	Included in the "Economic Policy and Instruments" cluster. But if this was articulated in terms of information exchange and management, then this is highly relevant and is captured as such in B1	B1	Sustainable and productive management and exploitation of natural resources as a result of shared planning and monitoring information and common metrics, not least with respect to mandatory environmental and social impact assessment
Governance Cont'd	Food	Valorise local products and strengthen programmes for a more balanced diet while involving young people and women in economic and social development of the oases	Nil relevance because these are socio-economic actions at a local, not transboundary level,	Not applicable	
	Energy			B2	

SENIOR CLUSTER	SECTOR	ORIGINAL ACTION	DISCUSSION	SUBSIDIARY FACTORS CARRIED FORWARD FOR FRAMEWORK DESIGN	
		Develop a sustainable program for diversified, multi-purpose renewable energy and the sustainable upscale of small scale solar irrigation	Included in the "Economic Policy and Instruments" cluster in Annex 3. But what is multi-purpose energy? In any case this should be about multi-purpose infrastructure, and as such has an appropriate objective in this cluster as well as the governance cluster		New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure optimised as a result of appropriate incentive structures and well enforced regulations (note that this is not the same as A3).
	ecosystem	Systematise environmental and social impact assessment for all new infrastructure (regardless of scale)	Included in the "Infrastructure and Innovation" cluster in Annex 3. But this is really a governance issue, which in transboundary terms also involves the need for common metrics.	Adequately captured by B1	
Economic policy and instruments	water	Set up dedicated policies and related incentives for wastewater reuse in agriculture and urban areas	Not sure how this is a nexus action, and in fact a "dedicated" policy is likely to be a silo'd policy! Not needed for the analytical framework	Not applicable	
	Water	Strengthening water demand management including through water saving programmes	The term "saving" is considered troublesome by some experts. If a farmer "saves" water, whose is it? His? That of society? The State's? The environment's? Better to think in terms of reallocation of water that is no longer needed at a given location rather than savings - hence C1	C1	Water demand management improved by a combination of smart economic policies along with institutional and legal arrangements that increase the economic mobility of water[160]
Economic policy and instruments Cont'd	Food	Set up agricultural policies oriented towards reasonable, sustainable and productive agriculture	This is a policy issue so on first consideration doesn't seem relevant to Governance and international cooperation, unless it is about transboundary trade within a river basin. If so, it is of profound relevance because responsible trade is needed to extract value from natural resources in a sustainable fashion.	C2	Transparent and equitable terms of transboundary trade within a river basin

[160] Water is economically mobile when the pertaining legal, regulatory and institutional framework allows it to be allocated to uses that reduce its opportunity cost which - simply stated - is the economic return of its most lucrative use minus its return on current use. It should be self-evident that where water governance is strong, the need for economic mobility applies only to the water left over when societal and environmental needs are satisfied. Economic efficiency of water use at basin level is obviously directly proportional the economic mobility of water within the basin. Seminal work by IFPRI (Cai et-al 2001) showed that when the economic efficiency of water use increases, so do environmental stream flows access to water by the poor.

SENIOR CLUSTER	SECTOR	ORIGINAL ACTION	DISCUSSION	SUBSIDIARY FACTORS CARRIED FORWARD FOR FRAMEWORK DESIGN
		Promote the circular economy including agroecological practices by means of ad-hoc economic measures and social instruments	Not relevant, agroecological practices are not transboundary investments, especially as in this case they result from ad-hoc measures and instruments	Not applicable
Infrastructure and innovation	energy	Develop a sustainable program for diversified, multi-purpose renewable energy and the sustainable upscale of small scale solar irrigation	Included in the "Economic Policy and Instruments" cluster in Annex 5. But for analytical purposes this has infrastructural implications hence D1, and decentralised service concepts (ie along mixed energy pathways) hence D4 (see below)	D1 New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure
	Water	Upscale the use of non-conventional water resources through desalination and waste water treatment	Too specific; needs to be captured in a more generalised fashion	D2 Water, energy, agriculture and environmental security enhanced, basin-wide as a result of innovations in infrastructure financing and operating rules, especially when due to multi-purpose paradigms
	Food	Enhance innovative practices and techniques for sustainable soil and crop management and invest in their upscaling and dissemination	This can, and is being taken to be about the holistic role that appropriate agribusiness concepts could plan.	D3 Water, energy, agriculture and environmental security enhanced, basin-wide as a result of landscapes restored or transformed by investments in in natural infrastructure or appropriate agribusiness operations
	Energy	Improve the reliability of electrical grids in the rural areas, thereby enhancing the integration of renewables for remote and multiple uses	The issue here concerns the relationship between scale and decentralisation.	D4 Water, energy, agriculture and environmental security enhanced, basin-wide as a result of increased use of decentralised service concepts and infrastructure.
Infrastructure and innovation Cont'd	Ecosystem	Increase awareness of the trade-offs and synergies between different sectors in public institutions	Highly relevant.	Adequately captured by A2

