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**Economic Commission for Europe**Meeting of the Parties to the Convention on  
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Resources Management****Tenth meeting**

Geneva, 24 and 25 June 2015

Item 8 of the provisional agenda

**Thematic assessment of the water-food-energy-ecosystems nexus****Major findings of the basin-level assessments of the water-  
food-energy-ecosystems nexus\*****Prepared by the secretariat with input from experts***Summary*

This document was prepared pursuant to a decision taken by the Meeting of the Parties to the United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) at its sixth session (Rome, 28–30 November 2012) (ECE/MP.WAT/37, para. 38 (i)), requesting the Task Force on the Water-Food-Energy-Ecosystems Nexus, in cooperation with the Working Group on Integrated Water Resources Management, to prepare a thematic assessment focusing on the water-food-energy-ecosystems nexus with a view to its publication prior to the seventh session of the Meeting of the Parties (Budapest, 17–19 November 2015).

The document contains a chapter on major findings of the basin-level assessments of the water-food-energy-ecosystems nexus. The content of the chapter was discussed by the Task Force on the Water-Food-Energy-Ecosystems Nexus at its third meeting (Geneva, 28–29 April 2015).

The document, revised in accordance with any comments from the Working Group, will become a part of the final publication on the nexus assessment submitted to the seventh session of the Meeting of the Parties for its endorsement.

\* The present document is an unedited advance draft aimed to facilitate the discussions at the Working Group on Integrated Water Resources Management. Because of delays in the preparation process and resource constraints it requires more work.



## Contents

	<i>Paragraphs</i>	<i>Page</i>
I. Background and proposed action by the Working Group on Integrated Water Resources Management.....	1–5	4
II. Major findings of the basin-level assessments of the water-food-energy-ecosystems nexus .....	6–67	5
A. Introduction .....	6–9	5
B. The basins at a glance .....	10	5
C. The government context .....	11–27	7
D. Outlook for addressing the nexus based on cooperation.....	28–32	12
E. Selected drivers and pressures .....	33–35	13
F. State of the (nexus) resources and impacts .....	37–42	16
G. State of the nexus (intersectoral relations) in the basins .....	43	24
H. Selected solutions .....	44–67	25
III. Conclusions and recommendations .....	68–77	33
IV. Lessons learned .....	78–83	34
<b>Figures</b>		
1. Maps of the riparian relationships in the basins assessed.....		6
2. Renewable Water Resources (FAO Aquastat, latest country reports).....		18
3. Electricity by source.....		22
4. Net energy as a percentage of total energy use .....		23
5. Energy and water productivity (World Development Indicators, World Bank, 2011 and 2013 respectively .....		24
<b>Tables</b>		
1. Basic information on the river basins assessed .....		6
2. The legal basis and scope of cooperation in the basins assessed, from the perspective of water .....		7
3. Climate change related projections in the subregions where the assessed basins are located .....		13
4. Pressures on the environment and the impact of environmental degradation on human activities by basin and sector .....		14
5. Selected developments and tendencies relevant to the nexus in the assessed basins .....		16
6. Key characteristics of water resources, management infrastructure and use in the assessed basins .....		17
7. Mean river flows and flow variability .....		19
8. Selected information and indicators to characterize agriculture, land resource and irrigation in the assessed basins .....		20
9. Key characteristics of energy sources, production and cooperation frameworks in assessed basins .....		20
10. Selected indicators of energy production and consumption in the basins .....		22
11. The main nexus interlinkages and opportunities in each assessed basin .....		24
<b>Boxes</b>		
1. Progress in Integrated Water Resources Management .....		11

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2.	Strategic environmental assessment: a perspective tool to support intersectoral planning and consultation .....	26
3.	EU integration and accession in the Sava River Basin countries .....	27
4.	Changing household fuel use in Georgia to improve flood control downstream .....	28
5.	Increasing Renewable Energy Technology (RET) deployment to improve agriculture in the Syr Darya basin and help recharge the Aral Sea .....	29
6.	Multi-purpose reservoirs and smart management to increase the deployment of renewable energy; and other constraints in the Western Balkans.....	30
7.	Benefits of and potential constraints to introducing water-efficient irrigation.....	31

## I. Background and proposed action by the Working Group on Integrated Water Resources Management

1. An assessment of the water-food-energy-ecosystems nexus in a number of selected transboundary river basins is being carried out as part of the programme of work for 2013–2015 of the United Nations Economic Commission for Europe (ECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) (ECE/MP.WAT/37/Add.1, programme area 5). The objectives of the nexus assessment are:

(a) To foster transboundary cooperation, by identifying intersectoral synergies that could be further explored and utilized and by determining policy measures and actions that could alleviate tensions or conflicts related to the multiple uses of and needs for common resources;

(b) To assist countries to optimize their use of resources, increase efficiency and ensure greater policy coherence and co-management;

(c) To build capacity to assess and address intersectoral impacts.

2. The Task Force on the Water-Food-Energy-Ecosystem Nexus, established by the Meeting of the Parties to overview and guide the preparation of the nexus assessment and chaired by Finland, agreed on the main features of the assessment at its first meeting (Geneva, 8–9 April 2013). Notably it was decided that a scoping-level assessment of the nexus, covering all confirmed basins, would be mostly qualitative, involving the identification of linkages and major issues, substantiated by appropriate indicators. The methodology was to be generic, applicable to diverse river basins and to aquifers.

3. The present document summarizes the experiences from the three basins already assessed using the nexus approach: the Alazani/Ganikh, shared by Azerbaijan and Georgia; the Sava, shared by Bosnia and Herzegovina, Croatia, Montenegro, Serbia and Slovenia;<sup>1</sup> and the Syr Darya, shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan.

4. The methodology for the assessments is described separately (ECE/MP.WAT/WG.1/2015/8).

5. The Working Group on Integrated Water Resources Management may wish:

(a) To review and endorse in terms of content the findings and conclusions in the present document while inviting the concerned countries and stakeholders to provide any necessary revisions to these chapters by 15 July 2015, with the understanding that the chapter will be developed further;

(b) To express its appreciation to the countries, joint bodies and local experts that contributed information to and participated in the basin assessments;

(c) To entrust the secretariat, in cooperation with the Bureau and the Chair of the Task Force, to address the comments received, if any, add the information from the assessment of the Isonzo/Soča River Basin (subject to timely availability of the material and to agreement of the riparian countries on the content), combine the different chapters and finalize the thematic assessment for publication, including by performing the needed editing and shortening to meet editorial requirements, and subsequently to design, publish and print the assessment for submission to the Meeting of the Parties at its seventh session (Budapest, 17–19 November 2015). The thematic assessment will be presented as an official printed publication and not an official document to the Meeting of the Parties in order to facilitate and accelerate improvement of intersectoral coordination and related transboundary cooperation in basins around the world. The English original will be presented to the Meeting of the Parties, with French and Russian translations to follow.

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<sup>1</sup> A small part of the basin lies in Albania.

## II. Major findings of the basin-level assessments of the water-food-energy-ecosystems nexus<sup>2</sup>

### A. Introduction

6. This chapter provides an overview of key aspects and findings from the assessments of the water-food-energy-ecosystems nexus in three transboundary river basins. The basins assessed are:

- (a) The Alazani/Ganykh, a sub-basin of the Kura River Basin in the South Caucasus;
- (b) The Sava, a sub-basin of the Danube River Basin in South-Eastern Europe;
- (c) The Syr Darya, sub-basin of the Aral Sea Basin in Central Asia.

7. These three basins are in many ways very different, most obviously in terms of their size, the number of countries that share them and the level of cooperation. However, there are also a number of parallels between them: all three subregions—South-Eastern Europe, the Caucasus and Central Asia—include countries with economies in transition that need to strike a balance between economic development and the protection of the environment. There are common challenges related to the efficient management of resources, improving intersectoral coordination and having environmental considerations better reflected in sectoral policies. It is therefore illustrative to compare these basins by looking at the resource base, the main water management issues and the links to other sectors from a technical perspective as well as to the legal and institutional basis on the governance side. Without attempting to be comprehensive, the chapter highlights some common features of the possible solutions or synergic actions that could reduce frictions between the economic sectors or reduce the impact on the environment. It complements the short basin assessments which inevitably can only cover a part of the relevant information that came up in the nexus assessment process.

8. Overall, what can be concluded from each basin is influenced by, for example, the availability of information, the stage of the assessment process in each basin and the level of participation of the key authorities and other actors. The limitations of the methodology, which continued to be developed in the course of the assessment process, affected the quality and level of detail of the findings.

9. At the end of the chapter, some lessons learned and general conclusions are drawn.

### B. The basins at a glance

10. Figure 1 shows the size and position of the basins in relation to the riparian countries. Table 1 provides basic data on the basins.

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<sup>2</sup> The drafting of this chapter was supported by the following KTH experts: Prof. Mark Howells, Ms. Lucia de Strasser, Mr. Dimitris Mentis and Prof. Stephen Stec.

