Methodology for Assessing the Water-Food-Energy-Ecosystems-Nexus Assessment in Transbounday Basins

Draft for a chapter of the final stock-taking report of the assessment of the water-food-energy-ecosystems nexus under the ECE Water Convention

Version for review by the Task Force on the Water-Food-Energy-Ecosystems Nexus

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This draft chapter, which describes the methodology developed for and used in the assessment of the water-food-energy-ecosystems nexus under the Water Convention, is made available for review and discussion at the third meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus (Geneva, 28-29 April 2015).

The methodology version presented in this document is the result of a recent review of the document that was presented at the Second Meeting of the Task Force (8-9 September 2014). The review takes into consideration the experiences from the three basins that have been assessed using this approach.

A revised and edited version of the draft chapter, in accordance with the discussion at the Task Force meeting, together with the other chapters and basin assessments will be submitted to the Working Group on Integrated Water Resources Management (Geneva, 24-25 June 2015) for review and endorsement for submission to the Meeting of the Parties.

The final version, revised with any comments from the Working Group, will be presented as part of the final stock-taking report of the nexus assessment to the seventh session of the Meeting of the Parties to the Water Convention (Budapest, 17-20 November 2015) for its final endorsement.

GLOSSARY OF KEY TERMS USED IN THE NEXUS ASSESSMENT

Components of the nexus	Water, Energy, Land Use and Ecosystems are often referred to – even in the course of this project – as 'sectors' and sometimes as 'resources'. This ambiguity is justified by the fact that they could be considered either way depending on the context of discussion. To avoid this ambiguity they can be referred to as 'components of the nexus'.
Ecosystem Services	The direct and indirect contributions of ecosystems to human wellbeing[1]. They are normally divided into: provision, support, regulation and cultural services.
Ecosystems (component of the nexus)	A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit.
Energy (component of the nexus)	Energy resources, energy production (including electricity), transportation / transmission and energy access (clean, constant and safe)
Energy productivity	The ratio between the wealth produced by a certain activity and the energy used to produce it. It can refer to the overall economy of a country or to a single sector/activity.
Food (component of the nexus)	Land resources and types of land use, with a strong focus on agriculture (crop production, fishing and livestock) but considering also urban areas, forestry etc. Due to scope, the food component of the nexus is commonly referred to as agriculture/land.
Governance	The rules and mechanisms that characterize how a society functions. Specifically, the governance analysis of a nexus assessment looks at the legislative, institutional and policy framework of the basin, the countries and the region.
Integration	The act of considering different sectors (or institutions) together. In general terms, better integration means improved cooperation, communication and collaboration. Integrated modelling refers to the merging of different models (e.g. the energy model and the water model) to obtain combined results.
Interdependency	A relation of mutual dependency or influence, here referred to sectors or actors involved in the assessment.
Interlinkage (between sectors)	Relations existing between two sectors. They may be unidirectional (impact from one sector to another) or bidirectional, (tradeoffs, affecting each other).
Modelling	The conceptualization of a system using quantitative and spatial information to allow for the representation of resources flows and evolutions. This is usually done using appropriate tools.
Nexus	The nexus term in the context of water, food (agriculture) and energy refers to these sectors being inextricably linked so that actions in one area commonly have impacts on the others, as well as on the ecosystems, which provide vital services to these sectors.
Nexus issue	A problematic situation that affects more than one sector.
Nexus solution	An intervention that would benefit more than one sector, in this context including also interventions that reduce the pressure on the ecosystems (or the environment at large).
Policy coherence	Policy coherence implies that the incentives and signals of different policies to target groups are non-conflicting. Policy coordination and policy integration help to increase coherence, introducing processes

[1] Definitions from the TEEB website http://www.teebweb.org/resources/glossary-of-terms/

	and means that reduce coherence problems between sectors.[2]
Reconciling (different uses)	To find solutions to tensions or conflicts related to the multiple needs/uses of a common resource.
Resource scarcity	A resource can be scarce in absolute or relative terms. In the first case, scarcity refers to a physical lack of availability (e.g. water scarcity means aridity). In the second case, scarcity is related to the uses of such resource. A large demand of one resource simply reduces its availability for other uses.
Scenario	An expected or possible situation characterized by certain conditions. Usually, factors such as climate change or important policy actions serve to characterize such scenarios.
Sector	In general terms sectors are resource users They can be both productive (e.g. industry) and consumptive (e.g. households).
Sustainable development	Sustainable development[3] is currently understood to consist of social, economic and environmental pillars. From an environmental perspective it can be understood as improving the quality of human life while living within the carrying capacity of supporting ecosystems.[4]
Synergy	A synergy is an action that two or more actors take together. By coordinating, the parties normally need to invest less effort than by acting separately.
Trade-off	A balance achieved between two desirable but incompatible features; a sacrifice made in one area to obtain benefits in another[5].
Water (component of the nexus)	Water resources and their management, water services (utilities, infrastructure including irrigation schemes) and water access (safe drinking water, sanitation)
Water productivity	The ratio between the wealth produced by a certain activity and the water used (withdrawn) to produce it. It can refer to the overall economy of a country or to a single sector/activity.
Water-Energy-Food—Ecosystem (WEFE) Nexus	As an extension of the 'traditional' water-food-energy nexus, the WEFE Nexus gives a more prominent role to the ecosystems and the services they provide. It should be noted that the assessment's food component focuses on agriculture (sector) and land (resource) management related aspects

[2] For a review of the terms and some relevant literature, e.g. the following publication can be referred to: Per Mickwitz et al 2009, Climate Policy
Integration, Coherence and Governance. Partnership for European Environmental Research.
[3] The most commonly quoted source for the concept of sustainable development, defined there as development that "meets the needs of the present without compromising the ability of future generations to meet theirs "is the following: World Commission on Environment and Development (WCED). Our common future. Oxford: Oxford University Press, 1987.
[4] Definition from IUCN/UNEP/WWF, Caring for the Earth: A Strategy for Sustainable Living, Gland, Switzerland, 1991, p 10.
[5] Definition from Oxford English Dictionary

1 BACKGROUND

An assessment of the water-food-energy-ecosystems nexus is being carried out as part of the programme of work for 2013–2015 under the Water Convention.

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 chaired by Finland, agreed on the main features of the assessment at its first meeting of the Task Force (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 also to aquifers.

To develop the process the UNECE, guided by the Task Force on the Water-Food-Energy-Ecosystems Nexus adopted an evolutionary 'learning-by-doing' process. With the guidance from the Task Force, a draft methodology was developed, circulated for review and tested in practice. The draft methodology version presented in this document is the result of a recent review of the document that was presented at the Second Meeting of the Task Force, 8-9 September 2014. The review takes into consideration the experiences from the three basins that have been assessed during the Work Programme 2013-2015 under the Water Convention: the Alazani/Ganikh shared by Azerbaijan and Georgia, the Sava shared by Bosnia and Herzegovina, Croatia, Serbia, Slovenia and Montenegro and the Syr Darya shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan.

This version of the methodology document includes all the improvements made and provides a better tested format and organization of nexus assessment work for future applications.

The main change from the previous methodology draft document is the merging of the governance aspects, which were initially described in a separated methodology document[6] but their treatment has evolved since then. In the light of the experience from consultation meetings held in Azerbaijan and in Georgia in February 2015, a follow up meeting with national authorities has been added as a further step in the nexus assessment process.

In addition to the improvements that were tested and used in the assessment of the basins, some further suggestions for developing the methodology further are illustrated in this document. These arise from the final evaluation of the process and

[6] The original governance methodology document, "A draft methodology for assessing governance aspects of the water-food-energy-ecosystems nexus" by Dr. Christian Bréthaut, University of Geneva is available at http://www.unece.org/fileadmin/DAM/env/documents/2014/WAT/09Sept_8-9_Geneva/UNECE_governance_assessment_methodology_forTaskForce_forWeb.pdf

will be modified according to the reactions of the Nexus Task Force at their third meeting, 28-29 April 2015.

The opportunity to apply the methodology in additional basins will be also discussed at the Third Nexus Task force meeting in Geneva.

The work of the UNECE on Nexus assessments of Tranbsoundary river basins aims at supporting transboundary cooperation by

1. identifying intersectoral synergies that could be further explored and utilized;
2. and determining policy measures and actions that could alleviate negative consequences of the nexus and help to optimize the use of available resources;

The Nexus Assessment aims also at helping to move towards increased efficiency in resource use, greater policy coherence and co-management as well as building capacity in the countries to assess and to address intersectoral impacts.

The need for an intersectoral approach to policy making, as well as the value added of a nexus approach to integrated water resource management, as relevant to this methodology, are described in the draft chapter "The application of a nexus approach in transboundary basins"[7].

2 NEXUS ASSESSMENT METHODOLOGY[8]

This methodology developed for assessing the water-food-energy-ecosystems nexus in transboundary basins provides a workable approach to determining what actions application of a nexus approach could concretely entail. More specifically, it provides for identification of positive and negative linkages, benefits and trade-offs among sectors at the national and transboundary levels, assessing their relative importance and exploring their development in the future, taking into account climatic and socio-economic changes. The methodology also sets a basis for the quantification a number of these features. The outputs of the nexus assessment of a basin provide information that can help coordination of policies and actions across sectors, institutions and countries. But even more importantly, the process involves an intersectoral dialogue in a transboundary context which is informed by a joint assessment.

