Petersberg Phase II / Athens Declaration Process

Protection and Sustainable Use of Transboundary Waters
in Southeastern Europe

Study for the identification of the state, challenges and issues of water and energy nexus in transboundary basins of Southeastern Europe

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Federal Ministry for Environment, Nature Conservation and Nuclear Safety
Head of Division "General, Fundamental, International and European Aspects of Water Management"

Postbox 12 06 29, D-53048 Bonn
T: +49 (0) 228 99 305 2790
E-mail: thomas.stratenwerth@bmu.bund.de

Athens, Beirut, Tunis
Web: www.gwpmed.org

Headquarters:
12, Kyrristou str., 10556 Athens, Greece
T: +30210-3247490, -3247267, F: +30210-3317127
E-mail: secretariat@gwpmed.org

Prepared for the Petersberg Phase II / Athens Declaration Process by:
T. Dworak, and L. Romanovska
Fresh-Thoughts Consulting GmbH - Where science meets policy!

Table of contents

1 Introduction and Background 4
1.1 Status of water resources and main water users 4
1.2 Governance and cooperation 6
1.3 The Nexus approach 8
2 Hydropower production in SEE 12
2.1 Electricity demand, import and export 12
2.2 Hydropower production in SEE 13
2.3 Hydropower potentials and utilisation rate 14
2.3.1 National potentials 14
2.3.2 Hydropower in transboundary river basins in SEE 15
2.4 Benefits and trade-offs of hydropower production 16
2.4.1 Benefits 16
2.4.2 Trade-offs 16
3 Water resources governance issues and management of transboundary basins, with a focus on hydropower 17
3.1 Governance issues and challenges related to hydropower production – an overview 17
3.2 Transboundary cooperation on hydropower 19
4 Future Challenges and tools to address them 21
4.1 Challenge 1: Developing hydropower plants and ensuring well-functioning ecosystems 21
4.2 Challenge 2: Ensuring water security and establishing transboundary cooperation for water and energy management 22
4.3 Challenge 3: Coping with climate change 23
4.4 Sustainable hydropower production - available governance and management tools 23
4.5 Using the nexus approach for transboundary water resources management and sustainable hydropower production 26
5 Priority issues to be discussed at the round table 30
6 Literature 32
Annex 1: IEA Recommendations for sustainable Hydropower decision-making (2010) 35
Energy policy framework 35
Decision-making process 36

Comparison and Selection of Project Alternatives 36
Improving Environmental Management of Hydropower Plants 37
Benefiting Local Communities 37
Annex 2: Mitigation of hydropower impacts 38
Annex 3: Water, Energy and Food security nexus 42
Annex 4: Electricity production and hydropower share overview in SEE............................... 47
Annex 5: Hydropower potential and utilisation in SEE 48

1 Introduction and Background

1.1 Status of water resources and main water users

The vast majority of river basins in the Southeastern Europe (SEE) are of transboundary nature, with at least half of them being shared among three or more countries.

Map 1. Transboundary Basins in SEE

Source: UNECE (2011) (The full map is available at http://ec.europa.eu/environment/water/water-framework/facts_figures/index_en.htm)

Based on UNECE Second Assessment of Transboundary Rivers, Lakes and Groundwaters it can be stated that both the quantity and quality of transboundary water resources in SEE are under significant stresses.

Agriculture, domestic use, industry and tourism are the main users influencing withdrawal rates of water resources. Inefficiencies in water use and losses due to ageing and sub-optimal infrastructure are significant, most prominently so in the agriculture sector where the majority of farmers apply unsustainable irrigation practices.

Agricultural activities also contribute significantly to the worsening of the quality of water resources through chemical pollution from the use of fertilisers and pesticides leading to loss of biodiversity and deterioration of ecosystems.

Another cause of pollution is insufficient or lacking wastewater treatment including illegal discharges from industry and erroneous use of septic tanks in rural areas. Mining activities are also having negative impacts on several basins in SEE. Additionally, illegal or uncontrolled waste disposal sites are contributing to the pollution of both surface and groundwaters.

Seasonal impacts on water use, generation of waste and wastewater originate from tourism, as well as illegal construction on the banks of water bodies for recreational purposes.

Hydropower is the main non consumptive water user in most of the transboundary basins in the SEE. Cooling for energy production, agriculture, domestic use, industry and tourism are the main consumptive users influencing withdrawal rates of water resources. The construction and operation of hydropower plants on waterways in SEE pose both challenges (ecological and socio-economic) and create benefits (e.g. job creation, flood regulation, water diversion, irrigation, drinking water supply and recreational purposes).

The challenges are multifaceted and range from bio-physical impacts, such as hydrological and morphological alteration, fragmentation of habitats, erosion linked to soil and land loss, changes in sediment transport capacity and deposition, impacts on water quality and landscapes; to social impacts related to resettlement, loss of cultural and historic sites, land-use changes and alterations of livelihoods of local communities[1] Furthermore, concerns about impacts of human health due to water storage in large reservoirs have also been expressed[2].

Coastal ecosystems are experiencing additional pressures from changing land-use patterns - reclamation of wetlands, uncontrolled urbanisation, illegal hunting and fishing.

The least understood constituent of SEE water resources are aquifers and the lack of the knowledge base hinders trans-border cooperation on aquifers that span more than one country. This is especially true for the karst aquifers. The aquifers are still insufficiently mapped and categorised. The first initiatives on improving the knowledge base and sustainable management of karst aquifers are being taken under the GEF-UNDP framework. Funded by GEF, the International Hydrological Programme of UNESCO is currently implementing the Regional Project on the Protection and Sustainable Development of the Dinaric Karst Aquifer System (DIKTAS) aiming to facilitate the equitable and sustainable utilization of the transboundary water resources of the Dinaric Karst Aquifer System, and to protect the unique groundwater dependent ecosystems that characterize the Dinaric Karst region of the Balkan peninsula[3].

Climate change impacts on water resources in SEE can be observed already with altered water regimes and runoffs in the area[4]. That is in line with IPCC projections of SEE being a region to be severely hit by climate change in the future. The area will be faced with decreasing summer rainfall, increasing frequency and severity of droughts, risk of floods and extreme weather events. This may lead to secondary impacts of deteriorating water

[1] IEA (2000b)
[2] Further details in IEA (2000b)
[3] UNESCO-IHP (2012)
[4] UNECE (2011)

availability and quality, damages to human health, negative impacts on industry, forest fires, soil degradation, desertification, loss of land and habitats. Climate change will thus exacerbate the tensions between competing water uses and between users at different parts of the basins within the region, further complicating cross-border cooperation.

The data on water withdrawal and main users for the region is patchy with large gaps in both spatial and temporal coverage and often not shared or published; therefore it is difficult to judge on the water withdrawal trends. For the purposes of this report data available through the UN system have been analysed[5]. The available data show that Greece, Serbia and Romania have stable or rising agricultural withdrawals trends. In the case of Romania it dipped dramatically in the 90s, but has been stable and increasing slightly since then. Industrial water withdrawals have also been influenced by the political situation in the region in the 90s, with the largest consumer – Romania steadily reducing the withdrawals since then. Other countries with relatively high demand for water in industry are Hungary[6], Bulgaria and Serbia. The municipal water withdrawals in Bulgaria, Romania and Slovenia have been shoving decreasing trends since the 90s; however the data are too incomplete to draw any reliable conclusions on the trends for the region as a whole. It will rather be the influences of climate change and economic and demographic developments not yet visible in the available data that will determine the level of water availability or scarcity in the region.

1.2 Governance and cooperation

Governance in shared (transboundary) water resources is in particular a critical issue. In water-scarce regions where the upstream and downstream impacts of consumption and pollution are magnified or in the case of hydropower where a dam changes the flow regimes the consequences can potentially lead to tensions between competing interests.

The large number of transboundary river basins in SEE raise several concerns of interest to at least three national states. Key challenges for the management of these basins and water bodies include availability of water in space and time as well as industrial and domestic pollution and increasing demand for development uses. Any changes and activities regarding water-use, land-use, construction of hydrological infrastructure, flood and disaster risk prevention, water diversion, and exploitation of water-related natural resources have effects on all other riparian states up- and down-stream. Furthermore, differences in governance regimes among the SEE countries add to the complexity.

This creates an essential need of well-coordinated transboundary water resources management (TWMR) often involving several national states inside and outside the EU.

[5] FAO (2013)

[6] In the Petersberg Phase II/Athens Declaration Process framework Hungary is not considered to be SEE country, however, it shares several transboundary river basins with other SEE countries and is therefore an important partner in IWRM activities in the region.

Nevertheless, according to the UNECE Second Assessment of Transboundary Rivers, Lakes and Groundwaters the cooperation remains weak and low on the political agenda[7].

In spite of the criticism there are some good examples of international cooperation on water management in the region as outlined in the box below. The role of joint bodies is instrumental for successful implementation of TWRM in transboundary basins and ideally the mandate of such bodies covers both strategic dialogue and planning, as well as operational implementation of measures for water resources management and monitoring.

Box 1. Examples of international cooperation on water management in SEE

Agreements and memoranda of understanding have been signed and several joint bodies have been set up to monitor the implementation of international agreements such as for the rivers Sava, Danube and Drin, and lakes Skadar/Shkoder and Prespa. (see map above).

International Sava River Basin Commission (ISRBC) is one of the best examples of a TWRM joint body in SEE. ISRBC mandate stems from the *Framework Agreement on the Sava River Basin* signed in 2002 by all the riparian countries of Sava river basin: Bosnia and Herzegovina, former Federal Republic of Yugoslavia (today: Serbia as the succeeding country), Croatia and Slovenia.

The aims of ISRBC include management of international regime of navigation, cooperation on TWRM and implementation and coordination of hazard prevention measures. ISRBC is working towards these aims through development of joint plans such as River Basin Management Plan, Flood Risk Management Plan and Contingency Plan; coordination of the establishment of integrated systems, such as GIS, River Information Services and Monitoring, Forecasting and Early Warning Systems. The Commission also prepares strategic documents and development plans and promotes the harmonisation of national legislation with EU regulations[8].

The International Commission for the Protection of the Danube River (ICPDR) is another well-established and successful international cooperation regime that covers Danube river basin across 14 countries and extends beyond SEE. It has been established in 1998 and is currently one of the largest international bodies of water resource management. The foundations of ICPDR lay in *The Danube River Protection Convention*, which aims to ensure sustainable and equitable management of surface and ground waters in the Danube basin and all related sub-basins, including 14 sub-basins located in SEE. ICPDR activities include coordination of the implementation of Danube River Basin Management Plan; implementation of EU WFD in the Danube river basin; joint development and implementation of pollution and accident prevention measures; development of sustainable flood protection measures; development and management of monitoring networks such as

[7 and 8] UNECE (2011)
[8] ISRBC (2008)

the Accident Emergency Warning System, the Trans-National Monitoring Network for Water Quality, and the Information System for the Danube[9].

There are also several examples of harmonisation of monitoring and information exchange on bilateral basis. However, it has been noted that often even though agreements on TWRM exist, they mostly are on a strategic level, lack essential elements, have limited scope or geographic coverage and the implementation of them has been poor.

The national water policies have advanced considerably over the last years, especially within EU Member States that seek to comply with the Water Framework Directive (WFD)[10] and implement River Basin Management Plans. UNECE Water Convention[11] is another driving force promoting TWRM in the region.

International bodies are active in promoting the TWRM development in SEE through several initiatives, most notably the Petersberg Phase II[12]/Athens Declaration Process[13] that is jointly coordinated by Germany, Greece and the World Bank.