Figure 1  
**Maps of the riparian relationships in the basins assessed (not to scale)**

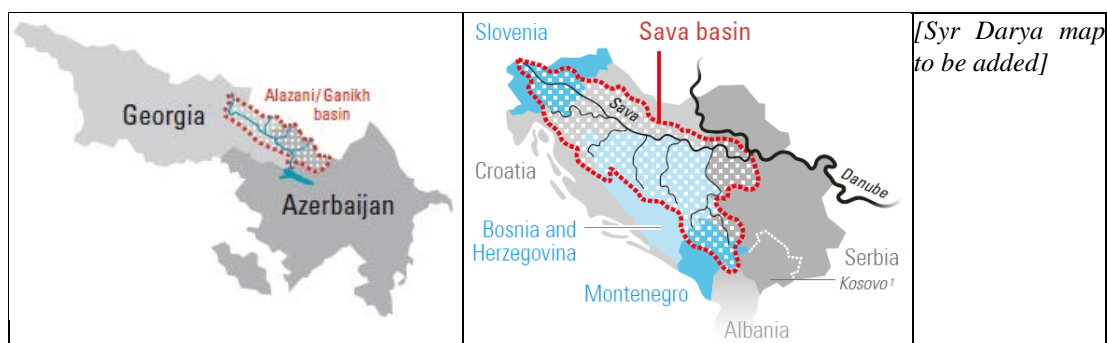


Table 1  
**Basic information on the river basins assessed**

	<i>Alazani/Ganykh</i>	<i>Sava</i>	<i>Syr Darya</i>
Size of the basin (square kilometres)	11,700	97,700	Estimates up to 782,600
Length of the river (kilometres)	391	945	3,019 <sup>a</sup>
Mean flow <sup>b</sup> (cubic metres per second)	110 m <sup>3</sup> /s	1,7722 m <sup>3</sup> /s	1,010 m <sup>3</sup> /s
Population (inhabitants)	854,500 (2013)	8,760,000 <sup>c</sup>	23,918,900 (2012)
Countries sharing (most upstream to most downstream, following the river)	Georgia, Azerbaijan,	Slovenia, Croatia, Bosnia and Herzegovina, Serbia. Catchment area in Montenegro and Albania	Kyrgyzstan, (Uzbekistan,) Tajikistan, Uzbekistan, Kazakhstan.
Climate	Warm temperate climatic zone.	Warm temperate climatic zone.	Arid/semi-arid climatic zone.
Main water uses	Irrigated agriculture, hydropower.	Hydropower and thermo-electric cooling, navigation.	Irrigated agriculture, Hydropower and thermo-electric cooling.
Main water management issues (non-exhaustive lists)	Erosion and sedimentation; flood management.	Hydropower expansion, point source pollution (insufficiently treated wastewaters); flood management.	Flow regulation (reconciling between hydropower and irrigation), diffuse and point source pollution.

<sup>a</sup> From the headwaters of the Naryn River.

<sup>b</sup> The mean discharge volumes shown are from the following locations: the Alazani/Ganykh—Ayrichay gauging station, Azerbaijan, Sava—at the river’s mouth, Syr Darya—Uchtepe-Kara Darya [*more accurate specification needed*]. Not all the values are from the mouth of the respective river, so they are only indicative of the magnitude. *Source:* ECE, *Our waters: Joining hands across borders* (United Nations, 2007); ECE, *Second Assessment of transboundary rivers, lakes and groundwater* (United Nations, 2011).

<sup>c</sup> Without Albania. *Source:* Draft Sava River Basin Management Plan

## C. The governance context

11. All of the countries<sup>3</sup> became independent upon or after the break-up of the Soviet Union and of Yugoslavia in 1991. This means that all basins became transboundary relatively recently, inheriting significant similarities in governance across riparians, but also social tensions and new political objectives, reflecting the needs of newly independent States.

12. The multiple-level governance of the resources in the water-food-energy-ecosystems nexus in each of the basins has distinct features. The discussion below focuses on those related to the regional setting and to transboundary cooperation. The governance context influences not only the potential for problematic nexus issues emerging or aggravating, but also how they can be addressed in and between countries through, for example, existing structures or procedure for intersectoral coordination

Table 2

### The legal basis and scope of cooperation in the basins assessed, from the perspective of water

<i>Aspect</i>	<i>Description</i>
<b>Alazani/Ganykh</b>	
Legal basis of (water) cooperation	Agreement between the Government of Georgia and the Government of Azerbaijan on Cooperation in Environmental Protection (1997). Memorandum of Understanding between the Ministry of Ecology and Natural Resources of Azerbaijan and the Ministry of Environment Protection and Natural Resources of Georgia (2007, signed).
Level of formality of cooperation, scope, functioning	A bilateral agreement on the transboundary waters of the the Kura River is being negotiated, which would provide for the establishment of a joint commission. Technical cooperation rather regular.
Scope of cooperation in terms of sectors	Technical cooperation on environmental protection (the new draft agreement proposes a multisectoral scope, including agriculture and energy).
<b>Sava</b>	
Legal basis of (water) cooperation	Framework Agreement of the Sava River Basin (2002) strengthened with: Protocol on the Prevention of Water Pollution caused by Navigation (2009, signed), Protocol on Flood Protection (2010, signed). Protocol on Sediment Management (text finalized in January 2015).
Level of	A multisectoral basin commission (International Sava River Basin

<sup>3</sup> Except Albania.

<i>Aspect</i>	<i>Description</i>
formality of cooperation, scope, functioning	Commission), with subsidiary bodies, operates regularly; 4 riparian countries are Parties, 1 is an observer. <sup>a</sup>
Scope of cooperation in terms of sectors	River basin management, navigation, hazards, tourism.
<b>Syr Darya</b>	
Legal basis of (water) cooperation	Agreement on Cooperation in Joint Management of Use and Protection of Water Resources of Interstate Sources. Establishment of the Interstate Commission for Water Coordination of Central Asia (1992). <sup>b</sup>  Agreement on Joint Actions to Address the Problems of the Aral Sea and Sub-Aral Area, Environmental Rehabilitation and Socio-Economic Development of the Aral Region (1993). <sup>c</sup>  <i>[Agreement on the Use of Water and Energy Resources in the Syr Darya River basin (1998)].</i>
Level of formality of cooperation, scope, functioning	Basin organization (Syr Darya Basin Water Organization) in practice does cover the whole basin at present.
Scope of cooperation in terms of sectors	Earlier water and energy at the basin level; now practically no cooperation.

<sup>a</sup> Montenegro has an observer status. Albania's share of the river basin is small.

<sup>b</sup> Turkmenistan is also a Party to this agreement

<sup>c</sup> This agreement, to which Turkmenistan is also a Party, established the Intestate Council on the Problems of Aral Sea Basin (now absorbed by the International Fund for Saving the Aral Sea)

### **Regional and basin level frameworks for cooperation**

#### *Energy*

13. As energy and other products relevant to the nexus are traded at the regional level and the regional setting influences the governance, it is important to consider the subregional frameworks where the basins are located.

14. Azerbaijan is an important producer and exporter of fossil fuels at the global level, while Georgia is mainly rich in hydropower, the potential for which is largely untapped. Energy trading between the countries comprises mainly the import of oil and natural gas by Georgia or its transfer through Georgia. At the border in the Alazani/Ganykh basin, natural gas is being sold and transferred to Georgia.

15. The Energy Community Treaty (entered into force in 2006) provides for the creation of an integrated energy market (electricity and gas) among the European Union (EU) member States and other contracting parties. All the Sava River Basin countries belong to the Energy Community either as EU member States or as parties to the treaty. The European Council adopted the 2030 Framework for Climate and Energy Policies that includes targets on, for example, greenhouse gas emissions, the share of renewable energy and energy efficiency. A new governance framework based on national plans for competitive, secure and sustainable energy is also proposed, which may eventually increase the say of the EU in its member States' energy trade deals.



16. The Central Asian Power System (CAPS), the regional electricity grid, connects all the countries in the Syr Darya Basin but is not fully functional at present. Due to political disagreements, it is not possible at the present time, for all countries to receive or transmit electricity from their neighbouring country although physically the connections would not be difficult to restore. Despite the importance of hydropower in the region, subregional frameworks for water cooperation have not included energy authorities. Lately electricity and fossil fuels have been traded on a bilateral basis between the Syr Darya countries.

17. The countries of both the Caucasus and the Syr Darya River Basin are important energy trade corridors, or are increasingly turning into such with projects leading to construction of new pipelines or grid extensions.<sup>4</sup> The development of infrastructure for energy trade is expected to shape the relationships between the countries and their cooperation opportunities. In particular, oil and gas pipelines and electricity grids are being expanded from the Syr Darya Basin countries to supply large external markets such as China and South Asia.

18. An uneven distribution of different energy sources is a common feature of the three regions. Promoting and improving energy trade is highly beneficial because it turns this asymmetry into a mutually beneficial complementarity. The countries with higher reserves of fossil fuels have to date enjoyed a higher level of energy security and, in some cases, stronger economic growth, but now face the important challenges of reducing emissions and advancing sustainable development. Trade not only helps ensuring security of supply and boosting economic growth, it also facilitates the gradual introduction of renewable energies (other than hydropower) in the energy mix of each of the countries. Wind and solar power are by nature intermittent and benefitting from them requires that the energy system has the necessary elements for integration of renewables and includes more stable sources of energy. Even hydropower generation is subject to the variability of river flows.

#### *Water*

##### *Alazani/Ganikh*

19. Though Azerbaijan and Georgia have a number of bilateral treaties and agreements, the degree of realization of these agreements, especially the items concerning water resources management, remains low and actions are rarely undertaken. The countries have participated in many international programmes and technical assistance projects on the Kura-Araks River, with some progress having been achieved. However, no official working group or intergovernmental agency has been created with the purpose of systematically monitoring or supporting the implementation of the agreements, or the signing of an additional one foreseen in the Agreement in the field of environmental protection between Georgia and Azerbaijan.<sup>5</sup>

20. A bilateral agreement on the transboundary waters that the two countries share in the Kura Basin is currently under negotiation. If the Kura-agreement under negotiation between Azerbaijan and Georgia is concluded, different water-using sectors may be engaged in its implementation.

##### *Sava*

21. The Framework Agreement on the Sava River Basin (FASRB) between Croatia, Bosnia and Herzegovina, Serbia and Slovenia, signed in 2002 and in force since 2004,

<sup>4</sup> For example, high-voltage transmission lines are being planned or developed to export electricity produced in Central Asia to China<sup>18</sup> and South Asia (CASA 1000 Project)

<sup>5</sup> Agreement between Governments of Georgia and Azerbaijan on Cooperation in the Field of Environmental Protection (signed in Baku, on 18 February 1997). *Source:* [www.unecce.org/fileadmin/DAM/env/water/npd/Transboundary\\_Water\\_resources\\_Management\\_Problems\\_in\\_Georgia\\_Eng.pdf](http://www.unecce.org/fileadmin/DAM/env/water/npd/Transboundary_Water_resources_Management_Problems_in_Georgia_Eng.pdf)

stands out as a successful example of transboundary cooperation in South-Eastern Europe. This cooperation integrates most aspects of water resources management. Three protocols to FASRB have been signed so far, a fourth one was finalized in January 2015 and a fifth protocol are in different stages of preparation. The International Sava River Basin Commission (ISRBC) has been established, with the legal status of an international organization, for the purpose of the implementation of FASRB and the realization of the following mutually agreed goals: (i) the establishment of an international navigation regime on the Sava and its navigable tributaries, (ii) the establishment of sustainable water management, and (iii) the undertaking of measures to prevent or limit hazards and to reduce or eliminate their adverse consequences. FASRB gives to ISRBC the international legal capacity for making decisions in the field of navigation and providing recommendations to the countries on all other issues.<sup>6</sup>

22. Compared with other institutions for transboundary cooperation in water management, the mandate of ISRBC is thematically broad. Further integration of water policy with other sectoral policies, as well as further dialogue with key sectoral stakeholders, have been foreseen in the Strategy on Implementation of FASRB as specific objectives in the field of river basin management.