[7] http://www.unece.org/fileadmin/DAM/env/documents/2015/WAT/04Apr_28-29_Geneva/3rd_Nexus_Task_Force_document_Nexus_Approach_Transboundary_Basins_22_Apr_2015.pdf

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2.1 PRINCIPLES

In connection to the aims of the transboundary nexus assessment and in order to ensure achievement of the objectives, there is a core set of features that should characterize the approach adopted. These features are:

1. **Participatory process** – Working with the national administrations of the riparian countries in line with the collaborative spirit of the Water Convention. Participation of representatives of the countries sharing the basin and the active sectors for ownership: The views of all the relevant stakeholders should be taken into account. Using a nexus approach it is possible to engage a variety of sectors and discuss intersectoral issues without being limited to a specific sector or aspect (e.g. climate or water management), which allows for a stimulating dialogue on development priorities, existing constraints and shared benefits of coordinated actions.

2. **Knowledge mobilization** - using to the maximum degree possible the expertise available in the basins assessed. Particularly relevant for the nexus assessment of a basin are local knowledge and experience of the issues and circumstances, studies, databases and models of the hydrology, energy system, land use and ecosystems as well as experiences from projects and activities aimed at improving resource efficiency as well as intersectoral and transboundary cooperation at local level.

3. **Sound scientific analysis** – it informs the process and draws from past experiences to improve the quality of the assessment outcome. The analysis is appropriately scaled according to the financial and human resources available. With significant constraints, at least data needs can be identified, as well as possible sources and approaches.

4. **Capacity building** - the process will help all parties better understand intersectoral linkages and to gain experience in sustainable management of natural resources by sharing examples, promoting constructive discussion across States and sectors, and providing the tools required to address nexus issues at the basin level.

5. **Collective effort** - the outcome of the nexus assessment will reflect the broad range of views and expertise involved throughout the procedure, including both Parties to the Water Convention and non-Parties.

6. **Benefits and opportunities** – focusing a large part of the dialogue and assessment on uncovering potential for improvement and benefits from cooperative and coordinated solutions is also a guiding principle of the methodological approach as it allows for a more constructive, solution-oriented participation and outcomes that may attract/mobilize wider support.

As such, the countries participating in this assessment would benefit from:

- An improved knowledge base about linkages between sectors, to support decision-making at national, basin and transboundary levels;
- The analysis and quantification of selected significant aspects of the nexus from the point of view of management challenges, the identification of possible knowledge gaps and their improvement;
- Joint identification of opportunities for benefits through, for example, intersectoral synergies and of solutions to negative intersectoral or environmental impacts, addressing trade-offs and reconciling different resource uses;
- Promotion of dialogue between the different sectors from the riparian countries at the basin level; bring together authorities, private sector, civil society;
- Exchange of good practices across countries and between basins;
- Capacity building through workshops, exchanges, self-assessments and knowledge mobilization during the assessment process; and
- Creation or increase of awareness and stimulation for further action on cross-sectoral issues.

2.2 EMPHASIS ON PARTICIPATION IN THIS COLLABORATIVE ASSESSMENT

A key element of this nexus assessment approach is joint identification of issues, mapping and capacity building together with officials and experts from the countries sharing the basins. The process helps develop dialogue from one sector to another, across borders, and between scales (local and national).

In particular, according to Matthews (2014)[9] consulting various stakeholders and incorporating their views in a nexus assessment from the very beginning is instrumental for its success and ensuring its responsiveness to specific needs and circumstances. Effective stakeholder engagement in a nexus approach should include consultations with:

- Local, national and regional decision makers to present early on in the process the relevant policy questions;
- Rural and urban planning authorities and resource managers that can provide information on future development plans and any conflicting development viewpoints;
- Practitioners that can quantify and prioritise various nexus issues, resource analysts and modelers who can discuss and align modeling scenarios, assumptions, and input data; and
- Additionally, identify the perceptions of stakeholders regarding inter-sectoral linkages/benefits/trade-offs and their expected future development as well resource security concerns.

[9] Report “Pilot Study: Applying the Nexus Approach in the Transboundary Alazani/Ganikh River. UNDP/GEF project "Reducing transboundary degradation n the Kura Ara(k)s river basin.

These consultations ensure that local, national and regional strategies and goals are adequately considered in the assessment process, and that the assessments are targeted towards the constraints in each particular context. This ultimately enables the key-stakeholders to both affirm and refine promising strategies and actions to address the identified intersectoral issues, and help identify areas in which the respective sectors may come into competition.

It is recognized that applying an insectoral assessment approach in a framework where theobjectives are specifically defined with local, national and regional decision makers can make it a valuable tool to answer specific questions and to ensure its findings are useful to inform future policies. However, the nexus assessment in the framework of the Convention is of scoping nature, meant as an overview of the intersectoral links, allowing to point at the related opportunities for benefits in terms of e.g. reduced negative externalities, improved resource efficiency and related economic benefits as well as higher sustainability.

2.3 PHASES OF WORK 2013-2015

The work itself is divided into three phases. Phase A is the development of a '*broad methodology*'. Phase B focuses on applying the methodology to analyse a specified set of transboundary river basins analysis. That application is composed of four parts: first a **diagnosis of the basin,** then a **workshop** where key issues are jointly identified, synergetic solutions, a **final report** that synthesizes the information, backs it up with descriptions and analysis and provides illustrative quantifications to justify the conclusions (including possible coordinated actions) and finally a **second workshop** to explore opportunities for including findings and outcomes from the assessment into actual policies and activities. Finally Phase C will result in a consolidated summary of the findings of the work.

The sequence of the phases is presented graphically below.

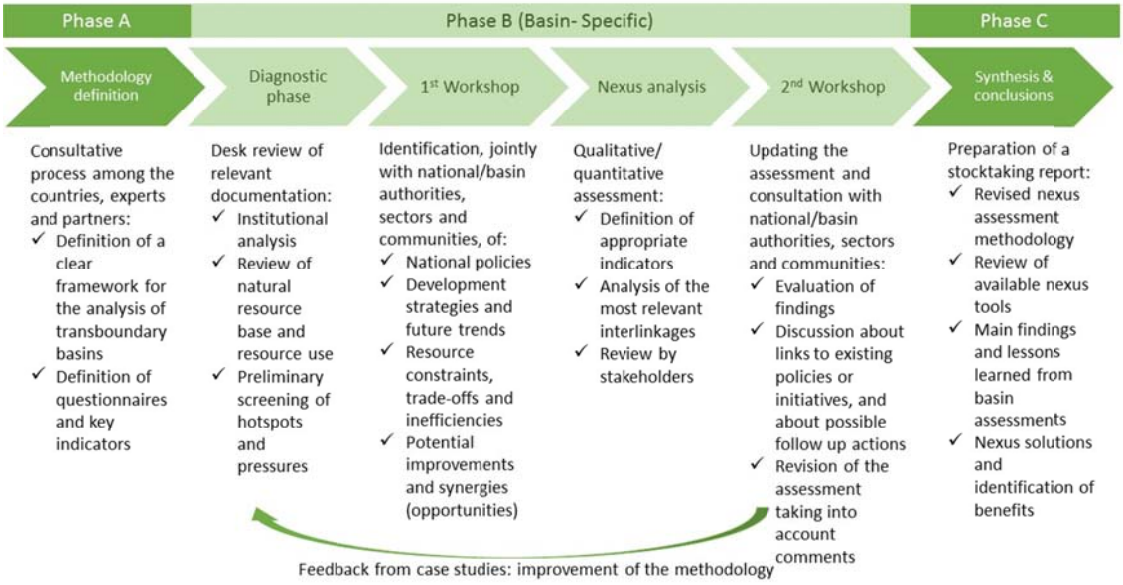

Figure 1 Phases of work

2.3.1 Phase A

Phase A, the '*broad methodology*' a basic structure which includes the development of a consistent terminology, organisational framework, indicators and preliminary areas of investigation. These are then applied in Phase B to different transboundary basins and results synthesised in Phase C.

Since the beginning of the assessment process under the Water Convention, it was planned that the application of this methodology to the basins (Phase B) would serve as a test for its appropriateness and that the respective lessons learned would be used to improve it. This helps increasing its value and its usefulness to future basin assessments. The basins that this methodology can be used to analyzing may be very different between each other. Hence, the objective is to come up with a simple structure that can be replicated in each basin, allowing at the same time a high degree of flexibility, responding to different circumstances and sets of intersectoral issues.

2.3.2 Phase B

Phase B has several objectives. These include:

- To identify 'nexus issues'[10]. Selected examples that illustrate the need for cooperation would be quantified.
- To identify potential 'nexus solutions'[11]. Selected examples of benefits can also be quantified.
- Build capacity in the process and support a dialogue between representatives of key sectors from all the riparian countries.
- Point to key data, indicators, processes and aspects of management and coordination that may support joint or coordinated actions.
- Discuss opportunities to include findings from the assessment into current policy developments or follow up projects.

The assessment of the basin evolves on two main lines: the analysis of natural resources and the analysis of governance[12]. These are parallel and complementary efforts, informing each other. The first line of analysis looks at the geography, climate, resources uses and flows as well as physical linkages between sectors, while the second aims at capturing the relevant features of the legal basis, institutional framework and the main policies with a focus on policy coherence as well as gaps, overlaps and complementarities of responsibilities.

It should be noted that this process draws from several information sources and key sets of indicators. These are described in the Annex 1.

[10] A problematic situation that affects more than one sector
[11] An intervention that would benefit more than one sector
[12] The governance analysis covers the institutional framework, legal basis and the main policies (see Glossary of terms)

2.3.3 Phase C

Phase involves synthesising conclusions and lessons from each of the basin assessments and developing recommendations regarding intersectoral coordination in transboundary basins. The conclusions highlight the value of an integrated, cross-sectoral approach in resource management to improve water, food, energy and environmental security and to support transboundary cooperation.