Table 13 Derivation of component elements

MEZANINE FACTOR	SUBSIDIARY FACTOR	COMPONENT ELEMENTS
International Cooperation	Sustainable and productive natural resource management as a result of stronger transboundary cooperation	Stronger transboundary cooperation
	Increased awareness concerning the benefits of and options for cross-sectoral,	Increased awareness of the benefits accruable to cross sector transboundary trade-offs, compromise and synergies

MEZANINE FACTOR	SUBSIDIARY FACTOR	COMPONENT ELEMENTS
	transboundary trade-offs, compromise and synergies	Increased awareness of options for cross-sector, transboundary trade-offs, compromise and synergies
	New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure optimised as a result of trans-sector governance and international cooperation.	New, multi-purpose “basin” level infrastructure
		Multi-purpose use of existing infrastructure
Governance	Sustainable and productive management and exploitation of natural resources as a result of shared planning and monitoring information and common metrics, not least with respect to mandatory environmental and social impact assessment	Shared data and information
		Common metrics
		Standardised social and environmental impact assessments
	New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure optimised as a result of appropriate incentive structures and well enforced regulations	Functional, transparent incentive structure
		Appropriate, well enforced regulations
Economic and policy instruments	Water demand management improved by a combination of smart economic policies along with institutional and legal arrangements that increase the economic mobility of water	Demand management policies
		Legal arrangements for demand management
		Institutional arrangements for demand management
		Economically mobile water
	Transparent and equitable terms of transboundary trade within a river basin	Transparent and equitable terms of transboundary trade between the riparians
Infrastructure and Innovation	New multi-purpose "basin" level infrastructure and multi-purpose use of existing "basin" level infrastructure.	Multi-purpose infrastructure
		Innovative infrastructure
	Water, energy, agriculture and environmental security enhanced, basin-wide as a result of innovations in infrastructure financing and operating rules, especially due to multi-purpose paradigms	Innovative financing
		Innovative infrastructure operating rules
	Water, energy, agriculture and environmental security enhanced, basin-wide as a result of landscapes restored or transformed by investments in natural infrastructure or appropriate agribusiness operations	Natural infrastructure
		Appropriate agribusiness
	Water, energy, agriculture and environmental security enhanced, basin-wide as a result of increased use of decentralised service concepts and infrastructure.	Decentralised service delivery concepts
		Decentralised service infrastructure

Annex 4 The analytical framework

					SOLUTION CATEGORIES																										
					International Cooperation				Governance					Economic policy and instruments						Infrastructure and Innovation											
					FACTORS OF SUCCESS																										
					Stronger transboundary	Increased awareness of the benefits	Increased awareness of options for	New, multi-purpose " basin" level	Multi-purpose use of existing	Shared data and information	Common metrics	Standardised social and	Functional, transparent incentive	Appropriate, well enforced	Demand management policies	Legal arrangements	Institutional arrangements	Economically mobile water	Transparent and equitable terms of	Multi-purpose infrastructure	Innovative infrastructure	Innovative financing	Innovative infrastructure operating	Natural infrastructure	Small scale conservation agriculture	Large scale conservation	Renewable energy	Smart energy strategies	Decentralised service delivery	Decentralised service infrastructure
PROBLEMS	Quantitative	Permanent	Too much water	Natural																											
				Anthropogenic																											
			Insufficient water	Natural																											
				Anthropogenic																											
			Excessive variability	Natural																											
				Anthropogenic																											
		Time based	Too much water	Natural																											
				Anthropogenic																											
			Insufficient water	Natural																											
				Anthropogenic																											
			Excessive variability	Natural																											
				Anthropogenic																											
	Qualitative	Permanent	Pollution	Natural																											
				Anthropogenic																											
			Salinity	Natural																											

				Anthropogenic																											
			Turbidity	Natural																											
				Anthropogenic																											
		Time based	Pollution	Natural																											
				Anthropogenic																											
			Salinity	Natural																											
				Anthropogenic																											
			Turbidity	Natural																											
				Anthropogenic																											
	Environment	biodiversity loss or compromise																													
		habitat loss or compromise																													
		sediment or erosion																													
		morphological change																													
		compromised human health																													

Annex 5 Questionnaire used for stock taking nexus solutions and investments.