23. The Sava Basin riparian countries participate also in cooperation in the field of water management at the level of the Danube River Basin, which was formalized earlier. The Sava and Danube Basins are among the few river basin districts where the EU Water Framework Directive is applied, and river basin management plans coordinated, with the participation of countries that are not EU member States. The ISRBC has also played a role in the implementation of the EU Strategy for the Danube Region.

24. Regional cooperation on the Danube is governed in part by two important conventions: the Danube River Protection Convention (DRPC), under which the International Commission for the Protection of the Danube River (ICPDR) was established; and the Convention Regarding the Regime of Navigation on the Danube (Belgrade Convention), under which the Danube Commission was established. FASRB serves as a multilateral agreement for implementation of the Water Convention, as well as dealing with other issues such as navigation. Therefore, it bears a relationship to both DRPC and the Belgrade Convention. Cooperation between ISRBC, ICPDR and the Danube Commission is based formally on memoranda of understanding, which provide opportunities for close cooperation and coordination. By means of mutual participation at sessions, expert group meetings and other events of the commissions, coordination of the activities is enhanced.

#### Syr Darya

25. The legal framework for water cooperation in the Central Asia subregion, between the Aral Sea riparian countries including those sharing the Syr Darya Basin, was put in place in the early 1990s, building on the Soviet-era allocation of water. A Basin Water Organization (BWO) was set up in 1986 to solve problems of competing claims by downstream and upstream countries in a unified water-energy system. According to the statutes agreed upon in 1992, the BWO Syr Darya, an executive body of the Interstate Commission for Water Cooperation, should fairly and rationally allocate water between different water uses. The 1998 Agreement on the Use of Water and Energy Resources in the Syr Darya River basin referred to existing institutional structures of management of Syr Darya. During the past decade, the agreed arrangements on water allocation have not been fully implemented or it has proven impossible to agree on water allocation. One limitation arises because the energy sector (hydropower, more precisely) is not addressed by the existing subregional organizations engaged in water management cooperation. A lack of trust has reduced the participation of the riparian countries in the operation of BWO. Consequently, as the geographical competence of BWO in practice is limited to the middle

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<sup>6</sup> Strategy on Implementation of the Framework Agreement on the Sava River Basin. Zagreb, International Sava River Basin Commission, April 2011.

part of the watercourse only, the restoration and enhancement of the functioning of BWO is needed. At present there is no bilateral institutional cooperation between basin States regarding the waters of the Syr Darya, although international assistance has supported bilateral interstate negotiations on the Agreement on Cooperation in the Use of International Rivers between Kyrgyzstan and Tajikistan, within a project that also proposed the establishment of a joint commission.

Box 1

**Progress in Integrated Water Resources Management**

The Sava countries, depending on their relationship to EU, have adopted the preparation of river basin management plans to different degrees: the EU member States, Croatia and Slovenia, are obliged to fully implement WFD, while the others have acquired valuable experience through participation in the preparation of the first draft plan of the Sava River Basin.

The countries of the Caucasus and Central Asia had experience of river basin management in the Soviet period. The Schemes of Integrated Use and Protection of Water Resources had similar features to integrated water resources management (IWRM), but were not developed by applying a participatory process and did not properly address environmental issues. Application of the basin approach, i.e., the transition from using administrative borders to boundaries of hydrographic basins is gradually getting introduced in these subregions.

Comprehensive IWRM plans are lacking for the time being in Azerbaijan and Georgia. However, the new Water Code for Georgia, which is at present subject to public consultations, will introduce a river basin approach and by-laws to put more integrated management of water resources into place.

Azerbaijan is also in the process of developing its national legislation to support the transition to a basin management approach. The National Water Strategy incorporates various aspects of water management, but has proven to be challenging to complete and adopt.

The introduction by legislative reforms of basin management in the Syr Darya riparian States requires the creation of basin-based organizations that will be able to develop river basin plans. The introduction of governing institutions at the basin level was initiated in Kazakhstan from 2005 to 2008 (River Basin Councils), in Uzbekistan from 2003 (Basin Irrigation System Authorities) and in Kyrgyzstan in 2008 (Talas Basin Council). In Tajikistan the establishment of such structures is underway. At present, the river basin councils in Kazakhstan have an advisory role to the basin inspectorates.

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*Source:* ECE and OECD. Integrated Water Resources Management in Eastern Europe, the Caucasus and Central Asia: European Union Water Initiative National Policy Dialogues progress report 2013. New York and Geneva, United Nations, 2014.

26. Due to their mandates covering different economic sectors and also having duties related to environmental protection, local authorities would in principle be in a position to integrate the work of different sectors. However, adequate guidance, oversight and resources need to be provided from higher level of administration, to ensure coherency of policies between and local and the national levels. A good level of decentralization, responding to the local needs while at the same time avoiding fragmentation is difficult to strike.

27. The need for policy coherence manifests itself at different levels:

- (a) In the Alazani/Ganykh:
  - (i) At basin level, between energy access, reforestation plans and basin management,
  - (ii) Between the district level and central Government in Georgia, between land-use planning and the repair and maintenance of infrastructure;
- (b) In the Sava:
  - (i) At the basin level, between flood protection and sediment and erosion control,
  - (ii) Between and within countries, between hydropower development , climate mitigation and environmental protection;
- (c) In the Syr Darya:
  - (i) At the basin level for optimization of reservoir regimes and cooperation on water quality,
  - (ii) Within countries, between energy, food security and water management (in terms of efficiency).

#### **D. Outlook for addressing the nexus based on cooperation**

28. Because of the different levels of cooperation in each of the three basins, the opportunities vary for evaluating the possible actions to reduce negative impacts across sectors and capitalizing on synergies.

29. In the Alazani/Ganykh, transboundary cooperation is now being built between the two countries, while in the Sava it is quite advanced, with ISRBC offering an established platform for cooperation across countries. In the Syr Darya, the institutional capacity to advance transboundary cooperation exists but its implementation is currently compromised by a general lack of trust between the countries.

30. The identification of solutions and their associated benefits reflects on the possibilities of how a nexus assessment would help advancing cooperation in their respective basins. In particular, the discussion on nexus solutions in the Alazani/Ganykh Basin it focused largely on identifying general main sectoral and intersectoral interventions needed that would provide elements for future cooperation in the basin. If the agreement under negotiation between Azerbaijan and Georgia on the waters of the Kura River with the actually envisaged scope is concluded, it would provide a basis for different sectors using water to be taken into account in its implementation.

31. In the Sava, the background of cooperation within the mandate of ISRBC made it more interesting to explore how the existing cooperation could be improved and in particular how to better involve the sectors of energy and agriculture in the dialogue over transboundary water management. This was done by investigating opportunities for advancing intersectoral coordination and policy coherence (including better accounting for environmental impacts) at the level of governance, while at the same time setting up the basis for some supporting quantitative analysis. The analysis involved modelling implications of energy sector developments on water resources in the basin (generation capacity expansion, meeting targets related to renewable energies), which could be further developed in collaboration with experts.

32. In the Syr Darya, where improving cooperation requires first its restoration, it was interesting to focus the discussion more on national policies, and how these could be pursued without compromising transboundary relations or even helping its recovery. In the Syr Darya basin, opportunities related to energy and trade cooperation, offering a wider range of benefits, could potentially allow taking a more constructive direction from the current “zero-sum” row over water allocation.

## E. Selected drivers and pressures

### Climate change

33. Climate change, as a global phenomenon, is projected to impact all river basins. It may in some cases (or at certain times) aggravate intersectoral impacts, for example through increasing water requirements in irrigated agriculture or affecting hydropower generation by reduced or more variable flows. An overview of the expected impact across the basins is provided in the following table.

Table 3

#### Climate change related projections in the subregions where the assessed basins are located

<i>By 2050</i>	<i>Caucasus</i>	<i>South-Eastern Europe</i>	<i>Central Asia</i>
<i>Various sources</i>	<i>(Alazani/Ganykh)</i>	<i>(Sava)</i>	<i>(Syr Darya)</i>
Temperature change	+1.7°	+1.8°	+2°
Rainfall change (annual)	not all models agree	seasonal changes, decrease in summer	precipitation intensity will increase (but not all models agree on mean annual precipitation)
Runoff change (annual)	especially in late summer and early autumn, affecting tributaries of the Alazani/Ganykh (Medea Inashvili, 2013).	some sections of the Sava will see a decrease of mean annual discharge (ICPDR, 2012).	decrease by 12%
Water scarcity <sup>a</sup> aggravated	not on large scale at Alazani/Ganykh basin level. (Medea Inashvili, 2013).	not on large scale at Sava basin level	acute in some areas at Syr Darya basin level

*Source:* (unless specified otherwise) WB & GFDRR, 2009.

<sup>a</sup> The remarks on water scarcity in this table are limited to the evolution of the physical availability. Even more important, especially in the shorter term, is how the different water uses will develop. For example, increased evapotranspiration because of an increase in temperature may lead to increased water demand for irrigation.

### Other pressures from economic activities

34. Pressures on the environment and the impact of environmental degradation on human activities for the different basins are synthesized in the following table, sector by sector.