3 NEXUS ASSESSMENT OF A TRANSBOUNDARY BASIN

3.1 ASSESSMENT PROCESS

The nexus assessment of a basin involves analysts, authorities and various stakeholders. Their role in the assessment process is illustrated in Figure 2.

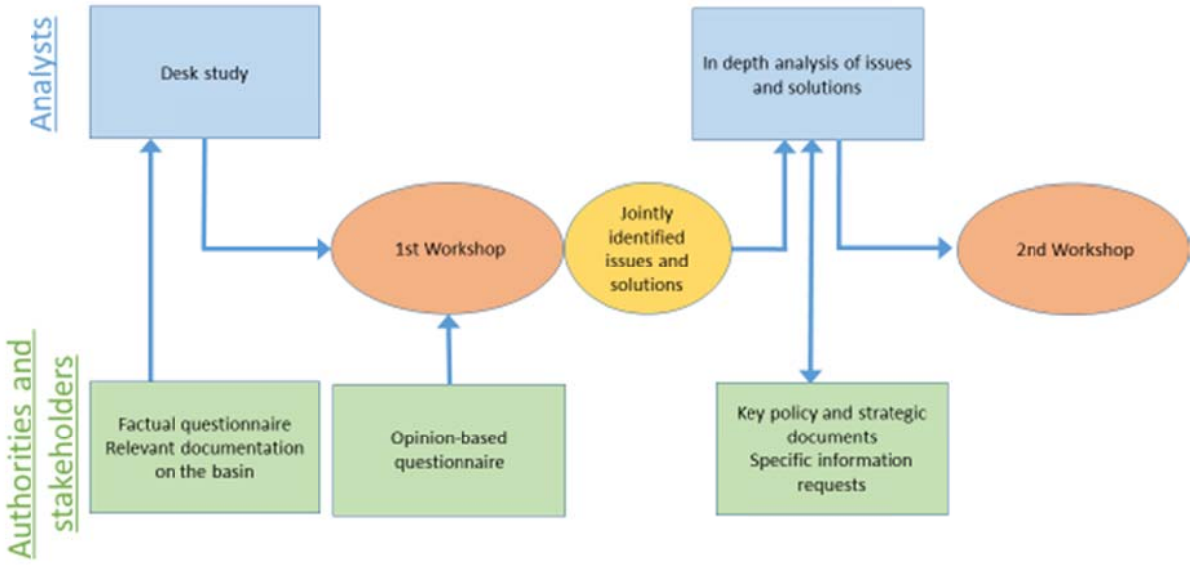

Figure 2 Information exchange in the nexus assessment of a basin

A six steps process is proposed for the analysts to organize the work and ensure a focused and timely communication with stakeholders. Their participation is key along the entire process. This includes various kinds of inputs and validations, information gathering, joint identification of issues and potential solutions, engagement of key officials and experts.

The six steps, revised and improved with the feedback from the three case studies, are described in the following paragraphs and for each, one some improvements are suggested and discussed. In each step participation by key stakeholders is critical.

Steps 1 to 3 support the *desk study*, which helps initiating the stakeholder consultations and participation processes with an awareness and a preliminary understanding of the main issues and challenges in the basins as well as an initial idea of potential opportunities of cross-sectoral cooperation. Building on Step 3, Steps 4 to 6 constitute the core activities of the *participatory workshop* and the analysis of its outcomes.

Table 1 Steps of the nexus assessment of a basin

Steps in the nexus assessment of a basin				
	Step	**Actors**	**Location**	**Sectors**
1	Identification of basin conditions and its socio economic context	Analysts.	Desk study	General. Information normally used to underpin sectoral planning. Key elements include general socio-economic goals and targets.
2	Identification of key sectors and stakeholders to be included in the assessment	Analysts. Authorities	Desk study	General. Requires expert judgment understanding of local context and governance.
3	Analysis of the key sectors	Analysts. Authorities	Desk study/ 1st Workshop	Individual sector experts and plans. Key elements include identifying resource base and uses, as well as institutional mapping.
4	Identification of intersectoral issues	Stakeholders	1st Workshop	Sectoral group discussion on interlinkages (input needs, impacts and trade-offs), and discussion on sectoral plans
5	Nexus dialogue and future developments	Stakeholders	1st Workshop	Agreeing on a prioritization of main interlinkages. How the interlinkages are expected to change according jointly identified development trends, noting key uncertainties and most important drivers
6	Identification of opportunities for improvement (across the sectors and countries)	Stakeholders and analysts	1st Workshop/ 2nd Workshop / Desk study	In step 5, there is an identification of solutions with multiple impacts between sectors, scales and boundaries. Such solutions could eventually be integrated into policies and programmes in the countries/basins.

As the nexus assessment aims at discussing inter-sectoral issues and uncovering potential opportunities for cooperation in the specific context of the basin considered, a zoom-in approach is suggested, to investigate first the broad socio-economic situation as well as the resource base of the basin and gradually focusing on sectoral analysis and intersectoral implications.

The real objective of the analysis will be describing different options for how negative impacts could be reduced and advantage taken of complementarities and opportunities for cooperating and sharing benefits. These are normally basin specific, which means that the analysts need to be ready to consider a variety of interlinkages. In identifying these intersector and transboundary issues and solutions a focused, facilitated dialogue needs to be initiated. For this purpose, it is important to elaborate appropriate materials to facilitate the discussion in the workshop and pre-instruct a number of facilitators for the working groups sessions.

Knowledge of the most typical tradeoffs and dynamics - such as conflicting seasonal water needs for hydropower and irrigation, water quality degradation and clean water needs for drinking and sanitation and so on - will certainly help the analysts in the assessment, but an effort should be made to keep an open, diagnostic and participative approach in the first steps of the desk study (1-3). This is needed to ensure that the assessment will capture the specificities of the basin thereby providing a basis for ad-hoc solutions.

It should be also noted that exchange about the findings and possible follow-up actions can continue beyond the current assessment in the framework of the Water Convention or other initiatives, possibly adding significantly to the value of the exercise.

3.1.1 Step 1: Identification of basin conditions and its socio economic context

The first step is to set up the basis of the desk study – until step 3 - that will serve as a background document for the workshop and the final nexus assessment. Ideally, the key documents to be taken into account for this should be identified by the national authorities. Practically, step 1 aims at characterizing:

1. The needs of the population living in the basin area, which include - amongst others - meeting basic human needs (such as water, food, energy and environmental security), poverty reduction/improvement of socio-economic conditions, economic development and, a healthy environment amongst others, or needs to address factors that compromise human wellbeing in these terms. These needs may or may not be satisfied, which means people and local activites may or may not have access to the resources they need to develop.
2. The relations that exist between the region, the basin and the its riparian countries. They are related to the economic activities that take place in the basin, to the natural resources that are found there and to how much its riparian countries rely on those for their overall economy. Resources can be exploited and transferred within or outside the region and at the same time local population may heavily depend on imported resources. These relations translate into regional and national development programmes and international agreements.

The aim of this step is to understand the dynamics that relate the basin with its population with its riparian countries and its development strategies. This requires an understanding of the broad socio-economic features of the countries, their administrational background as well as the resource base of the basin. For instance, a basin can be valuable for a country because of hydropower development or for the production of a specific crop, it can be the richest or the poorest area of a country or it can be an important energy corridor and so on. Similarly, resource management and economic activities in the basin can be related to the historical background of the countries and/or reflect important policy directions or regional trends.

In order to pursue this double aim efficiently, it is advisable to proceed along two parallel, complementary paths involving the necessary expertise. An analyst (or a team of analysts) should look at the basin and its population from the perspective of availability and access to resources. Another analyst (or a team of analysts) should look at it from a governance perspective, starting to define the institutional framework of the water, energy, agriculture/land use and ecosystems components of the nexus[13]. This involves a mapping of actors (ministries, state agencies, basin organization, regional and local authorities, private sector including utilities and civil society) that influence on the management of resources in the different areas of the nexus at local, basin, national and regional level together with their interrelations, which could be organizational structures as well as agreements and important joint efforts. The governance analysis aims at identifying potentially conflicting objectives of sectoral policies as well as shortcomings in administrative practice and in administrative philosophy that interfere with resolution of such conflicts. At this stage, the mapping exercise is aimed basically at understanding the dynamics across scales (region, basin, countries). A more detailed mapping of actors will be further developed for each key sector in step 3.

In order to describe the natural resource base that allows responding (or not) to the needs, readily available and tested indicator sets are used. It is acknowledged that for an accurate assessment, basin or local level information would be ideal, but in the case of many basins, national level information will need to be used as a proxy in the absence of more detailed data. A typical example of proxy is lack of access to water and sanitation, which is normally only available at country or province level. These indicators can be complemented with quantitative and qualitative information at basin level or at a local administrative level[14]. The existence of a well-established basin organization that can provide consistent statistics at basin level will be very

[13] Water, Energy, Land Use and Ecosystems have often been referred to – even in the course of this project – as 'sectors' and sometimes as 'resources'. This ambiguity was justified by the fact that they could be considered either way depending on the context of discussion. For clarity, they are here referred to as 'areas of the nexus'.

[14] An issue with collecting this type of information is that often local data are not consistent or incomplete. For example, the country's share of a basin may coincide with an administrative unit for which national statistics provide useful information, while the other countries' shares do not overlap with a specific unit and statistics are not available for it.

valuable not only to obtain basin level indicators but also to estimate the accuracy of the proxies used from national statistics.