The Petersberg Process, initiated in 1998, concerns cooperation on the management of transboundary waters. Phase II is intended to provide support to translate into action the current developments and opportunities for future cooperation on transboundary river, lake and groundwater management in South-Eastern Europe. It is supported by the German Ministry for the Environment, Nature Conservation and Nuclear Safety and the World Bank.

The "Athens Declaration Process" concerning Shared Water, Shared Future and Shared Knowledge was initiated in 2003. It provides a framework for a long-term process to support cooperative activities for the integrated management of shared water resources in South-Eastern Europe and the Mediterranean. It is jointly supported by the Hellenic Ministry of Foreign Affairs and the World Bank.

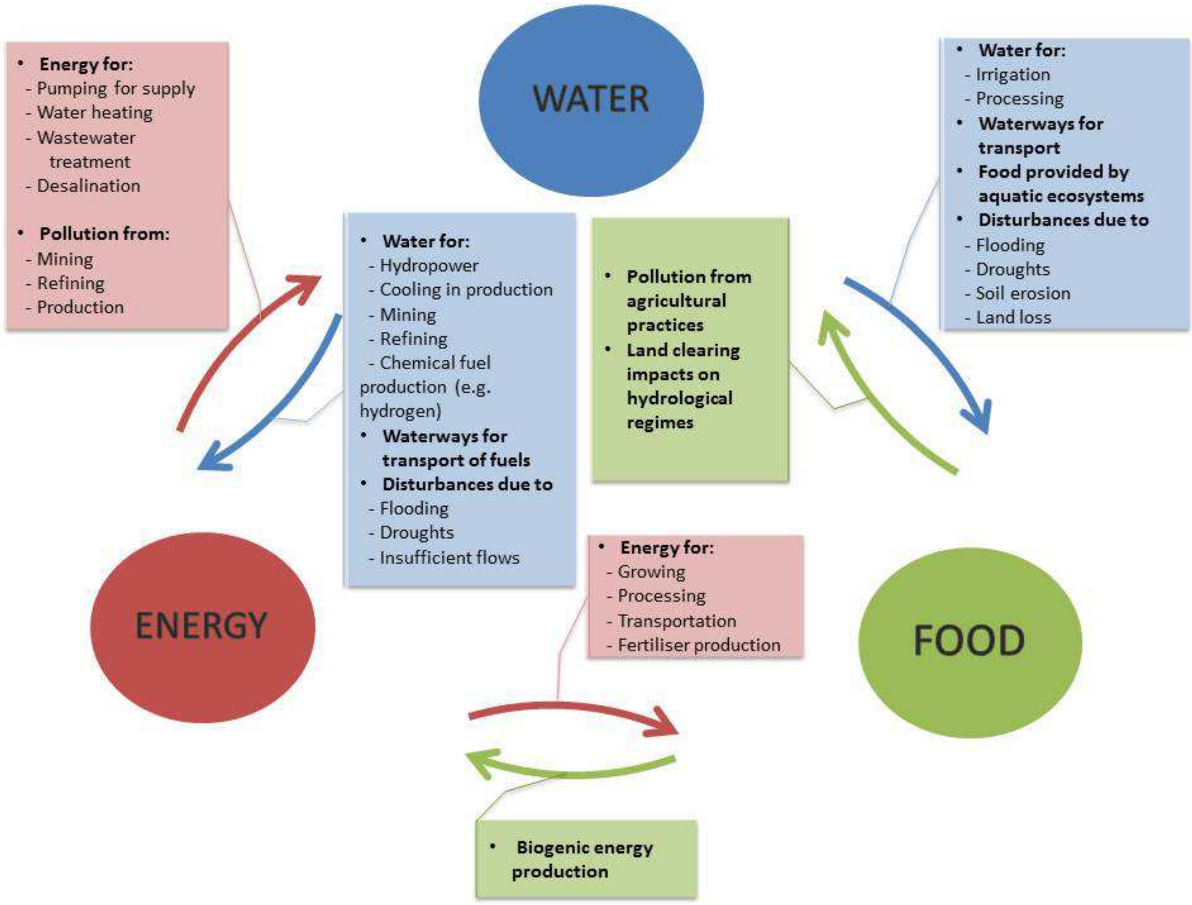
The two processes progressively came together in order to generate synergies and maximize the outcomes for the benefit of the SEE region. GWP-Med is the technical facilitator of related activities.

1.3 The Nexus approach

There are notable interdependencies between water resources, energy production and provision of food. Figure 1. illustrates the links and influences between the three sectors. A holistic approach to these interdependencies has been discussed and developed by international community as so called "Nexus approach"[14].

[9] ICPDR (2013)
[10] COM (2000)
[11] UNECE (1992)
[12] GFID (1998)
[13] Hellenic Presidency of the EU, World Bank (2003)
[14] Water Energy and Food Security NEXUS Resource Platform (2013): http://www.water-energy-food.org/en/knowledge/topics/view__nexus-approach.html

Figure 1. Interdependencies between water, energy and food



Source: own

In 2011 a conference in Bonn was held in order to open the debate and enhance the emerging notion of the interconnectedness of water, energy and food sectors, as well as links between the underlying resources of water, soil, land and ecosystems (Water, Energy and Food Nexus) and the resulting need for network thinking and integrated policy responses.

The Bonn2011 conference[15] recognized that these sectors and resources are interconnected in important ways and actions undertaken as regards one of them have imminent influences on all the others. Therefore policies and actions that short-sightedly address only one the three areas in isolation are likely to at best miss opportunities of synergies and promote inefficiencies or at worst create negative feedback loops and conflicts. This segregated business as usual approach therefore cannot achieve the aims of sustainable development and a new Nexus perspective has been proposed. Nexus approach "*increases the understanding of the interdependencies across water, energy, food and other policies such as climate and biodiversity"*. It promotes interdisciplinary solutions and interlinked action and cooperation that reap benefits from direct and indirect synergies and mitigates inter-sectoral tensions and trade-offs and work towards the aims of achieving water, food and

[15] NEXUS (2012a and b)

energy security, reducing hunger and eradicating poverty, upholding basic human rights, maintaining resilient ecosystems, reducing vulnerability to climate variability and change and achieving sustainable and equitable development. A Nexus perspective helps to identify mutually beneficial responses and provides a transparent framework for determining trade-offs to meet demand without compromising sustainability and exceeding environmental tipping points. It aims to bring economic benefits through more efficient utilization of resources, productivity gains and reduced waste.

The overarching principles guiding the Nexus approach are:

- Putting people and their basic **human rights** at the centre of the Nexus;
- Creating **public awareness** and the **political will** to establish effective legislative frameworks, promoting good governance, greatly reducing and eventually eliminating corruption;
- **Involving local communities**, including indigenous and women's groups fully and effectively in the planning and implementation processes related to water, energy and food nexus for local ownership and commitment.

The following "Opportunity Areas" have been identified:

- **Increase policy coherence** –ensuring inter-sectoral cooperation and co-ordination taking into account mutual synergies and trade-offs;
- **Accelerate access** – realizing the human rights related to access to water, energy and food;
- **Create more with less** – increasing resource productivity and promoting optimal resource allocation;
- **End waste and minimize losses** – reducing waste and losses along supply chains, turning waste into a resource;
- **Value natural infrastructure** – secure, improve and restore biodiversity and ecosystems;
- **Mobilize consumer influence** – acknowledging and utilizing the role of the consumption patterns of consumers on the use of water, energy and other resources.

The Nexus approach is consistent with Green Economy promoted by United Nations Environment Programme (UNEP). Both approaches promote sustainable development through green investments, resource efficiency and prevention of the loss of biodiversity and valuing ecosystem services with the participation of broad range of stakeholders.

The active participation of governments, private sector and civil society is a precondition for establishing the Nexus approach and specific policy recommendations have been developed for each of the Opportunity Areas alongside suggestions for action for various stakeholder groups - national governments, international organisations, local authorities, business and the private sector, investors and financing agencies, civil society, farmers, research organisations and regional bodies. The recommendations also include ratification of the UN Convention on Non-navigational Uses of Trans-boundary Watercourses and suggest going beyond water sharing to incorporation of benefit sharing. See the Annex 3 for a summary of all recommendations.

Taking into account the interdependencies illustrated in Figure 1 above in a transboundary setting, it becomes evident that the effects of activities in any one of the sectors in one national state trickle down the impact network extending wide beyond the traditional scope of TWRM and linking cross-border river basins in unexpected ways with water resources acting both as a cause and receiver of impacts (see also Box 2.).

Box 2. Theoretical example of interdependencies

In a theoretical example of these interdependencies, in a dry year increased water withdrawal from river Sava for irrigation in agriculture in Slovenia and Croatia may lead to decreased water availability for electricity production in Bosnia and Herzegovina. Bosnia and Herzegovina traditionally exports its electricity to neighbouring countries, e.g. to Montenegro, which relies on imports for 1/3 of its electricity needs. The declining imports of hydroelectric power from the neighbour country thus may lead to increasing energy prices in Montenegro.

Although IWRM, TWRM and Nexus approaches have emerged and developed on largely separate paths, increasingly there are efforts being put to integrate the two. Up to now the IWRM has gained wide political acceptance on an international level and is part of water resources management planning and implementation in 64%[16] of countries worldwide. IWRM has been developed to integrate water resources management between all water users basin-wide ensuring economic efficiency, social equity and environmental sustainability. The “lift up” of IWRM establishment and implementation efforts at a transboundary context has been the next step of the development to further coordinate the national IWRM efforts regarding transboundary water bodies. However the integration of other sectors has been achieved to a limited extend and only looked on the impacts other sectors have on water management and not vice versa. So the Nexus approach in its turn can be viewed as a possible further development step adding stronger cross-sectoral interlinkages perspective. The Global Water Partnership (GWP) has supported the view that water management should further develop to address not only water per se, but in the triple context of water, energy and food and has urged more political attention to nexus approach[17]. GWP has proposed three priorities for the Nexus approach: 1) full and real coordination between sectoral policies, preferably on national and international levels, 2) cross-sectorally coordinated and sound planning of infrastructure development and 3) focus on balanced economic and social development acknowledging the vital role of ecosystems[18]. UNECE is taking further steps in operationalizing the water-energy-food Nexus approach and complementing it with the fourth aspect: ecosystems. It has appointed a taskforce, which is to work on the Nexus assessment to be carried out under the UNECE Water Convention from 2013 to 2015.[19] UNECE emphasises that it is crucial to understand the interactions

[16] WWAP (2012)
[17] GWP (2011)
[18] GWP (2011)
[19] UNECE (2013)

between water, food, energy and water-related ecosystems and it is highly pertinent for transboundary basins to enhance sustainability of resources management.[20].

Adopting the Nexus approach to cross-border (integrated) water management ensures benefits to various sectors in the whole river basin area and ensures that synergies are explored both inter-sectoral and cross-country levels, improving coordination, cooperation and thus reducing conflicts and trade-offs. An agreement on water management leading to sustainable water resources management between countries sharing a river basin, aquifer or lake can only be reached taking into consideration all possible water uses as well as all influences on the volume and quality of water resources. The Nexus approach also ensures that decisions taken about water management do not compromise the aims of ensuring energy and food supply as well as are in line with sustainable development respecting natural constraints. Mutual commitments to increasing resource efficiency and eliminating unnecessary waste of water resources benefit all countries involved since they lead to increases of water availability in the entire basin. Focusing on human rights ensures that communities and vulnerable groups and their needs for access to water, energy and food are included in the equation. Putting the principles of public awareness and participation into action warrants wide stakeholder acceptance of agreements and decisions. And considerations regarding present-day and future climate variability and change ensure the durational soundness of today's decisions.

The Nexus approach does however require addressing the challenges of transforming the persistent silo thinking, establishing cross-border inter-sectoral cooperative structures and procedural mechanisms and puts demands on the quantity and quality of communication between the concerned. Switching to the Nexus approach may initially involve an overarching review of the existing sectoral policies and a subsequent harmonisation effort through participatory dialogue.