Table 4  
**Pressures on the environment and the impact of environmental degradation on human activities by basin and by sector**

<i>Pressures</i>	<i>Impacts</i>
<b>Alazani/Ganykh</b>	
Settlements	Flash floods cause damage to constructions. Lack of wastewater treatment affects water quality.
Energy	Expansion of hydropower is not possible in upper tributaries of the river because of geological conditions. In other parts of the basin, degradation of the hydrological regime can compromise its development. Lack of energy access in Georgia aggravates deforestation and indirectly exposure to flash floods.
Industry	Agro-industry (especially wine production) the most important industry in the basin. Old storage of pesticides still affecting soil quality but this problem is being contained.
Agriculture	Flash floods cause damage to irrigation schemes, which are in need of rehabilitation. High amounts of fertile soil are washed away in these events, increasing sediment loads in the river.
Tourism	The existing potential for tourism – especially in the wine region of Georgia - is compromised by environmental degradation and lack of appropriate infrastructure. Also because of its rich biodiversity, the potential for tourism in the basin is high.
<b>Sava</b>	
Settlements	Flood episodes can be devastating, affecting cities and smaller settlements along the river. Lack of adequate wastewater treatment in many areas of the basin.
Energy	Targets for renewables and climate mitigation push the countries to develop more hydropower while there are environmental concerns regarding the construction of new dams in environmentally sensitive areas. Extreme flood events can cause damage to coal mines, affecting security of fuel supply. Although is not clear how much hydropower will be affected by climate change, thermal power plants will likely need to be shut down more frequently, either because of low water availability or increased water temperature (ICPDR, 2012).
Industry	Various types of industry, of which chemical sector and intensive livestock production are important contributors to water quality degradation.
Agriculture	Irrigation is not developed in the basin at present time and represents a minor water user. Because of this, crops are highly exposed to droughts.
Tourism	River tourism has developed favourably, and could benefit from improved environmental quality if wastewater discharges and sedimentation are controlled better. River tourism and hydropower development are not necessarily compatible.

<i>Pressures</i>	<i>Impacts</i>
<b>Syr Darya</b>	
Settlements	Population in the basin can experience energy and/or food insecurity, especially in the upstream countries. Lack of access to alternative sources of water, energy and food increases environmental degradation by aggravating deforestation, building wells potentially providing unsafe water or exploiting groundwater reserves without control, increasing dependency on subsistence agriculture.
Energy	The almost complete reliance on hydropower in upstream countries makes them very exposed to production capacity reduction in dry years.  Lack of cooling water can undermine thermal production as well.
Industry	Various types of industry – from extractive industry to manufacturing and construction, to petro-chemical and agro-industry – all lacking proper wastewater treatment.
Agriculture	Irrigated agriculture is the main water consumer in the basin. Extensive use of water for irrigation and large water losses will aggravate water scarcity in water scarce areas with impact on water supply to settlements and fields, in particular downstream.
Tourism	Not developed much in the basin and not seen as having high potential.

35. The main economic activities relevant to the nexus are described in the following section. That information details further this brief synthesis of the pressures.

36. Some of the overall tendencies, as relevant to the nexus, are summarized in the table below. Energy demand is expected to increase in all the subregions concerned. For the Sava riparian countries, by 2020, increases of 15 per cent or more in energy demand are projected nationally, with the exception of Serbia which projects a minor decrease.<sup>7</sup> In all the basins, hydropower is envisaged to play an important role in meeting the increase.

<sup>7</sup> Document WG.1/2015/INF.5, notably table 8, can be referred to for details.

Table 5  
**Selected developments and tendencies relevant to the nexus in the assessed basins [To be completed]**

<i>Basin</i>	<i>Alazani/Ganikh</i>	<i>Sava</i>	<i>Syr Darya</i>
	<ul style="list-style-type: none"> <li>- increased development of hydropower</li> <li>- access to water supply and sanitation getting extended</li> </ul>	<ul style="list-style-type: none"> <li>- Integration to the EU acquis communautaire and markets</li> <li>- increased energy demand projected</li> <li>- renewable energy targets</li> <li>- agricultural water use expected to increase</li> </ul>	<ul style="list-style-type: none"> <li>- Variable trends on irrigated agriculture: KZ stable (no expansion planned); KG minor expansion; TJ expansion planned; in UZ the irrigated area decreasing</li> <li>- striving for taking new technologies and increasing productivity, but no concrete plans spelled out</li> <li>- small hydro use increasing, but not rapidly</li> <li>- Large hydropower: Kamarata is expected to be built soon, will change the regime; building of the Upper Naryn cascade further in the future</li> <li>- minimal efforts to introduce wastewater treatment</li> <li>- need for agriculture to cope with hydrological extremes increases</li> <li>- energy demand will increase significantly</li> <li>- degradation reduces agricultural land resource</li> </ul>

## F. State of the (nexus) resources and impacts

37. The state of the resource base and possible scarcity of the resources needs to be seen in the wider perspective of the countries sharing the basin. The national policies and management practices affect the degree of development and use of each resource as well as implications to other sector. Sectoral policies may integrate environmental concerns, improving environmental sustainability of resource use.

### Water resources

38. Some key aspects and indicators related to water resources are reported in table 6.



Table 6  
**Key characteristics of water resources, management infrastructure and use in the assessed basins**

<i>Aspect of the water resource or its management</i>	<i>Description</i>
<b>Alazani/Ganikh</b>	
Water resource base of the countries	Georgia has large freshwater resources. Azerbaijan is more arid than Georgia and relies heavily on transboundary inflow from Georgia and other countries.
Water scarcity in the basin <sup>a</sup>	Water scarcity for the time being is not an issue.
Water infrastructure in the basin	Irrigation schemes in the plain – mainly functioning with gravity flow. The Alazani/Ganykh discharges to the Mingechevir Reservoir on the Kura River. The associated dam is the largest for hydropower generation in the region. Most of the hydropower installations on the Alazani/Ganikh are small and medium-sized, type run-of-the-river (without impounding the flow)
Largest water-consumptive use	Irrigation (including high losses).
<b>Sava</b>	
Water resource base of the countries	Croatia and Bosnia and Herzegovina are the richest countries in terms of internal water resources, followed by Montenegro and Slovenia and finally Serbia. The transboundary waters of the Sava are vital for all countries.
Water scarcity in the basin	Water scarcity for the time being is not an issue, although climate change studies generally predict scarcity to increase.
Water infrastructure in the basin	Irrigation not developed to a large degree. Hydropower plants, with large potential still unexploited.
Largest water-consumptive use	Thermal and nuclear power plants.
<b>Syr Darya</b>	
Water resource base of the countries	Some countries highly dependent on external resources for water security. For example, the whole country of Uzbekistan and the South region of Kazakhstan would be in conditions of absolute scarcity without the inflow of transboundary waters (EDB, 2014). Most of the Syr Darya's flow is generated in Kyrgyzstan.
Water scarcity in the basin	Water scarcity is an issue in some areas (either in absolute or relative terms).
Water infrastructure in the basin	River completely regulated. Dams, reservoirs, counter-regulators. Large hydropower plants (the largest dam, Toktogul, is located on the Naryn tributary in the upstream part of the river). Large irrigation schemes in the mid-stream and downstream. Extensive and complex (and energy consuming) pumping and

Aspect of the water  
resource or its  
management

Description

drainage systems.

Largest water-  
consumptive use

Irrigation (including high losses).

<sup>a</sup> See “Resource Scarcity” in the glossary of terms.

Figure 2  
**Renewable Water Resources (FAO Aquastat, latest country reports)**

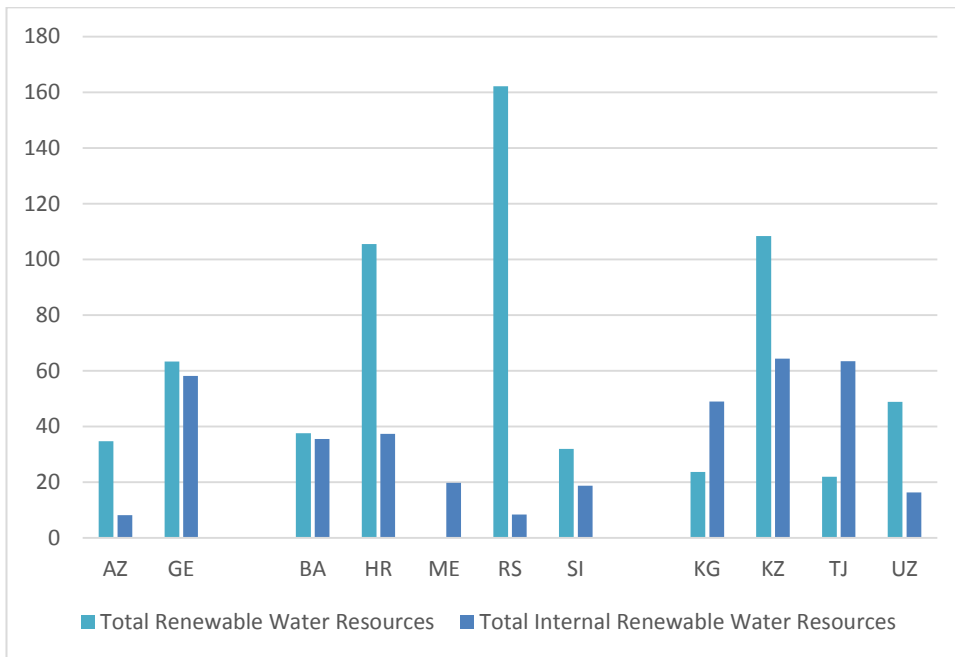


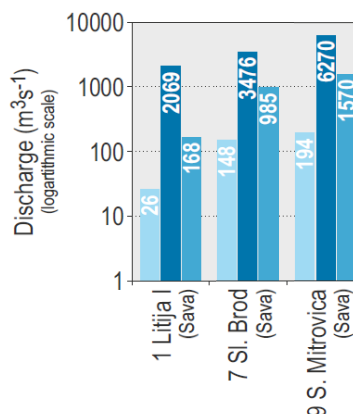
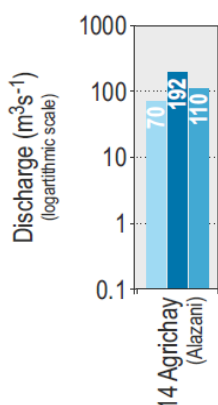
Table 7

**Mean river flows and flow variability** At all of the gauging stations on the Sava River, the relative variability between the minimum, mean and maximum flows observed is much more significant than on the Alazani/Ganikh.