The governance analysis, in parallel, needs to start from a mapping of actors, mandates and important regional dynamics, such as the relations of riparian countries with external economic and political players. In this first stage of the governance analysis, it is possible to capture the main strategic goals that characterize the economies of the riparian countries. Because of the broad spectrum of analysis that span from water governance to energy market, environmental management and agricultural development, the analysts would greatly benefit from an already acquired knowledge of the basin and the region.

Helpful input for this step will be the outcomes of a factual questionnaire screening the water, agriculture/land, energy, and ecosystem resources. This first screening of the basin and information gathered directly from focal points[15] in the countries through a questionnaire inform the desk study compiling relevant existing information and earlier studies. Particular attention is paid to documentation referred to by the participating authorities.

It is important to ensure a meaningful communication between the two analytical paths because the information the analysts collect in step 1 will form the basis of the desk study. Ideally, the analysts will work in the same team and regularly confront their findings, share the ones that are of common interest and responding to each other's request. For instance, the analyst looking at the basin from a resource perspective may recognize that there is an issue with energy access in rural areas. By knowing this, the governance analyst could make sure to include the important actors (energy producers, utilities, regulators) in its mapping.

<u>Outputs of step 1</u>

- Factual questionnaires compiled from each riparian country
- Answers to the questions:

    - What are the main issues that the population living in the basin face?
    - What are main economic activities that take place in the basin and that have a relevance in the riparian countries or regional level?
    - Which are the main actors and strategies for development that influence the resource use in the basin?

<u>Improvements to step 1</u>

[15] In the nexus assessment under the Water Convention, UNECE requested the main counterpart ministries, that is, ministries responsible for water resources, to nominate a focal person from the national administration to the process. In addition, a local expert was engaged (in some cases by partner organisations) to support the process, and commonly it was the expert who filled out the factual questionnaire.

In this project, the governance analysis and the analysis of resources and needs were not sufficiently syncronized. At the beginning of the project (for the Alazani/Ganikh) the analysis of the basin was set up with a team of experts looking at the resources and needs, to be complemented by a separate institutional analysis. This scheme was improved in the course of the project (for the Sava and the Syr Darya) and the institutional analysis evolved into a proper governance analysis, which would cover not only institutional aspects, but also the legal basis and the policy framework and allowed from the other side to focus more on the physical aspects of the nexus. The dialogue was also improved between the two teams. A further improvement would be strengthening the dialogue between experts even more, ideally working in the same place with a common schedule. Assigning different teams of analysts to the development of a resource assessment and a governance analysis is not necessary as long as the team in charge of the nexus assessment posseses all the necessary expertise. In addition, the economic aspects of the nexus – currently part of the governance analysis, which main points are synthetized in Annex 4 – would similarly benefit from the inputs of qualified experts.

In terms of instruments, these could be now revised to make them more useful also from the governance analyst's perspective and avoid duplication of efforts. In particular, the questionnaire used included sets of screening questions mostly related to the availability of resources, socio-economic conditions and economic activities in the basin and environmental risks. In the assessment of the third basin (the Syr Darya), a similar questionnaire was prepared for the governance analysis and handed out at the workshop. For the future, it would be useful to merge the two questionnaires and send the complete version to the stakeholders before the workshop to advance the investigation on governance issues and better align it with the overall assessment.

3.1.2 Step 2: Identification of key sectors and stakeholders to be included in the assessment

In step 2, the needs identified are associated to key sectors and institutions, according to their mandate and field of activity. The main purpose of this step is to identify which sectors and related institutions/actors need to be considered in the assessment process. These sectors will be analysed separately and more in depth in step 3.

In view of the upcoming workshop and its follow-up activities that will count on stakeholders' active participation (steps 4-6), this step also helps with identifying who these stakeholders should be. It is important to involve a diverse group of stakeholders including policy makers, experts and civil society that can contribute with the assessment both with their knowledge and power to take action. As a basis, stakeholders to be involved include national and local government institutions of the main relevant sectors (most commonly water, energy and agriculture sectors),

environmental protection authorities, and, where feasible, local communities[16]. As appropriate, involvement of the private sector and the civil society is also sought. In addition, involving experts who are involved in relevant work in the basin is also highly beneficial. Relevant work include climate change adaptation, environment, governance, as well as current and past efforts to improve intersectoral cooperation between the water, energy and agricultural sectors in the region.

Outputs of step 2

Answers to the questions:

- Which are the key sectors that need to be analysed in depth in the nexus assessment?
- Which are the key stakeholders to involve in the assessment?

Improvements to step 2

Due to the limited resources available in this project and practical organizational constraints, as priority the main ministries involved in the management of natural resources were engaged in the participatory process through their nominated representatives. As an improvement, an accurate identification of key stakeholders based on a governance analysis carried out sufficiently early in the process would be highly valuable. This would facilitate, with respect to the past application of this methodology, for screening that the key stakeholders have abeen taken into account and possibly for a better involvement of the private sector. *It would improve the work in the workshops to have decision-makers and policy persons better represented*.

3.1.3 Step 3 Analysis of the key sectors

In step 3, each of the key sectors identified in step 2 is analysed, following roughly the logic of the Driving forces-Pressures-State-Impacts-Responses framework[17]. As mentioned earlier, the water, energy[18] and agricultural sectors form the core group of key sectors. Others may include a particular industry, tourism, navigation, sub-sectors of agriculture (e.g. fishing or forestry). *It is important to ensure representation of environmental protection interests - authorities and civil society, in addition to enconomic interests.*

[16] Due to the highly variable number of riparian countries and size of the basins, the extent of stakeholder involvement inevitably varies. Because of the interactive format of the basin assessment workshop, it was not possible the increase the number of particpants beyond practical.

[17] DPSIR framework has been adopted by the European Environment Agency (EEA) and it is broadly used under the Water Convention. For details, please see Environmental indicators: Typology and overview. Technical report No. 25/1999. EEA. 1999

[18] Water and energy sectors include the production or extraction of resources, distribution and management - utilities and institutions.

In order to glean information necessary for the nexus approach the following four dimensions of each sector need to be qualitatively stepped through:

(a) Drivers: needs, incentives, policies and programmes

It is possible to produce at this stage a set of key policies, development targets, new laws and institutional evolutions to be associated with the key sectors. Many drivers are national (e.g. sectoral policies) but there can also be important ones at regional and basin levels (e.g. customs unions, regional development programs). Fulfilling basic needs of population, such as access to safe water, clean energy and functioning livelihoods is also part of this group.

From the user's perspective, important drivers to the types and entity of resources use are tariffs, incentives, subsidies and regulations. Depending on the legal and economic basis, which could be more state oriented or more market oriented, more centralized or more decentralized, these could play a major or minor role.

Because of the regional developments and national sector priorities, important pulls between these and local basin needs and constraints might be observed. Thus, common or contradictory transnational trends might also be uncovered.

(b) Pressures and Impacts: effects on the environment and impact on humans and ecosystems)

The sectors contribute to the economy in ensuring local needs and achieving national objectives. Here we consider, for each sector, which services they provide and which impacts they have. For example safe drinking water is a 'service' supplied by the water sector. An impact of the sector might include depletion of water resources upon heavy abstraction. Poor health of the population may be a resulting impact of inadequate water sector management.

(c) Setting (status):

(i) Flows and Physical setting

Here we consider the resource base and how the sectors use resources: water, energy and land. Developing a proper integrated analysis of the dynamics between the resources and their uses has not been a part of the assessment. However, it could be, upon expression of interest and depending on resources available, through a follow up project. At this stage it is important to sketch the main qualitative and quantitative aspects that would characterize such an analysis. This would involve 1) a GIS analysis of the basin

to determine basin borders, main land use types, the location of important ecosystems and key infrastructure; 2) the development of a reference energy system to map energy resources from the source to the main uses in the riparian countries; 3) the definition of a hydrological model[19] of the basin and 4) an understanding on the main ecosystems (e.g. glaciers, wetlands, forests etc) and the services they provide.[20]

(ii) Institutions and Governance setting (status):

Looking at each sector, the institutional and legal framework is reviewed and presented in the form of a graphical scheme. Drawing from the previous efforts (step 1), inter-sector, local-national as well as trans-national agreements and mechanisms are now *presented* in terms of sectoral institutional settings and activities. This will allow the analyst to study and compare mandates and responsibilities as well as identify institutional gaps or dysfunctional mechanisms that need better coordination.

(d) Solutions and related constraints (management response):

In this step, the activities aimed at reducing pressures and impacts for each sector are spelled out. Providing a broad view of possible options is aimed at, making reference to efforts which may already be made in the direction of the highlighted opportunities. Solutions can be of various types: policies, infrastructure-related, coordination arrangements and economic instruments, for example. Therefore, both the governance and technical perspectives help idenifying them. It is important to determine which solutions would have most impact and beneficial effect, or which solutions seem most feasible financially and/or politically. It is also valuable to recognize which solutions would be difficult to implement and why.

<u>Outputs of step 3</u>

- A good understanding of the sectors, their resource needs and impacts.
- A water, energy, land resource assessment including information on their availability and quality (as detailed as possible).
- An understanding of the most critical environmental issues in the basin and of the indirect impact on human activities, through the degradation of ecosystem services.
- A set of indicators available to substantiate the above.

[19] Note that the development of a hydrological model is highly time- and resource- consuming. In many cases, a hydrological model is already available and can be used as reference. If it is not available, its possible development by the analysts should be carefully considered on the basis of the level of detail that the assessment should to reach in terms of quantification of trade-offs.

