Thematic assessment on the water-food-energy-ecosystems nexus:

Basin assessments

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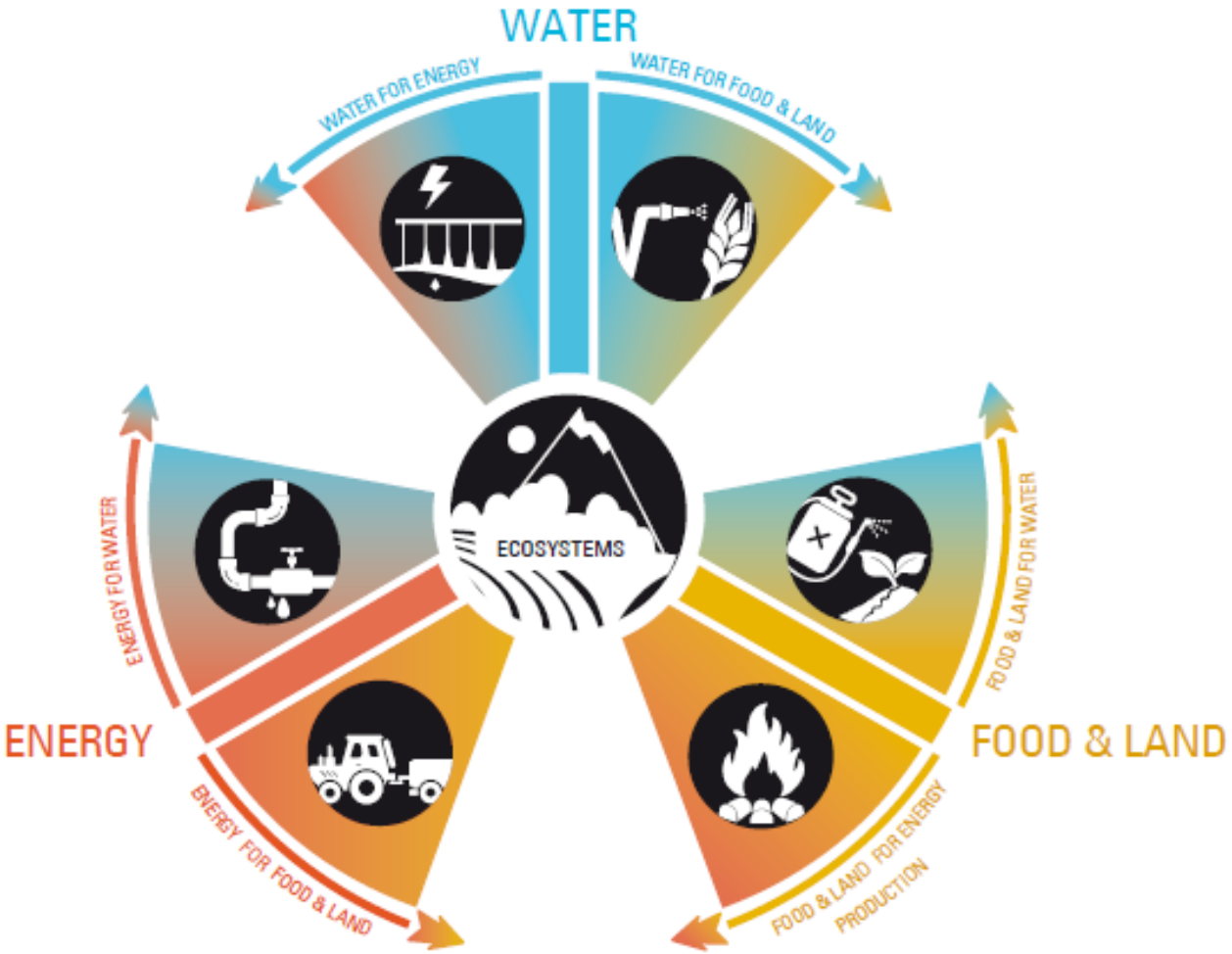
Conceptual presentation of interlinkages in the nexus by basin



Main nexus interlinkages and opportunities

Area/aspect	Alazani/Ganikh	Sava	Syr Darya
Main nexus interlinkages	Water-energy (hydropower), land-energy-water (biomass use, erosion/ sedimentation, hydrological flow)	Water-energy (hydropower); land-water (sediment management)	Water-land-ecosystems (irrigation, salinization), water-energy (hydropower), land-ecosystems
Main nexus opportunities	Facilitate access to modern energy sources and energy trade; minimize impacts from new hydropower development; catchment management to control erosion	Develop hydropower sustainably and integrate other renewable energies	Promote restoring and vitalizing energy market, develop the currently minimal trade in agricultural products; improve efficiency in energy generation, transmission and use; improve efficiency in water use (in agriculture in particular)

Approach to identifying solutions

Because of the different level of cooperation, evaluating the possible actions has different perspectives:

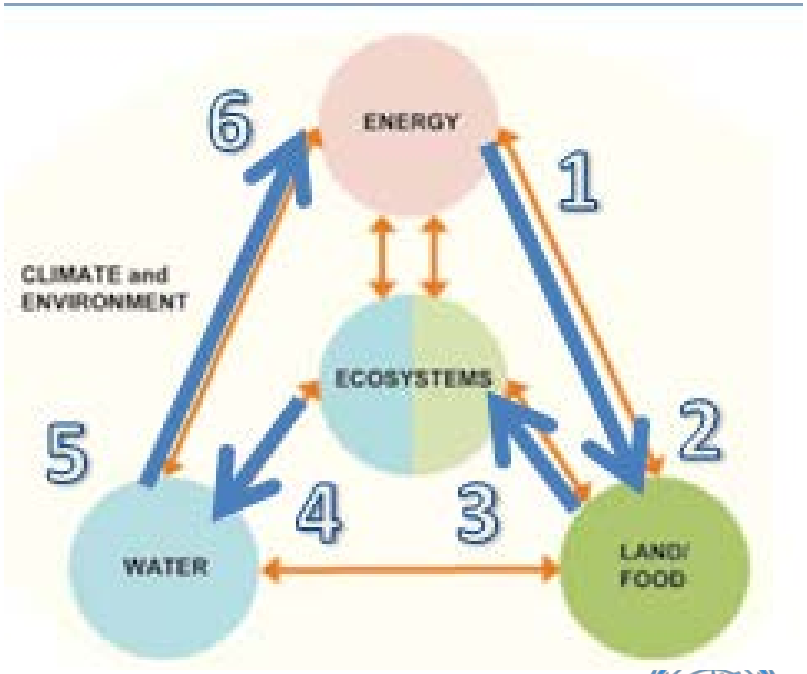
* **Alazani/Ganykh**: transboundary cooperation is being built now between the two countries -> Identify the main sectoral and intersectoral interventions needed.
* **Sava**: transboundary cooperation is advanced, covering multiple sectors and the ISRBC offering a platform for cooperation. -> Explore how the existing cooperation could be improved, in particular from the governance and technical perspectives.
* **Syr Darya**: transboundary cooperation is currently compromised by lack of trust -> Discuss how national policies could be aligned with a path towards restoring cooperation between countries.

Alazani/Ganykh Basin

Alazani/Ganykh: Changing household fuel use in Georgia to improve flood control

Fuel wood use in upstream Georgia in the basin (1) has important knock on effects. (2) Fuelwood harvesting leads to deforestation. (3) The loss of forest results in a loss of ecosystem service (water retention tempering runoff). (4) This increases the severity of flash floods requiring damage control in downstream. (5) In turn hydro generation infrastructure is utilized in a sub-optimal way.

A solution with multiple benefits and potentially cheaper than flood control is (1) to **substitute wood with modern fuels** improving indoor air. (2) decreased harvesting leading to **greater forest mass and carbon sink** (3). **Increased ecosystem service** including **natural flood control** (4) **less disruptive flooding** and damage and (5) better hydro generation performance.