2 Hydropower production in SEE

2.1 Electricity demand, import and export

SEE as a region is highly diverse in terms of their energy households and balances. The demand for electricity ranges from 3,68 TWh/a[21] in Kosovo (UN administered territory under UN Security Council resolution 1244 - from this point forward referred to as Kosovo) to 62,5 TWh/a in Greece due to differences in the size of a country, population size and electricity intensity of the industry (detailed statistics of electricity demand and production per SEE country, see Annex 4).

The demand for electricity in SEE fell in the early 90s, however, it has shown an increasing trend in the last 10 years. In 2005 it had reached the demand level of 1990 and continued

[20] UNECE (2013)

[21] Hydropower potential measured in GWh/a refers to the potential amount of electricity production per annum

rising with a drop in 2008/2009 due to the global financial crisis. The demand in Albania, Bosnia Herzegovina, Croatia, Greece and Kosovo – where growth rates are especially high - is projected to rise by 2,3% a year until 2030[22]. Like in the 90s, also now the largest consumer of electricity in SEE is industry. The trend is however for services sector to increasingly take over electricity demand.

Although the net electricity importers and exporters are evenly distributed in the region, there are several countries with significant electricity imports and electricity production gaps (e.g. Croatia and Greece) (see Annex 4). These gaps are projected to increase with planned decommissioning of older thermal electricity production plants as well as rising demand and need to be compensated with new installations. The region is projected to become a net energy importer by 2020, with the electricity gap of up to 10%[23]. The World Bank estimates that closing the gap will require around 44 billion EUR investments in the energy sector in addition to resources needed for the transition to low-carbon economy[24].

Several of the SEE countries see hydropower as a potential source of closing the existing or projected electricity gaps. For example, the Former Yugoslav Republic of Macedonia (from this point forward referred to as FYR Macedonia), which has imported on average 1500 GWh annually during the last decade[25] is planning to install more than 1178 GWh of additional hydroelectricity production, which is aimed to also target the 500-1000 MW peak loads in Balkans[26].

2.2 Hydropower production in SEE

The production of renewable energy in the region has been fuelled by the international commitments and international regulations that the countries seek to fulfil, especially so in the EU Member States. Hydropower along with biomass and wind energy are the leading renewable energy sources.

The differences in geographical, economic, historical, political and demographic factors between the countries in the region are reflected in the wide range of hydropower penetration in the national energy mixes. Almost all (99,8%)[27] of electricity produced in Albania comes from hydropower, which covers almost 70% of electricity consumption, it is also an essential electricity source in Montenegro, Croatia and Bosnia-Herzegovina, while Kosovo on the other end of the spectrum produces only 1,5% and Hungary less than 6% of the consumed electricity through hydropower.

The share of hydropower in terms of the total installed electricity generation capacity in SEE is around 23% and Romania is leading in terms of absolute installed hydropower capacity, while Kosovo and Hungary have the least developed hydropower capacities.

[22] IFC (n.d.)
[23] The World Bank (2012)
[24] The World Bank (2012)
[25] IMF(2010)
[26] IFC (n.d.)
[27] See Annex 4

Certain river basins in SEE are of key importance for hydropower production. The hydropower plants built on the Drin River in Albania represent 93% of total hydro energy production capacity in the country[28]. Two major dams have been constructed on the Black Drin in FYR Macedonia. In Neretva and Trebišnjica hydrogeological basin, hydroelectric production infrastructure includes dams and underground channels for the transfer of water, including one that transfers water across the border between Bosnia and Herzegovina and Croatia, to the Dubrovnik hydropower plant. As far as the Sava River Basin is concerned, there are five hydropower dams on Sava River itself and significant numbers of hydroelectric power plants on its tributaries[29].

2.3 Hydropower potentials and utilisation rate

2.3.1 National potentials

SEE is a region known for its large technical hydropower potential, which is only partially being utilised[30]. It is mainly the geography and topography that determine the technically feasible[31] hydropower potential in each country. It ranges from 800 GWh/a in Kosovo to 35000 GWh/a in Romania. (Detailed statistics on hydropower potentials and utilisation rates see Annex 5). Likewise the utilisation rates of this potential vary significantly. In this regard Croatia, Serbia and Romania are utilising half or more of their technically feasible hydropower. On the contrary, the utilisation rate in Kosovo is only 10% and it is 11% in Greece. Altogether SEE utilises around 41% of the economically feasible hydropower potential.

Based on these and additional criteria KPMG[32] (have developed a "Hydropower Potential Indices[33] – one for large and the other for small hydropower development (see Annex 5). According to their calculations, Albania is leading with the highest indices for both large and small hydropower development, even though it is already covering 70% of its electricity demand with hydropower. Nevertheless, it is still a net electricity importer having the potential to becoming a significant electricity exporter. Likewise Bosnia and Herzegovina ranks high in both indices. The highest small hydropower development potentials are in Montenegro and FYR Macedonia, even though their large hydropower potentials are modest.

Also Romania possesses considerable small hydro power development potential. Altogether the development potentials in SEE are larger for small HPPs as compared to large hydropower.

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[28] KPMG (2010)
[29] ISRBC (2010)
[30] KPMG (2010)
[31] Technical feasibility does not take into account economic, social and environmental aspects. The real feasibility therefore is likely to be less.
[32] Klynveld Peat Marwick Goerdeler
[33] The KPMG Hydropower Potential Index is based on unused technical potential, average electricity prices and electricity consumption of the individual countries. It is aimed at creating a ranking regarding the investment potential in hydropower.

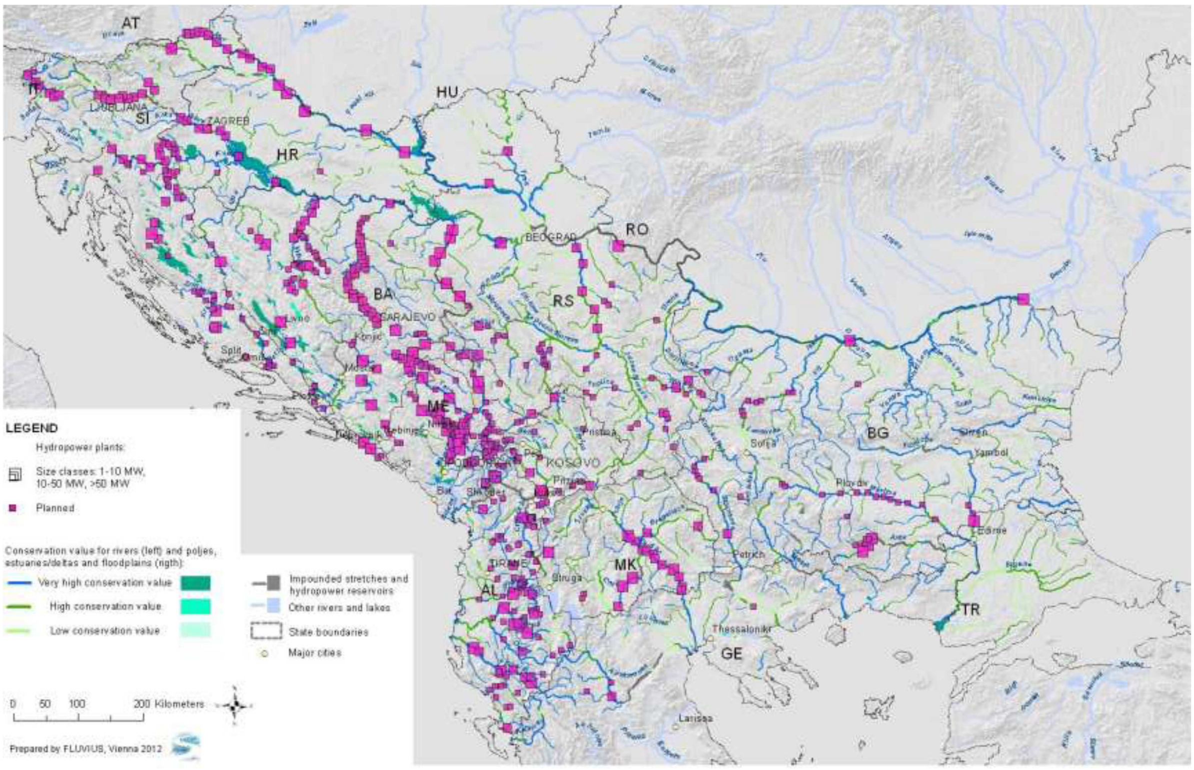
It needs to be noted that these calculations and indices of potentials are based on technical feasibility and do not reflect the other factors important for consideration in hydropower development planning. Thus, the figures presented above, need to be assessed alongside economic, social and environmental as well as cross-border concerns that strongly influence the actual feasibility of hydropower projects.

2.3.2 Hydropower in transboundary river basins in SEE

The large hydropower potentials of SEE countries discussed above are most often located in transboundary river basins. Due to the lack of basin-wide data it is, however, difficult to carry out a basin-based analysis. Furthermore, the planned hydropower developments are also largely attributable to transboundary river basins and pose up- and down-stream impacts on other riparian countries. The data on planned developments are habitually even more tightly guarded and kept undisclosed. Figure 2. maps the known hydropower development plans; and it is evident that large number of developments are bound to have transborder impacts. Knowing that the data set is incomplete one can judge that the reality is even more disquieting. This practice of secrecy strongly contrasts with the principles of sustainable IWRM, which prescribes early communication with all affected parties and wide participation of stakeholders.

It is also evident from Figure 2 that many of the planned hydropower plants are located on river stretches of high conservational value, which raises questions regarding the environmental sustainability of the plans.

Figure 2. Planned hydropower developments in SEE



Source: Schwarz U. (2012)

These issues are also problematic regarding compliance with the EU WFD, which prescribes cross-border coordination, information sharing, and solidarity among river basin countries, participatory basin-based decision-making and the prevention of the deterioration of the existing water status. According to Article 5 (and Annex III) of the EU WFD, an economic analysis of water uses has to be conducted in order to assess how important water is for the economy and the socio-economic development of the river basin district. The economic analysis should provide the river basin's economic profile in terms of general indicators, e.g. economic turnover, gross income, employment or number of beneficiaries for significant water uses. In a broader context, the economic analysis is intended to pave the way for the assessment of significant water management issues to be reported to the public by 2007 and the ensuing cost effectiveness analysis, by initiating investigations of likely trade-offs between socio-economic development and water protection within the river basin[34]. It also builds the basis for Art 4.7 (EU WFD) exemptions which allow deterioration of a water body in the case of overriding public interest and/or in the case that the benefits to the environment and to society of achieving the WFD objectives are outweighed by the benefits of the new modifications to human health, to the maintenance of human safety or to sustainable development.

2.4 Benefits and trade-offs of hydropower production

2.4.1 Benefits

Apart from providing regions with comparatively low-polluting and low-cost energy source, construction of hydropower plants serves several additional purposes benefiting the adjacent communities. Water storage in the reservoirs can serve as a stable supply of water for household use and irrigation. The dams can be efficient in flood regulation and improvement of navigation on rivers. However, managing dams and reservoirs to serve these different purposes may reduce the potential for electricity production (see below). The reservoirs can also be used for recreational purposes and fishery industry.

Even the projected climate change impacts in SEE can be partially mitigated through the operation of dams that allow water storage and controlled water availability during dry periods and flood regulation, especially for floods linked to extreme weather events. Pumped hydropower plants may furthermore provide energy storage services for other renewable energy sources.