Flow	Alazani/Ganikh	Sava	Syr Darya
Mean flow (m <sup>3</sup> /s)	47.5 (Shakriani – Georgia) 110 (Ayrichay - Azerbaijan)	168 (after Ljubljana - Litija I) 1,7722 (at its mouth)	1,010 (Uchtepe – Kara Darya) 66 (mouth of Ters river – Chaktal)

Flow variability

$Q_{av}$   
 $Q_{max}$   
 $Q_{min}$



39. Regarding table 7, it should be noted that the Sava receives large tributaries (e.g. the Drina) and becomes bigger at its mouth, where it discharges in the Danube. Similarly, the Alazani receives tributaries all along its course, in the plain. For the Syr Darya instead, the average flow is lower downstream. This is because the river is highly diverted along its course and from a certain point it does not receive significant tributaries.

#### Land/agriculture

40. Agriculture is a major sector in all basins in terms of employment, but it has very different features in terms of production and economic relevance in the different basins and countries. For example, the Georgian part of the valley of the Alazani/Ganykh is famous for wine production. Although a variety of other crops is also grown in the region, grape production and wine making and also in the touristic sector that is developing around wine tasting are key sectors for local employment and economic development. The Sava basin hosts most of the agriculture and agro-industry of the region. Currently the share of water used for agriculture and for irrigation in particular is very limited but it is expected to expand. In the Syr Darya Basin, irrigated agriculture is a very important economic sector as a large part of population is employed in the agricultural sector or depend on subsistence agriculture. Irrigation systems are extensive, serving mainly cotton and wheat cultivation, and the agricultural sector is the major consumptive water user in the basin.

Table 8

**Selected information and indicators to characterize agriculture, land resource and irrigation in the assessed basins**

<i>Basin</i>	<i>Alazani/Ganikh</i>	<i>Sava</i>	<i>Syr Darya</i>
	Grape most economically relevant crop in the Georgian side	In order of importance: corn and wheat production, oil plant production (soy and sunflower), orchards and vineyards.	Large monocultures. Historically, cotton for export. Nowadays, decrease in cotton and parallel increase in wheat.
Land use/land cover <sup>a</sup>	[For the Georgian part, at least, some agricultural and wood coverage statistics can be added]	35% cultivated 15% grassland/shrubland 49% forest 1% others	57% surface with little or no vegetation 19% grassland/shrubland 21% cultivated 2% water bodies
Water used for irrigation (million m <sup>3</sup> /year)	490	30	45,000
Irrigation per capita (million m <sup>3</sup> /year per person living in the basin)	574	3	1,881

<sup>a</sup> Second Assessment

**Energy**

41. In all the basins there is active hydropower development that may affect other water uses or the environment. However, the scale is very different: in the Syr Darya Basin large scale dams and reservoirs are operated and are still in the plans for energy development. In the Sava Basin it is mainly small and medium scale hydropower plants that are developed. In the Alazani/Ganykh Basin, the hydropower potential is still to be assessed in more detail and the geological conditions pose challenges to construction.

Table 9

**Key characteristics of energy sources, production and cooperation frameworks in assessed basins**

<i>Aspect of the energy sector</i>	<i>Description</i>
<b>Alazani/Ganykh</b>	
Energy source base of the countries	Azerbaijan is rich in fossil fuels (oil, natural gas mainly) and is a world leading exporter. Georgia rich in hydropower, largely unexploited.
Energy production in the basin	Hydropower production exists and has potential to expand but there are limitations to its development where slopes are prone to mudslides. <sup>a</sup> Other renewable sources are limited to small installations.
Energy cooperation	Fossil fuels (natural gas) import from Azerbaijan to Georgia.

<i>Aspect of the energy sector</i>	<i>Description</i>
frameworks	
<b>Sava</b>	
Energy source base of the countries	Some countries rich in fossil fuels and others in hydropower. Coal is an important share of energy production in Serbia, Bosnia and Herzegovina and Slovenia. Nuclear is important only in Slovenia. Montenegro has a large unexploited hydropower potential.
Energy production in the basin	Energy production is a very important sector (both hydropower and thermal and one nuclear plant) and expansion of capacity is planned in every country's share. Other renewable energies are currently underdeveloped but all countries are committed to expand their share of renewables and likely these will be produced in the basin area.
Energy cooperation frameworks	Energy Community; increasingly the EU market.
<b>Syr Darya</b>	
Energy source base of the countries	Kazakhstan and Uzbekistan are rich in fossil fuel. In particular, Kazakhstan holds and exports oil and coal reserves that are among the largest in the world –and is a leading exporter of oil - and Uzbekistan is rich in natural gas. Kyrgyzstan and Tajikistan are rich in hydropower. Reserves of fossil fuels found in in Kyrgyzstan and Kazakhstan are not easily exploitable.
Energy production in the basin	From an energy production perspective, the Syr Darya basin is vital for Kyrgyzstan, which is also planning to expand its hydropower capacity there. Thermal production is also present. Small hydropower well developed. Significant potential for developing other renewables (e.g. wind and solar) currently unexploited.
Energy cooperation frameworks	Central Asian Power System (CAPS), the regional electricity grid, currently not functioning due to some disconnections; bilateral trade deals.

<sup>a</sup> The actual hydropower potential is under evaluation by the Ministry of Energy of Georgia.

Table 10  
**Selected indicators of energy production and consumption in the basins**

<i>Basin</i>	<i>Alazani/Ganikh</i>	<i>Sava</i>	<i>Syr Darya</i>
Electricity production (country level) kilowatt hours billions	AZ: 20.3 GE: 10.2	BA: 15.3 HR: 10.7 ME: 2.7 RS: 38.0 SI: 15.9	KG: 15.2 KZ: 86.6 TJ: 16.2 UZ: 52.4
Hydropower in the basin <sup>a</sup> (megawatts)	38 installed capacity; 117 planned.	2,188 installed capacity; 3,358 planned.	4,614 installed capacity; 2,525 planned.
Total primary Energy Consumption per capita (million BTU per person) <sup>b</sup> (country level)	AZ: 58 GE: 38	BA: 91 HR: 77 ME: 62 RS: 100 SI: 153	KZ: 150 KG: 44 TJ: 26 UZ: 78

<sup>a</sup> Sources for Alazani/Ganykh: data from experts; for Sava there are various sources, document WG.1/2015/INF.11 can be referred to for details; for Syr Darya ADB , 2012.

<sup>b</sup> United States Energy Information Administration (www.eia.gov)

Figure 3  
**Electricity by source (by country)**

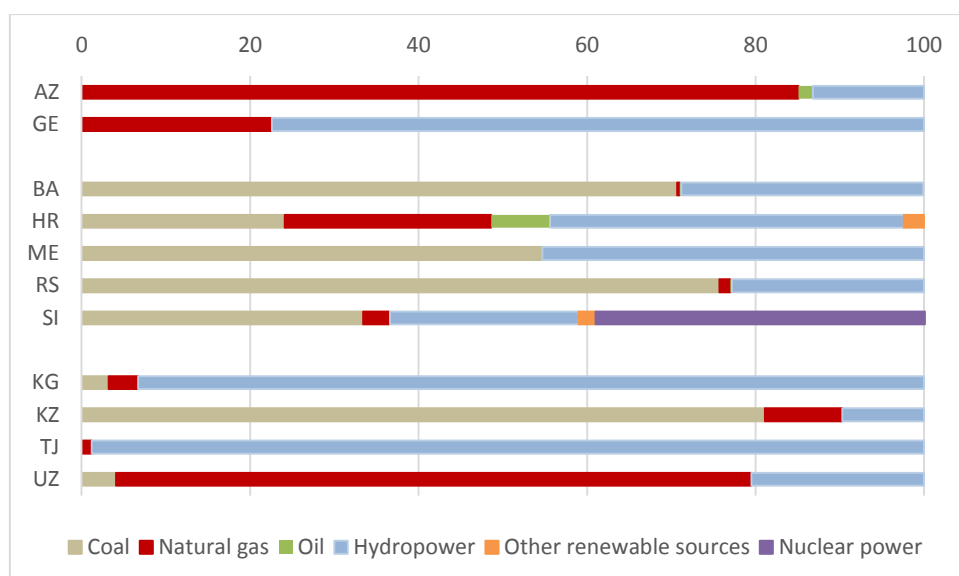
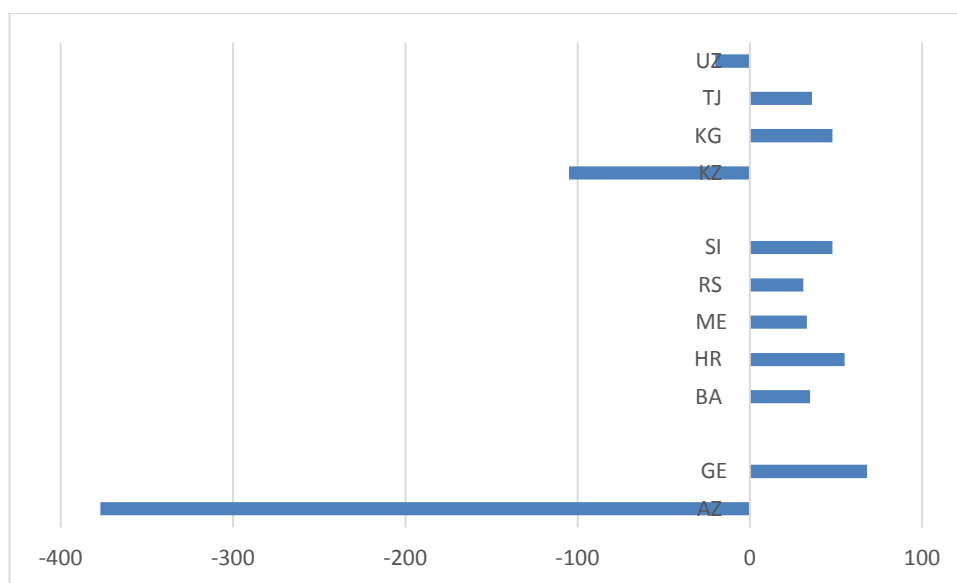