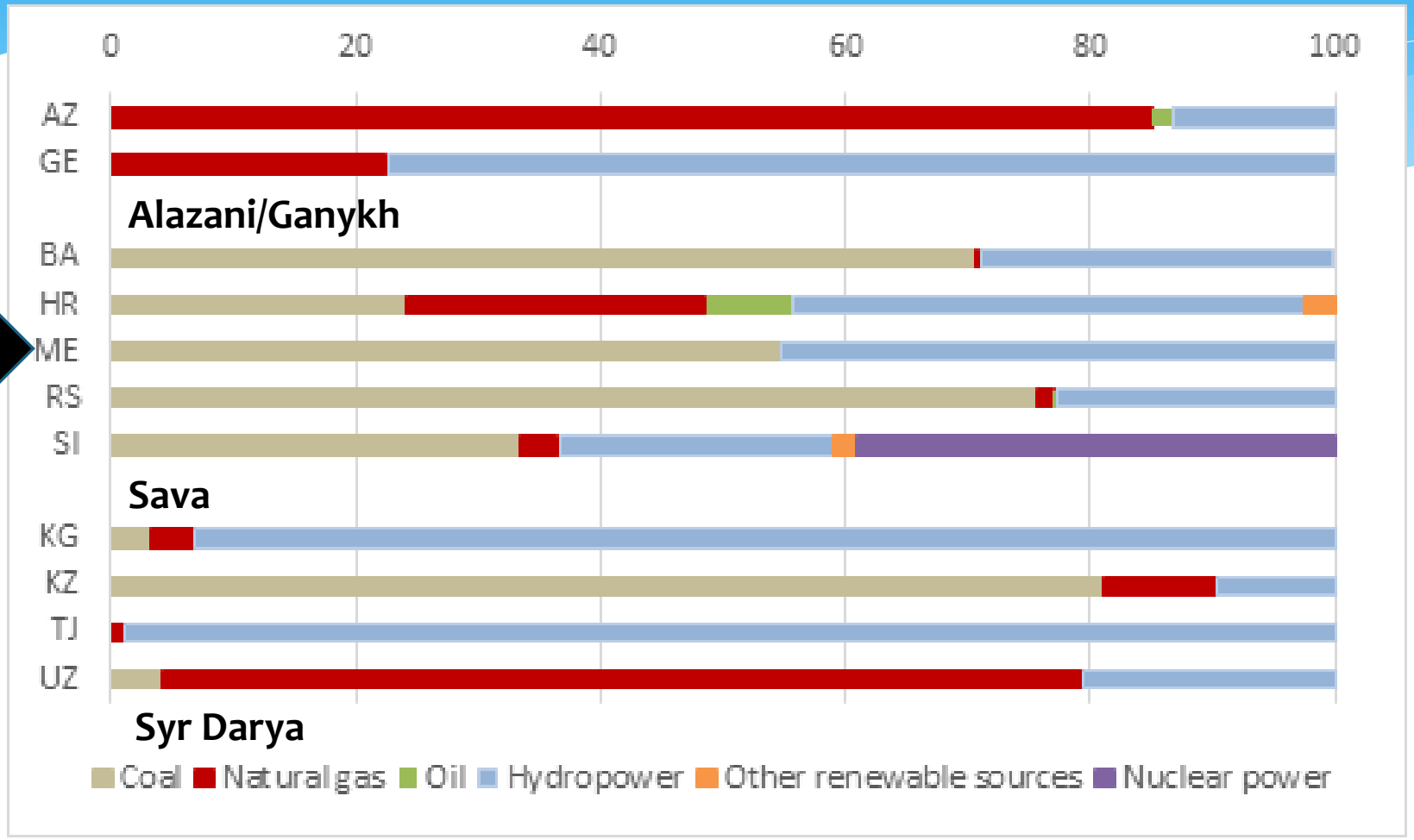
The benefits of transboundary cooperation in the management of the Alazani/Ganykh Basin's resources

	On economic activities	Beyond economic activities
From improved management of basin resources	Economic benefits • Increased productivity and viability of agriculture • Preservation and development of aquaculture • Avoiding hydropower generation losses due to floods and reservoir siltation • Cost savings in drinking water treatment • Reduced economic losses from floods • Reduced public spending on emergency situations and repairing damage • Expansion of tourism industry	Social and environmental benefits • Health benefits from reduced indoor air pollution • Reductions in human losses caused by floods • Reductions in unemployment • Poverty reduction and increased living standards • Recreational use by local communities • Preservation of forest habitats • Carbon sequestration
From increased trust	Regional economic cooperation benefits • Increased trade in energy carriers (electricity, natural gas, kerosene,…)	Geo-political benefits • Alignment to international and EU regulation • Reduced possibility of conflicts between Georgia and Azerbaijan

Sava Basin


Top agricultural commodities 2012 (in million US$)
2 000
1 000
500
200
Dairy and meat
Fruits and nuts
Grains, potatoes
Vegetables
AUSTRIA
HUNGARY
SLOVENIA
ITALY
CROATIA
BOSNIA AND HERZEGOVINA
SERBIA
MONTENEGRO
Kosovo
Villach
Klagenfurt
Maribor
Nagykanizsa
Kaposvar
Pecs
Subo
Udine
Slovenia
Trieste
Koper
Rijeka
Pula
Zadar
Split
Trogir
Dubrovnik
Mostar
Ljubljana
Zagreb
Karlovac
Sisak
Osijek
Timisoara
Novi Sad
Pancevo
Belgrade
Kragujevac
Krusevac
Serbia
Sarajevo
Banja Luka
Zenica
Tuzla
Bijelo Polje
Podgorica
Pristina
Croatia
Bosnia and Herzegovina
Montenegro
Nexus Sava basin
Power plant facilities
Installed capacity (MW)
< 50 MW
50 - 100 MW
100 - 250 MW
250 - 500 MW
> 500 MW
Thermal power plant (coal/oil/gas)
Hydro power plant with reservoir
Nuclear power plant
Run-of-river hydro power plant
Projected thermal power plant
Projected hydro power plant
Landcover
Forest
Agriculture
Volumes of traffic on the Sava river
Major terminals
3.5 - 9.6 mio t
5.8 - 15.5 mio t
7.8 - 20.8 mio t
Sava
Drava
Danube
Kupa
Una
Vrbas
Bosna
Drina
Tara
Lim
Ibar
Morava
0
50 km
Map produced by ZOÏ Environment Network, March 2014

Electricity generation by source in the basin countries



Multi-purpose designs and smart management to increase the deployment of renewable energy in the Sava Basin

