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Development of Hydropower Sector and its Impact on

Energy-Environment Nexus In Central Asia

OKTAY TANRISEVER
HALIL BURAK SAKAL

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DEVELOPMENT OF HYDROPOWER SECTOR AND ITS IMPACT ON ENERGY-ENVIRONMENT NEXUS IN CENTRAL ASIA

ERI Reports No: 3

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ISBN 978-601-7805-11-1

Edition: 2017, Almaty

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Abbreviations:

CAPS	*Central Asian Power System*
CAREC	*Regional Environmental Centre for Central Asia*
CASA-1000	*Central Asia – South Asia Electricity Transmission Project*
CASAREM	*Central Asia-South Asia Regional Electricity Market*
EEC	*European Economic Community*
EU	*European Union*
FAO	*Food and Agriculture Organization of the United Nations*
GEF	*Global Environment Facility*
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*
HPP	*hydroelectric power plant*
ICOLD	*International Commission on Large Dams*
IR	*International Relations*
IWRM	*integrated water resources management*
KEGOC	*Kazakhstan Electricity Grid Operating Company*
kV	*kilovolt*
kWh	*kilowatt-hours*
MWh	*megawatt-hours*
NATO	*North Atlantic Treaty Organization*
NGO	*non-governmental organization*
OSCE	*Organization for Security and Co-operation in Europe*
RBM	*river basin management*
UN	*United Nations*
UNDP	*United Nations Development Programme*
UNECE	*United Nations Economic Commission for Europe*
UNEP	*United Nations Environment Programme*
UNESCO	*United Nations Educational, Scientific and Cultural Organization*
UNICEF	*United Nations International Children's Emergency Fund*
US	*United States of America*
WHO	*World Health Organization*
WMO	*World Meteorological Organization*

Abstract

This research project is a combination of a comprehensive desk study and a field research on the environment and energy nexus in Central Asia. This final report seeks to produce recommendations based on experiences and needs of the people of the region, supported by a fieldwork and in cooperation with the partners from inside the region. This report is composed of seven sections. After the first introductory section, the second section summarizes the scope and objective, and the third puts the research question and the methodology. The fourth section gives a summary of the approaches in the literature that assess environment and energy issues, including the nexus approach, and the interrelationship between the nexus and politics and economics. The fifth section outlines the major problems in Central Asia that can be assessed through the lenses of environment-energy nexus. Then, the sixth section explores the main approaches to address these problems on three levels, which are state-level, regional level, and international level. Finally, the seventh section provides a short conclusion and some policy recommendations for the stakeholders.

Key words:

Central Asia; water-environment nexus; hydroelectricity; political economy of renewable energy; transboundary water management

1. Introduction

1. Introduction

This research project is a combination of a comprehensive desk study and a field research on the environment and energy nexus in Central Asia. The recently increasing number of scholarly work on water, energy, and environment of Central Asia may be seen as an indicator of the importance and relevance of this research topic.[1] On the other hand, a careful review reveals some weaknesses in the literature and policymaking processes, which this study aims to address.

The tendency in the literature towards producing recommendations for addressing energy, environment, and water problems of Central Asia from an "outside in" type of approach is one of the weaknesses observed during this study. This study seeks to produce recommendations based on experiences and needs of the people of the region, supported by a fieldwork and in cooperation with the partners from inside the region.

The Paris Agreement under the UN Framework Convention on Climate Change, signed in April 2016 in New York and valid as of November 2016, was a momentous occasion that confirmed the relevance of the focus on the environment on the international level. The key to the Paris Agreement is energy production as it is responsible for at least two-thirds of global emissions of greenhouse gases. A priority of this agreement is the development of the renewable energy sector, which is being increasingly preferred by the governments, especially in the developing world. The contribution of the international community is crucial here. As a recent promising development, as of 2015, the rise in the volume of greenhouse gases that is related to energy generation has ended.[2]

This study is based on a perspective of International Relations (IR)[3] as a discipline of social sciences. Therefore, the multi-disciplinal approaches to energy and environment issues in the extensive literature will be evaluated here through the lenses of the International Relations theories. This report is composed of six sections after this introductory section. The following second section summarizes the scope and objective of the project, and the third puts the research question and the methodology applied to answer the research question. The fourth section is composed of eight sub-sections, which give a summary of the approaches in the literature that assess environment and energy issues, including the nexus approach, and the interrelationship between the nexus and politics and economics. The fifth section outlines the major problems in Central Asia that can be assessed through the lenses of environment-energy nexus under five sub-sections. Then, the sixth section explores the main approaches to address these problems on three levels, which are state-level, regional level, and international level. Finally, the seventh section provides a short conclusion and a number of policy recommendations for the stakeholders, i.e. the academia, the regional governments, the local organizations, and the international bodies.

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1 Anton Du Plessis, "Charting the Course of the Water Discourse Through the Fog of International Relations Theory," in H. Solomon & A. Turton, eds. *Water Wars : Enduring Myth or Impending Reality*, 2000, p.9; Kathryn Furlong, "Hidden Theories, Troubled Waters: International Relations, the 'Territorial Trap', and the Southern African Development Community's Transboundary Waters," *Political Geography*, vol. 25, no. 4, 2006; Jeroen Warner & Kai Wegerich, "Is Water Politics? Towards International Water Relations," in K. Wegerich & J. Warner, eds. *The Politics of Water: A Survey* 1st ed., 2010.

2 International Energy Agency, World Energy Outlook 2016, OECD/IEA, 2016, p.21.

3 IR emerged as a discipline in 1919 with the establishment of the first IR department in Wales to bring about academic approaches to the question of wars. The theoretical aspect of IR strenghtened with the contributions from idealist, realist and critical scolars from around the world. IR has always been a discipline closely related with other disciplines in the social sciences, such as political science, history, sociology, philosophy, as well as economics and law, among others.

2. Scope and objective of the project

2. Scope and objective of the project

This study is based on the understanding that water, energy, and environment issues should be explored from a holistic perspective. The area of focus is Central Asia, i.e. the five Central Asian countries, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan (Figure 2.1). The development of hydroelectricity sector in Central Asia and its impacts on the inter-relationship between energy and environment will be assessed in this report on the state, regional and international levels.

Figure 2.1. Political map of Central Asia

Energy is an important issue for Central Asia. The hydroelectricity sector, in particular, has a special significance with regards to its connections with renewable and clean electricity, the environment and climate change, as well as the general situation of water in the basin. In Central Asia, water, energy, and environment are evaluated from various perspectives by upstream and downstream states in the river basins. The upstream countries, Kyrgyzstan and Tajikistan, put a particular emphasis on producing energy from water. The downstream countries, Kazakhstan and Uzbekistan, have different positions on the water. For Uzbekistan, water means a valuable input for agriculture. For Kazakhstan, hydroelectricity and irrigation are secondary subjects to the development and sustaining of the hydrocarbon extraction sector, on which a majority of the whole economy depends. Kazakhstan, on the other hand, is the leading country in the region that attributes a particular attention to environmental issues, clean energy and the Aral Sea problem being among major ones.

Under these complicated and politicized circumstances with regards to the energy and environment nexus in Central Asia, this project aims, first, to analyze the current developments in the hydroelectricity sector with the help of data, historical references, and the results of the field research. Second, it seeks to provide some useful policy recommendations for the stakeholders. The subject is limited to hydropower and its relations with energy-environment nexus from the perspectives of international politics, hydro-diplomacy, and international political economy.

3. The research question and methodology

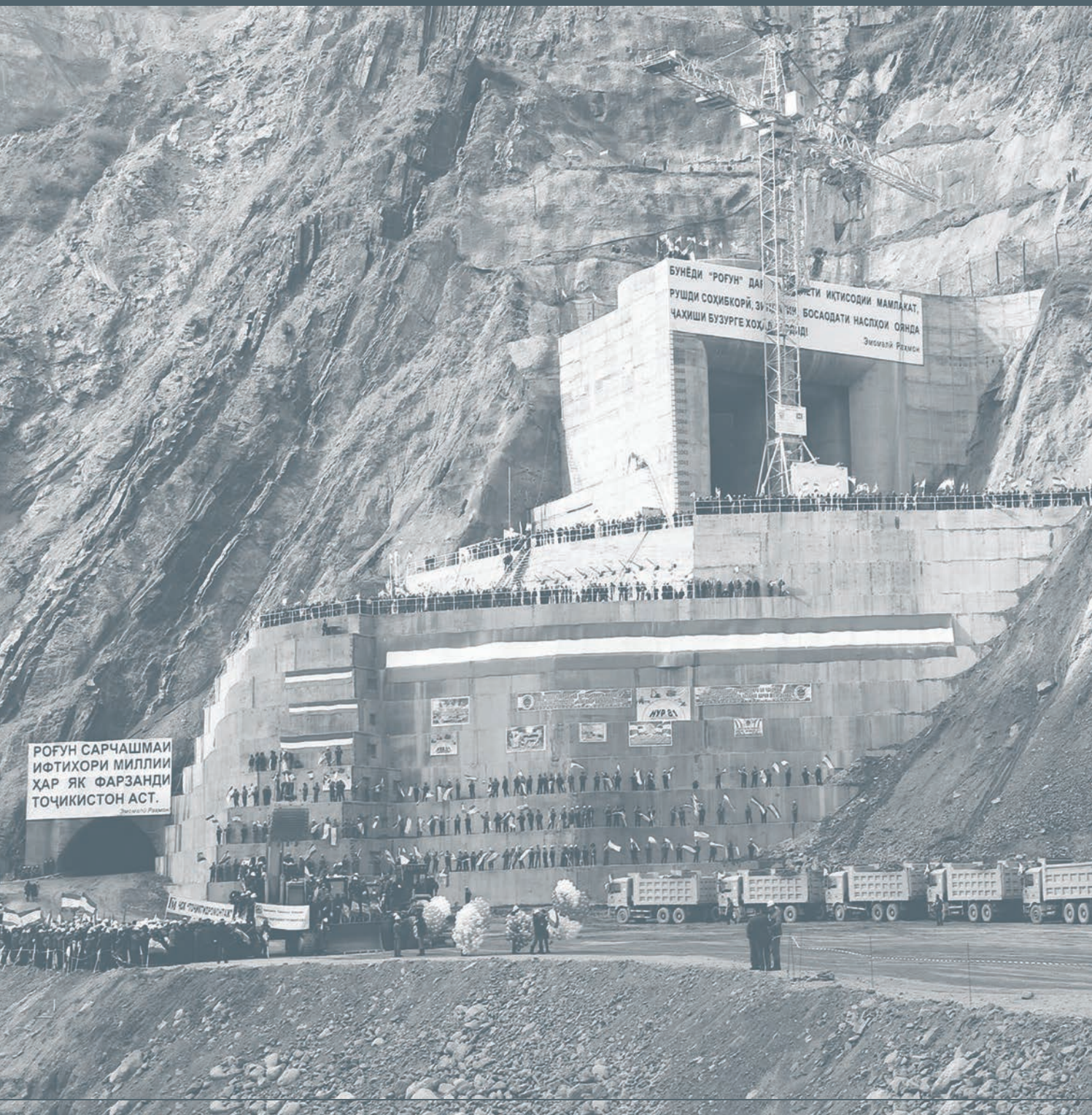
3. The research question and methodology

This study aims to develop a convincing answer to the following question: "What are the impacts of the development of the hydroelectricity sector on the environment and energy nexus in the Aral Sea basin in Central Asia?"