2.4.2 Trade-offs

Hydropower dams modify entire river landscapes, lead to a loss of habitats and species, interrupt river corridors, hamper sediment transport and produce channel degradation further downstream. Fish passes can only reduce this effect to a certain degree and are not

[34] COM (2000)

feasible for all projects; in particular for dams higher than 20 m. Reduced sediment transport causes coastal erosion.

Conversion from a free flowing river to a reservoir leads to replacement of riverine aquatic communities to reservoir communities and retention of nutrients and sediments in the reservoir, which leads to development of aquatic weeds and eutrophication. It also changes the water temperature regimes in the river and air as well as concentrations of dissolved oxygen.

The creation of the reservoir itself causes land inundation linked with loss of habitats, agricultural land, historic and cultural heritage sites, displacement of communities and terrestrial wildlife.

Furthermore, construction of new water reservoirs is linked to significant greenhouse gases emissions both directly through the releases of carbon dioxide and methane due to flooding of biomass and indirect emissions originating in the processes of producing concrete and construction. During operation trade-offs with e.g. agricultural production may occur in particular during summer depending on the management regime of the hydropower plants.

Box 3: Examples of trade-offs from hydropower in SEE

Hydropower is a key driving force causing river and habitat continuity interruption in the Sava river basin, representing 78% of all interruptions. Of the 31 barriers, 28 are dams. Significant number of hydropower dams is also present in the Drina River sub-basin (sub-basin of the Sava river basin). Chain of dams on the Drina River consists of large dams Višegrad (BA), Bajina Bašta and Zvornik (RS). Zvornik is a single dam equipped with fish migration aid, but its performance should be monitored. The key migration route for migratory fish species in the Upper Sava (between 42.9 and 189.7 km from the river source) is interrupted, impacting the development of self-sustaining populations. Fish migratory routes are also interrupted in the tributaries, e.g. by dams on tributaries: Sotla/Sutla, Kupa/Kolpa, Dobra, Una, Vrbas, Pliva, Lašva, Spreča, Bosut (gate), Drina, Ćehotina, Piva, Uvac, and Lim.[35]

3 Water resources governance issues and management of transboundary basins, with a focus on hydropower

3.1 Governance issues and challenges related to hydropower production – an overview

Tensions regarding water use may arise on transboundary rivers due to water abstraction and use up- and downstream as well as due to water pollution. Even though the issues identified below are just as relevant for river basins extending in one country, the

[35] http://www.savacommission.org/dms/docs/dokumenti/srbmp_micro_web/background_documents/no_9_background_paper_integration_of_water_protection_with_other_developments_in_the_sava_river_basin.pdf

transboundary character of a river basin adds an extra level of complexity in terms of water resources management and governance as coordination needs to be achieved internationally among a range of national institutions in all riparian countries.

Water use issues (with a focus on hydropower) can be related to:

- Downstream irrigation water needs and upstream hydropower needs (and to a lesser extend vice versa). This occurs because upstream water release does not coincide with seasonal irrigation needs of the downstream riparian.
- Competition for water resources in the case of cascading hydropower plants. The upstream plant(s) might cause lower production in the downstream plant(s) if the management is not coordinated.
- Impacts of hydropower on up and downstream flood protection. Benefits can result from better flood control. The upstream flooding can be lessened by increasing the water discharges from the reservoir and the reservoirs also serve as containers for flood waters that allow controlled water release for downstream flood control.
- Under drought conditions, hydropower dams have the potential to mitigate the impacts and secure water for most important services (e.g. drinking water). This retention of water however might also cause increased water scarcity downstream where less water will arrive if water resources management is not coordinated.
- Some dams operate by withholding water and then releasing it all at once, causing the river downstream to suddenly flood, a process called "hydro peaking". This action maximises the energy production in times of peak demand thus increasing the economic profit, but it can disrupt plant and wildlife habitats and affect drinking water supplies.
- Negative impacts of hydropower on downstream ecosystem services (fish migration, drying out of wetlands) and related economic activities such as e.g. tourism.
- Hydroelectric dams can cause erosion along the riverbed upstream and downstream, which can further disturb wildlife ecosystems and fish populations.

Under a changing climate all these issues might be amplified.

It is a common phenomenon in transboundary water agreements that water quality issues are absent while the majority of the agreements regard water quantity issues as the main priority[36]. Water quality issues mostly relate to upstream generated pollution[37] and can have two main impacts in the downstream area:

- human health considerations which may occur due to pollution of drinking water such as rivers, lakes or reservoirs, issues associated with fish consumption, and issues where contact or incidental water contact may occur, for example during recreational activities.
- Ecosystem impacts due to toxicity of certain substances (e.g. dying of fish).

[36] Bennett. (2000)

[37] There is also an issue of atmospheric deposition.

In order to address both issues (quality and quantity) in an internationally coordinated manner, it is important to have appropriate governance structures and water management tools.

3.2 Transboundary cooperation on hydropower

The cooperation on most transboundary river basins in SEE is governed by various bilateral or multilateral agreements. Even though the overall quality of cooperation is often limited, the multilateral hydropower production on some sites has a long history and is rather well regulated with bilateral agreements; especially so on rivers coinciding with national borders.

Since early seventies Romania and Serbia (formerly part of Yugoslavia) commonly manage Iron Gate I and II reservoirs on Danube river used for hydropower production and acting as a significant improvement of the navigation on a historically difficult river passage. The Iron Gate I power plant is one of the largest hydroelectric power plants in Europe and the capacities are shared equally between Romania and Serbia. Romania also manages the Stânca-Costeşti hydrological knot and a hydroelectric power station together with its neighbour Moldova. The construction of the dam was fuelled by efforts to improve flood protection.

Bilechko reservoir on river Neretva is used both by Bosnia and Herzegovina and Montenegro for hydropower production and there are several water diversion channels through the poljes[38] in Neretva and Trebišnjica basins; one of them is crossing the Bosnia-Herzegovina and Croatia border.

There are, however, examples of failed transborder cooperation projects. An example located in a region bordering SEE is the Hungarian-Slovak project on river Danube. Although it started as a common hydropower development project, it was implemented only partially – only on the Slovak side, while Hungarians stepped out of the project due to political and environmental considerations. The continuation of the project by Slovakia led to high-level international tension between the countries.

More recently controversy has surrounded the Upper Horizons project planning to divert water from eastern Herzegovina in Bosnia and Herzegovina, towards the hydroelectric power plants on Trebišnjica River. Croatia has protested against the project arguing that it will damage freshwater reservoirs, protected nature areas and the quality of agricultural lands.[39] Nevertheless the project was completed in 2006 and 2009 CEECEC[40] project team in their *Study of Environmental Conflicts and Issues in South-Eastern Europe* reported that

[38] Polje is a term used in SEE to refer to elongated basins found in karst topography with flat floor and steep walls and having no outflowing surface rivers.
[39] Permanent Mission of the Republic of Croatia to the International Organizations in Vienna (2007)
[40] CEECEC (Civil Society Engagement with ECological EConomics) is a European Commission FP7 funded project that aims to enable Civil Society Organisations (CSOs) to engage in and lead collaborative research with ecological economists.

international conventions regarding transboundary watercourses have not been adhered to in this case[41].

In order to mitigate negative socio-economic and environmental impacts common agreed principles of sustainable international hydropower management are instrumental. Furthermore, this would increase the likelihood of sustainable cooperation among riparian countries and the potential of establishing agreements that will allow the sharing of benefits.

[41] Macura et al.(2009)

4 Future Challenges and tools to address them

4.1 Challenge 1: Developing hydropower plants and ensuring well-functioning ecosystems

SEE is a region of rich biodiversity with significance on the European and global level, including endangered aquatic species of fish and mollusc fauna. 288 hydropower plants with a capacity over 1 MW are currently operating on rivers in SEE and further 573 are planned[42]. That represents a significant impact on many river ecosystems. So far the decisions on the number, size and locations of new dams for hydropower production are based on maximum energy exploitation not following ecological planning principles.

Intact river landscapes are not “renewable” and ecological compensation measures can never fully balance the loss of biodiversity. Furthermore, the damaging impacts on ecosystems render them incapable to provide ecosystem services that benefit human well-being. These are[43]:

- Regulating services: climate, water, natural hazard and disease regulation, water purification and waste treatment;
- Provisioning services: freshwater, energy and capture fisheries;
- Supporting services: nutrient cycling and primary production which underlie the delivery of all the other services but are not directly accessible to people;
- Cultural services: Recreation and ecotourism services.

Unsustainable and uncoordinated water use for energy production overuses the ‘provisioning’ services on the expense of the other ecosystem services, and the changes in water quality and hydrological regimes caused by hydropower plants undermine all of the above.

The analysis of planned hydropower developments by ECA watch[44] and EURONATUR (European Nature Heritage Fund)[45] shows that many of them will be located in ecologically valuable areas: 70% in river stretches of “very high” and 23% in “high” conservation value. The expected damage to river ecosystems is consequently particularly high. This threat appears to be highest in Albania and Montenegro, in particular due to the fragmentation of still entirely free-flowing rivers. The authors criticise planning procedures, which have ignored the environmental aspects focusing predominantly on maximum gains from power production[46].

In Slovenia and Croatia on the lower Mura and Drava Rivers, a total of 17 new dams are planned in spite of the fact that the creation of a trans-boundary biosphere reserve is

[42] Schwarz, U. (2012)
[43] UNEP (2005)
[44] ECA (Export Credit Agencies) Watch is a network of NGOs from around the world.
[45] Schwarz, U. (2012)
[46] Schwarz, U. (2012)

underway. Furthermore, Slovenia wants to develop many more power stations on the upper Sava and together with Croatia along the upper Kolpa/Kupa. For the lower Sava in Croatia several new large dams are planned partially in conjunction with navigation. In Bosnia the Vrbas and Bosna rivers, are expected to be turned into canalized chains of hydropower plants. The lower Drina in Serbia - a unique remnant of a meandering large gravel dominated river - might be developed for hydropower exploitation. Many narrow river valleys such as along Ibar in Serbia would be turned into chains of hydropower plants. The nearly untouched upper courses of Moraca and Tara in Montenegro are subject of ambitious plans which would disconnect the upper river systems of Moraca towards Skadar/Shkoder Lake and Adriatic Sea. Two large braided rivers in Albania, the Vijosa and Devoll Rivers, will be interrupted by major dams. The still free-flowing Vardar River in FYR Macedonia would be turned into a hydropower cascade. In Bulgaria, the Struma could be disconnected systematically by new dams. Lower Danube is threatened by two mega projects impounding some 500 km. Dams on lower Veliki Morava in Serbia and one on lower Tundzha River on the Bulgarian-Turkish border will interrupt large river systems.

4.2 Challenge 2: Ensuring water security and establishing transboundary cooperation for water and energy management

With the expected socio-economic developments in SEE the demand for water and energy is most likely expected to increase as growing populations and economic development, particularly have increased water demand in other newly emerging countries as well[47]. Secure access to water for all riparian countries in a basin is thereby essential and directly linked to water security which can only be achieved by transboundary cooperation. A water secure world integrates a concern for the intrinsic value of water together with its full range of uses for human survival and well-being. It means enough, safe, affordable water to lead a clean, healthy and productive life, including flood protection but also environmental protection[48].

IWRM approach provides the necessary tools and guidance for achieving the above and in the context of the food/energy/water nexus this also means that transboundary cooperation has to go beyond water management and needs to consider at least energy issues.

Barriers to progress for achieving water security through governance and establishing functioning TWRM frameworks are often related to: lack of political will for functioning cooperation, simplistic solutions (i.e., not enough integration), a lack of stakeholder engagement, persistent inequities, lack, poor recognition of environmental issues, inadequate and inflexible regulations and lack of proper implementation of existing adequate regulations.