Figure 4  
**Net energy imports as a percentage of total energy use (%) (WDI, World Bank, 2011)**



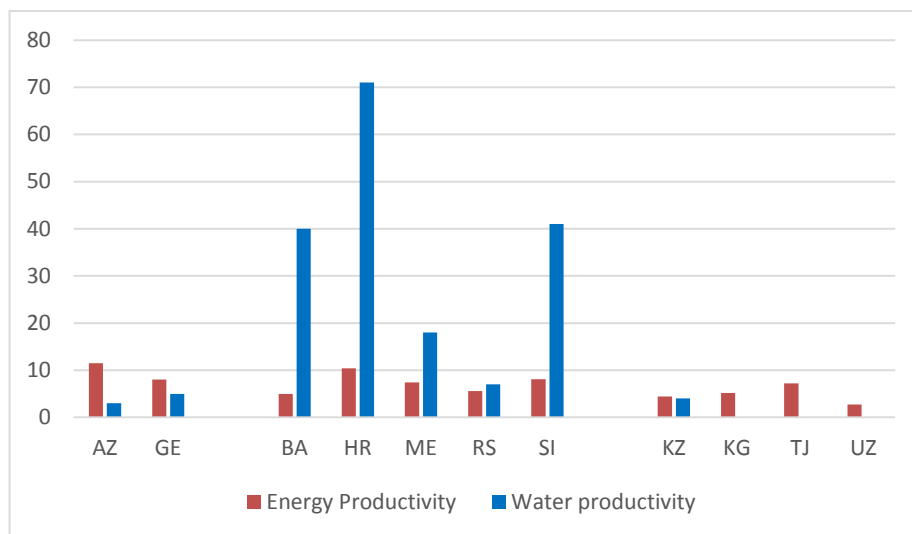
42. The energy and water productivities for the countries sharing the assessed basins is shown in figure 5. A low value of productivity indicates that the amount of resource used is high (energy or water) compared to the GDP generated. In particular:

(a) The countries of the Sava have high values of water productivity, compared to the other basins. This indicates that the water use is lower and in some cases GDP is higher than that of the other countries;

(b) Energy productivity is of the same order of magnitude in all countries. However, it can be noted that productivity in Tajikistan is relatively high, despite the fact that its GDP is the lowest. This means that its total energy used is very low;

(c) The difference between the two large exporting countries is due to Kazakhstan having a significantly higher internal consumption of energy, even though its GDP is almost three times higher than that of Azerbaijan..

Figure 5  
**Energy and water productivity<sup>8</sup> (World Development Indicators, World Bank, 2011 and 2013 respectively)**



**G. State of the nexus (intersectoral relations) in the basins**

43. The dialogue with stakeholders on intersectoral issues and opportunities was very broad and touched upon many aspects of the nexus, in all basins. For each basin however, there is one storyline that can be taken as most representative of current developments and intersectoral challenges.

Table 11  
**The main nexus interlinkages and opportunities in each assessed basin**

<i>Aspect</i>	<i>Description</i>
<b>Alazani/Ganykh</b>	
Main nexus storyline	Lack of energy access aggravates deforestation, which increases the exposure to flash floods, erosion and landslides. A poor maintenance of irrigation systems aggravates the impact of flash floods on loss of fertile soil and damage to settlements.
Key sectors	Settlements, forestry and water (hydrology and water supply for irrigation)
Main nexus interlinkages	Water-energy (hydropower), land-energy-water (biomass use, erosion/sedimentation, hydrological flow).
Main nexus opportunities	Facilitate access to modern energy sources and energy trade; minimize impacts from new hydropower development; catchment management to control erosion.
Adaptation options with	Enhanced reforestation upstream. Regular clean-up of sediments.

<sup>8</sup> Water productivity, total (constant 2005 US\$ GDP per cubic meter of total freshwater withdrawal). Water productivity is calculated as GDP in constant prices divided by annual total water withdrawal. GDP per unit of energy use (PPP \$ per kg of oil equivalent). GDP per unit of energy use is the PPP GDP per kilogram of oil equivalent of energy use. PPP GDP is gross domestic product converted to current



<i>Aspect</i>	<i>Description</i>
multisectoral benefits	
Sava	
Main nexus storyline	Energy production in the riparian countries heavily depends on water availability in the Sava basin. Targets for renewables and climate mitigation push the countries to develop more hydropower but there are environmental concerns for dam construction in environmentally sensitive areas.
Key sectors	Energy (hydropower, thermal and other renewables) and environment
Main nexus interlinkages	Water-energy (hydropower); land-water (sediment management).
Main nexus opportunities	Expand hydropower sustainably and integrate other renewable energies.
Adaptation options with multisectoral benefits	Early warning for floods and better land use planning. Drought resilient crops.
Syr Darya	
Main nexus storyline	Energy and food insecurity are drivers for conflicting seasonal water uses and make the countries prioritise self sufficiency over cooperation. This aggravates the current situation of sub-optimal use of resources.
Key sectors	Energy (hydropower, other renewables and trade), agriculture (irrigation schemes and trade)
Main nexus interlinkages	Water-land-ecosystems (irrigation, salinization), water-energy (hydropower), land-ecosystems.
Main nexus opportunities	Promote restoring and vitalizing energy market, develop the currently minimal trade in agricultural products; improve efficiency in energy generation, transmission and use; improve efficiency in water use (in agriculture in particular).
Adaptation options with multisectoral benefits	Changing/diversifying crops according to climatic conditions. Reducing dependency on single sources of energy.

## H. Selected solutions

44. The basin assessments under the Water Convention include a wide variety of issues, opportunities and benefits and go beyond the technical aspects. A broad range of possible actions were identified in the process, from technical to governance.

45. Despite the local and particular nature of the nexus in the different basins, there are a number of lessons learned that can be shared in the interest of other transboundary basins, some facing perhaps similar challenges.

46. Some specific solutions, integrated across sectors in the basins assessed are presented below. They provide illustrative examples of what intersectoral dialogue developed in each assessment, reflecting different expectations of what an improved intersectoral coordination would contribute to, practically. In addition, some types of solutions to challenges that are common to two or more of the basins, are discussed reflecting on the particularities of the situation in each of the basins.

### Instruments

47. Diverse policy instruments can be used to address the trade-offs and exploit the synergies:

(a) Regulatory instruments, such as Environmental Impact Assessment (EIA; for projects, also in a transboundary context), Strategic Environmental Assessment (SEA; for plans and programmes), minimum environmental flows (regulated by law), etc.;

(b) Economic instruments, which can serve both to provide behaviour-altering incentives (positive or negative) and to raise funds. To support stable institutions as well as to ensure good functioning and operation of infrastructure, financial resources are necessary. Water and energy savings, water conservation and protection and so on can be effectively promoted by economic incentives;

(c) Information instruments, in particular guidance and training of productive agents (such as farmers), but also including awareness of users and consumers (for example regarding water and energy use).

48. The States sharing the assessed basins have engaged in various mechanisms aimed at the implementation of important and relevant global standards, such as national strategies on sustainable development or establishment of platforms for consideration of environmental and social impacts of development plans (in some cases followed by adoption of national legislation on EIA and SEA).

#### Box 2

#### **Strategic environmental assessment: a perspective tool to support intersectoral planning and consultation**

The purpose of SEA is to ensure that environmental considerations inform and are integrated into strategic decision-making. SEA improves the process of planning and programming by helping it to be more focused, rigorous and open to alternatives, and to consider potential effects and opportunities at large.

The status of ratification of (accession to) the ECE Protocol on SEA in the Caucasus, South-Eastern Europe and Central Asia —still in its early stages —as well as the perspectives for its application are described here.

Neither Azerbaijan nor Georgia is yet a Party to the Protocol on SEA; Georgia is a Signatory (2003). In South-Eastern Europe, Montenegro, Serbia, Croatia and Slovenia are Parties to the Protocol. Bosnia and Herzegovina is only Signatory and but indicated that it plans to ratify the Protocol. None of the Central Asian countries (Syr Darya) are Parties to the Protocol.

In recent years, through the Greening Economies in the Eastern Neighbourhood (EaP GREEN) programme (2013–16) ECE supports the participating countries (Eastern Europe and Caucasus) in developing and applying SEA legislation and systems in accordance with the Protocol. The activities contribute to promoting ratification of/accession to the Protocol. As a result, it is expected that Georgia will ratify and Azerbaijan will accede to the Protocol, when legislative and institutional structures have been established. In parallel, the Programme promotes the practical application of SEA through the pilot application of SEA to identified by the countries plans or programmes. The experiences from this programme may be useful for other interested countries. In addition, the ECE Espoo secretariat is

providing legislative support to Kyrgyzstan on both EIA and SEA, with the support of Switzerland; and will implement capacity building activities on SEA in a water management project (EU financing) for Kazakhstan.

Once the application of SEA legislation and systems will be more advanced in some of these countries, experience will be interesting for the others to learning from.

### **International coordination and cooperation.**

49. While many beneficial actions can be taken at the national level, international coordination and cooperation at basin and regional level offers additional opportunities to “manage the nexus”. Examples include:

(a) Legal instruments – including transboundary agreements and related protocols but also including the EU Directives (Water Framework Directive, Floods Directive);

(b) Guidelines of intersectoral scope. Examples include (i) the Guiding Principles for Development of Inland Navigation and Environmental Protection in the Danube River Basin; (ii) the Guidelines for Sustainable Development of Hydropower in the Danube River Basin, and (iii) Eco-tourism Development Guidelines for the Sava River Basin;

(c) Planning processes – such as the Sava River Basin Management Plan (to coordinate action between water, energy and agricultural sectors) and the Flood Risk Management Plan of the Sava River Basin (to coordinate action around flood retention areas and wetlands).