Within the scope of the project, a comprehensive and far-reaching desk study and a field research were conducted. The central part of the field research was held in Almaty, Kazakhstan between 16-22 May 2017. Due to the relatively tight schedule of the field research, the experts in the institutions in Almaty were interviewed face-to-face. Other interviews were conducted online. The researchers interviewed both face-to-face and through online distance interviews with experts and policymakers from inside and outside of the region on wide-ranging topics throughout May 2017.

The interviewees are selected from think-tanks, academia, international organizations, governmental bodies, and advisors to policy-makers. The interviewees are from the following institutions: The Regional Environmental Centre for Central Asia (CAREC), the Kazakh Research Institute of Soil Science and Agro Chemistry Named After U.U. Uspanov, the Institute of World Economics and Politics under the Foundation of the First President of the Republic of Kazakhstan-The Leader of the Nation, the Kazakh-German University, the International Fund for Saving the Aral Sea, the Al-Farabi Kazakh National University, the Eurasian Research Institute of the Khoca Akhmet Yasawi International Turkish-Kazakh University. A full list of the interviewees and their areas of expertise are provided in the Bibliography of this report.

4. The state of art in the study of the environment and energy nexus



4. The state of art in the study of the environment and energy nexus

In the 2010s, some historical developments in water and energy sectors were on the agenda of the developed and the developing countries. While in the US, discussions are on the undamming of national rivers,[4] other nations intensified efforts on building dams and reservoirs. The Ethiopian government initiated the famous Great Renaissance Dam in 2011; [5] Turkey kicked off numerous grand projects in the underexploited northeastern regions of the country, China accomplished the controversial Three Gorges Dam in 2012 and currently possesses the largest hydropower generating capacity in the world in a particular dam. The country has recently focused on the upstream Mekong river basin to boost its hydroelectricity generation capacity.[6]

Parallel to this general global trend, with the involvement of the international development agencies and foreign investors, Central Asian countries developed major hydropower projects. As an example, the Rogun Dam project began officially in late 2016,[7] and the Kyrgyz government launched test drills for yet another giant venture, the second phase of the massive Kambarata project, in 2013.

All these development projects and water management schemes are, in one way or another, related to political and economic decision-making processes and refer to the theoretical approaches in the relevant literature. As some scholars argue, the water, environment and energy issues cannot be understood until the local and international politics is entirely and sufficiently explained.[8] From the political economy perspective embraced in this study, water is a means for politics as it is the essential input for high-yield agricultural activity and industrial production. In addition, water is the main source of hydroelectricity generation, which is usually seen as the fastest, primary, and sometimes only, driver of the early stage development, in particular for the developing world. This is often referred to as the "hydraulic mission."[9] The main sponsor of the hydraulic mission on the global scene has been the developed economies of the world.

The approaches to water issues in the literature are classified differently by various authors. Selby, for instance, distinguishes three types of rhetoric,[10] while Homer-Dixon classifies the relevant literature in two parts.[11] According to Selby, ecologist, technical and political explanations are made in the literature for explaining the relationship between water scarcity and conflict. The historical materialist analysis of Selby argues that neither of three approaches has explanatory power for the phenomenon of water conflict in a separate manner, a holistic

4 E. Stanley, M. Luebke, M. Doyle & D. Marshall, "Short-term changes in channel form and macroinvertebrate communities following low-head dam removal," Journal of the North American Benthological Society, vol. 21, no. 1, 2002.

5 Ayman Batisha, "Sustainability assessment in transboundary context: Grand Ethiopian Renaissance Dam," Model. Earth Syst. Environ, vol. 36, no. 1, 2015.

6 International Centre for Environmental Management, *Strategic Environmental Assessment of Hydropower on the Mekong Mainstream: Summary of the Final Report*, MRC, 2010.

7 Lea Melnikovová, Bohumil Havrland & Radim Valenčík, "Rogun – Hydropower Generating Controversy in Central Asia," *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 62, no. 6, 2015.

8 Jeroen Warner & Mark Zeitoun, "International Relations Theory and Water Do Mix: A Response to Furlong's Troubled Waters, Hydro-Hegemony and International Water Relations," Political Geography, vol. 27, 2008, p.802.

9 F. Molle, P.P. Mollinga & P. Wester, "Hydraulic Bureaucracies and the Hydraulic Mission: Flows of Water, Flows of Power," *Water Alternatives*, vol. 2, no. 3, 2009; J. Allan, "IWRM: The New Sanctioned Discourse?," in P.P. Mollinga, A. Dixit & K. Athukorala, eds. *Integrated Water Resources Management : Global Theory, Emerging Practice and Local Needs*, 2006.

10 Jan Selby, Water, Power and Politics in the Middle East The Other Israeli–Palestinian Conflict (London & New York: I.B. Tauris, 2003).

11 Thomas Homer-Dixon, "On the Threshold: Environmental Changes as Causes of Acute Conflict," International Security, vol. 16, no. 2, 1991.

and historical approach should, therefore, be embraced. He associates the ecologist view with Malthusian or neo-Malthusian perspectives. Homer-Dixon, on the other hand, associates neo-Malthusians with pessimistic political scientists and classifies optimistic-idealist approaches as "cornucopians." According to him, cornucopians may be right in the past, but in the future, the arguments of the neo-Malthusians are more compelling.[12]

In this report, the literature is classified into three groups. These are the realism-inspired conflict approach, institutionalism-inspired cooperation approach, and the nexus approach, along with critical approaches to all these perspectives.

4.1 Conflict based approaches

The first approach to be analyzed here is the conflict-based nation-state-centric approach to the control of the natural resources and the solution to the environmental problems. This approach is inspired by realism[13] in theoretical IR studies. In parallel, the "water and conflict" literature is a reflection of the realist assumptions in the literature[14] by taking the state power as the central concept. In general terms, this approach investigates the impact of power on environmental and resource management problems and the interests of the states therein.

In the journalistic accounts, the concept of "water wars" became quite popular, although this idea became subject to severe criticism in the academia. On the other hand, the conflict approach has been quite popular in the literature and on the global scene. The former Egyptian Foreign Minister and former Secretary-General of the UN, Boutros Boutros Ghali argued that the next war in the Middle East will be fought over water.[15] Bulloch and Darwish have argued that the Jordan river water was one of the main causes of the 1967 war between Israel and the Arab states.[16] Homer-Dixon and Ehrlich et al. have been one among the most famous proponents of the Malthusian idea that the scarcity of natural resources may lead to social conflicts, particularly in the developing countries.[17]

Zeitoun and Warner accept that water wars have not been the case in world politics, but the authors emphasize that in a riparian relationship, "the absence of war does not mean the absence of conflict."[18] According to Gleick, the rivalry on the scarce resources, such as water, can be a reason for, or a significant catalyzer to, the armed dispute between countries.[19] The author gives four characteristics of water that would make it "a source of strategic rivalry." These are: "the degree of scarcity [of water], the extent to which the water supply is shared by more than one region or state, the relative power of the basin states, and the ease of access

12 Thomas Homer-Dixon, "On the Threshold: Environmental Changes as Causes of Acute Conflict," International Security, vol. 16, no. 2, 1991.

13 As a very simple summary, the realist school of IR is based on the assumptions on human nature, which is selfish, driven by power and self-interest. In parallel, world politics is based on states as rational actors, which pursue their national interest in an anarchical world order. See: Hans Morgenthau, Politics Among Nations (New York: Knopf, 1950). The neorealist school carries the debate to the system-level and embraces a structural and positivist discourse. See: Kenneth Waltz, Theory of International Politics (Long Grove: Waveland Press, 2010).

14 Anton Du Plessis, "Charting the Course of the Water Discourse Through the Fog of International Relations Theory," in H. Solomon & A. Turton, eds. Water Wars : Enduring Myth or Impending Reality, 2000, pp.21-22.

15 BBC, "Talking Point: Ask Boutros Boutros Ghali," BBC News, 2003, available at: http://news.bbc.co.uk/2/hi/talking_point/2951028.stm (accessed 23 September 2017).

16 John Bulloch & Adel Darwish, Water Wars: Coming Conflicts in the Middle East (London: Victor Gollancz, 1993).

17 Thomas Homer-Dixon, Environment, Scarcity, and Violence (Princeton: Princeton University Press, 1999); Paul Ehrlich, Anne Ehrlich & John Holdren, Ecoscience: Population, Resources, Development (San Fransisco: Freeman, 1977).

18 Mark Zeitoun & Jeroen Warner, "Hydro-hegemony: A Framework for Analysis of Trans-Boundary Water Conflicts," Water Policy, vol. 8, no. 5, 2006, p.437.

19 Peter Gleick, "Water and Conflict: Fresh Water Resources and International Security," International Security, vol. 18, no. 1, 1993, p.83 and 84.

to alternative fresh water sources."[20] On the other hand, Earle, Jägerskog, and Öjendal assert that water-related disputes may be observed throughout the history, yet these seldom turn into deeper struggles. [21]

Some studies were devoted to generating methodologies for diagnosing the nature of the political relations between states that depend on resource management, i.e. whether these relationships are conflictual or cooperative. Methodologically, the most widely used analytical tools are scales that measure the level of conflict or cooperation in a river basin. Some examples are Water Event Intensity Scale[22] developed upon the Basins at Risk Project, Stages of Conflict Development developed by NATO in 1999, and Transboundary Water Interaction Nexus.[23] Numerous academic projects contribute to conflict and cooperation research agenda, along with various institutions, such as Pacific Institute and Oregon State University, and observe water-related conflicts since the 1990s.[24]

Although the conflict literature is dominant and popular, the academia tends to conclude, in general, that scarce shared natural resources, such as transboundary rivers, do not cause war. However, when other political issues are involved with natural resource and energy issues, some hostility may occur. In the words of Warner and Wegerich, "water is the occasion, not the reason, for conflict."[25]

The dominance of the conflict approach is severely challenged by critical scholars such as Selby (especially the scarcity and conflict literature),[26] and the institutionalism based approaches that will be explored further in the following sub-section.

4.2 Cooperation based approaches

While the conflict-centered approach is quite famous, as stated above, most scholars reject the idea of all-out international water wars based on institutional principles and viewpoints.[27] In criticism of the literature on water wars, a research agenda based on institutionalism and cooperation began challenging the former,[28] although less sophisticated than the conflict

20 Peter Gleick, "Water and Conflict: Fresh Water Resources and International Security," International Security, vol. 18, no. 1, 1993, pp.84-85.

21 Anton Earle, Anders Jägerskog & Joakim Öjendal, "Introduction: Setting the Scene for Transboundary Water Management Approaches," in A. Earle, A. Jägerskog & J. Öjendal, eds. Transboundary Water Management: Principles and Practice, 2010, p.2.

22 Shira Yoffe, Aaron Wolf & Mark Giordano, "Conflict and Cooperation over International Freshwater Resources: Indicators of Basins at Risk," JAWRA Journal of the American Water Resources Association, vol. 39, 2003; S. Yoffe et al., "Geography of international water conflict and cooperation: Data sets and applications," Water Resources Research, vol. 40, no. W05S04, 2004.