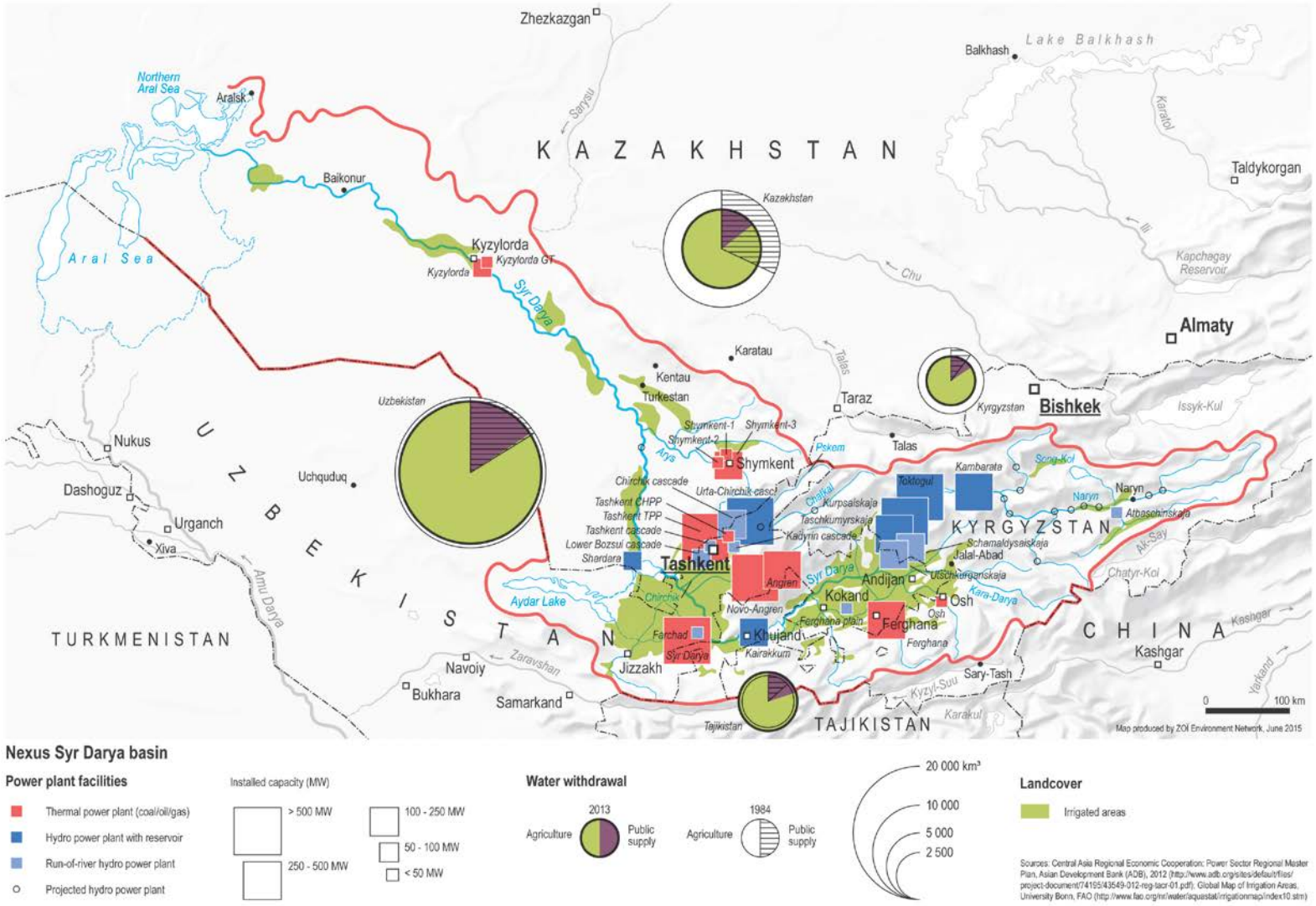
Countries	*RES share in 2009*	*RES share in 2020*
Bosnia and Herzegovina	34%	40%
Croatia	12.6%	20.0%
Montenegro	26.3%	33%
Serbia	21.2%	27%
Slovenia	32.5%	39.3%