[20] According to the many classifications, ecosystems services are divided into four groups: Provisioning, Supporting, Regulating and Cultural. For definitions and examples refer to The Economics of Ecosystems and Biodiversity http://www.teebweb.org/resources/ecosystem-services/

- Four thematic GIS maps to facilitate the discussion at the workshop (energy, water, agriculture/land use and ecosystems).
- The activities in place to reduce pressures and impacts (laws, policies).
- Data gaps to be addressed to experts and country representatives.

Improvements to step 3

(a) It can be valuable to ask countries experts for a revision of the collected key policies, development targets, new laws and institutional evolutions. During thefirst basin assessments, this aspect was improved by explicitly requesting the presenters at the workshop to provide a set of key policies divided by areas of the nexus. *Ideally the key policy documents should be available to the analysts before the workshop.*

(c) The extent to which the analysis of natural resources varied in the three basins that have been assessed, reflecting partly availability of data, access to tools and resources . Even though it was not strictly part of the envisaged process, it became clear that limited modelling is needed to be able to provide illustrative quantification to interlinkages across sectors. If there are specific issues that the countries want to look at, the quantification can be focused on the issue at stake, ideally using already available models and liaising with local research institutes. If there are enough resources to allow for a modelling exercise, this can be also valuable to advance capacity building[21].

3.1.4 Step 4: Identification of intersectoral issues

The following steps are carried out in the framework of a participatory multi-sector workshop, followed by an in-depth analysis of the interlinkages idenfified (issues and solutions) and by a second workshop to explore the potential for addressing the nexus assessment's conclusions and implementation of solutions into existing policies and strategies of the countries (see step 6).

The general structure of the first participatory workshop is provided in Annex 2. A representative set of the relevant actors identified in step 2 – officials, other key stakeholders experts – should take part to it. The desk study produced (steps 1-3) serves as a background document for the workshop and help shaping the type of discussion that will take place there.

The opinions of the participants are collected to appreciate the differences in perspective by country and by sectoral affiliation. These can be presented in the

[21] This especially if freely available modelling tools are used which the local experts and officials would have access to also later.

course of the workshop to show what “everyone agrees upon” and what is viewed differently from different sectors or countries [22].

Selected thematic or regional overview presentations and overview of the sectors and national policy developments from the riparian countries (see Annex 3) are used to set the stage at the beginning of the workshop.

Participants at the workshop are then divided into 'sectoral groups'[23] to focus and analyse each component of the nexus. They are asked to consider the component’s sectoral plans (including the time frame), their links to other components as resource input requirements (for example energy sector’s water need in hydropower generation or cooling) .

The key activity in this step is to consider linkages of their sector with other sectors and the implications there of. Relevant inter-sectoral relations and impacts from each sector’s point of view are captured. The discussion can be extended to where in the basin the interlinkages are most prominent by looking a thematic GIS map of the basin. Thematic presentations for each sectoral group can be prepared on the basis of the desk study to start the discussion[24].

As an example, the land use group may draw an arrow from energy to land use to indicate that hydropower production reduces the availability of water stored thereby limiting irrigation potential. The same group may, for instance draw an arrow from land use to ecosystems to indicate the effect of agricultural discharges.

The participatory aspect of this step is important to ensure that the local knowledge in the countries and in the basins points to the most relevant and pressing intersectoral issues. *This provides a basis for an intersectoral (nexus) dialogue.* Each group is empowered to present the 'integrated nature' of their component in the next step.

Outputs of step 4

- For each sectoral group, an integrated-sector diagram that links the component in focus with the others by means of explicit resource input needs, impacts and effects

[22] The opinion based questionnaires is available at http://www.unece.org/fileadmin/DAM/env/documents/2014/WAT/09Sept_8-9_Geneva/Methodology_1Sept2014_clean_forWeb.pdf

[23] For simplicity, the groups are called sectoral although they are defined on the basis of the four areas of the nexus (water, energy, agriculture/land and ecosystems). The key sectors identified need to be assigned sensibly to one of these four areas. For example, tourism could be well integrated in the discussion around ecosystems while agriculture (including forestry etc) would probably lead the discussion on land use.

[24] This was tested in the workshop on the Syr Darya basin - for the energy group – and proved to be useful.

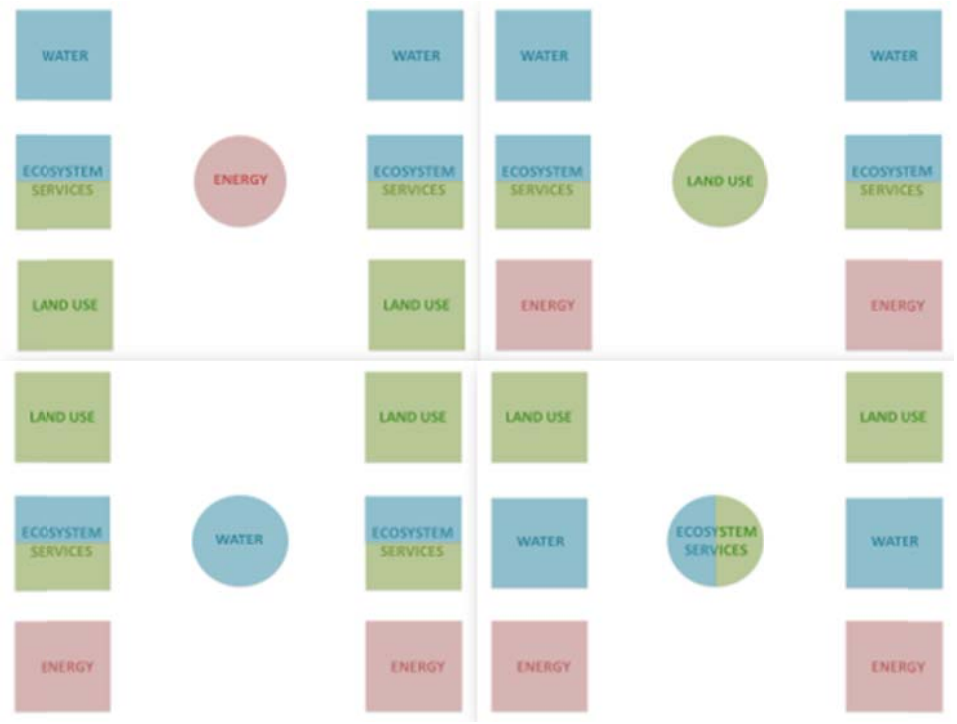

Figure 3 Diagrams of each sectoral group for the purpose of identifying Intersectoral issues.

Improvements to step 4

The future dimension was not explicitly considered in this step in any of the workshops. If a clear list of key policies is available for each group, the sectoral groups could be asked, towards the end of the session, to comment on how those policies (each sector will have its ones) will affect the identified interlinkages.

3.1.5 Step 5 Nexus Dialogue

A nexus diagram, includes links between sectors, is drawn collectively in the workshop. This, and pictures all sectors as equally important. Links identified in step 4 from a sector perspective are considered in this step and jointly prioritized. The links might be unidirectional (impact from one sector to another) or bidirectional, (tradeoffs, affecting each others).

This part of the workshop evolved significantly from the pilot to the last workshop. At the beginning, a second working group session (in ' sectorally mixed' groups) was established to build consensus on a set of 'priority interlinkages'. Later this session was made shorter and prioritization was made in an interactive plenary session. This allowed to allocate more time to discuss the future dimension in another session in working groups.

Next, the relevant future tendencies are identified jointly with the participants: scenarios are developed, and the effects between sectors are qualitatively described. This was initially done in very general terms, discussing in plenary session socio-economic trends (population growth, economic development etc.), strategic directions of the sectors and priorities of the countries and external constraints, such as climate change. In the last workshop, an attempt was made to structure more this discussion on the future dimension and make it more interactive. It was decided to take one session and use it to build scenarios in working groups, define key uncertainties and discuss the evolution of the identified interlinkages in those scenarios.

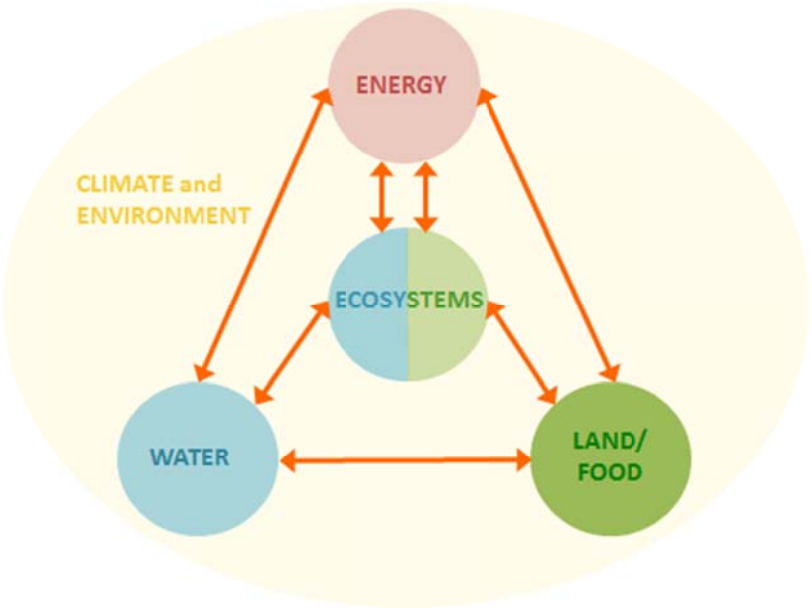

Figure 4 Nexus dialogue. Diagram representing agreed key interlinkages.