[47] Flörke, M., Kynast, E., I Bärlund, I. et al.(2013).
[48] GWP/INBO (2012)

4.3 Challenge 3: Coping with climate change

According to UNEP (2012) climate change could have the following impacts on water and energy:

- Decreased precipitation can significantly reduce river flows, even though in the near term such reductions may be balanced by glacial melt in the mountain regions. This melting will potentially increase stream flow in the initial phase, but the final result would be a general decline over time affecting hydropower potential. In addition to seasonal water availability, changing environmental conditions will affect generation efficiency and reservoir management, and especially affect already water-scarce areas.
- Accelerated evaporation and droughts will result in changes in the timing and volume of flow.
- Temperature rise across the region will lead to changes in the level and timing of peak demand. This will result in a flattening of the electricity consumption profile across the year, as demand for cooling energy rises and demand for heat energy drops.
- A significant improvement in irrigation is recommended by the report in order to improve the current inadequate irrigation systems which limit agricultural production so far. If not done so, the competition among water users will be intensified.
- A wide range of studies identifies water pollution problems for the transboundary river basins in South Eastern Europe.

4.4 Sustainable hydropower production - available governance and management tools

Considerable attention is being paid worldwide on the improvements of sustainable hydropower technologies, management and mitigation of negative environmental and socio-economic impacts.

The International Energy Agency (IEA) Agreement for Hydropower Technologies and Programmes has carried out surveys and analyses of different hydropower technologies, their environmental and social impacts, ethical dilemmas, trends towards more sustainable planning procedures of the power plants and the effectiveness of measures mitigating the negative impacts of hydropower. The IEA provides guidelines for decision-making first published in 2000[49] and updated in 2010[50] (see Annex 1), as well as recommendations of mitigation measures of negative environmental and socio-economic impacts[51] (see Annex 2 for a complete list of recommended mitigation measures). The "New Planning Concept" described by IEA is based on considering a hydropower project as an integrated element of IWRM, involvement of wide range of stakeholders at early planning stages already, multi-criteria planning procedures, integration of environmental assessment procedures, new

[49] IEA (2000a)
[50] IEA (2010)
[51] IEA (2000b)

technological designs and increasing participation of the private sector, independent monitoring and quality assurance.

The agency has also collected a vast database of good-practise examples of mitigating the 10 key negative impacts of hydropower[52]: the biophysical impacts on biodiversity, hydrological regimes, fish migration and navigation, reservoir sedimentation, water quality, reservoir impoundment; and the socio-economic impacts on minority groups, resettlement, public health, landscape und cultural heritage.

European funded SHERPA project[53] (Small Hydro Energy Efficient Promotion Campaign Action) lists measures for mitigating the negative impacts of small hydropower plants specifically, including measures beginning with low impact planning (applying the principle of multi-purpose schemes, restoration of ancient watermills, upgrading and repowering existing SHP), reserved flow management, aesthetical improvements, noise reduction, establishment of fish passages, use of fish-friendly turbines, active integration of other environmental purposes and benefits. The SHERPA project report also presents several case-studies of implementation of the suggested measures.

The South-East-Europe Transnational Cooperation Programme, co-funded by the European Regional Development Fund has issued a series of recommendations and handbooks on sustainable management of hydropower as part of the SEE HydroPower Project[54]. The publications range from a handbook addressed to decision-makers and public administrations with country-by-country recommendations to improve small hydropower concession practices in SEE[55] to technical recommendations as regards the operation of hydropower plants, managing the sedimentation processes and ensuring optimal operation of the plant and other uses of the reservoir[56][57]. Furthermore, an innovative technological approach to SHP with integrated smart monitoring and measuring system is presented[58].

European Commission is providing support to the research of more efficient and environmentally friendly hydropower technologies[59].

Euronatur and ECA Watch[60] in their report suggest upgrades of the existing power plants and energy efficiency as the first steps that contribute to sustainability more that construction of numerous new power plants on high conservational value rivers. They also promote the creation of "no go" areas, where hydropower developments should be prohibited altogether as a necessary step to preserve the rich biodiversity and natural course of the unadulterated

[52]IEA (2000c) Available at: http://www.ieahydro.org/Case_Studies.html
[53] Gollesi, S., Valerio G. (n.d) Available at: http://www.esha.be/fileadmin/esha_files/documents/SHERPA/Annex_XII_Environmental_Report.pdf
[54] Available at http://www.seehydropower.eu/download_deliverables/
[55] Popa et al. (2011)
[56] Harb et al. (2011)
[57] Christoforidou et al. (2011)
[58] Magureanu et al. (2011)
[59] See http://ec.europa.eu/research/energy/eu/index_en.cfm?pg=research-hydropower-support
[60] Schwarz U. (2012)

stretches of rivers. Taking environmental considerations into account during the planning stage would also promote compliance with Habitat and Water Framework Directives compulsory for EU Member States and countries aspiring EU membership in the future. The designation of “no go” areas is also one of the recommendations of the 2010 EU Water Directors Statement[61].

Other important tools and legally required for EU Member States are the Environmental Impact Assessment (EIA) and the Strategic Environmental Assessment (SEA). Formally, EIA/SEA are structured approaches for obtaining and evaluating environmental information prior to its use in decision-making in the development process. This information consists basically of predictions of how the environment is expected to change if certain alternative actions are implemented and advise on how best to manage environmental changes if one alternative is selected and implemented[62]. Both can be distinguished by the level they apply to. While an EIA focuses on the project level such as highways, power stations, water resource projects and large-scale industrial facilities a SEA focuses on proposed actions at new or amended laws, policies, programmes and plans.

Box 4: Good Practice example to reduce trade-offs between dam construction and environment: Ashta Hydro Power Plant (HPP) in Albania

The Ashta HPP (recently finished in March 2013) is the fourth and most downstream hydropower on the Drin River Cascade in northern Albania. The HPP was initially developed in the 70s known as Bushat HPP and some of the structures were built in the 1970s i.e. Spathari weir.

The project included river diversion through a diversion weir, a headrace canal, an aboveground powerhouse and a tailrace canal discharging to the Buna River, some 4.5 km downstream of its current confluence with Drin River and Shkodra Lake (wildlife refuge shared by Albania and Montenegro). The Shkodra Lake level would have been affected by the project which would cause serious impacts in health, tourism, fisheries and farming just to mention a few. Environmentalists alerted the authorities and the World Bank (WB/IFC) who in 2002-2007 revisited the design and developed an alternative that addressed the environmental concerns.

The new design envisaged a smaller scale HPP which avoids both river diversion as well as impacts on the Shkodra Lake. An Environmental Impact Assessment was prepared for the project. An analysis of potential project sites was included in the EIA where the IFC was involved in the site selection. Compared with other alternatives, this project site was chosen as it:

• Keeps at a very minimum inundation of arable land;

• Has the shortest channel length, affecting merely a small part of the Drin River which is poorer and less valuable in habitats and biodiversity than other parts;

[61] Kampa E., Weppen J., Dworak T. (2011)
[62] UNEP (2004)

• Does not affect Protected Areas and cultural/historic heritage sites;

• Does not directly affect the Shkodra Lake ecosystem;

• Does not affect the quantity and quality of underground water;

• Respects international environmental standards for minimal ecological water release in the existing riverbed (agreed at 10% of the water flow);

The impacts of Ashta HPP will be negligible compared with the impacts of existing larger dams and reservoirs upstream. With Ashta HPP the level of the Spathari reservoir will increase by 1.5 m; however, mitigation measures will be in place to allow for fish migration and vegetation corridor. In addition, the new Ashta HPP has put in place a mitigation plan that includes the construction of a fish pass, provisions for ecological water release, erosion reduction measures, and flood protection measures to allow for increased biological activity.

Source: www.balwois.com/2012/USB/papers/951.pdf

Since 2010 the International Commission for the Protection of the Danube River operating in under the lead of Austria, Romania and Slovenia has been developing the Guiding Principles for Sustainable Hydropower Development[63]. It aims to support a coherent and coordinated implementation of relevant legislation, in particular for the EU Renewable Energy Directive, the EU Water Framework Directive and other relevant environmental and water management legislation. The document was finalised and adopted in June 2013. The Principles cover the topics of refurbishment and modernisation of existing hydropower facilities, strategic planning approaches, as well as mitigation measures[64].

4.5 Using the nexus approach for transboundary water resources management and sustainable hydropower production

Putting the nexus approach into practice is a challenge and it is even more a challenge when transboundary issues are involved. As mentioned previously (Chapter 1.3), UNECE has recently appointed a task force mandated to carry out the Nexus assessment, however, the methodological guidelines are in the early stages of development[65]. Altogether up to now only a few guidance documents exist. One of the most recent ones is the International Institute on Sustainable Development (IISD) Report (2013): "The Water–Energy–Food Security Nexus: Towards a practical planning and decision-support framework for landscape investment and risk management". This participatory planning process includes four main stages:

- Stage 1: Assessing the Water–Energy–Food Security System
- Stage 2: Envisioning Future Landscape Scenarios

[63] ICPDR (2013)
[64] See https://www.icpdr.org/main/activities-projects/guiding-principles-sustainable-hydropower
[65] UNECE (2013)

- Stage 3: Investing in a Water–Energy–Food Secure Future
- Stage 4: Transforming the System

Each stage consists of a set of sub-steps as outlined in the figure below:

Figure 3. Participatory planning process for the Water–Energy–Food Nexus

Source: IISD Report (2013)

Stage 1 begins with stakeholder involvement in the assessment and discussion of the current status and trends of key aspects of water, energy and food security, goes on to the historical analysis of the past stresses, alterations of the environment, their causes, human responses to them and the results of those responses. At the last sub-step of Stage 1 past experiences are transferred to the assessment of future risks, which uses wide range of data available on future projections of socio-economic and climate scenarios. Stage 1 is iterative and on-going as it develops through acquirement of new data and improved knowledge.

In Stage 2 the future is assessed from the perspective of how the stakeholders prefer to manage the developments framed by drivers emerging from the work of Stage 1. For this purpose a shared set of principles needs to be developed. The principles are of broad nature and describe the desired future characteristics of the environment in question. Notions of excess natural capital and social capital are recommended for consideration as a hedge against future risks. After the definition of common principles, plausible future scenarios integrating critical uncertainties can be crafted. To that end stakeholders are asked to identify the most important factors that are likely to influence water-energy-food security in the next half century and to rank them according to their importance and uncertainty. The most important and uncertain factors then represent the critical uncertainties. Based on the critical uncertainties, the plausible future scenarios are drafted. For the purposes of manageability 2-4 scenarios are recommended. The future scenarios or "stories" provide the basis for the discussion on actions for ensuring water-energy-food security. Adaptive and transformative stance is recommended to further work. According to the adaptive stance participants are asked to develop SWOT[66] analysis for each of the scenarios to then identify possible adaptive actions to tap into opportunities or to mitigate risks. The transformative stance is applied by asking the participants to elaborate the realisation of the scenarios and discuss which of them are most agreeable to all. Based on this context the roles and responsibilities for turning the favourable scenarios into reality can be elaborated. Actions can then be categorised in 'robust' ones that make most sense in most of the scenarios and create no-regret consequences and 'triggerable' ones that are instrumental for only one or few scenarios and need more background knowledge before implementation.

Thus Stage 2 prepares the ground for Stage 3 activities of creating a practical strategy for the future. The work of Stage 3 starts with broad involvement of a wide range of stakeholder groups in the communication of the desirable future scenario developed in Step 2, then branded and actively communicated across the region. The stakeholders take an active role in defining a specific and pragmatic investment strategy based on the favourable future scenario. This document ideally is 'owned' by the participants, represents the aspirations of the region as a whole, transparently discusses uncertainties and risks, and is implementation-oriented backed by specific financial and policy mechanisms.