23 Naho Mirumachi & John Allan, "Revisiting Transboundary Water Governance: Power, Conflict Cooperation and the Political Economy," in Proceedings from CAIWA International Conference on Adaptive and Integrated Water Management: Coping with Scarcity., 2007; Naho Mirumachi & John Allan, "Revisiting Transboundary Water Governance: Power, Conflict Cooperation and the Political Economy," in Proceedings from CAIWA International Conference on Adaptive and Integrated Water Management: Coping with Scarcity., 2007.

24 Peter Gleick & Matthew Heberger, "Water and Conflict: Events, Trends, and Analysis (2011-2012)," in P.H. Gleick et al., eds. World's Water Volume 8: The Biennial Report on Freshwater Resources, 2014, p.159; Aaron Wolf, Kerstin Stahl & Marcia Macomber, "Conflict and Cooperation within International River Basins: The Importance of Institutional Capacity," Water Resources Update, vol. 125, no. 2, 2003, p.1.

25 Jeroen Warner & Kai Wegerich, "Is Water Politics? Towards International Water Relations," in K. Wegerich & J. Warner, eds. The Politics of Water: A Survey 1st ed., 2010, p.7.

26 Jan Selby, Water, Power and Politics in the Middle East The Other Israeli–Palestinian Conflict (London & New York: I.B. Tauris, 2003).

27 Filippo Menga, "Reconceptualizing Hegemony: The Circle of Hydro-Hegemony," Water Policy, vol. 18, no. 2, 2016, p.409.

28 Ana Cascão & Mark Zeitoun, "Power, Hegemony and Critical Hydropolitics," in A. Earle, A. Jägerskog & J. Öjendal, eds. Transboundary Water Management: Principles and Practice, 2010, p.29

literature.[29] On the other hand, the mainstream IR institutionalism differs from the institutionalism of the environmental studies. While the former underlines the magnitude of "norm development and diffusion" in the formation of regimes, the latter focuses on "norm enforcement and norm purchase."[30]

The rivalry for controlling scarce resources may foster the likelihood of dispute, yet it brings about openings for collaboration as well.[31] This is only achievable through the contribution of *institutions*.[32] Institutions and regime type are crucial in determining the distribution of natural resources.[33] The cooperation-based approach is based on the presence of interdependence[34] between the stakeholders, which entails a cooperative approach for managing shared natural resources through established regimes, especially water of the transboundary rivers.

The theme of management of the transboundary rivers and its methodology has undergone significant change in the course of history. The concepts transformed from "sustainable development" to "river basin management (RBM)," from "integrated water resources management (IWRM)" to "water governance."[35] One of the primary instances of the cooperative approach to the river basin management was the Tennessee Valley Authority in the US in 1933.[36] The RBM has been in use in advanced regions such as Canada and EU, becoming the base of EU Water Framework Directive embraced in 2000. The RBM is described as "the management of water systems as part of the broader natural environment and about their socio-economic environment."[37] In recent years, the literature was developed towards the concept of the IWRM[38] and the water governance.

According to the Global Water Partnership, IWRM is

> [...] a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.[39]

29 Mark Zeitoun & Naho Mirumachi, "Transboundary Water Interaction I: Reconsidering Conflict and Cooperation," International Environmental Agreements: Politics, Law and Economics, vol. 8, 2008, p.299.

30 Kathryn Furlong, "Hidden Theories, Troubled Waters: International Relations, the 'Territorial Trap', and the Southern African Development Community's Transboundary Waters," Political Geography, vol. 25, no. 4, 2006, p.442.

31 Nils Gleditsch et al., "Conflicts Over Shared Rivers: Resource Scarcity or Fuzzy Boundaries?," Political Geography, vol. 25, no. 4, 2006, p.364.

32 Anton Earle, Anders Jägerskog & Joakim Öjendal, "Introduction: Setting the Scene for Transboundary Water Management Approaches," in A. Earle, A. Jägerskog & J. Öjendal, eds. *Transboundary Water Management: Principles and Practice*, 2010, p.2; Aaron Wolf, Kerstin Stahl & Marcia Macomber, "Conflict and Cooperation within International River Basins: The Importance of Institutional Capacity," *Water Resources Update*, vol. 125, no. 2, 2003, p.3; Theodora-Ismene Gizelis & Amanda Wooden, "Water Resources, Institutions, and Intrastate Conflict," *Political Geography*, vol. 29, no. 8, 2010, p.445.

33 Theodora-Ismene Gizelis & Amanda Wooden, "Water Resources, Institutions, and Intrastate Conflict," *Political Geography*, vol. 29, no. 8, 2010, p.451; Paul Hensel, Sara Mitchell & Thomas Sowers, "Conflict Management of Riparian Disputes," *Political Geography*, vol. 25, no. 4, 2006, p.384 and 388.

34 Robert Keohane & Joseph Nye, *Power and Interdependence* (Boston, MA, 1977).

35 Cecilia Tortajada, "Water Governance: Some Critical Issues," *International Journal of Water Resources Development*, vol. 26, no. 2, 2010, p.313.

36 Animesh Gain, Josselin Rouillard & David Benson, "Can Integrated Water Resources Management Increase Adaptive Capacity to Climate Change Adaptation? A Critical Review," *Journal of Water Resource and Protection*, vol. 5, 2013, p.12.

37 Jen Nelles, "Wet vs Dry: Theorizing a Multilevel Water Framework for Canadian Communities," in *Annual Meeting of the Canadian Political Science Association*., 2008, p.18.

38 See, for example: Asit Biswas, Olli Varis & Cecilia Tortajada, *Integrated Water Resources Management in South and South-East Asia* (New Delhi: Oxford University Press, 2005); Asit Biswas, Benedito Braga, Cecilia Tortajada & Marco Palermo, *Integrated Water Resources Management in Latin America* (Hoboken: Taylor and Francis, 2013).

39 Global Water Partnership, Integrated Water Resources Management, 2000, p.22.

The reports and projects of international organizations usually refer to the well-known concepts of the RBM, the IWRM and more recently the water governance. As some academicians remind, the IWRM approach is a redefinition of a concept first suggested in the 1960s.[40] In the 1990s and the 2000s, it is accepted by the international organizations,[41] including the United Nations.[42] On the international level, it was first on the agenda of the World Summit on Sustainable Development in 2002.[43]

Another popular concept is the water governance. The complexity of water governance is well discussed in the literature.[44] For Tortajada, governance refers to "a complex process that considers multi-level participation beyond the state, where decision-making includes not only public institutions but also the private sector, civil society and society in general."[45] Similarly, water governance embraces "political, economic and social processes and institutions" for the right and fair use, allocation and development of water resources.[46] Some scholars expect that the governance of water will be "more complex than ever before witnessed in human history" because of escalating and cumulative water-related struggles in the coming decades.[47]

4.3 Criticisms of the conflict and cooperation based approaches in the literature

Both the literature on conflict and cooperation are subject to criticism. Arsel and Spoor argue that both are deterministic approaches and have their restraints.[48] According to Cascão and Zeitoun, "water-conflict" and "water-security" are "major forms of bias in the hydropolitics literature." The subject should be approached from a perspective which sees hydropolitics as a "dynamic and ongoing process involving several other dynamics – notably society, environment, and culture."[49] The authors make a classification in terms of interaction over transboundary waters. According to the authors (and other authors as well),[50] conflict and cooperation often coexist.[51]

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40 Mark Giordano & Tushaar Shah, "From IWRM back to Integrated Water Resources Management," *International Journal of Water Resources Development*, vol. 30, no. 3, 2014, p.364; Asit Biswas, "Integrated Water Resources Management: Is It Working?," *International Journal of Water Resources Development*, vol. 24, no. 1, 2008.

41 Asit Biswas, "Integrated Water Resources Management: Is It Working?," *International Journal of Water Resources Development*, vol. 24, no. 1, 2008, p.7.

42 Mark Giordano & Tushaar Shah, "From IWRM back to Integrated Water Resources Management," *International Journal of Water Resources Development*, vol. 30, no. 3, 2014, p.364.

43 Peter Rogers & Alan Hall, Global Water Partnership/Swedish International Development Agency, 2003, available at: http://dlc.dlib.indiana.edu/dlc/handle/10535/4995 (accessed 10 September 2016), p.16.

44 Nicole Kranz, Antje Vorwerk & Rodrigo Vidaurre, "Towards Adaptive Water Governance: Observations from Two Transboundary River Basins," in *International Conference on Adaptive and Integrated Water Management (CAIWA), 12-15 November 2007*., 2007.

45 Cecilia Tortajada, "Water Governance: Some Critical Issues," *International Journal of Water Resources Development*, vol. 26, no. 2, 2010, p.298.

46 Cecilia Tortajada, "Water Governance: Some Critical Issues," *International Journal of Water Resources Development*, vol. 26, no. 2, 2010, p.299.

47 Asit Biswas & Cecilia Tortajada, "Future Water Governance: Problems and Perspectives," *International Journal of Water Resources Development*, vol. 26, no. 2, 2010, p.130.

48 Mark Zeitoun & Jeroen Warner, "Hydro-hegemony: A Framework for Analysis of Trans-Boundary Water Conflicts," *Water Policy*, vol. 8, no. 5, 2006; Murat Arsel & Max Spoor, "Follow the Water," in M. Arsel & M. Spoor, eds. *Water, environmental security and sustainable rural development: conflict and cooperation in Central Eurasia*, 2010, p.10.

49 Ana Cascão & Mark Zeitoun, "Power, Hegemony and Critical Hydropolitics," in A. Earle, A. Jägerskog & J. Öjendal, eds. *Transboundary Water Management: Principles and Practice*, 2010, p.29.

50 See: Anders Jägerskog, *Water Security: Origin and Foundations* (Los Angeles: Sage, 2015), p.xxvi; Mark Zeitoun & Naho Mirumachi, "Transboundary Water Interaction I: Reconsidering Conflict and Cooperation," *International Environmental Agreements: Politics, Law and Economics*, vol. 8, 2008.

51 Ana Cascão & Mark Zeitoun, "Power, Hegemony and Critical Hydropolitics," in A. Earle, A. Jägerskog & J. Öjendal, eds. *Transboundary Water Management: Principles and Practice*, 2010, pp.31-32.

A significant problem of the global water governance approaches is that they were established long ago and are in need of urgent updates. Cooley et al. argue that intergovernmental organizations need leadership and coordination to achieve efficient water governance performance globally. Under the umbrella of the United Nations, various bodies deal with the water issues. The United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), the United Nations International Children's Emergency Fund (UNICEF), the United Nations Development Programme (UNDP), the Food and Agriculture Organization (FAO), the World Health Organization (WHO), the World Meteorological Organization (WMO) are examples. Media, NGOs, academia, and corporations also play important roles in developing new and advanced approaches.[52]

As stated above, the problem-solving strategies[53] of the IWRM and water governance were designed for the economically advanced parts of the world, such as the US and the EU, where it functions correctly. A major setback here is the underlying assumption that the water, energy, and environmental problems are similar in all the basins in the world and the principles of the IWRM should apply to all transboundary basins.[54] This is why the international organizations and donors endeavor to integrate the people in the developing world into the IWRM programs.[55] These approaches may not generate the expected outcomes in some parts of the world,[56] including Central Asia, where almost all of the five Central Asian countries have their priorities for water management. Before going into more detail about the current water management schemes and their setbacks in the fifth section, the nexus approach embraced by the authors of the report will be summarized in the following sub-section.