Outputs of step 5

- An agreed set of priority interlinkages across sector
- Few agreed scenarios to be considered in the assessment
- Key uncertainties and drivers of change
- A preliminary (qualitative) understanding of the evolution of the interlinkages under those scenarios

Improvements to step 5

In the last workshop, the working group session to discuss the future dimension was designed on the basis of the Scenario Thinking exercise developed by FAO. According to FAO, in previous applications, this exercise was carried out with a duration of an entire workshop and gave very satisfying outcomes. While the time was downscaled to three hours but the procedure was not enough modified to fit such a short time slot. In future applications, this sessions will need to be redesigned and its require outputs better defined.

3.1.6 Step 6: Identification of synergies (across the sectors and countries)

In step 6, possible solutions to the most pressing intersectoral issues are identified and their potential implementation is discussed with stakeholders. Solutions could be of various kinds:

- policies solutions (changes to existing policies or new policies);
- land use and management (planning and change of practices) and measures practices;
- cooperation agreements (institutional arrangements, trade etc);
- technology, operation and infrastructure (new investments, changes in infrastructure operation;
- coordination and communication (e.g. capacity building, common databases) and
- economic instruments (market based or regulatory).

Solutions discussed need to 1) benefit at least two different sectors and 2) have a clear transboundary dimension.

Ideally the thinking and dialogue should be prolonged to explore who (which sector, organization etc.) is in a position to address the identified potential solutions and what concrete actions could be undertaken by whom. Actions could be incorporated into ongoing or planned initiatives. For instance, in some basins the riparian countries are part of the EU Water Initiative's National Policy Dialogues or there are regional organisations like basin organisations or other joint bodies, possible with a multiple sector representation, which could provide a framework for identification of beneficial future activities. The potential benefits of such options of cooperation across sectors and countries could be substantiated, wherever the available data is enough to support it, with explicit calculations (for example, savings of water or energy feasible to obtain etc).

The participatory workshop provides a good forum to brainstorm on such solutions, as they naturally arise from the discussion on intersectoral issues. At the same time, it is difficult to expect the discussion to evolve into detailed solutions at this stage, not only because the workshop would probably be overloaded but more importantly because a more in-depth analysis of the jointly identified issues, trends and solutions is needed before proposing concrete actions.

The in-depth analysis of interlinkages is to be carried out by the analysts. Limited quantification of intersectoral issues and benefits arising from the suggested solutions is possible but constrained by the resources available. A qualitative identification of benefits is nevertheless possible. Identifying clear benefits for the sectors and the countries is key to pursue the final objective of the assessment, which is to find entry points to existing or new policies and legislation.

In general, the nexus approach adds value in the sense that it can help uncover the co-benefits (or external costs) associated with actions in one sector, providing important insights at local and national level as well as across boundaries.

Transboundary water cooperation has the potential to generate diverse and significant benefits for cooperating countries. Those benefits can be realised by accelerating economic growth, increasing human well-being, enhancing environmental sustainability and contributing to political stability. Commonly the understanding of possible benefits is narrowly focused on sharing (volumes of) water. The intersectoral or nexus approach invites to consider the intersectoral implications of policies and management measures, and the related opportunities for benefits in a broad sense. Aid in recognizing wide-ranging benefits is sought from the "Policy Guidance Note on identifying, assessing and communicating the benefits of transboundary water cooperation" (UNECE).[25]

Table 2 Types of benefits of cooperation.[26]

	On economic activities	Beyond economic activities
From improved water management	**Economic benefits** • Expanded activity and productivity in economic sectors (aquaculture, irrigated agriculture, mining, energy generation, industrial production, nature-based tourism) • Reduced cost of carrying out productive activities • Reduced economic impacts of water-related hazards (floods, droughts) • Increased value of property	**Social and environmental benefits** • Health impacts from improved water quality and reduced risk of water-related disasters. • Employment and reduced poverty impacts of the economic benefits • Improved access to services (such as electricity and water supply) • Improved satisfaction due to preservation of cultural resources or access to recreational opportunities. • Avoided/reduced habitat degradation and biodiversity loss
From enhanced trust	**Regional economic cooperation benefits** • Development of regional markets for goods, services and labour • Increase in cross-border investments • Development of transnational infrastructure networks	**Peace and security benefits** • Strengthening of international law • Increased geopolitical stability • New opportunities from increased trust • Reduced risk and avoided cost of conflict • Savings from reduced military spending

Following the in-depth analysis of interlinkages, the analysts and the stakeholders should meet again to discuss real opportunities to take action.

<u>Outputs of step 6</u>

[25] The Guidance is currently under development as part of the Work Programme 2013-2015 under the Water Convention. A draft of the Guidance is available at http://www.unece.org/index.php?id=37301#/

[26] Source: Policy Guidance Note on identifying, assessing and communicating the benefits of transboundary water cooperation (forthcoming, UNECE)

- A set of potential actions that can be considered as nexus 'solutions', which means that have clear cross-sectoral benefits and transboundary dimensions.
- The identification of existing or potential policies and actions that could provide a vehicle for the implementation of such solutions. This would naturally lead to answering the question of who could take action.

Improvements to step 6

A second workshop to discuss opportunities for the implementation of selected actions is one of the key moments of the nexus assessment process. Initially not included among the elements of the methodology, a follow up meeting with the countries is taking place naturally, to discuss findings and realistic application of nexus solutions. Such meetings have been held as side events of National Policy Dialogues (co-organized by UNECE and OECD) in the countries of Caucasus and Central Asia, but these have been national.

3.2 USE OF INDICATORS

The nexus assessment of each basin is data dependent and indicator-based. Figure 1 shows how indicators and data relate to the 6 steps of the basin assessment.

The information provided by the national administrations in the riparian countries is the preferred source of data[27]. Where information is already available as reported by national authorities or as country statistics it is gathered directly.

The analysis evolves from a diagnostic analysis of the basin and the riparian countries - zooming in on the key sectors - to a participatory phase where intersectoral issues are discussed together, and then to an in depth analysis of the identified main issues and potential synergic solutions.

Thus, a first set of indicators helps in the diagnosis of the basin. These might be available at national or basin level depending on the topic. The historical or spatial variation of indicators and information is considered whenever relevant (e.g. water quality can be different from point to point; access to safe water can be increasing, decreasing or stable) and whenever available (often, data at basin level are simply not available or they partially overlap with regional/district level data). This group includes also the Nexus indicators of FAO that specifically look at the interlinkages across Water - Energy, Food - Energy, Water - Food and their trends.

It is important to keep in mind that a comprehensive list of indicators is difficult to establish a nexus assessment does not have a pre-defined focus. Rather than trying to collect all possible information the analyst should have a critical approach during this screening. If something is relevant, further indicators should be looked at. Just

[27] To facilitate the process, national experts/coordinators engaged for the assessment project support the information collection and liaising with the focal points.

as an example, knowing that a country has a large share of land cultivated with a certain crop, the analyst may be interested to establish what part of the GDP comes from the export of that crop. An effort has been made in the assessment unthe Water Convention to use the indicators for the purpose of visualizing and comparing different basins, but in the end few common indicators for all basins have been used. Not all indicators will be comparable for all basins assessments, but for the purpose of this exercise it has been more important to focus on what is relevant in each case rather than ensure comparability.

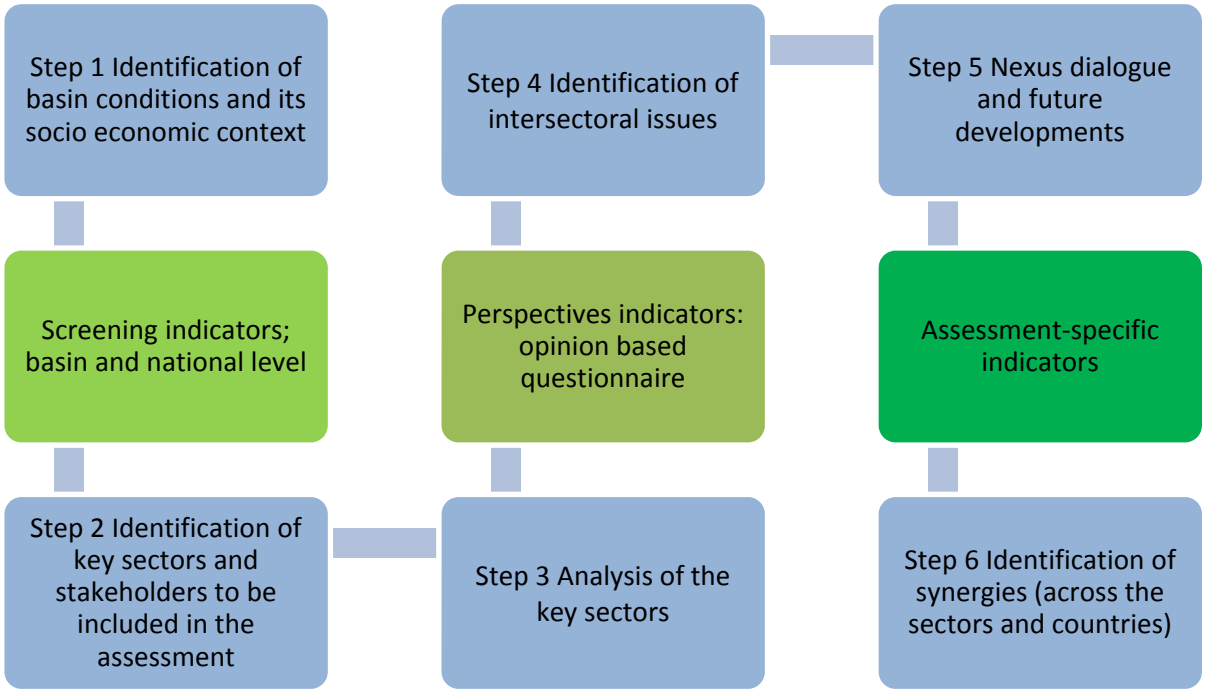

Figure 5 Indicators (in green) and how they are used in the steps (in blue).