At this point Stage 4, which is oriented on the practical actions of strategy implementation, can take place. Firstly, the strategy developed needs to be communicated widely and effectively in order to market the investment strategy, build the necessary public, financial and policy support for scaling up the actions. The implementation of the strategy requires technical know-how and personnel capacities, but also a clear identification of an organisation or a consortium of organisations to be the appointed steward of the strategy responsible and accountable for the implementation and reporting to the broader public. Monitoring of the progress, learning from the experience and necessary adjustments of the strategy arising from previously unforeseen developments or new knowledge are further essential elements of the implementation process. The identification of a range of outcome and output indicators and their regular and transparent communication are instrumental for this purpose.

In order to implement this approach it is important to engage stakeholders to build awareness and capacities, share ways to minimize trade-offs and explore synergies. According to the "Handbook for Integrated Water Resources Management in the Basins of Transboundary Rivers, Lakes and Aquifers"[67] in such a process attention should be paid to the following key points (modified to fit to the particular case of hydropower):

- Ensure the representativeness of water and energy stakeholders (including the private sector), the civil society and of the users, whether they are organized (NGOs, associations) or not.

[66] Strength, Weaknesses, Opportunities and Threats
[67] GWP/INBO, (2012)

- Start from the organization of stakeholders at the national level and from the latter's relationship to the local level, to enable effective participation on transboundary and regional scales.
- Include transboundary basin organizations (if existing) which can play a significant role in the participation of stakeholders and in bridging communication challenges between regions and/or countries.
- Sufficient resources should be allocated to the participation of the civil society. This can require technical assistance or financial resources.
- Ensure public consultations on major structuring projects, including consultations in countries experiencing their impacts downstream.

5 Priority issues to be discussed at the round table

The following chapter aims at developing the way ahead towards the use of the Water–Energy–Food Security Nexus as an additional and alternative tool for sustainable water resources management and sustainable hydropower development.

The chapter should enable and facilitate an open and constructive discussion before, at and after the conference on related issues. Optimally, this discussion would lead to a common understanding and possible agreement between the key stakeholders participating, regarding necessary priorities to be addressed and related next steps.

In order to structure the discussion a step-wise approach is considered. The steps/questions are structured according to the agenda.

Session 1: Water and Energy Nexus - Securing hydropower sustainability at the transboundary level

- What are the main challenges and opportunities to explore towards the establishment of sustainable water resources management and the development of sustainable hydropower in a transboundary context? How does the first interrelate with the latter? What needs to be done by whom and by when to overcome these existing challenges?
- What are the current hydropower production trends for Southeastern Europe in terms of capacity and investments? Will the underlying assumptions for further exploration of hydropower potential become vulnerable under a changing climate?
- To what extent does the planning process for hydropower projects allow the involvement of all interested parties, in particular if cross boarder issues are involved?

Session 2 Part A: Mapping the Water and Energy Security Nexus: the hydropower trade-offs

Discussion in two Working Groups:

Working Group Theme 1: Trade-offs between "Economy" and "Environment"

- Which environment - energy production trade-offs are most relevant in the transboundary river basins of the region?
- Which mitigation mechanisms exist on the national and international level? What are the difficulties in their application?
- What is needed in addition to the existing mechanisms in order to better protect the environment and ensure an economically viable production of hydropower?

Working Group Theme 2: Trade-offs between "Economy" and "Economy"

- Which are the negative and positive externalities of the energy industry on other water using sectors in Southeastern Europe that need to be taken into consideration: (i) in water resources management plans (ii) in the development and operation of energy production schemes?

- How can upstream / downstream issues between energy and other water users be addressed?
- What needs to be done by whom and by when to overcome these existing challenges?

Session 2 Part B: Mapping the Water and Energy Security Nexus - identifying benefits and establishing mechanisms for sharing them

- Which benefits (economic, social and environmental) at national and transboundary levels could be gained by better taking into account the Water and Energy Nexus? Which are the main knowledge gaps that need to be filled to identify benefits?
- Which benefit identification and benefit sharing mechanisms and tools are considered as most promising for being applied in Southeastern Europe?
- Are there any governance structures in place in the Southeastern European countries or at transboundary/regional level for identifying and sharing benefits? Who is or should be responsible? What governance structures at national and transboundary levels would be necessary?

Session 3: Addressing the trade-offs between hydropower, other water uses and water ecosystem needs

- Which priority issues need to be discussed between the energy sector and other water related sectors?
- Does Water Security translate into Energy Security in the context of hydropower production?
- Can policy coherence between water and energy sectors at national and transboundary levels lead to balanced trade-offs to the benefit of all stakeholders? What would be needed to achieve such policy coherence?
- [Considering that the Nexus approach contributes towards sustainable water resources management and sustainable hydropower production] What measures and governance structures are needed towards the adoption of the Nexus approach at national and transboundary levels?
- What is needed to diffuse the Water and Energy Security Nexus concept into the existing governance structures?
- How can good practices from outside the Region be replicated to the benefit of the water and energy sectors?

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Annex 1: IEA Recommendations for sustainable Hydropower decision-making (2010)

Energy policy framework

Countries and responsible jurisdictions should write and promote sustainable energy policies that set out clear objectives and provide a transparent framework for the development of all power generation options, including hydropower.

- Energy policy should be based on clear sustainability objectives for all power generation options.
- Sustainability objectives should cover the full accounting of all environmental and social costs to enable the fair comparison of alternate electric power generation options.
- Sustainability policy objectives should cover the assessment of the carbon balance of all power generation options and the development of appropriate carbon assessment and pricing mechanisms.

Existing or planned hydropower projects that meet acceptable environmental and social criteria should be classified as a renewable and sustainable resource.

- Guidelines should be established that define acceptable environmental and social criteria for a fair, credible and effective classification of hydropower as a renewable and sustainable resource.
- Classifying hydropower as a renewable and sustainable resource should be based on meeting acceptable criteria and not on capacity, reservoir size or other physical characteristics.
- Discussions on the classification of hydropower should include participatory consultation with interested parties over the full range of issues.

Hydropower should be acknowledged for its fundamental and important contribution to the electrical system and its ability to integrate other energy sources.

- As electricity markets evolve, the full environmental and social advantages of using hydropower as the predominant system regulator should be studied and evaluated.
- Hydropower should be recognized as a having the inherent capability to integrate Wind energy y and other non-firm renewables into the electrical system.
- Hydropower should be recognized as a having the ability to provide fast, efficient, cost effective system regulation with minimum energy losses and equipment wear.
- Hydropower should be recognized for its provision of ancillary services for system regulation, including storage, peak power generation, load following and other forms of system support.
- Provision of ancillary services can be very valuable to hydropower owners.
- The regulating function that hydropower (including pumped storage) can provide will be important for dealing with the increased output fluctuation risk caused by the future growth of non-firm renewable energy sources.

Each country's regulations and policy should be clearly set out, so that the rules are known and the process can be effective.

- Hydropower developers need to know at an early stage if their projects will be encouraged, and under what conditions, particularly as long lead-times and expensive engineering and environmental studies are required.
- Hydropower development, whether publically or privately funded, must meet strict financial criteria.

Hydropower should be promoted in developing countries through technical cooperation to investigate hydropower potential, and through financial cooperation to develop integrated water systems and efficient utilization of water resources.

- There is a huge undeveloped hydropower potential, mainly in developing countries in Asia, Africa and Latin America. The importance of this potential should be recognized and technical and financial cooperation for the development of renewable and sustainable hydropower should be promoted.

Decision-making process

A fair, credible and effective decision-making process should be established that integrates the interests of people and the environment.

- The decision-making process for hydropower assessment and licensing should effectively protect the environment and local communities without unfairly burdening project proponents with procedural uncertainties and unreasonable delays.
- Environmental and social decision-making should include the ESIA process and the applicable regulatory and legal frameworks.

The environmental decision making process should have established rules, clear responsibilities, and a fixed and reasonable coverage of issues.

- The decision making process should have a clearly defined and reasonable timeframe.
- Unreasonably long environmental assessment and licensing processes for hydropower projects translate into a competitive disadvantage e for hydropower producers compared to other forms of power generation, including, for example, coal-fired power plants. Time delays generate significant costs for all participants in a hydropower project and they can lead to significant social and economic costs for concerned communities.
-

All hydroplant developments should include multi-purpose options, where feasible.

- The design, implementation and operation of a hydroplant should include all feasible multi-purpose options that meet acceptable environmental, social and economic criteria.
- Multi-purpose developments should include: hydropower, flood control, irrigation, potable water supply, navigation, reservoir recreation and fishing, and other tangible benefits
- Cost allocation among beneficiary sectors should be clearly defined.

Comparison and Selection of Project Alternatives

Project designers should apply environmental and social criteria to various project alternatives early in the planning process, to ensure selection of the most appropriate alternative for development.

- For designers and project developers to effectively and consistently compare alternative hydropower projects and project arrangements, appropriate environmental and social decision-making criteria must be used. These criteria will be set by government agencies or regulators responsible for approving and licensing hydropower development.
- Environmental and social criteria should be consistent across all countries and jurisdictions, subject to specific regional issues. The use of international guidelines, such as the IHA Sustainability Guidelines, is strongly encouraged.
- The evaluation of net GHG emissions from reservoirs should be based on established methods of measurement and an evaluation protocol based on scientific evidence.

The selection of projects and project arrangements should be made on best practice considerations.

- Best practice considerations should include the following issues: using already developed river basins; balancing energy production with environmental and social impact; threats to vulnerable social groups and population displacement; public health risks; designated natural and human heritage sites and development in high quality habitats; incorporation of lessons-learned from previous projects; disappearance of known rare, threatened or vulnerable species; high risk of sediment accumulation.

Project designers should clearly identify any specific environmental and social criteria that apply to hydro projects of different sizes and types.

- Project designers should develop and apply tools to assess the merits of project alternatives from an environmental and social perspective, and consider both negative and positive impacts in the prioritization of such alternatives.
- The design of the hydroplant should incorporate best practice management of environment and social issues over the full project life-cycle.

Renewal and upgrading of existing power plants, and adding hydropower facilities to existing dams should be promoted.

- Existing hydroelectric facilities that are ageing, have poor reliability and have the potential to provide more power or system flexibility in an economic manner, should be considered for upgrading.
- In many countries, significant numbers of existing dams provide flood control, irrigation and water supply, without the provision of hydropower. The possibility of adding hydropower facilities to these existing dams should be considered.

Improving Environmental Management of Hydropower Plants

A hydroplant should be built and operated based on best practice environmental and social management throughout its life-cycle.

- The construction of the hydroplant should incorporate best practice management of environment and social issues.
- Environmental and social management should include interaction with interested parties over the full range of issues.
- Throughout the project life cycle, and including decommissioning, hydropower projects must be harmoniously integrated into their surroundings and communities. Responsibilities must be clearly identified to ensure that commitments are fulfilled.
- Best practice in environmental and social management cover the following important considerations, as applicable:
    - Human health and safety issues, including water quality impacts
    - Flow regimes and flow operating rules that acknowledge other water users
    - Fish passage for migratory species
    - Promoting conservation and protection of biodiversity
    - Reservoir sedimentation and reservoir debris
    - Monitoring and environmental follow-up programs and effectiveness of existing mitigation measures

Benefiting Local Communities

Hydropower projects should benefit local communities throughout the project life cycle.

- Local communities should benefit from projects based on a fair assessment of net impacts to that community.
- Non-monetary benefits should be considered through community and infrastructure improvements, business and employment opportunities during construction and operation, improved electricity supply and multi-purpose uses of the water resource, where possible.

Local communities are key players in hydropower development projects, as they are most directly affected by a project, and their involvement should be continuous from the early stages of the project.