4.4 The nexus approach

This study suggests that the solution to the water, energy, and environmental problems should be based on a nexus approach. There is an abundant literature on various links between water and energy,[57] together with the environment,[58] pollution,[59] climate change,[60] ag-

52 Heather Cooley et al., "Global Water Governance in the Twenty-First Century," in Peter Gleick et al. *The World's Water*, 2014, pp.7-8.

53 Jan Selby, *Water, Power and Politics in the Middle East The Other Israeli–Palestinian Conflict* (London & New York: I.B. Tauris, 2003), p.12.

54 For some remarks on the inefficiencies in water project design and operation processes in the developing world and on the importance of local knowledge, see: Charles Howe & John Dixon, "Inefficiencies in water project design and operation in the third world: An economic perspective," *Water Resources Research*, vol. 29, no. 7, 1993.

55 See, for a critical approach to the donor and international organization behavior: François Molle, "Why Enough Is Never Enough: The Societal Determinants of River Basin Closure," *International Journal of Water Resources Development*, vol. 24, no. 2, 2008.

56 J. Allan, "IWRM: The New Sanctioned Discourse?," in P.P. Mollinga, A. Dixit & K. Athukorala, eds. *Integrated Water Resources Management : Global Theory, Emerging Practice and Local Needs*, 2006, p.39.

57 Karen Hussey, "Interconnecting the water and energy cycles: identifying and exploiting the synergies," 2010; Apoorva Santhosh, Amro Farid & Kamal Youcef-Toumi, "Real-time economic dispatch for the supply side of the energy-water nexus," *Applied Energy*, vol. 122, 2014; M.R. Talebpour, O. Sahin, R. Siems & R.A. Stewart, "Water and energy nexus of residential rainwater tanks at an end use level: Case of Australia," *Energy and Buildings*, vol. 80, 2014.

58 World Bank, High and Dry: Climate Change, Water, and the Economy, World Bank, 2016.

59 Prashant Kumar & Devendra Saroj, "Water–Energy–Pollution Nexus for Growing Cities," Urban Climate, vol. 10, no. 5, 2014; Sudeep Nair, et al., "Water–energy–greenhouse gas nexus of urban water systems: Review of concepts, state-of-art and methods," Resources, Conservation and Recycling, vol. 89, 2014; Brian Tarroja, et al., "Evaluating options for balancing the water–electricity nexus in California: Part 2—Greenhouse gas and renewable energy utilization impacts," Science of the Total Environment, vol. 497-498, 2014.

60 M. Welsch et al., "Adding Value with CLEWS – Modelling the Energy System and its Interdependencies for Mauritius," *Applied Energy*, vol. 113, 2014; Michael Beck & Rodrigo Villarroel Walker, "On Water Security, Sustainability, and the Water-Food-Energy-Climate Nexus," *Frontiers of Environmental Science & Engineering*, vol. 7, no. 5, 2013; Mark Howells, et al., "Integrated analysis of climate change, land-use, energy and water strategies," *Nature Climate Change*, vol. 3, no. 7, 2013.

riculture (or food),[61] and similar issues that together contribute a system, a complex, or a nexus. More recently, the efforts for quantifying the nexus have gained pace.[62] Also, the relationship of the nexus with climate change is being researched by an increasing number of scholars.[63] Endo et al. have finalized a comprehensive literature research on the current status of the nexus approach in seven regions of the world.[64]

The recently popular nexus approach has been a less studied or ignored subject until the 1980s.[65] The nexus became popular at the UN Conference on Environment and Development in Rio de Janeiro in 1992 with the discussions on "development versus environment." But the IWRM approach became widely accepted on the international level, instead of the nexus approach.[66] In parallel to the criticisms to the IWRM, an alternative approach gained prominence that suggests that water and water management issues should be addressed locally, not globally.[67] The necessity of going beyond the resource management discourse made the nexus approach gain impetus in the academia and decision makers in the 2000s.[68]

Various definitions appear for various nexuses in the literature. According to Keskinen et al., water-energy-food nexus is an "analytical tool" for academic research, and a "governance framework" closely related to water management issues discussed above.[69] The nexus approach of governance should rely on "multisectoral" and "multistakeholder processes" on multistate or regional levels.[70] The water-energy nexus is another common approach in the

61 For examples, see: M. Bazilian, et al., "Considering the Energy, Water, and Food Nexus: Towards an Integrated Modelling Approach," *Energy Policy*, vol. 39, no. 12, 2014; Marko Keskinen & Olli Varis, "Water-Energy-Food Nexus in Large Asian River Basins," *Water*, vol. 8, no. 446, 2016; J. Pittock, et al., "Tackling trade-offs in the nexus of water, energy and food," *Aquatic Procedia*, vol. 5, no. World Water Week, 31 August to 5 September 2014, Stockholm, Sweden, 2015; U. Lele, M. Klousia-Marquis & S. Goswami, "Good Governance for Food, Water and Energy Security," in *At the Confluence - Selection from the 2012 World Water Week in Stockholm*., 2013; Richard Lawford et al., "Basin perspectives on the Water–Energy–Food Security Nexus," *Current Opinion in Environmental Sustainability*, vol. 5, no. 6, 2013; Heather Cooley et al., "Global Water Governance in the Twenty-First Century," in Peter Gleick et al. *The World's Water*, 2014, p.5; Marko Keskinen et al., "The Water-Energy-Food Nexus and the Transboundary Context: Insights from Large Asian Rivers," *Water*, vol. 8, no. 5, 2016; Mike Muller, "The 'Nexus' As a Step Back towards a More Coherent Water Resource Management Paradigm," *Water Alternatives*, vol. 8, no. 1, 2015; John Finley & James Seiber, "The Nexus of Food, Energy, and Water," *Journal of Agricultural and Food Chemistry*, vol. 62, 2014; Alex Smajgl, John Ward & Lucie Pluschke, "The Water–Food–Energy Nexus – Realising a New Paradigm," *Journal of Hydrology*, vol. 533, 2016; Eloise Biggs, et al., "Sustainable development and the water–energy–food nexus: A perspective on livelihoods," *Environmental Science & Policy*, vol. 54, 2015; Valeria Laurentiis, Dexter Hunt & Christopher Rogers, "Overcoming Food Security Challenges within an Energy/Water/Food Nexus (EWFN) Approach," *Sustainability*, vol. 8, no. 95, 2016. For a set of methodological suggestions, see: Lucia Strasser, et al., "A Methodology to Assess the Water Energy Food Ecosystems Nexus in Transboundary River Basins," *Water*, vol. 8, no. 59, 2016; Bassel Daher & Rabi Mohtar, "Water–energy–food (WEF) Nexus Tool 2.0: guiding integrative resource planning and decision-making," *Water International*, vol. 40, no. 5-6, 2015.

62 Yuan Chang, et al., "Quantifying the Water-Energy-Food Nexus: Current Status and Trends," *Energies*, vol. 9, no. 65, 2016; Aiko Endo, et al., "Methods of the Water-Energy-Food Nexus," *Water*, vol. 7, 2015.

63 Golam Rasul & Bikash Sharma, "The nexus approach to water–energy–food security: an option for adaptation to climate change," *Climate Policy*, vol. 16, no. 6, 2016.

64 Aiko Endo, Izumi Tsurita, Kimberly Burnett & Pedcris Orencio, "A review of the current state of research on the water, energy, and food nexus," *Journal of Hydrology: Regional Studies*, 2015.

65 Heather Cooley et al., "Global Water Governance in the Twenty-First Century," in Peter Gleick et al. *The World's Water*, 2014, p.5; Rebecca Dodder, "A Review of Water Use in the U.S. Electric Power Sector: Insights from Systems-Level Perspectives," *Current Opinion in Chemical Engineering*, vol. 5, 2014, p.7; Tony Allan, Martin Keulertz & Eckart Woertz, "The Water–Food–Energy Nexus: An Introduction to Nexus Concepts and Some Conceptual and Operational Problems," *International Journal of Water Resources Development*, vol. 31, no. 3, 2015, p.309.

66 Mike Muller, "The 'Nexus' As a Step Back towards a More Coherent Water Resource Management Paradigm," *Water Alternatives*, vol. 8, no. 1, 2015, p.675.

67 Mike Muller, "The 'Nexus' As a Step Back towards a More Coherent Water Resource Management Paradigm," *Water Alternatives*, vol. 8, no. 1, 2015, p.689.

68 Hayley Leck, Declan Conway, Michael Bradshaw & Judith Rees, "Tracing the Water–Energy–Food Nexus: Description, Theory and Practice," *Geography Compass*, vol. 9, no. 8, 2015, p.447.

69 Marko Keskinen et al., "The Water-Energy-Food Nexus and the Transboundary Context: Insights from Large Asian Rivers," *Water*, vol. 8, no. 5, 2016.

70 Marko Keskinen et al., "The Water-Energy-Food Nexus and the Transboundary Context: Insights from Large Asian

literature.[71] This gained prominence at the end of the century, and Gleick first conceptualized it in 1994.[72] The water-energy nexus emphasizes on system-level[73] that water and energy depend on each other. Energy is required to capture,[74] pump, transfer and treat water. Water, on the other hand, is consumed for mining, hydraulic fracturing,[75] refining oil and gas,[76] power plant cooling and hydroelectricity generation.[77] Further interdependencies may be counted: agriculture is a significant user of water. The agriculture sector is responsible for almost 70 percent of all consumptive freshwater withdrawals globally. Energy is also a major input for agricultural production.[78]

A remarkable peculiarity here is the difference between the concepts of withdrawal, use, and consumption of water.[79] Water withdrawal is defined as "any water diverted from a surface or groundwater source."[80] Water consumption refers to the water that does not return to its source, because of evaporation, transpiration by plants, incorporation into products, transfer to a different catchment area or the sea or withhold and release at various periods of the season.[81]

Outdated thermoelectric power plants use massive volumes of water for cooling systems, for generating steam to drive turbines and to run "environmental control systems."[82] Some

Rivers," *Water*, vol. 8, no. 5, 2016, p.14.

71 See, for example: Lucy Allen, Michael Cohen, David Abelson & Bart Miller, "Fossil Fuels and Water Quality," in Peter Gleick et al. *The World's Water*, 2014; Frank Ackerman & Jeremy Fisher, "Is There a Water-Energy Nexus in Electricity Generation? Long-term Scenarios for the Western United States," *Energy Policy*, vol. 59, 2013; Asit Biswas, "Integrated Water Resources Management: Is It Working?," *International Journal of Water Resources Development*, vol. 24, no. 1, 2008; Karen Hussey & Jamie Pittock, "The Energy–Water Nexus: Managing the Links between Energy and Water for a Sustainable Future," *Ecology and Society*, vol. 17, no. 1, 2012; Benjamin Sovacool & Kelly Sovacool, "Identifying Future Electricity–Water Tradeoffs in the United States," *Energy Policy*, vol. 37, no. 7, 2009; Lu Liu et al., "Water Demands for Electricity Generation in the U.S.: Modeling Different Scenarios for the Water–Energy Nexus," *Technological Forecasting and Social Change*, vol. 94, 2015; Brendan Walsh, Sean Murray & D.T.J. O'Sullivan, "The Water Energy Nexus, An ISO50001 Water Case Study and the Need for a Water Value System," *Water Resources and Industry*, vol. 10, 2015; Arjen Hoekstra & Mesfin Mekonnen, "The Water Footprint of Humanity," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 109, no. 9, 2012; Robert Holland et al., "Global Impacts of Energy Demand on the Freshwater Resources of Nations," *Proceedings of the National Academy of Sciences of the United States of America*, 2015; Afreen Siddiqi & Laura Anadon, "The Water–Energy Nexus in Middle East and North Africa," vol. 39, no. 8, 2011.