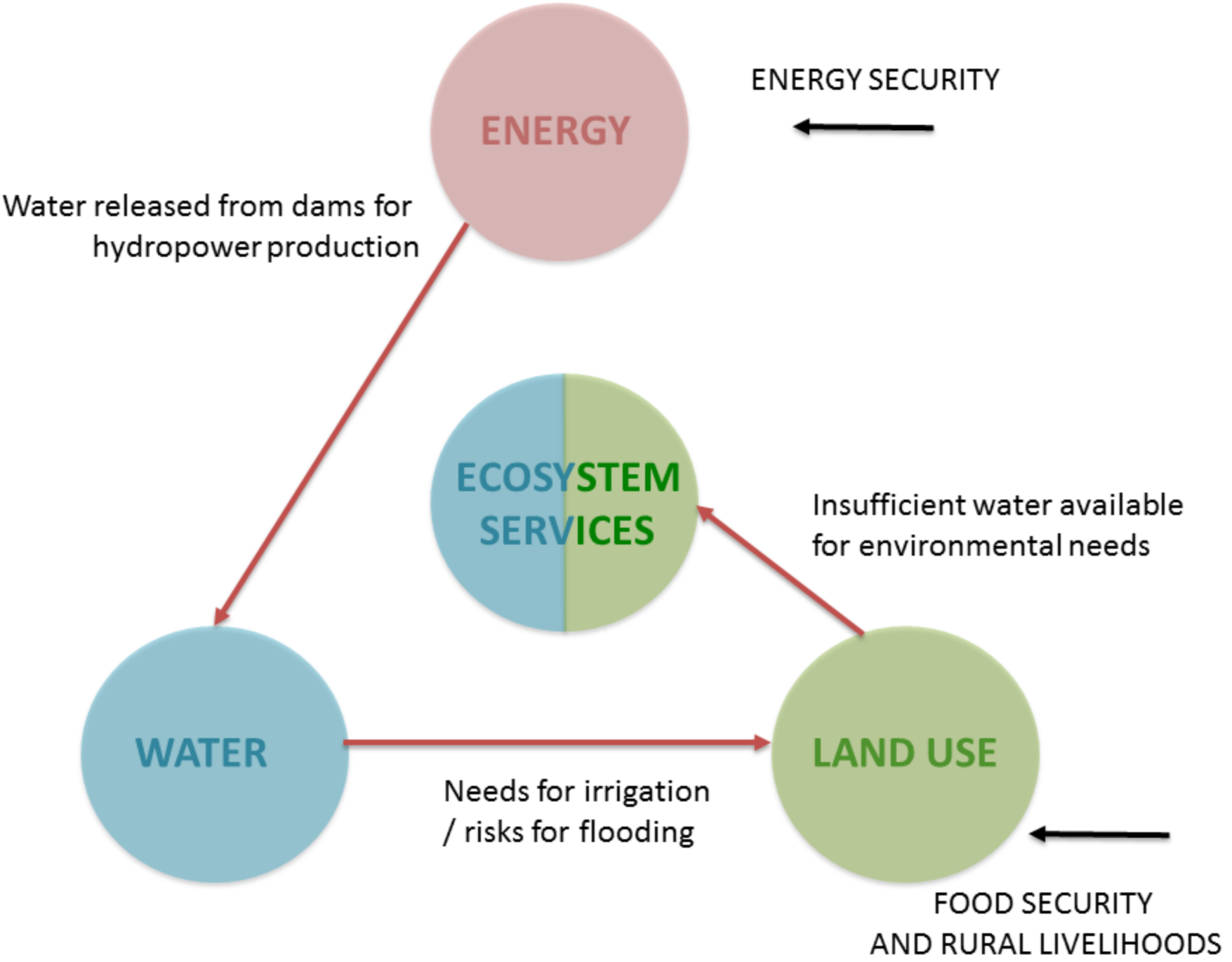
Strong renewable energy targets. Power plants linked to dams are characterised by great ramping rates and can be used to **integrate other renewables** (wind and solar power). When the wind is not blowing or sun not shining, hydro can be used to increase generation. This will be key in advancing towards renewable targets (as well as GHG mitigation and energy security targets) responding at the same time to the increasing need of having more flexibility in the energy system.

The benefits of transboundary cooperation on the nexus issues in the management of the Sava basin's resources