Multiple answers are possible. However, each questionnaire must capture a single case, otherwise it will be impossible to align success factors with the problem in question. However, that does not mean that a problem cannot have multiple characteristics. For instance, floods and turbidity would be an example of problems, as could water scarcity and pollution. Accordingly, if you are able to cite more than one case, and have time to do so, then please complete a separate questionnaire for each of them.

1. Your first name:	
2. Your last name:	
3. Your position:	
4. Your organisation:	
5. Your country:	
6. Your e-mail address:	
7. Your telephone number:	
8. Which transboundary river basin or aquifer does this solution/ investment concern?	

SECTION 1 – BRIEF SUMMARY

9. Please provide a very brief description of the case to which this questionnaire refers. Ideally you should include mention of where the problem occurs, who are its winners and losers, and who is or has been involved in fixing it.	

SECTION 2 – THE PROBLEMS FACED

This section begins by establishing which water using sectors are affected by the problem in question. For the purpose of this study, these sectors are characterised as shown below. These characteristics are not offered as a technical definition of each sector. Rather, they are offered as simple guide to make sure that we understand your responses in the context of your nexus problem.

For instance, if you have a water quality problem because the abstraction of too much water for irrigation means that there is not enough left in the natural system to absorb polluting farm run-off, you might wish to select water, agriculture and environment. Or perhaps, if your problem is that unregulated tailings discharge from mines, compromises a touristic opportunity based on pristine landscapes, you might select water, tourism, industry and the environment. Thus:

Water

- water resource management
- bulk water
- bulk water infrastructure

- domestic water
- water quality
- wastewater treatment

Agriculture

- irrigation
- food crops
- energy crops
- industrial crops

Energy

- hydropower
- fossil fuel based energy production
- other thermal including solar thermal/CSP
- floating solar installations
- renewable energy (including invasive biomass)

Environment

- natural water bodies (surface water and aquifers)
- watersheds
- hydromorphology
- habitat and biodiversity
- natural flood and turbidity cycles

Industry

- all water using sectors other than agriculture, energy and navigation

Navigation

- draft depths

Tourism

- amenity
- landscape

The remainder of the section invites you to select the elements which, taken together, define the problem (their causes are captured in the next section). Please select as many as apply while noting that:

- natural elements are those which have not directly arisen as a result of human activity (except for climate change which is considered here to be a natural element)
- anthropogenic elements are those which have arisen directly as a result of human activity, or lack of if, due to for instance, poor enforcement of regulations.

10. Which sectors are affected (select 2 or more)?	
Water	Selected by means of a “button”
Agriculture	Selected by means of a “button”
Energy	Selected by means of a “button”
Environment	Selected by means of a “button”

Industry				Selected by means of a "button"
Navigation				Selected by means of a "button"
Tourism				Selected by means of a "button"
Other (if yes specify the sector)				Selected by means of a "button"
11. Which of these combinations of options define the problem?				
(11, 12) Water quantity	**(11.) Permanent**	Too much water	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
		Insufficient water	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
		Excessive variability	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
	12. Time based	Too much water	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
		Insufficient water	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
		Excessive variability	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
(13, 14) Water quality	**13. Seasonal/time based**	Pollution	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
		Salinity	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"

		Turbidity	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
	14. Seasonal/time based	Pollution	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
		Salinity	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
		Turbidity	Natural	Selected by means of a "button"
			Anthropogenic	Selected by means of a "button"
15. Environment	Biodiversity loss or compromise			Selected by means of a "button"
	Habitat loss or compromise			Selected by means of a "button"
	Sediment or erosion			Selected by means of a "button"
	Compromised human health			Selected by means of a "button"

SECTION 3 – THE ROOT CAUSES

This section invites you to identify all the root causes that have caused or have contributed to the problem in question. Please select as many as apply.