50. Some examples about some processes involving intersectoral coordination are given below.

#### **Box 3**

#### **EU integration and accession in the Sava Basin countries**

Among the Sava River Basin countries, the EU accession and approximation provide a common driver and has have already played an important role in calling for the integration of policies and supporting investments water management and beyond. These processes introduce a level of harmonization gradually to the legal bases. The EU common market also lead into harmonization of rules and application of common standards

Among the relevant EU rules, from the point of view of the nexus, are those dealing with water, in particular the Water Framework Directive and its daughter directives, the emerging EU strategies in the field of energy and directives aiming at common energy markets and renewable energy, control measures related to food safety, the Common Agricultural Policy and the Rural Development Policy, partly aimed at forestry and combating climate change, and the Birds and Habitats Directives.

For Slovenia and Croatia as EU membership means compliance with the *acquis communautaire* and other relevant rules found in European Union law , that is, it is a matter of treaty obligation. For non-member states (Bosnia and Herzegovina, Montenegro, Serbia), commitments are a part of the closure of particular chapters in the accession process.

In the Caucasus, the following can be highlighted: In Georgia, some adjustments in the structure of the Ministry of Environment Protection were made in late 2014, in order to enhance its capacity for implementing the Association Agreement with the European Union signed in June 2014. The Division of Environmental Policy was

transformed into the Division of Sustainable Development and EU Integration Policy. The EU and Azerbaijan began negotiations on an Association Agreement in 2010 and Azerbaijan has participated in EU's Neighbourhood programmes, but Azerbaijan has not signed an Association Agreement.

51. Most of the countries sharing the basins assessed have adopted the user pays and beneficiary pays principles, although to different degree and implementation challenges are common. While farmers pay for irrigation water, the rates are typically very low and reflect neither the cost of the service nor the scarcity of the resource. In Central Asia and the Caucasus, non-consumptive water users rarely pay fees (Tajikistan is an exception), and the water supply and sanitation tariffs are low. Energy suppliers (who extract a rent from using water resources) are usually not charged for the water they use.<sup>9</sup>

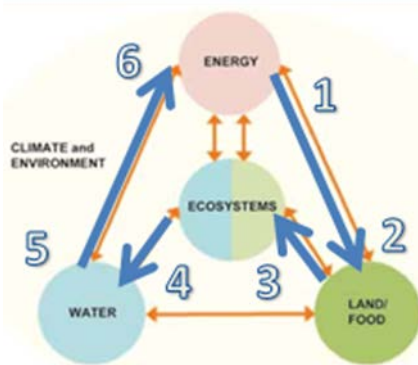
52. To encourage investment in the power sector in the country, Kazakhstan has adopted a programme of gradual increase in electricity prices to 2015 by groups of energy sources. Tajikistan's National Development Strategy envisages energy policy measures aimed at increasing electricity tariffs. The current electricity tariffs in Kyrgyzstan, Tajikistan and Uzbekistan do not stimulate energy efficiency measures.

53. Energy demands will increase and especially the poorest countries need to ensure energy security for development. Even then, there is significant room for application of demand management tools to encourage saving both water and energy, and reducing the investment need into new capacity. Improving attractiveness of investing into efficiency with policy would help.

54. In the case of the Alazani/Ganykh Basin, an intervention aimed at household fuel use can improve downstream flood control, increase a carbon sink and improve health.

#### Box 4

#### Changing household fuel use in Georgia to improve flood control downstream



The impacts of the use of fuel wood in upstream Georgia in the Alazani/Ganykh basin (1) have important knock on effects. (2) Fuelwood harvesting leads to deforestation. (3) The loss of forest results in a loss of ecosystem service. Woods no longer retain water tempering runoff as well as soil. (4) This increases the severity of flash floods resulting in damage control downstream in both countries. (5) In turn hydropower generation infrastructure is utilized in a sub-optimal way and infrastructure is affected by the sediment load. A solution that has multiple benefits and potentially cheaper than flood control measures would be (1) to

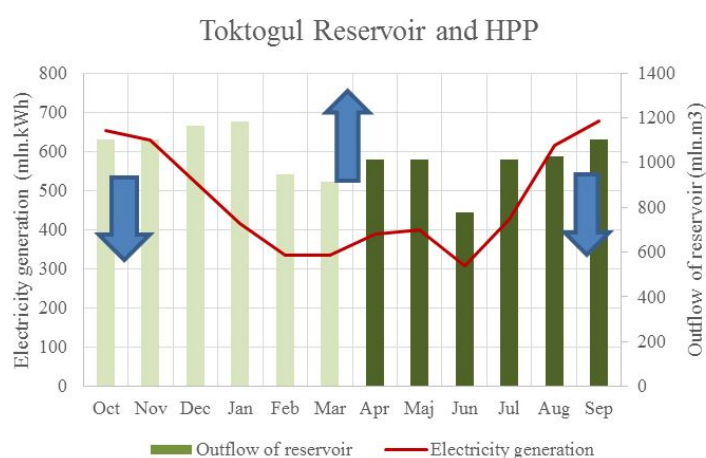
<sup>9</sup> ECE and OECD. *Integrated Water Resources Management in Eastern Europe, the Caucasus and Central Asia: European Union Water Initiative National Policy Dialogues progress report 2013*. New York and Geneva, United Nations, 2014.

substitute wood with modern fuels improving indoor air resulting in (2) decreased harvesting leading to greater forest mass and carbon sink (3). Increased ecosystem service including natural flood damage mitigation and ground stability (4) less disruptive damage from flooding and erosion and (5) better hydropower generation performance.

55. In the Syr Darya basin upstream energy management can influence downstream agriculture and ecosystem rebuilding.

#### Box 5

#### Increasing Renewable Energy Technology (RET) deployment to improve agriculture in the Syr Darya basin and help recharge the Aral Sea



In the Syr Darya basin, demand for electricity peaks during winter. This results in upstream hydropower being used during winter months (see figure). However, this result in water discharges being moved from summer to winter. The water discharged in winter freezes and then thaws in wetlands, and, at the same time, irrigation requirements go unmet as irrigation water is needed in summer. However, it is possible to 1) improve energy efficiency 2) improve trade and 3) increase the share of production from other sources (e.g. the wind energy upstream where wind regimes are strong in winter). The result (shown in blue arrows) is to reduce winter generation of hydroelectricity and free up water for summer flows for irrigation and for ecosystems. Continuing and intensifying efforts to improve water use efficiency in agriculture downstream in parallel would further help in meeting the different water needs.

#### Infrastructure

56. Smart, resource efficient technologies well adapted to the location and the needs can significantly reduce use of inputs as well as emissions.

(a) Promoting multiple and flexible use of infrastructure – in particular dams, irrigation and drainage systems: In addition to hydropower generation may serve flow regulation for navigation and flood protection, for example. By adopting appropriate designs, fish passes may limit impacts of structures on migratory fish or installation of smaller, run-of-river type hydropower plants have less negative impact on other uses as the environment;

(b) Investing in expanding and upgrading water infrastructure – such as wastewater treatment;

(c) Coordinating infrastructure investments – such as in hydropower and other renewable energy sources;

(d) Protecting natural infrastructure assets – such as floodplains and wetlands. These may serve as an important element in mitigating impacts of flooding.

57. In the Caucasus and in Central Asia but also in the Western Balkans, significant investments into wastewater treatment are necessary in the coming years. In the Sava Basin, in total around 43% percent of the general pollution load, or around 3 million person equivalents is not treated.<sup>10</sup> In the Alazani/Ganikh and the Syr Darya, the wastewater collection and treatment efforts are commonly limited to larger towns and related deficiencies are common. Making the necessary investments into wastewater treatment in a 'nexus conscious' way allows to capitalize on the synergies by, for example, opting for wastewater treatment technology that uses beneficially heat released in the processes and even generates energy (electricity?).

58. Depending on the cooling technology chosen, water use for electricity generation in thermal plants vary significantly, even by orders of magnitude, and effects on water resources are different: Open-loop cooling withdraws large volumes of surface water but returns nearly all to the water course whereas closed-loop cooling requires less water withdrawal but its consumption upon evaporation is higher.<sup>11</sup> In Central Asia, upgrading thermal power plants offers significant opportunities for reducing also water requirements and impacts on the environment.

59. In all the basins assessed, hydropower plays a special role. Its operation affects downstream flows of water (and subsequent services, such as irrigation). Its operation also affects the shape of the riparian country's fuel mix. As hydro can 'ramp' its production of electricity up and down fast, it allows those countries to introduce higher levels of variable 'intermittent' renewable energy technologies like solar and wind power. Judicious operation of hydropower plants can affect a number of services in river basin. In the Sava Basin, integration of intermitted renewable energies has been spurred by the renewable energy and GHG emission targets.

Box 6

**Multi-purpose reservoirs and smart management to increase the deployment of renewable energy; and other constraints in the Western Balkans**

<i>Countries</i>	<i>RES share in 2009</i>	<i>RES share in 2020</i>
Bosnia and Herzegovina	34%	40%
Croatia	12.6%	20.0%
Montenegro	26.3%	33%
Serbia	21.2%	27%
Slovenia	32.5%	39.3%

<sup>10</sup> Sava River Basin Management Plan

<sup>11</sup> Stillwell et al. 2011 (from the World Water Development Report 2014)

In the Sava river basin, each country has long term renewable energy targets, have energy security concerns and GHG mitigation goals - each of these is strongly impacted by current and future hydropower generation in the Sava River Basin. At the same time, regulating water flows and reservoir levels provides a slew of other services. These include ensuring: appropriate water levels for withdrawals for water supply and irrigation; maintaining appropriate depths for navigation; and providing a buffer for flood control. The use of multi-purpose reservoirs to ensure that short term operational constraints are satisfied, while longer term goals are realised will be critical to utilizing the Sava River Basin waters.