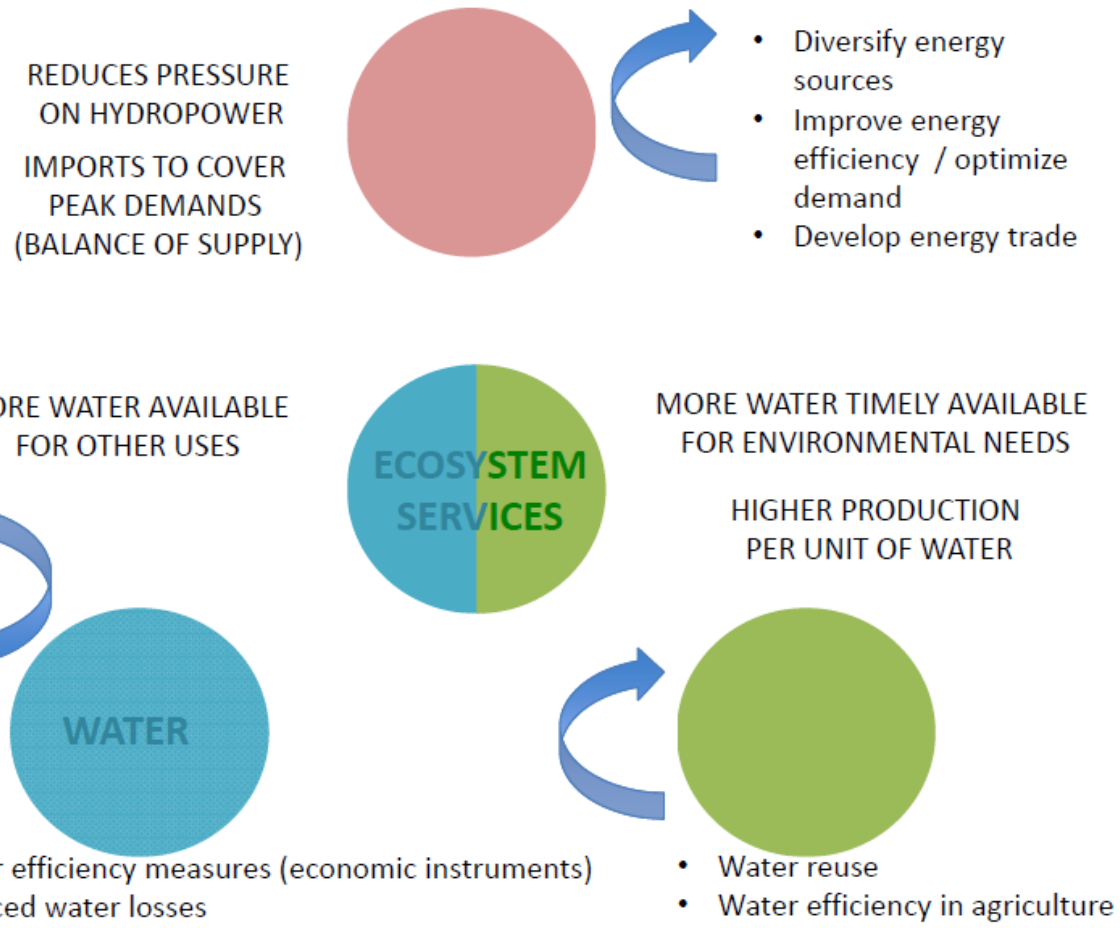
	On economic activities	Beyond economic activities
From improved management of basin resources	Economic benefits • Increased viability of economic activities relying on basin resources • Development of agricultural sector & its value • Development of sustainable river tourism • Reduced economic costs of water-related hazards • Reduction of transport costs or increased volume of traffic (thanks to increased capacity and use of better maintained waterways) • Reduction of energy costs (thanks to optimisation of potential energy sources) • Reduction of water infrastructure costs (thanks to avoidance of duplication and sub-optimal location)	Social and environmental benefits • Employment creation (e.g. in agriculture and tourism) • Reduced human costs of water-related hazards • Health benefits from improved water quality • Improved water services • Improved recreational opportunities from improved water quality and healthier ecosystems
From increased trust among	Regional economic cooperation benefits • Increased trade through waterways • Development of regional markets for goods, services and labour	Geo-political benefits • Improved complying with EU requirements and regional targets (e.g. status

Syr Darya


Zhezkazgan
Balkhash
Lake Balkhash
Northern Aral Sea
Aralsk
Sarysu
K A Z A K H S T A N
Karatal
Taldykorgan
Baikonur
Kazakhstan
Aral Sea
Kyzylorda
Kyzylorda GT
Kyzylorda
Syr Darya
Chu
Kapchagay Reservoir
Almaty
Karatau
Talas
Kentau
Turkestan
Taraz
Kyrgyzstan
Bishkek
Issyk-Kul
Uzbekistan
Shymkent-1
Shymkent-3
Shymkent-2
Arys
Shymkent
Pskem
Talas
Nukus
U Z B E K I S T A N
Kambarata
Song-Kol
Uchquduq
Chirchik cascade
Urta-Chirchik casc
Toktogul
Naryn
Dashoguz
Tashkent CHPP
Tashkent TPP
Tashkent cascade
Lower Bozsu cascade
Shardara
Kurpsaiskaja
Taschkumyrskaja
Kadymn cascade
K Y R G Y Z S T A N
Atbaschinskaja
Urganch
Xiva
Tashkent
Angren
Schamaldysaiskaja
Jalal-Abad
Ak-Say
Andijan
Utschkorganskaja
Chatyr-Kol
Amu Darya
Aydar Lake
Chirchik
Novo-Angren
Kokand
Osh
Kara-Darya
Ferghana plain
Ferghana
Osh
Farhad
Syr Darya
Khujand
Kairakkum
Ferghana
C H I N A
Kashgar
TURKMENISTAN
Navoiy
Zaravshan
Jizzakh
Sary-Tash
Bukhara
Samarkand
Kyzyl-Suu
Yarkand
Tajikistan
Karakul
T A J I K I S T A N
0
100 km
Map produced by ZOI Environment Network, June 2015
Nexus Syr Darya basin
Power plant facilities
Thermal power plant (coal/oil/gas)
Hydro power plant with reservoir
Run-of-river hydro power plant
Projected hydro power plant
Installed capacity (MW)
> 500 MW
250 - 500 MW
100 - 250 MW
50 - 100 MW
< 50 MW
Water withdrawal
2013
Agriculture
Public supply
1984
Agriculture
Public supply
20 000 km³
10 000
5 000
2 500
Landcover
Irrigated areas
Sources: Central Asia Regional Economic Cooperation: Power Sector Regional Master Plan, Asian Development Bank (ADB), 2012 (http://www.adb.org/sites/default/files/project-document/74165/43549-012-reg-tacr-01.pdf). Global Map of Irrigation Areas, University Bonn, FAO (http://www.fao.org/nr/water/aquastat/irrigationmap/index10.stm)