Most are self-explanatory, but the following may need definition, clarification or elaboration:

- *Unsuitable infrastructure:* This refers to infrastructure that may not be the best way to solve the problem. An example would be the construction of flood bunds which simply send the flood downstream, meaning that one party's solution becomes another party's problem. A nexus alternative could be the restoration of flood plains which could have proven economic and environmental benefits; or to attenuate floods on bunded rice fields, ditto.

- *Infrastructural limitations*: This can mean either that existing infrastructure is not fit for purpose in terms of specification and/or operation; or that the needed infrastructure has yet to be developed.

- *Unsuitable operating rules for infrastructure*: This refers to infrastructure with multi-purpose potential but which is operated as optimized for a single purpose. An example would be a cascade of hydropower dams that are maintained at full supply level, meaning that: i) evaporation losses might be higher than necessary; ii) water with a high opportunity cost downstream is not available when needed; and iii) the risk of cascade failure and severe flood damage downstream is greatly increased. Multi-purpose operating rules could proved a win-win-win solution.

- *Data and information limitations:* This can mean that data and information is non-existent; is poorly agglomerated or is not made available between sectors and/or across national boundaries ("information is power").

- *Policy silos and linear thinking:* Policy silos refer to the "space" within single sector policies are drafted in isolation from and without consultation and coordination with policy makers from other sectors which might compete for the resources (such as land, water and finance). Linear thinking is the opposite of lateral thinking and constrains innovation. For instance, to solve problems of water scarcity with expensive dams, when the same result could be achieved by changing water law to introduce a system of water use permits and seasonal allocations, would be an example of linear thinking.

- *Political economy:* Political economy is all about saving political capital i.e. avoiding unpopular policies or initiatives. For example, promulgation and strict enforcement of demand management regulations may require more political capital than might providing free energy for irrigation.

- *Resistance to new ideas:* Resistance to new ideas to an extent is self-explanatory, except to note also that when faced with an opportunity to adopt or promote a new idea, a planner or decision make may perceive a reputational risk.

- *Constraints of donor financing:* These constraints arise when a donor dependent government has policies that are better suited to new ideas such as nexus, when its donor(s) programming might not provide for such new realities and opportunities, e.g. due to financing sources being of sectoral in nature and hence constraining trans-sector support.

16. Does the problem arise from any of the following (please select all that apply)	Deforestation or forest degradation	Selected by means of a "button"
	Climate change	Selected by means of a "button"
	Natural change in hydrology or another natural cause of some sort (if yes, please explain)	Selected by means of a "button"
	Anthropogenic change in hydrology	Selected by means of a "button"
	Land use change	Selected by means of a "button"
	Poor land use and management	Selected by means of a "button"
	Unsuitable infrastructure	Selected by means of a "button"
	Infrastructural limitations	Selected by means of a "button"
	Unsuitable operating rules for infrastructure	Selected by means of a "button"
	Poor water resource management	Selected by means of a "button"
	Data and information limitations	Selected by means of a "button"

Poor inter-sectoral coordination	Selected by means of a "button"
Regulatory inadequacies (abstraction and discharge)	Selected by means of a "button"
Policy silos and linear thinking	Selected by means of a "button"
Political economy	Selected by means of a "button"
Resistance to new ideas	Selected by means of a "button"
Constraints to donor financing	Selected by means of a "button"
Inadequate institutional arrangements and mechanisms	Selected by means of a "button"
Inadequate institutional capacity	Selected by means of a "button"
Inadequate finances	Selected by means of a "button"
Poor disaster planning and preparedness	Selected by means of a "button"
Lack of transparency or corruption	Selected by means of a "button"
Other anthropogenic (if yes please explain)	Selected by means of a "button"
Other natural (if yes please explain)	Selected by means of a "button"

SECTION 4 - THE FACTORS OF SUCCESS

This section invites you to identify factors that comprised or contributed to the solutions. Please select as many as apply.

Most are self-explanatory, but the following may need definition, clarification or elaboration:

- *New, multi-purpose "basin" level infrastructure and/or the planning thereof:* This refers to infrastructure that is intentionally implemented to provide benefits for more than one riparian

- *Common metrics:* It is not enough to share objectives, it is also important to agree how their achievement is monitored or measured. Common metrics, by definition, are likely to be highly objective. This applies between sectors and between riparians.