72 Rebecca Dodder, "A Review of Water Use in the U.S. Electric Power Sector: Insights from Systems-Level Perspectives," *Current Opinion in Chemical Engineering*, vol. 5, 2014, p.7.

73 Rebecca Dodder, "A Review of Water Use in the U.S. Electric Power Sector: Insights from Systems-Level Perspectives," *Current Opinion in Chemical Engineering*, vol. 5, 2014, p.7.

74 Heather Cooley et al., "Global Water Governance in the Twenty-First Century," in Peter Gleick et al. *The World's Water*, 2014, p.6.

75 Heather Cooley & Kristina Donnelly, "Hydraulic Fracturing and Water Resources," in Peter Gleick, et al. *The World's Water*, 2014.

76 Louis Otts, *Water requirements of the petroleum refining industry* (Washington, DC: US Government Printing Office, 1963).

77 Karen Hussey & Jamie Pittock, "The Energy–Water Nexus: Managing the Links between Energy and Water for a Sustainable Future," *Ecology and Society*, vol. 17, no. 1, 2012.

78 Heather Cooley et al., "Global Water Governance in the Twenty-First Century," in Peter Gleick et al. *The World's Water*, 2014, p.5.

79 May Wu, Marianne Mintz, Michael Wang & Salil Arora, *Consumptive Water Use in the Production of Bioethanol and Petroleum Gasoline*, Center for Transportation Research, 2008.

80 Lu Liu et al., "Water Demands for Electricity Generation in the U.S.: Modeling Different Scenarios for the Water–Energy Nexus," *Technological Forecasting and Social Change*, vol. 94, 2015, p.319; US Department of Energy, *The Water-Energy Nexus: Challenges and Opportunities*, 2014, available at: http://energy.gov/sites/prod/files/2014/07/f17/Water%20Energy%20Nexus%20Full%20Report%20July%202014.pdf; Rebecca Dodder, "A Review of Water Use in the U.S. Electric Power Sector: Insights from Systems-Level Perspectives," *Current Opinion in Chemical Engineering*, vol. 5, 2014, p.8.

81 Arjen Hoekstra, Ashok Chapagain, Maite Aldaya & Mesfin Mekonnen, *The Water Footprint Assessment Manual: Setting the Global Standard* (London, Washington DC: Earthscan, 2011), p.24.

82 Rebecca Dodder, "A Review of Water Use in the U.S. Electric Power Sector: Insights from Systems-Level Perspectives," *Current Opinion in Chemical Engineering*, vol. 5, 2014, p.8. See also: Bevan Grifiths-Sattenspiel, *Water~Energy Toolkit: Understanding the Carbon Footprint of Your Water Use*, River Network, 2010; International Energy Agency, *Water for Energy: Is Energy Becoming a Thirstier Resource?*, 2012; United Nations, *Water and Energy*, UN Water, 2014.

power plants constructed in the mid-twentieth century to 1970s use a technology which extracts water from the source and returns it at a higher temperature. More updated systems use the same water several times. During this process, evaporative consumption is greater, while water withdrawal is less in comparison to once-through systems.[83] Renewable electricity generation, including hydroelectricity, also consumes water. But the consumptive water use appraisals vary notably. One reason for this is that most calculations ignore evaporation at big reservoirs. In the US, the estimates range from 0 to 18,000 gallons of water per MWh of hydroelectricity.[84]

An approach for measuring the water consumption while completing a process is "water footprint" approach. Worldwide, agricultural activities bear the highest percent of water footprint (92 percent), while the shares of industry and domestic uses are 4.4 and 3.6 percent, respectively.[85] On the global scale, electricity generation consumes 6.5 cubic kilometers of freshwater per year. The oil and gas sectors consume 1.6 and 0.3 cubic kilometers, respectively.[86] According to the estimates of the International Energy Agency, between 2010 and 2035, freshwater consumption will likely be increased by 85 percent.[87] The high amount of water used in the lifecycle of energy (oil, electricity, bio-energy) raises the issues of sustainable water and energy production, water degradation and pollution, and ecosystem damage.[88]

Regarding energy and environment nexus, agricultural water withdrawal is an essential element.[89] As of 2014, agriculture uses 70 percent of all freshwater withdrawn in the world. As a general observation, it can be stated that the Central Asian republics, Uzbekistan, Turkmenistan, Kyrgyzstan, and Tajikistan are serious water users. They consume over 90 percent of their freshwater resources for agricultural processes.[90]

4.5 The nexus and politics

Some authors observed that energy, environment, and water policies are often modeled unconnectedly.[91] Strategies to develop one sector generate burdens on other interdependent sectors.[92] This is valid, especially for developing nations. There is a close relationship

83 Rebecca Dodder, "A Review of Water Use in the U.S. Electric Power Sector: Insights from Systems-Level Perspectives," *Current Opinion in Chemical Engineering*, vol. 5, 2014, p.8.

84 Rebecca Dodder, "A Review of Water Use in the U.S. Electric Power Sector: Insights from Systems-Level Perspectives," *Current Opinion in Chemical Engineering*, vol. 5, 2014, p.11.

85 Arjen Hoekstra & Mesfin Mekonnen, "The Water Footprint of Humanity," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 109, no. 9, 2012, p.3233; Robert Holland et al., "Global Impacts of Energy Demand on the Freshwater Resources of Nations," *Proceedings of the National Academy of Sciences of the United States of America*, 2015, p.E6708. For a comprehensive assessment of the water footprint, see: Arjen Hoekstra, Ashok Chapagain, Mesfin Mekonnen & Maite Aldaya, *The water footprint assessment manual: Setting the global standard* (London, Washington, DC: Earthscan, 2012).

86 Robert Holland et al., "Global Impacts of Energy Demand on the Freshwater Resources of Nations," *Proceedings of the National Academy of Sciences of the United States of America*, 2015, p.E6708.

87 Robert Holland et al., "Global Impacts of Energy Demand on the Freshwater Resources of Nations," *Proceedings of the National Academy of Sciences of the United States of America*, 2015, p.E6713.

88 May Wu, Marianne Mintz, Michael Wang & Salil Arora, Consumptive Water Use in the Production of Bioethanol and Petroleum Gasoline, 2008, p.4.

89 The concept of virtual water trade emerges from agricultural water use and exports of the agricultural products. See: A. Hoekstra & P. Hung, "Globalisation of water resources: international virtual water flows in relation to crop trade," *Global Environmental Change*, vol. 15, 2005.

90 World Bank, "World Development Indicators," *The World Bank Databank*, 2017, available at: http://data.worldbank.org (accessed 31 January 2017).

91 Karen Hussey & Jamie Pittock, "The Energy–Water Nexus: Managing the Links between Energy and Water for a Sustainable Future," *Ecology and Society*, vol. 17, no. 1, 2012.

92 Karen Hussey & Jamie Pittock, "The Energy–Water Nexus: Managing the Links between Energy and Water for a Sustainable Future," *Ecology and Society*, vol. 17, no. 1, 2012.

between the nexus approach and international political economy,[93] like Allan, Keulertz, and Woertz emphasize. According to the authors, the political economy is usually "dominated by market mechanisms" that may have damaging impacts on the nexus.[94] This is also valid while utilizing water and energy, as people somehow cause an impact on climate and environment during the consumption process.[95]

Quite recently, climate change has been accepted in the policymaking circles as a threat to the economy. In that respect, Welsch et al. highlight the significance of climate change in assessing the nexus, the importance of which would further increase with the increasing demand for hydroelectricity, especially in the developing economies.[96] A report of the World Bank indicates that water scarcity and climate change may lead to a decrease in national incomes up to 6 percent by 2050. Adverse impacts of water shortages and climate change may be reversed with better water and environment policies,[97] according to the World Bank.

Similar to the water and conflict, the IWRM, and the resource governance literature, the nexus approach has also been subject to criticism. For instance, Leese and Meisch assert that the nexus approaches are influenced by the neoliberal discourse and are highly "securitized." This means that the agenda in the literature on the water, environment and energy nexus has altered from the concentration on "distributional justice" towards supply security of water and energy for the proper functioning of economies. The authors argue that the topic of sustainability is seen as an "imminent threat that legitimizes urgent action."[98]

A major criticism of the nexus approach is that it is too water-centric. A more balanced among the sectors and a more dynamic nexus approach is needed.[99] Therefore, this study suggests an approach based on energy and environment nexus to solve the regional problems of environment and energy requirements of the people in the Aral Sea basin.

Some researchers try to merge the nexus approach with the IWRM approach. Benson et al. argue that the primary concerns and goals of both the IWRM and the nexus approach coincide to a significant degree. The IWRM, on the other hand, has been dominant as international bodies adopted it as a direction for development.[100]

4.6 Hydroelectricity and the Nexus

Electricity trade and interconnections between regions have a significant influence on the global political economy of energy and the nexus. Hydroelectricity is an essential element

93 See: Kathleen Hancock & Vlado Vivoda, "International political economy: a field born of the OPEC crisis returns to its energy roots," *Energy Research & Social Science*, vol. 1, 2014; Frans Koch, "Hydropower—the politics of water and energy: Introduction and overview," *Energy Policy*, vol. 30, 2002.

94 Tony Allan, Martin Keulertz & Eckart Woertz, "The Water–Food–Energy Nexus: An Introduction to Nexus Concepts and Some Conceptual and Operational Problems," *International Journal of Water Resources Development*, vol. 31, no. 3, 2015, pp.302-04.

95 Brendan Walsh, Sean Murray & D.T.J. O'Sullivan, "The Water Energy Nexus, An ISO50001 Water Case Study and the Need for a Water Value System," *Water Resources and Industry*, vol. 10, 2015.

96 M. Welsch et al., "Adding Value with CLEWS – Modelling the Energy System and its Interdependencies for Mauritius," *Applied Energy*, vol. 113, 2014, pp.1443-44. See also: Sebastian Hermann, et al., *The CLEW Model – Developing an integrated tool for modelling the interrelated effects of Climate, Land use, Energy, and Water (CLEW)*, 2011.

97 World Bank, High and Dry: Climate Change, Water, and the Economy, World Bank, 2016.

98 Matthias Leese & Simon Meisch, "Securitising Sustainability? Questioning the 'Water, Energy and Food-Security Nexus'," *Water Alternatives*, vol. 8, no. 1, 2015, p.704.

99 Alex Smajgl, John Ward & Lucie Pluschke, "The Water–Food–Energy Nexus – Realising a New Paradigm," *Journal of Hydrology*, vol. 533, 2016.

100 David Benson, Animesh Gain & Josselin Rouillard, "Water Governance in a Comparative Perspective: From IWRM to a 'Nexus' Approach?," *Water Alternatives*, vol. 8, no. 1, 2015.

here.[101] As of 2011, there are more than 58 thousand large dams (higher than 15 meters) registered by the International Commission on Large Dams.[102] This is nearly 50 percent surge in comparison to a quarter century ago when the number of registered large dams was around 39 thousand.[103]

In some parts of the world, hydroelectricity is seen as a potential of boosting economic activity and ensuring growth,[104] especially in hydrocarbon-poor countries. On the other hand, large dams and HPPs may have some damaging impacts for people and environment.[105] First, the large reservoirs behind dams flood suitable land for agriculture. Second, dams have considerable negative impact on the integrity of the river and the riverine ecosystem. As Bakis reminds, a large-size reservoir may transform a terrestrial ecosystem into an aquatic one.[106]

Therefore, the environmental concerns must be taken into consideration while supplying people with energy and electricity.[107] This is valid, especially for large dams and HPPs. In general, there is a trend of not involving HPPs with large reservoirs among renewable energy sources.[108] After the environmental necessities are wholly or mostly met during the generation process of electricity, the benefits of integrating renewable power production schemes with demand centers have the potential of providing numerous benefits both for the economic development and the environment.