ENERGY
ENERGY SECURITY
Water released from dams for hydropower production
ECOSYSTEM SERVICES
Insufficient water available for environmental needs
WATER
LAND USE
Needs for irrigation / risks for flooding
FOOD SECURITY AND RURAL LIVELIHOODS

Paths for addressing factors affecting water quantity



JNECE

A broad range of possible solutions/synergic actions identified in the Syr Darya Basin: 3 foci

1. **National development with unintended co-benefits**
   - Improving energy efficiency, reducing dependency on water for energy
   - Rationalizing water use (esp. in agriculture)
2. **Broader sustainable development and national policy coherence**
   - Reinforcing environmental legislation and integrating environmental considerations into sectoral policies and management practices
   - Increasing policy coherence and coordination across sectors
   - Climate-proofing national development
3. **Accelerate national development by furthering cooperation**
   - Improving communication, information and knowledge sharing as well as joint monitoring
   - Facilitating trade for energy and agricultural products among the riparian countries
   - Capacity building (human and technical)

Isonzo/Soča: drivers, pressures and nexus linkages (to be explored with Slovenia and Italy)

1. **Economic activities**

* Valorization of natural capital, landscape, historical-cultural sites and heritage, local products and development tourism
* Wine making and other agricultural activities
* Hydro-electrical production and operations

2. **Nexus linkages**

* Hydropower-agriculture-environment (water quantity / timeliness)
* Water-environment (water scarcity also due to natural permeability of the river bed and groundwater uses with potential saline water intrusion)

Isonzo/Soča: possible solutions
(to be explored with Slovenia and Italy)

1. **Policies (in different nexus sectors)**

* Realise the potential for basin-level green economic growth (taking advantage of complementarities between the two sides of the basin. E.g. natural and cultural tourism)
* restore existing infrastructure, assess the potential of storage capacity alternatives (natural infrastructure, managed groundwater recharge), optimization and coordination of developing renewable energy sources, including operation of water management infrastructure (e.g. energy trade).
* Potential for river restoration with benefits for ecosystems and tourism.
* Continue promoting advanced practices in agriculture, including new technologies (for water efficiency, energy efficiency and on-site energy production from renewables)
* Requirements of a good environmental status (WFD); Floods Directive; coping with water scarcity

2. **Projects (in different nexus sectors)**

* Existing cross-sectoral efforts (e.g. renewable energies and agriculture – solar and small hydropower; energy and tourism in multi-purpose dams)

Main categories of solutions

* **Institutions** (intersectoral, multiple level governance, engaging resource users, responsibilities etc.)
* **Information** (multi-sector information to support policy, assessing impacts across sectors, guidelines etc.)
* **Instruments** (economic instruments, SEA etc.)
* **Infrastructure** (built and natural – investments, operation, multiple use designs etc.)
* **International coordination and cooperation** (sharing information, plans, good practices etc.)

Institutions

* In strengthening the institutional capacity, **building on existing structures** by their further development and broadening the scope of work can be recommended as a first step
* **Coordination** between regional economic organisations, basin organisations, power pools is important
* **Appropriately broad representation of sectors** in joint bodies; broadening the mandate gradually reflecting uses & pressures
* Many **river basin organizations** and other joint bodies already have a **multisectoral scope**: can function as effective platforms for a dialogue, negotiation and agreeing about actions
* Formal structures and processes facilitate but do not guarantee coordination and consultation planning. The political will is of key importance
* Appropriate mechanisms for **enabling participation** of different stakeholders and the public and for communication strengthen decision-making

Instruments

* **Diverse policy instruments: regulatory, economic** etc.
* Useful basis: Mapping the current structure of policy instruments (such as subsidies and resource allocation rights) and assessing their impacts, in order to identify opportunities for improving coherence
* **Intersectorally coordinated processes** can help to align policies:
  * National sustainable development strategies
  * Adaptation plans on climate change
  * Strategic Environmental Assessment, EIA
  * Regional development strategies and integration processes (e.g. EU approximation, where applicable)
* **Sound spatial plan**ning