- Project proponents should maximize the benefits to the local community by:
- Informing and consulting with local communities at all stages of the project
- Acknowledging gender equity in participation, as well as outcomes
- Liaising and cooperating with social and economic development agencies.
- Designing and implementing monetary transfer mechanisms to local and regional institutions
- Optimizing local and regional economic spin-offs.

Information associated with hydropower should be actively disseminated to society.

The importance of providing information related to hydropower to society should be recognized, and information associated with hydropower's value, environmental suitability and contribution to the economy should be actively disseminated to the public and the press.

Annex 2: Mitigation of hydropower impacts

Table 1: Mitigation of hydropower impacts

Name	Comments and examples
Climatic and local air quality controls	- Design construction schedule to limit noise - Design blasting schedule and provide warnings, etc., to limit dust, smoke and noise disturbance - Design powerhouse to reduce operating noise - Design submerged outlet to limit frost mist, changes in winter air temperature, etc. - Provide or retain vegetation or engineered windbreaks for wind and dust control - Controlled burning to limit air quality impact of smoke - Limit construction and operational use of air pollutants - Use of environmentally acceptable dust suppressants - Maintain vehicles and equipment to limit noise and fumes
Economic impact management	- Train and hire local workers for project work - Award work and supply contracts to local firms - Enhance local recreational and community facilities - Enhance municipal infrastructures or create new ones in resettlement areas - Provide regional development planning - Provide monetary or other compensation - Support or enhance medical, social and communications services and facilities
Erosion prevention and control	- Timing of soil disturbance periods to avoid periods of high rainfall - Physical bank stabilisation (riprap, gabions, fibre mats, etc.) - Maximise use of previously disturbed areas during construction and operation (roads, cleared areas) - Stabilise stripped areas (mulch, berms, check dams, matting, hydroseeding, etc.) - Retain buffer strips of vegetation - Minimise water level fluctuation
Fish protection	- Design and construct fish ladders and fishways - Design diversion and by-pass facilities to aid downstream migration - Design intake, turbine and discharge facilities to reduce fish mortality or prevent entrainment - Use fish attractant or repulsion techniques or barriers (physical, acoustic, chemical) to mitigate blasting mortality and entrainment - Avoid in-water work during fish spawning and migration - Minimum flow during spawning and rearing of sensitive species - Water level management to mitigate effects of drawdown - Create or enhance spawning grounds or other habitat - Protect or re-establish areas of sensitive habitat for endangered species. - Promote fish farming - Fish stocking - Fertilisation - Management of harvests (fishing restriction) - Conduct fish rescue and relocation operations

Name	Comments and examples
Human health and safety risk management	- Provide programs to warn downstream and upstream users of sudden flow variations - Spill prevention and response plan - Emergency preparedness and response plan - Chemical and hazardous materials storage and handling procedures - Provide fencing and safety booms upstream/downstream of stations, dams and spillways - Disease prevention, detection and risk management - Enhance medical services and facilities - Provide mercury-in-fish risk management program (including warnings on fish consumption limits) - Provide medical follow-up and mercury monitoring services - Design and operate facilities to decrease habitat for disease vectors - Vector control
Minimising soil contamination and loss of soil due to inundation	- Engineered landfills to consolidate and segregate potential soil contaminants - Excavate and properly dispose of known areas of soil contamination - Site selection to minimise reservoir flooding - Reservoir shoreline erosion control - Removal of reservoir substrate prior to inundation - Reclamation/stockpiling and re-use of topsoil
Mitigating cumulative effects of multiple hydroelectric facilities	- Site selection - Optimise cascade operation (e.g. improved manual or computerised water dispatching) - Negotiate operational constraints - Develop long-term watershed management plans - Carry out long-term monitoring programs
Mitigating effects on resource use	- Site planning to avoid time periods of important resource use (e.g. high use recreation or harvesting periods) - Design water allocation plans to accommodate large and small resource users in an equitable manner - Design roads (route selection, road standard, etc.) to optimise planning goals for resource use - Design and site facilities to avoid and minimise farm, mine, forest and other resource loss - Establish road access restrictions at levels to limit overexploitation of fish and wildlife and non-renewable resources or to optimise permissible access levels - Maximise recovery, marketing and use (by public, project or established users) of salvageable timber, crops, topsoil, peat, aggregate buildings, etc. prior to impoundment - Recover floating debris from reservoir to benefit recreational and other resource use - Provide wharf and ramp facilities - Provide temporary or permanent bypasses (roads, trails, portages, marine railways) - Provide maps and navigation aids - Increase land/water productivity to enhance resource use on adjacent or damaged lands - Retrain affected resource users and provide resource management programs - Negotiate and plan for integrated land use to reduce land use conflicts - Develop hunting, fishing, boating, commercial ventures - Assist in relocation and/or compensation of fixed commercial establishments (tourists camps, etc.)
Other	- Specify in 'Other mitigation measures'

Name	Comments and examples
Protecting or minimising changes in channel morphology	- Design (site selection, etc.) for minimisation of changes in stream morphology - Design (site selection), block dams, excavation, etc.) for minimisation of size and shore zone characteristics of reservoirs - Dredging to re-establish channel characteristics - Stream restoration techniques - Creation of pools and rapids - Design and use of fords, bridges, and cofferdams - Use temporary flumes and site channels to protect sensitive stretches of river - Use tunnelling technologies under watercourses - Complete in-water work as quickly as possible during low-flow periods
Protecting or mitigating changes to aboriginal land use, cultural heritage, archaeological resources	- Ensure preservation of traditional land uses for aboriginal peoples (e.g. hunting, fishing, trapping, gathering, burial sites) - Re-establish reserved lands or provide alternative reserved lands or other compensation for use by aboriginal peoples - Conduct inventories of cultural resources - Protect cultural heritage features - Relocate cultural resources - Create archaeological or cultural museums, or establish points of interest including lookouts
Protecting or mitigating changes to landscape	- Protect areas with important landscape features - Landscape enhancement by clearing trees from reservoirs or upland areas to improve waterscape and landscape aesthetics
Protection of valued ecosystem components (aquatic and terrestrial habitats, communities, rare, threatened species and spaces, and particular species other than fish)	- Habitat protection (specific to habitat type, e.g. wetland, riparian, upland) - Habitat enhancement (specific to habitat type) - Habitat creation (specific to habitat type) - Retention of key habitat features (stumps, licks, colonial nesting areas, caves, denning areas, etc.) - Protection of rare, threatened and endangered species (fencing; road gating; nest relocation, new nesting structures, etc.) - Programs for rescue and relocation of animals - Schedule work which disturbs animals (due to noise human presence, traffic) during non-sensitive time periods (breeding, nesting, wintering, rearing, fledging, etc.) - Anchor floating peat bogs - Forest management - Wildlife management (hunting restrictions) - Provide environmental awareness training to construction staff
Protection, replacement and control of vegetation	- Design (site selection) to minimise vegetation removal, to selectively clear certain areas for specific benefit (e.g. trimming, pruning, pollarding, etc.), or to retain particular types or zones of vegetation (endangered, riparian, wetland) - Revegetation programs (including monitoring and maintenance): conduct fertilising, seeding, hydroseeding, sodding, and plant tree seedlings and other propagules, either on site or in compensation elsewhere - Habitat replacement or enhancement - Protection of endangered vegetation and spaces (e.g. wetlands) - Retain vegetated buffer strips around work areas and shore zones - Fire prevention and control program and provision of firefighting equipment - Promote aquatic macrophyte growth - Weed control measures (e.g. harvesting for compost, fodder, biogas; regulation of water levels and discharges to control weed growth) in areas stimulated by increased nutrient levels

Name	Comments and examples
Sedimentation prevention and control	- Design intakes to enable sediment bypass and prevent local setting - Reduce sediment mobility by providing settling ponds, silt fences, in-stream silt curtains, cellular cofferdams - Controlled dredging and segregation of dredgeate - Reduce in-water and shoreline work and work on erosive slopes - Use established, specially prepared fords or bridges - Control watershed land use to prevent sedimentation of reservoirs (e.g. reforestation, conservation).
Social impact management	- Site planning and scheduling to accommodate resettlement needs - Avoid dislocation of communities and unacculturated peoples to the extent possible - Create a communications plan, enable local consultation and stage information presentations with local communities - Provide for a community impact agreement - Create liaison committees to solve social problems - Provide compensation - Conduct monitoring programs - Develop dispute resolution processes to handle unforeseen issues
Water quality protection and adjustments	- Design measures (site selection) for keeping contaminants away form watercourses (e.g. refuelling sites, landfills, berms, sewage tile drains, etc.) - Design measures to limit discharges of contaminants (drip-trays; refuelling practices; transformer and sump configurations, etc.) - Spill prevention and response plan and deployment of clean-up equipment - Aeration and provision of weirs or rapids for DO improvement - Provide minimum flow for downstream DO improvement - Water intake design for establishing downstream temperature control and reservoir stratification pattern (selective intake) - Provide minimum flow for downstream temperature control - Provide alternative sources of high quality water - Tailrace tunnel design to control gas supersaturation - Sewage treatment for nutrient and bacteria control
Water quantity control (flow, velocity, level; including ice formation and movements)	- Design and construction of intakes, weirs, dikes, riffles, energy dissipators and diffusers for water level and velocity control - Site selection to avoid activities in areas sensitive to flow and level changes (e.g. groundwater recharge areas) - Manage facility flows to regulate water velocities, flows and levels - Provide minimum flow to prevent dewatering of downstream areas - Provide flushing program - Design of excavations and provision of block dams along reservoir and stream perimeters to manage the size of the drawdown shore zone - Regulation of flow to minimise salinisation of floodplain lands - Maintain minimum flow to prevent salt water intrusion in estuary and upstream - Provide weirs or ice booms to control ice movements - Provide bubble systems to prevent local ice build-up - Flow management to manage ice hinge formation

Source: IEA (2000b)

Annex 3: Water, Energy and Food security nexus

Table 2: Summary of policy recommendations per Nexus Opportunity Area

Increase policy coherence	• Ensure that development pathways explicitly account for the inter-dependency between water, energy and food. • Encourage cooperative structures and procedural mechanisms for implementation of a more interlinked 'nexus' perspective at international, national and local levels. • Promote sustainable development opportunities through a collaborative trans-boundary and basin-wide approach to development decisions that cross borders. • Review and redress distorting subsidies. • Adopt a rights-based and participatory approach to land-use policy and related investments. • Mainstream climate change mitigation and adaptation policy and strategies to reinforce considerations of water, energy and food security and the local environment.
Accelerate Access	• Achieve access to safe water, sanitation, food and energy for human survival and dignity, poverty reduction and sustainable development. • Apply an integrated approach to the provision of reliable, affordable and clean energy. • Promote access, productivity gains and more equitable sharing of benefits through explicit commitments to transparency and integrity systems. • Increase the contribution of water storage and its role in reducing vulnerability to short and long term climate variability and change.
Create more with less	• Further raise awareness among the public and in industry of resource use in manufacturing and production processes and publicize innovations and good practice for demand management, increasing efficiency and raising productivity • Encourage savings in industrial and agricultural sectors, electricity generation and transmission and in urban utilities by adopting innovative ways to raise efficiency and productivity and to reduce water, energy and carbon footprints. • Provide an enabling framework for innovation and shortcutting development pathways. • Conserve and increase the long term productivity of land and soil through adoption of sustainable agricultural management practices.
End waste and minimize losses	• Promote a 'minimum' waste policy at national and local levels. • Encourage effective regulatory and planning frameworks for the re-use of waste and address environmental and human health concerns and cultural sensitivities. • Create a culture of innovation for re-use of wastewater • Ensure options for re-using waste are considered objectively prior to exploiting new resources. • Encourage and maintain momentum for recycling