4.7 The interconnections

One of the main policy recommendations of this study is regional cooperation in electricity sector through an integrated electricity market and a common pool.[109] The transfer of power from one location to another is the key factor here. "A cable or overhead line connecting two separate market or pricing areas" is known as an interconnector.[110] An interconnector can be in alternating current and direct current, where the former can only be used between synchronous frequency systems.[111]

Electricity integration can be on various levels.[112] For Europe and North America, a highly in-

101 For a history of the development of hydroelectricity, see: Engelbertus Oud, "The evolving context for hydropower development," *Energy Policy*, vol. 30, 2002.

102 International Commission on Large Dams, "General Synthesis," *CIGB/ICOLD*, 2011, available at: www.icold-cigb.org (accessed 20 December 2016).

103 Gregory Morris & Jiahua Fan, *Reservoir Sedimentation Handbook: Design and Management of Dams: Reservoirs, and Watersheds for Sustainable Use* (New York: McGraw-Hill, 1997), p.2.5.

104 Alison Bartle, "Hydropower Potential and Development Activities," *Energy Policy*, vol. 30, 2002, pp.1232-35.

105 For a comprehensive analysis in two volumes, see: Berga, L. et al., eds., *Dams and Reservoirs, Societies and Environment in the 21st Century, Two Volume Set: Proceedings of the International Symposium on Dams in the Societies of the 21st Century, 22nd International Congress on Large Dams (ICOLD)* (Barcelona, Spain: CRC Press, 2006). For an analysis of costs and benefits of dam construction, see: P. Brown, et al., "Modeling the costs and benefits of dam construction from a multidisciplinary perspective," *Journal of environmental management*, vol. 90, 2009. See also: Daming He, et al., "Transboundary hydrological effects of hydropower dam construction on the Lancang River," *Chinese Science Bulletin*, vol. 51, no. 22, 2006; Timo Karjalainen & Timo Järvikoski, "Negotiating river ecosystems: Impact assessment and conflict mediation in the cases of hydro-power construction," *Environmental Impact Assessment Review*, vol. 30, no. 5, 2010.

106 R. Bakis, "The Current Status and Future Opportunities of Hydroelectricity," *Energy Sources, Part B: Economics, Planning, and Policy*, vol. 2, no. 3, 2007, p.262.

107 Dominique Egré & Joseph Milewski, "The diversity of hydropower projects," *Energy Policy*, vol. 30, no. 14, 2002.

108 Gary Frey & Deborah Linke, "Hydropower as a renewable and sustainable energy resource meeting global energy challenges in a reasonable way," *Energy policy*, vol. 30, no. 14, 2002.

109 For a critical analysis based on economic theory, see: Etienne de Villemeur & Pierre-Olivier Pineau., "Regulation and electricity market integration: When trade introduces inefficiencies," *Energy Economics*, vol. 34, no. 2, 2012.

110 Ralph Turvey, "Interconnector Economics," *Energy Policy*, vol. 34, 2006, p.1457. For a history of electricity transfer, see: Massimo Guarnieri, "The beginning of electric energy transmission: Part one," *IEEE Industrial Electronics Magazine*, vol. 7, no. 1, 2013; Massimo Guarnieri, "The Beginning of Electric Energy Transmission: Part Two," *IEEE Industrial Electronics Magazine*, vol. 7, no. 2, 2013.

111 Ralph Turvey, "Interconnector Economics," *Energy Policy*, vol. 34, 2006, p.1458.

112 Pierre-Olivier Pineau, Anil Hira & Karl Froschauer, "Measuring international electricity integration: a comparative study

tegrated electricity market is a major policy priority.[113] There is a growing trend, especially in the developing economies, of seeking energy and electricity self-sufficiency.[114] Energy is often regarded as a strategic policy tool, which leads to the establishment of the state-controlled and vertically integrated energy companies. More recently, the electricity distribution companies are being separated and privatized in the developing world.

There are some universal benefits studied in the relevant literature of integrating electricity markets. First, the operation costs are usually reduced through integration. Second, the balance in the integrated power system is essential in cases of peak demands. By involving into an integrated system, the costs of making separate investments[115] for isolated peak demand centers can be reduced.[116] Furthermore, integrated electricity markets reduce the fluctuations in demand structure.[117] Charpentier and Schenk note that the integrated systems provide "emergency support" to the demand centers.[118] The more integrated an electricity network, the more is the diversification of the sources of electricity, in other words, the pooling of resources. Varying sources, such as hydro, nuclear, solar, etc. can be combined to boost energy security from the supply side.[119] This also helps to increase the efficiency in electricity production and cost reduction,[120] and an enhancement in the quality of electricity services provided by the companies. Finally, integrating electricity systems and markets have potential environmental and social benefits.[121]

of the power systems under the Nordic Council, MERCOSUR, and NAFTA," *Energy Policy*, vol. 32, 2004.

113 Rüdiger Kiesel & Michael Kusterman, "Structural models for coupled electricity markets," *Journal of Commodity Markets*, vol. 3, 2016. For a detailed assessment of the US electricity transmission network, see: Matthew Brown & Richard Sedano, *Electricity Transmission: A Primer*, National Council on Electric Policy, 2004. For a critical analysis of the American and European electricity interconnections, see: Adrian Van den Hoven & Karl Froschauer, "Limiting regional electricity sector integration and market reform: the cases of France in the EU and Canada in the NAFTA Region," *Comparative Political Studies*, vol. 37, no. 9, 2004.

114 Manuel Baritaud & Dennis Volk, Seamless Power Markets: Regional Integration of Electricity Markets in IEA Member Countries, International Energy Agency, 2014, pp.22-23.

115 Pierre-Olivier Pineau, Integrating Electricity Sectors in Canada: Good for the Environment and for the Economy, The Federal Idea, 2012, p.5.

116 Global Sustainable Electricity Partnership, *Guidelines for the Pooling of Resources and the Interconnection of Electric Power Systems (RECI)*, E7 Network of Expertise for the Global Environment, 2000, p.5. See also: Manuel Baritaud & Dennis Volk, *Seamless Power Markets: Regional Integration of Electricity Markets in IEA Member Countries*, International Energy Agency, 2014, pp.15-18; Pierre-Olivier Pineau, *Integrating Electricity Sectors in Canada: Good for the Environment and for the Economy*, The Federal Idea, 2012, p.5.

117 Manuel Baritaud & Dennis Volk, *Seamless Power Markets: Regional Integration of Electricity Markets in IEA Member Countries*, International Energy Agency, 2014, p.17; Richard Pierce, Michael Trebilcock & Evan Thomas, "Beyond Gridlock: The Case for Greater Integration of Regional Electricity Markets," *C.D. Howe Institute Commentary*, vol. 228, 2006, p.3.

118 J. Charpentier & K Schenk, International Power Interconnections: Moving from electricity exchange to competitive trade, The World Bank, 1995, p.1.

119 Manuel Baritaud & Dennis Volk, Seamless Power Markets: Regional Integration of Electricity Markets in IEA Member Countries, International Energy Agency, 2014, p.17; Francisco Burgos, Regional electricity cooperation and integration in the Americas: Potential environmental, social and economic benefits, Organization of the American States, 2007, pp.11-13.

120 Richard Pierce, Michael Trebilcock & Evan Thomas, "Beyond Gridlock: The Case for Greater Integration of Regional Electricity Markets," *C.D. Howe Institute Commentary*, vol. 228, 2006, p.1. See, for an endeavor of measuring the value of electricity connections: P.-O. Pineau, D.J. Dupuis & T. Cenesizoglu, "Assessing the value of power interconnections under climate and natural gas price risks," *Energy*, vol. 82, 2015; Ralph Turvey, "Interconnector economics," *Energy Policy*, vol. 34, 2006.

121 Francisco Burgos, *Regional electricity cooperation and integration in the Americas: Potential environmental, social and economic benefits*, Organization of the American States, 2007. For an analysis on the relationship between electricity trade and greenhouse gas emissions, see: M. Amor, P. Pineau, C. Gaudreault & R. Samson, "Electricity trade and GHG emissions: Assessment of Quebec's hydropower in the Northeastern American market," *Energy Policy*, vol. 39, no. 3, 2011; M. Amor, C. Gaudreault, P. Pineau & R. Samson, "Implications of integrating electricity supply dynamics into life cycle assessment: a case study of renewable distributed generation," *Renewable Energy*, vol. 69, 2014; Luc Gagnon & Joop Vate, "Greenhouse gas emissions from hydropower: the state of research in 1996," *Energy Policy*, vol. 25, no. 1, 1997.

In the example of Central Asia, Uzbekistan has sufficient fossil fuels to produce power while Kyrgyzstan and Tajikistan hinge on hydropower. Pooling may contribute to consistency and stability of electricity systems. In Europe, on the other hand, electricity trade and balance mechanisms are estimated to have a potential of about 4.35 billion US dollars annual benefits.[122] This is far more than the simple transboundary transfer of power through cables.[123]

If hydroelectric generators and interconnectors are combined, some substantial gains can be achieved. First, the HPP construction costs are high, and the building process necessitates expert knowledge. On the other hand, operation costs are relatively small. That is to say, *economies of scale* reduce the marginal costs during the lifetime of the HPP. In order this benefit to be achieved, the generators must operate at the maximum capacity as much as possible. This, in turn, requires a stable and continuing demand. Connecting an HPP to multiple market centers in a network is the easiest solution here. Second, HPPs are influenced by the water flow fluctuations in a season. If an HPP is integrated into a system, the dry season generation can be reimbursed by other generators. Third, if the geographical properties of a region permit, generators can function as interconnected systems. Of the most suitable regions for such an interconnected network in the world are South America[124] and Central Asia.

4.8 Environment and energy

Energy production and consumption are closely related to climate change. The Paris Agreement under the UN Framework Convention on Climate Change signed in April 2016 in New York and effective as of November 2016 highlights this point. China and the US, two major sources of greenhouse gases globally with their 20 and 18 percent contributions to global emissions, respectively, ratified the agreement, which is a remarkable achievement.[125] More recently, the US announced that it would withdraw from the agreement, a decision met with criticism and even resistance.

Hydropower production is widely known as clean and environment-friendly, yet since a while, the legitimacy of this argument has been challenged. Especially the hydroelectric power plants (HPPs) with large reservoirs are subject to discussion because of their environmental and social impacts.[126] Small and micro hydropower, as well as radically designed green

122 Converted from 3.9 billion euros mentioned in the original source using the arithmetic average of the 1 June 2016 interbank spot EUR/USD opening and closing rates.

123 David Newbery, Goran Strbac & Ivan Viehoff, "The Benefits of Integrating European Electricity Markets," *Energy Policy*, vol. 94, 2016, p.261.