Example of instruments: economic instruments

1. Valuing water services (differ by 'commercial vs basic needs' & service and location)
2. Valuing energy inputs (cost reflective tariffs)
3. Metering, monitoring and measuring
4. Setting up pricing / subsidy structures that:

* Locally acceptable and supportive to the poor
* Encourage / reward responsible water management and rational use (supply and demand)
* Recover costs required for infrastructure

Also other market and non-market instruments: trading, water allocation, abstraction and pollution charges, Payments for Ecosystem Services (PES)

Infrastructure

* **Promoting multiple and flexible use** of infrastructure – in particular dams, irrigation and drainage systems.
  * E.g. in addition to hydropower generation may serve flow regulation for irrigation, navigation and/or flood protection
  * appropriate designs, fish passes may limit impacts of structures on migratory fish or installation of smaller, run-of-river type hydropower plants have less negative impact on other uses as the environment;
* Investing in infrastructure and technologies to be more water and energy efficient (including upgrading existing), environmentally friendly
* **Coordinating infrastructure investments** – such as in hydropower and other renewable energy sources;
* **Protecting natural infrastructure assets** – such as floodplains and wetlands.

Example on infrastructure solutions (1): hydropower

Basin	*Alazani/Ganikh*	*Sava*	*Syr Darya*
Hydropower capacity (in megawatts)	38 installed; 117 planned.	2,188 installed; 3,358 planned.	4,614 installed; 2,525 planned.

- **Alazani/Ganykh**: Developing and applying guidelines (based on international experience!) to improve sustainability in the location, design (small scale, environmentally friendly, supporting multiple uses) and construction; benefits from erosion control
- **Sava**: Beneficial to coordinate hydropower investments with other infrastructure investments such as for other renewable energy sources (helps to integrate them); put ICPDR guidelines into practice; ensure coordination with needs for cooling thermal power plants and for navigation etc. and with flood control and low flow preparedness

Example on infrastructure solutions: hydropower

Basin	*Alazani/Ganikh*	*Sava*	*Syr Darya*
Hydropower capacity (in megawatts)	38 installed; 117 planned.	2,188 installed; 3,358 planned.	4,614 installed; 2,525 planned.

- **Syr Darya:**
  - Solving energy security challenges upstream would significantly benefit from diversification of sources — alternatives might include some fossil fuels, energy trading, integrating more of other renewable energy sources, for example
  - Water- and energy-efficiency programmes would slow the burden of investment in new capacity, help make the most of existing infrastructure in all countries and be more cost efficient
  - Without restoration of the regional electricity grid and further development of connections, major capacity expansions might have limited utility. Any such expansions would best allow for multiple uses of the overall flow regulation system

Example on infrastructure solutions (2): water-efficient irrigation

Water efficiency in irrigation can have important benefits: commonly less energy used, could result in more water for ecosystems; But there are constraints and preconditions.

For drip irrigation systems:

- The **initial costs** for the equipment and training on use are **high**

- The cash flow and profitability is also potentially much higher, assuming that there is an **established market** to trade the crops produced. **Good irrigation management** is essential and there are specific **water quality requirements**.

E.g., **social factors** need to be considered as well as energy requirements, appropriate **legislation/regulation** is needed etc.

Example on infrastructure solutions (2): water-efficient irrigation

Alazani/Ganikh: Azerbaijan has been investing in water-efficient technologies. The Georgia Government is supportive of **repairing the degraded infrastructure**, investing in water saving technologies and looking into economic instruments, but there is a **gap of responsibility for maintenance** (after irrigation associations ceased to operate).

Syr Darya : Extensive irrigation (45,000 million m^3/year); aridity contributes, large size & condition of the systems. Possible actions: **repair and upgrade the degraded irrigation infrastructure** , improving **water use practices** and introduce **incentives** (e.g. through economic instruments), access to affordable **financing**, facilitation of **trade** in agricultural products etc.

Sava: Water use for agriculture **currently very low**, but irrigation needs are expected to increase. Predicted scarcity (seasonality etc.), climate change, development of other water requirements need to be taken into account. The infrastructure designs could in some cases serve flood response.

International coordination and cooperation

* Transboundary **agreements** and related protocols, regional and international conventions, the EU Directives
* **Guidelines** of intersectoral scope
* **Planning processes** involving multiple sectors
* **Trade** (facilitation etc.)

Potential for learning from experience of different basins

* Sustainable hydropower guidelines (Sava/Danube)
* Multi-sector transboundary governance (Sava)
* Water efficient irrigation (Isonzo/Soča)
* Effective afforestation by switching fuel in households (Alazani/Ganykh)
* Crop diversification from monocultures (Syr Darya)
* Institutional framework for water allocation (Syr Darya)