- *Standardised social and environmental impact assessments between sectors and between riparians*: Different stakeholders have different evaluation indicators. This means that an investment that is satisfactory for one, may not be for another. This is not uncommon among development partners. Transboundary cooperation requires mutually consistent and understood assessment indicators and

methodology. The indicators should moreover be as objective as possible in order to avoid politically advantageous subjectivity.

- *Economically mobile water*: Water is economically mobile when the pertaining legal, regulatory and institutional framework allows or facilitates water to be allocated to uses that minimise its opportunity cost. This, simply stated - is the economic return of its most lucrative use minus its return on current use. It should be self-evident that where water governance is strong, the need for economic mobility applies only to the water left over when societal and environmental needs are satisfied. A possible reallocation mechanism would comprise trades of water not needed by one permit holder to another user that does need it. This requires a system of water permits and well regulated water markets. It is not the same as volumetric water pricing by the state or its regulators!

- *Transparent and equitable terms of transboundary trade between the riparians*: Related to the concept of economically mobile water, is the idea that well-regulated and equitable produce or product trade is the best way to extract value from the factors of production by allowing production to be concentrated where resources are available – in this case water. This concept is not limited to agriculture.

- *Innovative infrastructure*: This speaks to the linear thinking challenge. An example would be that of Thailand where in some locations bunded rice fields are use to attenuate floods. Rice yield losses prove to be minimal, while capture fisheries increase, aquatic gene pool integrity is enhanced along with tangible habitat benefits.

- *Innovative financing*: Including blended finance and revenue based models for both infrastructure and institutional financing.

- *Small scale conservation agriculture:* In this context refers to landscape/watershed restoration as a result of widespread uptake of sustainable, more productive smallholder farming systems and could include sustainable intensification.

- *Large scale conservation agribusiness*: For instance, large scale production of soil binding crops with multi-sector benefits, such as crops with food, energy, industrial uses and diverse value chain potential, etc.

- *Renewable energy*: This includes wind, PV solar, wave, biofuels. zero head turbines and non-storage based hydro. It does not include single use hydropower dams, but can include multi-purpose hydropower dams.

- *Smart energy strategies:* This could include e.g. a mix of energy sources having local comparative advantage in a well regulated energy market. It could also include one-off use of invasive biomass for pelletised use in thermal power stations.

17. Which of these factors comprised or contributed to the solutions?	Stronger transboundary cooperation	Selected by means of a “button”
	Increased awareness of the benefits accruable to cross sector transboundary trade-offs, compromise and synergies	Selected by means of a “button”
	Increased awareness of options for cross-sector, transboundary trade-offs, compromise and synergies	Selected by means of a “button”
	New, multi-purpose “basin” level infrastructure and/or the planning thereof	Selected by means of a “button”
	Multi-purpose use of existing infrastructure	Selected by means of a “button

Shared data and information	Selected by means of a “button
Common metrics	Selected by means of a “button
Standardised social and environmental impact assessments between sectors and between riparians	Selected by means of a “button
Functional, transparent incentive structure	Selected by means of a “button
Appropriate, well enforced regulations	Selected by means of a “button
Demand management policies	Selected by means of a “button
Legal arrangements	Selected by means of a “button
Institutional arrangements	Selected by means of a “button
Economically mobile water	Selected by means of a “button
Transparent and equitable terms of transboundary trade between the riparians	Selected by means of a “button
Innovative infrastructure	Selected by means of a “button
Innovative financing	Selected by means of a “button
Innovative infrastructure operating rules	Selected by means of a “button
Natural infrastructure	Selected by means of a “button
Small scale conservation agriculture	Selected by means of a “button
Large scale conservation agribusiness	Selected by means of a “button
Renewable energy	Selected by means of a button
Smart energy strategies	Selected by means of a “button
Decentralised service delivery concepts	Selected by means of a “button
Decentralised service infrastructure	Selected by means of a “button

	Other (if yes, please provide a simple explanation)	Selected by means of a "button"

SECTION 5 – NEXUS FINANCING

Water sector financing is a highly complex issue, not helped by the fact that the potential players have a diverse mix of perceived risks. Yet the issue is of crucial importance because of the huge global underinvestment in crucial water sector infrastructure. And the challenge is not limited to infrastructure: the financing of transboundary water management and the needed institutions is also proving to be a significant challenge.

The questions in this section represent an attempt to condense a complex issue into its simplest, indivisible parts. Nonetheless you are invited to add anything that you think is missing from the two subsections (type of finance, and delivery pathway).