Source: NEXUS (2012)

Table 3: Summary of recommendations for actions per stakeholder group

National governments and parliamentarians	• Make the sectors work for the poor: Facilitate, and finance to adequate levels of food and nutrition, water, sanitation and energy: • Assess the potential for a more interlinked approach by preparing a medium to long-term "Nexus Strategy" based on cross-sectoral knowledge base - a National Water, Energy and Food "Outlook" • Establish an enabling framework for policy dialogue and coherence across sectors. • Build coherence in regulatory, planning and management frameworks and incentivize nexus outcomes: Ensure interlinkages and consequences for other sectors are explicit in regulatory processes and market instruments and encourage more efficient and equitable resource allocation and use through strategic planning processes and by removing or reducing perverse subsidies or incentives. • Sector-based actions based around the dimensions of policy, institutions and finance: Parallel initiatives to address lack of access and stimulate sustainable growth are required. • Adopt conventional and innovative financing arrangements to achieve water, energy and food security and implement a nexus approach that also reflects the value and services provided by the natural environment. • Improve governance arrangements through more open, participatory processes, recognition of human rights and adoption of accountability and monitoring mechanisms. • Consider the trans-national consequences and externalities of trade policy on water, energy and food security. • Adopt both a regional and a basin-wide perspective reflecting the principles of integrated water resources management and influences that go beyond the boundaries of a river basin. • Provide the learning and knowledge management opportunities necessary to create a cadre of leaders to think interlinked. • Establish monitoring systems to comprehensively track and monitor food security, water, energy and carbon movements and nexus indicators so policy development is based on sound evidence.
International organizations and development organizations	• Further develop the evidence base for the nexus – Global 'Nexus' Outlook Report on Water, Energy and Food. • Establish a portal of good practice examples across the nexus. • Encourage cooperation between UN-Water and UN-Energy to address nexus issues. • Facilitate countries in attaining water, energy and food security and adopting nexus approaches through financial support and capacity development • Prepare voluntary guidance standards for land leasing. • Review and further develop guidelines on water quality for re-use in industry and agriculture and for aquatic ecosystems. • Improve global governance on trade. • Encourage a coordinated approach to implementation of multi-lateral environmental agreements and other conventions. • Accelerate knowledge generation on ecosystem processes and their value. • Further encourage partnerships and tool development. Promote, improve and disseminate existing initiatives on life cycle analysis, foot-printing and stewardship, sustainable production. • Intensify efforts to stimulate cooperation across administrative boundaries to identify mutual benefits for water, energy and food security and in resource use and

	to mitigate any trans-boundary shifting of environmental burdens.
Local authorities and utilities	• Declare a minimum waste policy and prepare plans for water and wastewater utilities to become carbon neutral. • Ensure coordination in planning processes responsible for waste management, water re-use, peri-urban agriculture, energy from waste, etc. • Develop conceptual frameworks and plans that identify the synergies between urban water management and agriculture and create the enabling environment for implementation, • Develop clear national and municipal roles and responsibilities and facilitate inter-sectoral cooperation to achieve more sustainable water, sanitation, health and food security impact and manage natural disasters, • Address the externalities of urbanization on coastal waters and river systems, particularly related to water quality and productivity of aquatic ecosystems • Stimulate urban planning and related regulatory framework to consider the benefits of and interlinkages between flood management, urban agriculture, climate protection and recreation, • Prioritize capacity building for achieving water, energy and food security and related nexus considerations • Ensure nexus considerations are taken into account by utilities in water supply and energy expansion programs and there is a proactive focus on measures to reach the poor; • Raise efficiencies of existing infrastructure through rehabilitation and technological advances including optimizing the performance of existing energy generation and distribution infrastructure and explore multiple benefits including social and environmental. • Channel financing and create incentives for income generation in re-use of water, nutrients and energy.
Business and the private sector	• Incorporate a nexus perspective in business planning including investing in and developing innovative technologies and systems and a business model that proactively considers water, energy and food security and natural resources utilization. • Broaden water and energy stewardship and application of corporate sustainability. Voluntary and regulated measures are needed to ensure the activities do not compromise the water, energy and food security of others, especially the poor or ecosystems. • Benefit from resource efficiency and productivity gains that may have both single and multi-sector consequences including opportunities for increasing productivity in existing water and energy systems, increasing efficiency of supply chains and reducing waste • Adopt financing schemes for sustainable production and natural resource management such as payment for environmental services • Recognize the rights and needs of workers and the contribution they can make to productivity gains. • Extend product longevity. • Include a nexus perspective in corporate sustainability reporting.
Investors and financing agencies	• Increase collaboration between the public sector, business and finance, and civil society, including proactive and innovative financing arrangements to achieve water, energy and food security. • Incorporate nexus considerations into existing initiatives such as the UNEP-Finance

	Initiative and UN-based Principles for Responsible Investment, and further support Water Disclosure such as through the Carbon Disclosure Project. • Adopt international good practice for infrastructure development, and foreign direct investment and recognize relevant sustainability guidelines, assessment tools and certification schemes. • Leverage sustainable finance and responsible investments to place a premium on long-term investment horizons that incorporate environmental and social issues as a matter of risk-management and so are synergistic with a nexus approach. • Adopt social and environmental safeguards in infrastructure projects including the Equator Principles. • Reflect nexus thinking in corporate sustainability reporting of investment portfolios.
Civil society (communities, NGOs, media)	• Raise awareness of nexus solutions through local organizations and media campaigns and use of social media, • Encourage communities to be more involved in the planning and management of water and energy systems including decentralized options. • Undertake cooperative, stakeholder driven assessments of resource supply and demand to help inform policy makers and the public. • Provide oversight for transparent and sustainable resource allocation and the fulfilment of the human right to food, water and sanitation
Farming community	• Raise awareness, develop capacity and respond to incentives for increasing productivity and reducing waste such as post-harvest losses, etc., • Support GIAHS program (Globally Important Agricultural Heritage Systems) and adoption of the Integrated Food Energy System (IFES) • Adopt the System of Rice Intensification (SRI) and similar techniques to increase food production and productivity of water.
Research organizations	• More in-depth analysis of the benefits of the nexus perspective, policy coherence on economies, jobs etc., and incentive systems that influence market and consumer behaviour. • Applied research to address the management and institutional related aspects of addressing the nexus perspective, including arrangements for coordination and cross-sectoral policy formulation and initiatives to examine how existing research can be better used by the public and private sector in pursuit of nexus objectives, • Develop 'nexus' indicators and baseline data required for monitoring and reporting nexus aspects of productivity, social well-being, natural resource resilience, etc. • Build a knowledge base and applied R&D to support decision making, including: o more drought and flood resistant and nutrient efficient crop varieties; o lower water consuming techniques including both modern and traditional agricultural technologies; o new technologies and processes for efficiency improvement, e.g. promoting technical innovation to raise efficiency in the production and use of bioenergy, (second and third generation technologies, use of waste and ligno-cellulosic biomass); o techniques to achieve 'clean' waste by separating chemicals including phosphorous; o ways to bring down the costs (and consumptive requirements) of renewable energy and desalination; o efficient application of water harvesting systems; and ecological sanitation systems. • Undertake research to better understand ecosystems and further develop economic tools to incorporate externalities.

	• Analyse inter-regional and global trade from a nexus perspective; • Further develop hydrological tools and risk management strategies under conditions of climate change uncertainty to ascertain whether past records can still predict the future hydrology and how this influences design and the need for greater emphasis on risk management and adaptive management (for hydropower, irrigation, etc.); • Improve communication between soil scientists and politicians to ensure solutions to prevent land degradation and improve soil fertility are implemented particularly in view of increasing pressures; • The interlinkage between fertility of soils and food security, water quality and flow, green water availability in soils, as well as biodiversity needs to be considered in decision making processes.
Regional bodies	• Many of the actions covered above are relevant for implementation within a regional perspective and include regional data sharing, trade opportunities and benefit sharing:

Source: NEXUS (2012)

Annex 4: Electricity production and hydropower share overview in SEE[68][69]

Table 4: Electricity production and hydropower share overview in SEE

Country	*Electricity demand, TWh*	*Electricity production, TWh*	*Share of hydropower in electricity production*	*Share of hydropower in electricity consumption*	*Electricity import/export balance, TWh*	*Existing electricity gap*[70]
Albania	5,58	2,26	99,8%	68%	-1,34	Yes
Bosnia and Herzegovina	14,02	14,03	39,8%	39,8%	+ 1,46	No
Bulgaria	33,38	42,38	8,41%	9,8%	+5,34	No
Croatia	16,44	12,69	54.7%	40,5%	-6,58	Yes
Greece	62,51	59,33	6,79%	6,63%	-4,62	Yes
Hungary	37,82	35,91	5,7%	5,6%	-3,9	Small
Kosovo[71]	3,68	5,7	1,7%	1,5%	+0,45	No
FYR Macedonia	7,08	6,83	17.8%	11,9%	+ 2.73	Small
Montenegro[72]	4,02	3,28	57%	1,54	- 1,77	Small
Romania[73]	48,49	57,74	32%	26,9%	+4,248 (2008)	No
Serbia	30,93	37,42	27%	32%	+ 0,82	No
Slovakia	26,68	25,92	17,2%	16,7%	- 0,88	Small
Slovenia	12,45	16,40	28,7%	37%	+3,06	No

Sources: REEGLE database (including data from IEA, UN, World Bank, EUROSTAT, Enerdata) World Bank, CIA World Factbook, KPMG, KOSTT, Kosovo Agency of Statistics

[68] 2009 data, if not otherwise noted
[69] Discrepancies between electricity production, import and export relate to distribution and transmission losses, as well as possible differences in data collection methodology between different sources
[70] Annual electricity gap, does not take into account possible seasonal electricity gaps
[71] 2011 data
[72] 2008 data
[73] 2008 data

Annex 5: Hydropower potential and utilisation in SEE

Table 5: Hydropower potential and utilisation in SEE

Country	*Technical hydropower potential, GWh/a*	*Utilisation rate*	*Installed capacities, MW*			*Planned hydropower plants*			*Hydropower potential index*[74]	
			Large HPPs	*Small HPPs*	*Total*	*Large HPPs*		*Small HPPs*	*Large HP*	*Small HP*
						Number, type	*Capacity, MW*	*Capacity, MW*		
Albania	15000	24%	1432	14	1446	3, storage	810	-	**203**	**175**
Bosnia and Herzegovina	24000	19%	2056	9	2065	13, storage	1316	-	**90**	**180**
Bulgaria	15000	24%	2480	513	2993	3 storage, 4 other large HPPs	1808	18	17	52
Croatia	9000	59%	1970	37	2007	2 storage, 4 other HPPs	353	100	13	74
Greece	20000	11%	3061	182	3243	N/A	544	3	N/A	N/A
Hungary	8000	3%	39	7	46	-	-	3	17	4
Kosovo	800	10%	35	9	44	1 storage	305	64	9	71
FYR Macedonia	6000	18%	536	50	586	4 storage, 1 pumped storage	1400	-	16	**281**
Montenegro	15000	36%	649	11	660	2 storage, 3 other HPPs	1243	20	41	**362**

[74] According to KPMG methodology

Romania	35000	48%	4895	7	4902	4 pumped storage, 2 storage, Several other medium size HPPs	1637	25	28	**158**
Serbia	19000	53%	2818	13	2831	Several run-of-river, 3 storage	3180	-	7	114
Slovakia	7000	62%	2254	224	2478	1 pumped storage, 1 storage, 1 run-of-river	674	93	11	61
Slovenia	9000	36%	963	16	979	1 pumped storage, 4 run-of-river	557	-	37	101

Source: KPMG, intpow