A second set of indicators consists of the evaluation of importance of issues occurring in the basin, according to the opinion of participants to the nexus assessment process. The questions are divided into four general groups: water, energy, agriculture/land and ecosystems. The answers are kept anonymous given the nature of the questionnaire but each person answering has to specify if he is an expert in W, E, L or Eco and which country he represents in order to allow for comparisons. The indicators developed from the analysis of this questionnaire consist of comparisons between opinions from different countries or different perspectives (components of the nexus).

The third set of indicators and data is the most variable in terms of type and use. These indicators will be needed to validate statements, substantiate qualitative analysis and to calculate inter-sectoral benefits. These are difficult to meaningfully predict beforehand.

Table 3 Indicators. Types and uses.

Group	Screening indicators	Opinion indicators	Assessment-specific indicators
Type	**National Indicators** Socio-economy, demography, poverty, environment, access to resources. Resource base*: availability, quality and uses at basin level. Resource uses and intensity*. World Development Indicators: Progress towards MDGs, demography and society, environment, economy, states and markets **Basin Indicators (including GIS)** Geo-spatial analysis: land use types, location of important ecosystems and key infrastructure. Resource base*: availability, quality and uses at basin level. Resource uses and intensity*. Indicators related to water resources and uses.	Issues related to energy, water, land use and environment according to local authorities (who have good knowledge of the basin) The opinions are in the form of ranking (very important to not important, high intensity to low intensity of impact).	Indicators related to basin-specific issues and solutions. These can be quantitative, qualitative, semi-quantitative. If specific indicators are not available, national and basin indicators can be used as proxies.
Use	Used in the initial phases of the assessment.	Used to appreciate the differences in	Used to substantiate the in-depth analysis of

	If needed, they can be validated or adjusted via country/ stakeholder consultations. At basin level, data available can differ very much in levels of aggregation, accuracy, reliability, etc. In a final stage of the assessment, if better data is missing, they can be used as proxies for potential calculations. Data on energy and water consumption by sector (A) are also used to determine their energy efficiency and water efficiency Qualitative and semi-quantitative indicators can be very useful information to complement the indicators (for example, types of groundwater use in the basin or water quality)	perspective by country and by sectoral affiliation. These can be presented in the course of the workshop to show what "everyone agrees upon" and what is viewed differently from different sectors or countries.	the identified issues and solutions. Wherever possible, their quantification can help determining the entity of major issues across sectors and the costs and benefits of synergic solutions Given the specificity of the focus of the in-depth analysis, the type of evaluation and/or quantification highly depends on the data available.

*Resource uses and availability are relevant both at national and basin level to understand how dependent are the riparian countries on the basin (e.g. % of energy produced in the basin).

A list of indicators and sources is presented in Annex 1. It is important to keep in mind that the nexus assessment needs to move across scales. Sometimes indicators will be available at national, basin, sub-basin or even local level. Very often, it will be difficult to obtain information that will specifically refer to countries' shares of the basin. This will probably require the use of proxies, highly aggregated data and partial information.

Annex 1

Indicators and sources

Groups of indicators *The list proposed for screening indicators is not comprehensive but it provides a good overview of the basin and its riparian countries.*	Suggested sources *For all indicators, preference is given to national statistics and indicators directly received from countries' authorities.*

Screening indicators

Basin – note: not all indicators are available for all basins	
River and Basin: Length Basin area Country´s share Land use by type	FAO Aquastat Database[28] UNECE Second Assessment of Transboundary Rivers, Lakes and Groundwaters[29]
Withdrawals in the basin: Total withdrawal Agricultural share Domestic share Industry share Energy share	FAO Aquastat Database
Trasnboundary underground aquifers: Border length, Area, Thickness mean, max Main groundwater uses (qualitative) Groundwater management measures (qualitative)	UNECE Second Assessment of Transboundary Rivers, Lakes and Groundwaters
Groundwater balance: Precipitation Total flow Inflow Infiltration river Infiltration precipitation Discharge evaporation Discharge river	UNECE Second Assessment of Transboundary Rivers, Lakes and Groundwaters
Renewable water resources in the basin: Mean annual runoff Internal renewable surface water resources (IRSWR) by country	FAO Aquastat Database
Wastewater information: Wastewater generated Wastewater treated (primary, secondary, tertiary treatment)	UNECE Second Assessment of Transboundary Rivers, Lakes and Groundwaters
Stress (ranking): Baseline stress Inter-annual variability Seasonal variability Flood occurrence Drought severity	World Resource Institute Aqueduct Database[30]

[28] http://www.fao.org/nr/water/aquastat/dbase/index.stm
[29] http://www.unece.org/?id=26343
[30] http://www.wri.org/our-work/project/aqueduct/aqueduct-atlas

Countries	
GDP GDP growth GDP growth per capita Population Population growth Rural population Rural population growth Population density	World Bank World Development Indicators Database[31]
Contribution of natural resources to GDP: Total natural resources rent Oil rents Natural gas rents Coal rents Mineral rents Forest rents Population below national poverty line	World Bank World Development Indicators Database
Employment by sector (in Agriculture, Industry, Services)	World Bank World Development Indicators Database
Contribution to total GDP by sector (Agriculture, Industry, Services)	World Bank World Development Indicators Database
Water productivity In Agriculture In Industry In Services/Domestic Use	To be calculated on the basis of water withdrawals and GDP (by sector)
Energy productivity In Agriculture In Industry In Services/Domestic Use	To be calculated on the basis of energy consumption* and GDP (by sector) *this information needs to be made available from country statistics (no openly accessible database)
Water Resources Actual renewable water resources Internal renewable resources (IRWR) External renewable resources (ERWR) Quantity of flow reserved to upstream and downstream countries through formal or informal agreements or treaties Renewable water resources per capita	FAO Aquastat Indicators
Water use: Annual freshwater withdrawal Withdrawals for Agriculture Withdrawals for Industry Withdrawals for Domestic Use Access to improved water source Access to improved sanitation facilities	World Bank World Development Indicators Database FAO Aquastat Indicators

[31] http://data.worldbank.org/data-catalog/world-development-indicators

Land: Land area Forest Area Permanent Cropland Arable Land Arable land per person Total wood resources Logging harvest (official) Logging harvest (illegal) Agricultural irrigated land Average annual precipitation Land under cereal production Fertilizer consumption Agricultural machinery	World Bank World Development Indicators Database
Energy: Energy production total Energy use Energy use per capita Use of fossil fuels Combustible renewable and waste Alternative and Nuclear (= Hydropower) Energy use growth	World Bank World Development Indicators Database
Electricity: Electricity production from Coal from Natural Gas from Oil from Hydropower from Renewables from Nuclear Electricity access	World Bank World Development Indicators Database
Environment: Threatened species (mammals) Threatened species (birds) Threatened species (fishes) Threatened species (higher plants) Terrestrial protected areas Marine protected areas	World Bank World Development Indicators Database
Emissions: CO2 emissions per unit of GDP CO2 emission per capita Total CO2 emissions	World Bank World Development Indicators Database
Risks related to climate change: Land area where elevation is below 5 m Population living in areas where elevation is below 5 m Population affected by droughts, floods and extreme temperatures	World Bank World Development Indicators Database

Perspective indicators

Difference of opinions by country, by area of expertise (sector): Overview of the basin Water quality and quantity Food and land use Energy Environment	Opinion based questionnaire.

Assessment specific indicators

Interlinkage 1	(Previous studies) Experts, authorities.
Interlinkages 2	
…	
Solution 1	
Solution 2	
…	

Geo-spatial indicators

All data are collected in GIS-readable formats (raster based maps or referenced geographic information)

Administrative Country data
Freely available country boundaries data. UNSALB, http://www.unsalb.org/
Administrative areas and boundaries. Global Administrative Areas database (GDAM) Year 2012.
http://gadm.org/

Socioeconomic Data
Open source maps and data used. EC Joint research Centre "About Global Environment Monitoring Unit". Data also include elevation and slope data as "distance to markets" maps.
http://bioval.jrc.ec.europa.eu/
Country and population data."Socioeconomic data and application centre", SEDAC.
http://sedac.ciesin.columbia.edu/gpw/global.jsp#

Hydrological basins, rivers and irrigation maps
The boundaries of the hydrological basins and irrigation related maps are extracted from FAO AQUAMAPS geodatabase. http://www.fao.org/nr/water/aquamaps/

Digital elevation
The CGIAR-CSI GeoPortal provides global SRTM 90m Digital Elevation Data. Year: 2003
http://srtm.csi.cgiar.org/ and http://www.cgiar-csi.org/category/elevation/

Land cover
Land cover data. FAO and JRC's databases.
http://www.fao.org/nr/lada/index.php?option=com_content&view=article&id=154&Itemid=184&lang=en http://bioval.jrc.ec.europa.eu/products/gam/sources.htm
Land cover classes . GLC2000 dataset produced by JRC Year: 2008/2000
http://bioval.jrc.ec.europa.eu/products/gam/sources.htm

Lakes and wetlands
Spatial information about wetlands, water bodies, rivers and other water related land forms. 1:1 to 1:3 million resolution. "The global lakes and wetlands database". Year: 2004
http://worldwildlife.org/pages/global-lakes-and-wetlands-database

Protected areas
Database on Protected Areas. Year: 2012 http://protectedplanet.net/

Agricultural production area
Potential of agriculture are based on the Global Agro-Ecological Zoning model (GAEZ) IIASA and FAO. http://www.fao.org/nr/gaez/en/ and http://www.gaez.iiasa.ac.at/.