Most are self-explanatory, but the following may need definition, clarification or elaboration:

- *Project specific funding*: This is funding for a single, discrete investment (infrastructural or institutional).

- *Specific programme financing*: This is funding for a pre-determined suite of investments (infrastructure and/or institutional).

- *Adaptable programme financing*: This is funding for a suite of investments (infrastructure and/or institutional), that is not predetermined but have a common cascade of objectives and outputs.

- *Sector budget support*: This is funding made available to line ministries or their decentralised/devolved authorities to be disbursed at their discretion.

- *Central budget support*: This is funding made available to non-line ministries and/or decentralised/devolved authorities to be disbursed at their discretion.

Cross-cutting to all of these and hence difficult to capture as such with a simple "click" is *basket funding*. Hence, if this is significant in the context of the solution to hand, then please provide a simple note to this effect.

18. How was the solution financed?	By the state (including credits from development partners)	Selected by means of a "button"
	By the state with development partner grant support	Selected by means of a "button"
	By development partner grants	Selected by means of a "button"
	By blended finance	Selected by means of a "button"
	By the private sector	Selected by means of a "button"
	Other (if yes, please provide a simple description)	"
19. How was the finance delivered?	Project specific funding	Selected by means of a "button"
	Specific programme financing (e.g. climate funds)	Selected by means of a "button"

	Adaptable programme financing	Selected by means of a "button"
	Sector budget support	Selected by means of a "button"
	Central budget support	Selected by means of a "button"
	Other (if yes, please provide a simple description)	Selected by means of a "button"
20. Was basket funding involved? If yes, please provide a simple description		

SECTION 6 – NEXUS ADED VALUE

This section speaks to the heart of the entire study and is largely self-explanatory except for the following:

- *Decentralised/devolved financing opportunities*: An example of this would be where a commercially funded agribusiness stabilises a watershed with crops having potential for profitability, socio-economic transformation, economic growth and environmental sustainability/restoration. Another would be where a significant tourism venture finances restoration and conservation of the landscape on which its revenues depend.

- *Reduced demands on line budgets:* The costs of multi-purpose infrastructure can be shared between the line-ministries involved.

- *Increased returns on sunk costs*: An example of this would be where multi-purpose operating rules applied to existing, say hydropower dams, or bunded rice fields (as above) diversifies their benefit streams.

- *Increased returns on investment*: The more benefits streams accrue to an investment, the greater the returns on investment are likely to be.

21. In what way did the nexus approach add value to the intended result.	Improved infrastructural functionality	Selected by means of a "button"
	Improved ecosystem services	Selected by means of a "button"
	Reduced tension	Selected by means of a "button"
	Regional peace or stability	Selected by means of a "button"
	Improved resource security (water, energy or food)	Selected by means of a "button"
	Better resilience or reduced risks	Selected by means of a "button"
	Establishment of improved planning practices and paradigms	Selected by means of a "button"
	Enhanced intersectoral cooperation	Selected by means of a "button"
	Enhanced transboundary cooperation	Selected by means of a "button"

	Greater transparency	Selected by means of a "button"
	Increased returns on the factors of production (especially land and water)	Selected by means of a "button"
	Decentralised/devolved financing opportunities	Selected by means of a "button"
	Reduced demands on line budgets	Selected by means of a "button"
	Increased returns on sunk costs	Selected by means of a "button"
	Increased returns on investment	Selected by means of a "button"
	Other (if yes, please provide a brief explanation)	Selected by means of a "button"

SECTION 7 – NEXUS OPPORTUNITY IGNORED

This section is self-explanatory, any necessary definitions or elaborations are already provided above.

22. Which of the following problems was a constraint on nexus approaches?	Poor inter-sectoral coordination	Selected by means of a "button"
	Policy silos and linear thinking	Selected by means of a "button"
	Political economy	Selected by means of a "button"
	Resistance to new ideas	Selected by means of a "button"
	Constraints of donor financing	Selected by means of a "button"
	Inadequate institutional arrangements and mechanisms	Selected by means of a "button"
	Inadequate institutional capacity	Selected by means of a "button"
	Inadequate finances	Selected by means of a "button"
	Other (if yes, please provide a brief explanation)	Selected by means of a "button"
23. Please explain the options selected above:		

24. Are you willing to be contacted for a more detailed follow-up discussion	