124 Global Sustainable Electricity Partnership, *Guidelines for the Pooling of Resources and the Interconnection of Electric Power Systems (RECI)*, E7 Network of Expertise for the Global Environment, 2000, pp.10-11.

125 Potsdam Institute for Climate Impact Research, "Entry Into Force of the Paris Agreement," *Paris Reality Check - Pledged Climate Futures*, 2016, available at: https://www.pik-potsdam.de/primap-live/entry-into-force/ (accessed 21 December 2016); Climate Analytics, "Paris Agreement Ratification Tracker," *Climate Analytics*, 2016, available at: http://climateanalytics.org/hot-topics/ratification-tracker.html (accessed 21 December 2016)

126 Mitch Beedie, "Hydro – An Environmentally Friendly Source?," *Power-Technology.com*, 2007, available at: http://www.power-technology.com/features/feature1459/ (accessed 16 December 2016); Tasneem Abbasi & S. Abbasi, "Small hydro and the environmental implications of its extensive utilization," *Renewable and sustainable energy reviews*, vol. 15, no. 4, 2011; D. Rosenberg, R. Bodaly & P. Usher, "Environmental and social impacts of large scale hydroelectric development: who is listening?," *Global Environmental Change*, vol. 5, no. 2, 1995; Bryan Tilt, Yvonne Braun & Daming He, "Social impacts of large dam projects: A comparison of international case studies and implications for best practice," *Journal of Environmental Management*, vol. 90, 2009. For the impacts of the large dams on human health, see: Leonard Lerer & Thayer Scudder, "Health Impacts of Large Dams," *Environmental Impact Assessment Review*, vol. 19, 1999. See, for a comprehensive field research in the Upper Mekong river basin: P. Wang, J. Lassoie, S. Dong & S. Morreale, "A framework for social impact analysis of large dams: A case study of cascading dams on the Upper-Mekong River, China," *Journal of environmental management*, vol. 117, 2013; GuoLiang Wei, et al., "Impact of dam construction on water quality and water self-purification capacity of the Lancang River, China," *Water resources management*, vol. 23, no. 9, 2009.

energy dams and power plants, are highly recommended in the literature.[127] Numerous articles emphasize the benefits of the dams as well. Besides generating electricity, they are used or irrigation, navigation, flood control, recreation,[128] and freshwater supply purposes.[129] The impacts of hydropower schemes on the environment and social development must be taken into consideration.[130]

Energy production is accountable for at least two-thirds of global greenhouse gas emissions. The International Energy Agency statement asserts that a "transformative change in the energy sector" is crucial in order the Paris Agreement to reach its aims.[131] Renewables may play a key role here.[132] Another key player may be electricity integration. Integrated electricity networks and resource pooling have the potential of boosting renewable electricity and more efficient power production.[133] There are some prerequisites for this, which are: energy policy coordination, established institutions, and regulation[134] among regional states. As an example, coal-fueled power plants in a country with a low hydro or solar potential can be supported by renewable electricity generation in its neighbors. This is what this study suggests for a comprehensive solution to the environment and energy issues in Central Asia, which will be examined in the next section.

The theoretical perspective on the nexus approach as summarized in this section provides a suitable framework within which the current interdependent energy and environment problems in Central Asia may be evaluated. The next section assesses the major issue areas in the region under five sub-sections that cover the unavoidably interrelated topics of hydroelectricity, interconnections, water use and its environmental impacts, impacts of environmental challenges on food and agriculture, and the availability of energy and environment data.

127 ResearchSEA, "Engineering a multipurpose, environmentally friendly dam," *ScienceDaily*, 2015, available at: https://www.sciencedaily.com/releases/2015/03/150323182619.htm (accessed 16 December 2016); Oliver Paish, "Small hydro power: technology and current status," *Renewable and Sustainable Energy Reviews*, vol. 6, 2002. See, for a detailed analysis of the costs of small hydropower: G. Aggidis, E. Luchinskaya, R. Rothschild & D. Howard, "The costs of small-scale hydro power production: Impact on the development of existing potential," *Renewable Energy*, vol. 35, no. 12, 2010.

128 See: Alison Bartle, "Hydropower Potential and Development Activities," *Energy Policy*, vol. 30, 2002; A. Demirbas, "Focus on the World: Status and Future of Hydropower," *Energy Sources, Part B: Economics, Planning, and Policy*, vol. 2, no. 3, 2007; K. Kaygusuz, "The Role of Hydropower for Sustainable Energy Development," *Energy Sources, Part B: Economics, Planning, and Policy*, vol. 4, no. 4, 2009.

129 K. Kaygusuz, "The Role of Hydropower for Sustainable Energy Development," *Energy Sources, Part B: Economics, Planning, and Policy*, vol. 4, no. 4, 2009, p.371.

130 See, for a discussion on energy, environment and social developement: Trevor Price & Douglas Probert, "Harnessing Hydropower: A Practical Guide," *Applied Energy*, vol. 57, no. 2/3, 1997; R. Sternberg, "Hydropower: Dimensions of social and environmental coexistence," *Renewable and Sustainable Energy Reviews*, vol. 12, 2008; R. Sternberg, "Hydropower's future, the environment, and global electricity systems," *Renewable and Sustainable Energy Reviews*, vol. 14, 2010.

131 International Energy Agency, *World Energy Outlook 2016*, OECD/IEA, 2016, p.21.

132 For a set of policy recommendations for sustainable hydroelectric development, see: Jean-Etienne Klimpt, , Hannu Puranen & Frans Koch, "Recommendations for sustainable hydroelectric development," *Energy Policy*, vol. 30, 2002.

133 Francisco Burgos, *Regional electricity cooperation and integration in the Americas: Potential environmental, social and economic benefits*, Organization of the American States, 2007, p.2.

134 Francisco Burgos, *Regional electricity cooperation and integration in the Americas: Potential environmental, social and economic benefits*, Organization of the American States, 2007, p.11.

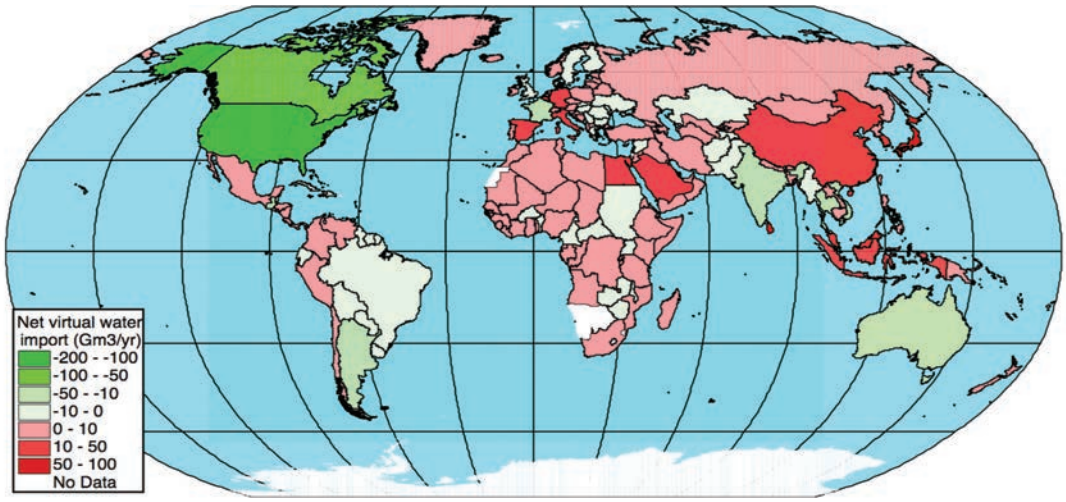
5. Dilemmas of environment and energy nexus in Central Asia

5. Dilemmas of environment and energy nexus in Central Asia

The nexus approach is increasingly becoming a widely-used methodology for studying the water, energy, agriculture and environment related problems of the Central Asian countries. Before scrutinizing the major energy-environment nexus issues in the region, a brief overview of the most recent scholarly works on this topic is in order.

Spoor and Krutov emphasized the dilemma of water and energy needs of Central Asian countries in 2003. The authors speculated that the water and energy interlinkage might even lead to military conflict in the region, in parallel to the conflict-based approaches examined in the previous section.[135] This study was one of the earliest examples that also included environmental issues, and also, it was an approach based on the political economy. But the reference of the authors to the debatable water and conflict literature was a major weakness of this study.

Figure 5.1. Global virtual water exports and imports



Source: Hoekstra & Hung, 2005.

The issue of "virtual water trade" (Figure 5.1) and its impacts on water scarcity and water stress were examined by Porkka et al. in 2012. The authors suggest exporting less water-dependent commodities from the region to reduce the stress on the populations caused by water scarcity.[136] In one of the most recent works published by Abdullaev and Rakhmatullaev in 2016, the authors emphasized the vagueness of the nexus concept for the Central Asian policymakers. The concept of the IWRM is being implemented since a while in the region, as "an externally driven concept."[137] The authors argue that the water and resource management policies in the region are highly politicized and securitized.[138]

Some authors emphasize the importance of regional integration and cooperation in managing transboundary water resources. Accordingly, the rehabilitation of the Soviet era power

135 Max Spoor & Anatoly Krutov, "The 'power of water' in a divided Central Asia," *Perspectives on Global Development and Technology*, vol. 2, no. 3/4, 2003.

136 M. Porkka, M. Kummu, S. Siebert & M. Flörke, "The role of virtual water flows in physical water scarcity: The case of Central Asia," *International Journal of Water Resources Development*, vol. 28, no. 3, 2012.

137 I. Abdullaev & S. Rakhmatullaev, "Setting up the agenda for water reforms in Central Asia: Does the nexus approach help?," *Environmental Earth Sciences*, vol. 75, no. 10, 2016, p. 2.

138 I. Abdullaev & S. Rakhmatullaev, "Setting up the agenda for water reforms in Central Asia: Does the nexus approach help?," *Environmental Earth Sciences*, vol. 75, no. 10, 2016, p. 2.

network, the Central Asian Power System (CAPS) is a viable and beneficial option for the developmental, economic, and environmental problems in Central Asia, based on the functionalist principles of "benefit sharing" as suggested in the literature.[139] The approach of the authors based on functionalism asserts that the regional countries are likely to cooperate if the benefits of cooperation are more than the benefits of non-cooperation.[140] On the other hand, Granit et al. see the revitalization of the CAPS under current political conditions and under the lack of a hegemon (like the Soviet Union that once imposed the CAPS in Central Asia) quite unrealistic.[141] Another study that suggests the rehabilitation of the CAPS was finalized in 2016 by Jalilov et al. Taking the example of the Rogun Dam, the authors examined the alternative uses of the Rogun reservoir, in irrigation mode and energy mode. This study also suggests a benefit-sharing scheme, but at the same time, it demonstrates the difficulty of achieving a "win-win" solution for all the stakeholders, i.e., the upstream and the downstream countries, during the operation of the Rogun Dam and the reservoir.[142]

Stucki and Sojamo studied the water-energy-security nexus in Central Asia from a political economic perspective emphasizing environmental problems in the region.[143] The authors stress that the nexus is highly politicized and securitized in Central Asia.[144] They try to show how the interests of the major powers, such as China, the US, and Russia, as well as some other international organizations like the UN and the EU have been involving in shaping the political economy of water and energy issues in the region.[145]

Figure 5.2. The Syr Darya basin

Source: Basin Water Organization "Syrdarya"

139 Jakob Granit, et al., "Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin," in V. Stucki, K. Wegerich, M.M. Rahaman & O. Varis, eds. *Water and Security in Central Asia: Solving a Rubik's Cube*, 2012, pp. 425.-427. See also: Shokhrukh-Mirzo Jalilov, et al., "Managing the water–energy–food nexus: Gains and losses from new water development in Amu Darya River Basin," *Journal of Hydrology*, vol. 539, 2016, p.657.