European River Catchments
Homogeneous European catchments dataset at scale 1:1 million. Year: 2006
http://www.eea.europa.eu/data-and-maps/data/european-river-catchments

Urban areas
30 arc-second land area grid. Global Rural-Urban Mapping Project (GRUMP). Year: 2000
http://sedac.ciesin.columbia.edu/data/collection/grump-v1 and
http://bioval.jrc.ec.europa.eu/products/gam/sources.htm

Water risks
AQUEDUCT GLOBAL MAPS 2.0, which includes 12 global indicators related to a water risk framework (physical risk quantity, physical risk quality, regulatory and reputational risk). Year: 2008
http://pdf.wri.org/aqueduct_metadata_global.pdf

Night time light
The Earth Observation Group (EOG) of the National Geophysical Datacenter (NGDC). Lights and combustion sources. Year: 2000 http://ngdc.noaa.gov/eog/

Forest change
Global Forest Change 2000-2013 database created by Hansen et al., Science 2013
http://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.1.html

Further Sources
Other Sources for free online available geographic information and tools include (amongst many others) the GeoNetwork - Open Source , NASA's Earth Observing Data and Information System (EOSDIS), DIVA-GIS and Natural Earth.
http://geonetwork-opensource.org/ https://earthdata.nasa.gov/
http://power.larc.nasa.gov/cgi-bin/cgiwrap/solar/sse.cgi?+s01+s03#s01
http://www.diva-gis.org/Data
http://www.naturalearthdata.com/

Annex 2

Structure of the nexus assessment workshops at the basin level

A. Introduction of the nexus and relevant explicatory examples (by the analysts)
B. Distribution of the opinion based questionnaire
C. Introduction to the key sectors, their main characteristics and issues by selected speakers
D. Presentation of national sectoral policies by relevant authorities, as well as relevant national strategies and targets that may affect the basin
E. Focus on the basin. Discussion on future possible developments of the basin (river basin or aquifer management plan, infrastructure plans, sectoral targets, policy priorities etc.)
F. Illustration of possible interlinkages and nexus conditions. Explanation of the working groups sessions;
G. First working group session on intersectoral mapping. Stakeholders are divided according to their area of expertise or work (land, water, energy, ecosystems). Each group identifies the most important interlinkages (impacts and tradeoffs) associated to its component
H. Joint prioritisation of the key interlinkages to be considered in the assessment
I. Presentation of official data on climate change and, if available, the predicted impact on the basin
J. Second working group session on future dimesion. Participants are divided into mixed groups to define few relevant scenarios and discuss how the key interlinkages will change under those scenarios.
K. Discussion on synergic actions for the identified nexus conditions, by means of measures, policies, coordination arrangements as well as techno-economic solutions, reflect on the transboundary dimension discussion on the benefits and limitations; identification of who/which actors could advance the actions;
L. Discussion on indicators and sources available.
M. Presentation (by analysts) of some key findings/results from the workshop and the preparatory work, in the form of nexus graphs and storylines that will be analysed further and included in the basin assessment;
N. Presentation of next steps in the assessment

The second workshop (on the basis of a draft nexus assessment report for a review):

A. Presentation of findings and solutions
B. Discussion on how the findings and solutions relate to policies or programmes in the countries, and what could be done to address the identified intersectoral issues.

Annex 3

Template for presentations by national representatives

National development plans and sectoral goals in the river basin

1. State → Basin

Targets and goals to achieve (at national level):
- food security
- energy security
- water security

National policies and action plans for:
- poverty alleviation
- environmental protection
- climate mitigation and adaptation

2. Basin → State

List of key sectors in the basin (such sectors have to be "key" from the country's perspective, in the context of the basin) – just as an example:
- large scale plantation of a certain crop (agriculture)
- extractive industry

List of sectors that could potentially play a bigger role in the economy of the basin (high potential from the country's perspective) – just as an example:
- wind power production
- tourism

3. Regional development programs involving the key sectors in the basin
4. Implementation measures (for instance, incentives or other economic benefits to promote specific sectors)

General notes:
- wherever possible, refer to quantitative and/or spatial information (e.g. irrigated land expansion: XX ha)
- include list of sources (policy, documents, website pages) that the presentation refers to

Annex 4

Guide for the governance analysis

The governance analysis of a nexus assessment looks at the legislative, institutional and policy framework of the basin, the countries and the region.

By analysing

1. Institutional structure of water, energy, agriculture, ecosystems at local, national, transboundary and regional levels;
2. Legislative framework and social aspects;
3. Measures and policy instruments to implement sectoral strategies at national level;
4. Economic instruments;
5. Level of coordination and coherence among sectors and countries

the governance analysis will help address the following questions:

A. Where does the institutional framework lack coherence? E.g. gaps or overlaps of responsibilities, diverging objectives.

B. What are potential conflicting objectives of sectoral policies - not only the objectives themselves, but also shortcomings in administrative practice and in administrative philosophy that interfere with resolution of such conflicts?

C. Does the implementation of measures and regulation have the desired effect from a sectoral point of view? Does a nexus (intersectoral) point of view highlight the need to change them or to better coordinate them?

D. What opportunities there are for administrative cooperation, for dispute resolution, for expert input, etc?

E. What is the scope of transboundary cooperation in relation to resource uses in the basin, , and what aspects may hinder it? Can transboundary cooperation help addressing the identified issues and how?

While governance analyses commonly also highlight the importance of political differences and power asymmetries, these factors have not been specifically considered in this assessment.

The following questions are meant to help the analyst in this task. In order to evaluate measures from their coherence at an institutional level to their actual implementation, the questions are divided into four groups: *institutions, sectors and policies, implementation (including economic instruments and legislation), incentives and safety nets*

Institutions

- What are the institutions at local, national, regional level governing the use of water, energy and land resources?

- What institutions protect the ecosystems and the functioning of the services they provide?
- Type of institution(s)
- Mandates (Utility = to supply, Regulator = to establish prices/uses; separation of regulatory and operational functions etc.)
- Is there coordination or conflict between institutions: within a sector, between sectors, between national and local levels or national and regional?
- Are there institutional arrangements in place to support inter-sectoral dialogue/cooperation?
- Are there mechanisms in place to solve conflicts related to suboptimal resources allocation?

Sectors and policies

- What are the sectoral plans at local, national and regional level for:
  - General: priorities for economic developments and (if applicable) reduce poverty
  - Energy production and distribution (also for export)
  - GHG mitigation and adaptation
  - Water supply, sanitation, wastewater treatment facilities
  - Agriculture, irrigation plans, significant shifts to new crops or agro-industry type (also for export)
  - Ecosystems protection and support (including flood protection)
  - Expected/planned economic development in the region (including tourism)
- What are the sectors that pravail in the discussion?
- Is there integrated planning (centralised/decentralised)? If too decentralised: how are significant plans taken into account in the activities of municipalities (coherence)? If too centralised: how can optimisation be achieved locally?

Implementation (including economic instruments and legislation)

It is important to differentiate between countries in which a market economy is predominant and where state regulation is the main engine for change. In both cases legislation is important although its extent may differ, but in the former case the application and relative significance of economic instruments is typically greater. The role of the market and economic instruments in the allocation of resources in particular is more prominent in market economies.

- What are the main incentives, regulations / legal requirements and standards aiming at protecting the environment?
- Is the legal basis adequate?
- Pricing of energy and water. What are the market or 'allocation' rules behind the pricing of these resources? How does this vary from sector to sector?
  - How is land allocated? Are there many small farmers or large plantations? Are they formal or informal?
  - How is water allocated to the different sectors? In particular, do the agricultural sector and/or the energy sector particularly benefit from national policies?

- Are environmental assets related to the basin valued as economically significant? How is that value translated into policy?
- Are the economic sectors (resource users) simply in conflict with environmental protection actors or there is some kind of collaboration (e.g. eco-tourism or bio-agriculture)? If yes, at which level?
- With regards to the energy sector, is there specific legislation governing water/land uses by the energy sector (e.g. environmental flows, legislation on chemical/thermal pollution, environmental impact assessment requirements for the installation of renewables)?
- Regulations on resources use: Water (treatment requirements, discharges etc), Energy (efficiency), Land (allotments, deforestation etc.)

Incentives (to reduce impact and improve efficiency) and safety nets

When analysing measures and instruments, it is important to include the point of view of the farmer (or cooperative etc), water and energy utilities, private sector (e.g. industry). How are they governed, and what are the incentives for them to efficiently use resources and limit their impact? Do they work?

- Are inputs (resources) regulated, are outputs regulated and how?
- How are economic activities supported? (e.g. reduced taxation, subsidy, rations, fixed tariffs) What institution oversees the implementation of the incentives? In particular:
    - Subsidies to agriculture. How much does water cost to farmers and how is it provided (e.g. fixed connection, ration)? Are fertilizers, machineries etc accessible at convenient prices? Are the incentives directed at specific crops (is growing certain crops more convenient than growing others)?
- Are there significant subsidies for one energy source over another, that cause the poorest to over-use one resource / or that avoid the exploitation of other resources?
- What are the mechanisms to ensure that tariffs increases, new technologies and new regulations don't hit the poorest shares of population?