60. Water is a limited resource and its upstream diversion reduces the level of downstream service. The timing of water releases from upstream storage also affects services, especially those that are required at specific times. Summer water levels may drop when irrigation is needed, as winter hydro generation might help meet upstream electricity demands for heating. Thus in both settings, water efficiency is important. It reduces upstream diversion and needs while allowing downstream countries to get more service per drop. In the case of cropping, this goes beyond irrigation technology, to potentially changing crops. [SYR DARYA]

61. Improving water use efficiency in irrigated agriculture can have many benefits: reduced energy requirements, reduced costs, less problems of water logging and salinization, and improved water availability for ecosystems. However, the effects should be carefully analysed.

62. In the Sava Basin, commonly one per cent or even less of the agricultural land in the countries is irrigated, and of the total water use in the basin only some 11 per cent is used for agricultural purposes. However, climate is predicted to get warmer and water scarcity is to increase. Even if volumes would not be large, at specific locations in low water years or seasonally, possible implications on other uses are worth assessing.

#### Box 7

##### **Benefits of and potential constraints to introducing water-efficient irrigation**

Successful use of water efficient irrigation systems has various requirements. For setting a drip irrigation system up, the initial costs for the provision of equipment and training on use it are high. The resulting cash flow and profitability is also potentially much higher, assuming that there is an established market to trade the crops produced. Good irrigation management is essential and water quality requirements are higher than for simpler systems.

Azerbaijan has been investing to water-efficient technologies. In the Georgian part of the Alazani/Ganikh Basin the challenge is the currently unclear responsibility for the repair and maintenance for the dilapidated irrigation networks. The municipalities lost the responsibility for maintenance in the reforms which gave the role to irrigation associations in the late 1990s; the associations ceased to exist in mid-2000s which left a void when the state companies responsibilities do not extend to such a low level of operation.

In the Syr Darya water use for irrigation reaches some 45,000 million cubic metres/year. Various factors contribute: aridity, the extensiveness of the systems (and related path dependency) In the Syr Darya Basin various actions would be useful: repair and upgrade irrigation infrastructure, improve water use practice and introduce incentives e.g. in the form of economic instruments. Facilitation of trade in agricultural products could also help.

An example that illustrates the necessity of a thorough assessment of the risks is the rapid transformation of irrigated agriculture in Spain: Between 2002 and 2008

the use of drip irrigation systems, involving replacement of gravity irrigation systems, increased by 40%, bringing about a 10% per volume unit increase of net electricity consumed in irrigation. From 2006 to 2008, the price for energy increased by 30% to 70%, affecting significantly the economic implications of such a change. What is a sensible investment in a country with a high energy resources endowment and predictable energy prices, may have a less favourable economic outlook elsewhere.

63. Further examples of tools and case studies, which illustrate how water infrastructure (built and natural) can better meet different sectors' needs have been compiled by the International Union for Conservation of Nature (IUCN) and the International Water Association (IWA).<sup>12</sup>

### Information and planning

64. The implementation of a nexus approach to managing the basins resources requires better information to improve national-level inter-sectoral coordination and the development of a shared knowledge base for transboundary cooperation. Options include:

(a) Monitoring of basin resources (groundwater, surface waters, biodiversity, soil) both in terms of quantity and quality, and with particular attention to some degradation processes (e.g. erosion and sedimentation);

(b) Forecasting, in particular of water-related hazards (floods and droughts) in order to reduce related risks;

(c) Information sharing, for example through development of databases hosted by basin organizations.

65. The basins have national pressures placed on them that may be out of sync with current IWRM planning. IWRM planning may, have a limited medium term cycle and outlook. Yet, national priorities such as: food security, employment, energy security, and GHG mitigation may involve longer term outlooks. In the longer term, there will be expectations or assumption made on the potential service the basin can deliver, for example about certain water availability for cooling a thermal power plant at a particular location. However, without integrated modelling of the basin into the longer term accounting for potentially growing and competing needs, those expectations will be misplaced. Thus **national policy making needs to be clearly informed of the longer term constraints and opportunities presented by the basins. Sharing information in a harmonized form** is a prerequisite for an accurate analysis across the basin.

66. There are significant opportunities for co-benefits in policy effectiveness. For example, many riparian countries have energy efficiency policies. These can be met by actions in the water sector that are not 'seen' by planners in the energy sector. They are not 'seen' as there is often no 'direct' energy usage. Similarly, IWRM modellers, will not compute the energy saved. This has implications. Typically energy efficiency is valued. If aspects of a water policy and an energy policy were realised by one measure the cost effectiveness of that measure may increase significantly. Consider a few simple examples. Groundwater might be pumped for irrigation. Shifting to drip irrigation would save water, and require lower volumes to be pumped. Lower pumping means energy reductions. Both

<sup>12</sup> In the framework of the Nexus Dialogue on Water Infrastructure Solutions, a selection of tools and case studies has been collected, which examine how water infrastructure (built and natural) can be optimized to meet the needs across the water, energy and food sectors, looking at innovations, institutional arrangements, policy, decision making and financing. The Reference Library is available at <http://tools.waternexusolutions.org>. It should be noted, though, that reference to transboundary solutions remains limited.



water and energy are saved effectively with a single measure. Similarly, low flow household appliances (in households serviced by basin water), reduces water use. Less water implies less heating in a geyser, less treatment and associated pumping - each of these requires energy. Thus energy use is lowered. [SYR DARYA]

67. In order to undertake clear decision making and value water which provides multiple services, effort is required to improve the modelling and assessments. This will in turn help better inform the effectiveness of co-benefits across policies as well as evaluate the added value of multi-purpose reservoirs. For example, a set of multi-purpose reservoirs may help control: navigation, electricity generation and balancing reserves, ensure ecosystem flows, parry flood impacts and others. Each of these functions or services has a value. The higher the combined value, the lower the cost/benefit ratio, and chances for investment improved. Yet at present it is difficult to establish values and potential trade-offs. It can also help inform trade and agreements. [SAVA]

### III. Conclusions and recommendations

*[This chapter will be developed further.]*

68. Water management organizations and professionals do not know enough about energy or land, as water is used by several sectors whose plans could be better coordinated. Risks related to availability and variability of water could be better acknowledged.

69. An effective intersectoral coordination, even at the national level, is difficult to achieve, irrespective of the level of economic development. In many of the cases assessed, the energy sector policy would have an important role in the solutions. At the same time, even though the basin cases illustrate that the links between water and energy extend far beyond hydropower, the energy sector remained not easy to engage.

70. Development of new hydropower is an issue in all the basins, albeit at a different scale. Although it remains to be verified, regional integration to harmonize approaches, jointly agreed principles for developing hydropower more sustainably, sufficient water for different uses and improving environmental regulation may all be factors in making hydropower less conflictual.

71. Experience could be shared between the basins for example about the guidelines for making hydropower development more sustainable.

72. Coordination between regional economic organisations, basin organisations, energy organisations/power pools is important.

73. In strengthening the institutional capacity, building on existing organisational structures by their further development and broadening the scope of work can be recommended as a first step in applying a nexus approach. It does not necessarily require putting in place specific “nexus governance”.

74. Many river basin organizations and other joint bodies already have a multisectoral scope, and consequently they can function as effective platforms for a dialogue, negotiation about developments with intersectoral and transboundary impacts and agreeing about actions that require involvement of several sectors. An appropriately broad representation of sectors in joint bodies facilitates playing such a role. Joint bodies’ effectiveness to address the nexus depends on various factors, among them the breadth of the mandate and decision-making. Subject to willingness and decisions by the riparian States, confirmed in the form of an adequate legal basis, the mandate of a joint body gradually broaden (with increasing trust) to reflect the main resource uses and pressures.

75. Formal structures and processes facilitate but do not guarantee coordination and consultation planning. The political will to cooperate and coordinate is of key importance.

76. Various intersectorally coordinated processes can help to align policies, among them, for example, national sustainable development strategies, adaptation plans on climate

change, Strategic Environmental Assessment and Environmental Impact Assessment as well as regional development strategies and integration processes (e.g., EU approximation, where applicable).

77. Short-term, interventionist and reactive policies without sufficient (including sufficiently broad) assessment and adequate social consultation may not be efficient. Appropriate mechanisms for enabling participation of different stakeholders and the public and for communication strengthen decision-making.

## IV. Lessons learned

### Assessment process in framework of the Water Convention

78. Due to the broad scope of the nexus assessment, the expectations concerning what the assessment can provide are highly diverse, and therefore prone to disappointments. It should be underlined that in the assessment under the Water Convention, limited resources have constrained ambitions. Especially this has limited possibilities to have a more interactive process, or to coordinate more actively with the countries and experts.

79. **This scoping level exercise allowed for a first joint identification of the main intersectoral issues as well as possible solutions.** Follow-up initiatives would be needed if more in-depth analysis and quantification are to be done, but the basin assessments carried out provide a basis for further work. The chapter on assessment approaches and analytical tools is meant as an indicative guide for countries or joint bodies that may want to pursue a more detailed and quantitative study.

80. The methodology developed as a generic one allows it to adjust to the particular setting of each basin and the configuration of sectors and resources. **All basins are unique the application of the general approach and the process shapes differently.** This inevitably leads to a certain heterogeneity in the extent and level of detail of the results. As assessing the nexus is complex and time consuming, a workable approach was needed, with an understanding that application experience would allow it to be gradually improved. Some further use of the methodology in other basins (including an aquifer) is foreseen, and further application is encouraged.

81. **An active participation and commitment from the countries in the process** are necessary to shape the practical application of the nexus assessment approach into a valuable, relevant exercise that supports policy by responding to relevant policy questions — or at least highlight effects that need to be taken into account — and supports decisions at different levels.

82. **Among the challenges is a clear and accessible communication** about the complex interlinkages and intersectoral effects to ensure attention to the findings

83. **Continued intersectoral dialogue at the transboundary level about possible actions to take in response:** It is clear that a valuable next step arranging, when possible, follow-up opportunities for getting the stakeholders to discuss the findings and possible responses to the recommendations. With the support of the European Union's Water Initiative and Germany, if was possible to hold some, however, further efforts in this direction would be needed.