140 Jakob Granit, et al., "Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin," in V. Stucki, K. Wegerich, M.M. Rahaman & O. Varis, eds. *Water and Security in Central Asia: Solving a Rubik's Cube*, 2012, p. 421.

141 Jakob Granit, et al., "Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin," in V. Stucki, K. Wegerich, M.M. Rahaman & O. Varis, eds. *Water and Security in Central Asia: Solving a Rubik's Cube*, 2012, p. 429.

142 Shokhrukh-Mirzo Jalilov, et al., "Managing the water–energy–food nexus: Gains and losses from new water development in Amu Darya River Basin," *Journal of Hydrology*, vol. 539, 2016, pp. 653-657.

143 Virpi Stucki & Suvi Sojamo, "Nouns and numbers of the water–energy–security nexus in Central Asia," *International Journal of Water Resources Development*, vol. 28, no. 3, 2012, p. 413.

144 Virpi Stucki & Suvi Sojamo, "Nouns and numbers of the water–energy–security nexus in Central Asia," *International Journal of Water Resources Development*, vol. 28, no. 3, 2012, p. 409.

145 Virpi Stucki & Suvi Sojamo, "Nouns and numbers of the water–energy–security nexus in Central Asia," *International Journal of Water Resources Development*, vol. 28, no. 3, 2012, p. 412.

The international organizations are quite interested in the regional studies that lean on the nexus approach in the recent years. They developed suggestions based on an economic approach that foresaw, e.g., compensation payments to Kyrgyzstan by the downstream countries and developing the grand HPP schemes in Kyrgyzstan jointly by all riparians in the Syr Darya basin (Figure 5.2).[146] In 2008, a report published by the Eurasian Development Bank emphasized the impacts of the large HPP development projects such as the Kambarata 1 and 2, as well as the Rogun dams on the environment. The report stated that

> In considering the options for dam projects, equal (if not greater) importance should be placed on the social and ecological effects of the project as on technical and economic considerations. In the past, the ecological role of water resources, even the fact that water is needed to sustain natural habitats and eco-systems, was barely acknowledged, and therefore there is an urgent need to carry out ecological audits of hydro energy projects, especially ones as large as the Rogun and Kambarata HPPs.[147]

The report emphasized the importance of cooperation in solving the nexus problems in the region, as well as the role of the international community in facilitating this cooperation.[148] The efforts of the international organizations will be further explored in the following section.

The role of institutions and transboundary context are important from the perspective of this study. One important research that examined the role of institutions in the water-energy-food nexus based on the "institutional analysis and development" approach was published in 2015.[149] This study does not explore Central Asia among its several case studies, yet the study of Keskinen et al. in 2016 includes Central Asia as a case while scrutinizing the transboundary aspect of the nexus. According to the authors, the cross-border dimension of the nexus affects policies on water, energy and food sectors in three ways:

> Firstly, the transboundary context requires an increased emphasis on multiple geographical scales and on diversity of different perspectives. Secondly, international transboundary contexts have distinctive key players in the nexus, notably nation-states. Thirdly, these two factors emphasise the importance of looking at the political aspects related to the nexus, which may help to broaden the nexus as a concept in that direction.[150]

Also, the approach of nexus has some impacts on transboundary issues. The authors summarize these impacts as follows:

> Firstly, the nexus may provide new resources and approaches for transboundary cooperation. Secondly, the nexus alters actor dynamics by engaging key actors from energy and food sectors. Thirdly, the nexus can help to reset transboundary cooperation between the riparian countries by extending thinking about cooperation from water

146 World Bank, *Water and Energy Nexus in Central Asia: Improving Regional Cooperation in the Syr Darya Basin*, 2004, available at: http://siteresources.worldbank.org/INTUZBEKISTAN/Resources/Water_Energy_Nexus_final.pdf (accessed 12 November 2015).

147 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, pp. 19-20.

148 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, p. 27 and pp. 32-35.

149 S. Villamayor-Tomas, et al., "The water-energy-food security nexus through the lenses of the value chain and IAD frameworks," *Water Alternatives*, vol. 8, no. 1, 2015.

150 M. Keskinen, et al., "The water-energy-food nexus and the transboundary context: Insights from large asian rivers," *Water*, vol. 8, no. 5, 2016, p. 10.

resources management to broader aspects of water, energy and food security.[151]

From the perspective of this study, the transboundary dimension of the environment and energy nexus, as well as its political economic aspect are of crucial importance. The field research of this study found five main dilemmas within the region regarding environment and energy nexus that will be analyzed in the following subsections.

5.1 Hydroelectricity and renewable energy

Hydroelectricity and renewable energy use in Central Asia have been among the major items on the agenda of the regional governments. It is important to note that the issue of hydroelectricity is not pivotal for all the Central Asian countries. The hydrocarbon-rich countries, especially Uzbekistan and Kazakhstan, see hydropower and renewable energy as options for development and opportunities for diversification for their economies. The hydrocarbon-poor Kyrgyzstan and Tajikistan are more dependent on hydropower and renewable energy both for meeting the domestic demand as well as for exporting the excess electricity produced in the HPPs with large reservoirs. The emphasis of Tajikistan and Kyrgyzstan on exporting power for supporting their national budgets is sometimes subject to criticism as well because these countries prioritize exporting electricity over the needs of their people, especially those living in rural and impoverished regions.[152]

The majority of the interviewees during the field research pointed out that one of the biggest dilemmas in the region regarding hydroelectricity and renewables is that the individual countries have their priorities that depend on individual state interests.[153] For Kazakhstan, the primary concern is sustainability and environment, while for Uzbekistan, self-sufficiency in electricity, as well as food production, is a priority. Tajikistan and Kyrgyzstan look for export earnings through generating massive amounts of excess power using their vast hydropower potential. The economic potential of Kyrgyzstan is estimated at 55 billion kWh and 317 kWh for Tajikistan, annually. While Kyrgyzstan utilized 25 percent, Tajikistan used only 6 percent of its total economic potential.[154]

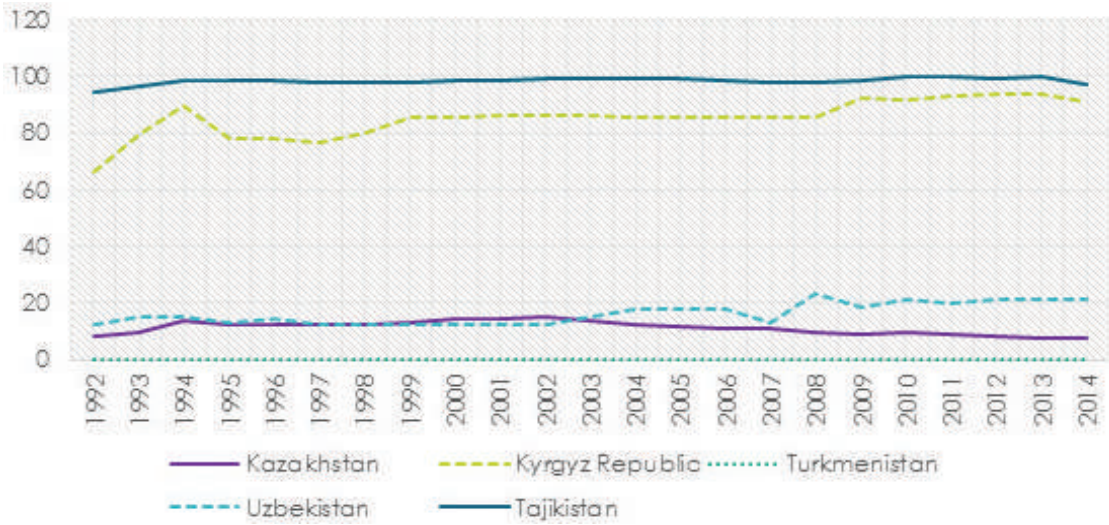
151 M. Keskinen, et al., "The water-energy-food nexus and the transboundary context: Insights from large asian rivers," *Water*, vol. 8, no. 5, 2016, p. 12.

152 Interview with Lydia Parkomchik, Water and Energy Specialist, Eurasian Research Institute, 19 May 2017, Almaty.

153 Online distant interview with Shairbek Juraev, Marie Curie Fellow, University of St Andrews, United Kingdom; Online distant interview with Shokhrukh Jalilov, Research Fellow, Institute for the Advanced Study of Sustainability, United Nations University (UNU-IAS); Online distant interview with Gabit Zhumatay, Senior Lecturer at the Department of Regional Studies at the Kazakh Ablai Khan University of International Relations and World Languages.

154 Vladimir Yasinskiy, Alexander Mironenkov & Tulegen Sarsembekov, *Modern Water Management in the CIS Countries* (Almaty: Eurasian Development Bank, 2014), p. 37.

Figure 5.3. Electricity production from hydroelectric sources, percent of total



Source: World Bank, 2017.

For Kyrgyzstan, the Naryn basin is of crucial importance for hydroelectricity production. There is a cascade of five HPPs downstream of the Toktogul Reservoir, including the Toktogul HPP with 1,200 megawatts of design capacity, and the Kurpsai, the Tashkumir, the Shamaldisay, and the Uchkurgan HPPs with a total of 1,670 megawatts capacity.[155] The Kyrgyz government planned two further cascades on the upper Naryn river. The former includes the Kambarata-1 (1,900 megawatts) and the Kambarata-2 (360 megawatts) dams and HPPs. The latter is known as the Upper Naryn Cascade and includes the Ak Bulun, the Naryn-1, the Naryn-2, and the Naryn-3 HPPs. The Kambarata-2 is finished, but it needs Kambarata-1 to complete to become fully operational. The cost of the Upper Naryn project is estimated at more than 700 million US dollars, while the Kambarata-1 is estimated at 2 to 2.5 billion US dollars.[156]

The deteriorating world economic conditions and the weakened Russian economy had severely affected the future of these projects. The agreements signed with the Russian government in 2012 were rebuked in early 2016.[157] While the construction of the Kambarata-1 raises concerns in the downstream countries of Kazakhstan and Uzbekistan, a coordinated operation of the Kambarata and Toktogul reservoirs would benefit all the upstream and downstream countries by supplying enough electricity and adequate irrigation water.[158]

Tajikistan has even bigger hydroelectricity development plans. The Vakhsh river has a high potential for hydropower generation. The massive Nurek Dam with 3,000 megawatts of in-

155 Hydroworld, "Kyrgyzstan seeks safety study of five dams in 2,870-MW Naryn cascade," *Hydroworld.com*, 2012, available at: http://www.hydroworld.com/articles/2012/09/kyrgyzstan-seeks-safety-study-of-five-dams-in-2870-mw-naryn-cascade.html (accessed 22 May 2017).

156 Olga Dzyubenko, "Kyrgyz leader says Russia unable to finance hydropower projects," *Reuters*, 2015, available at: http://www.reuters.com/article/us-kyrgyzstan-russia-projects-idUSKBN0U70Y520151224 (accessed 23 May 2017); Umida Hashimova, "Kyrgyzstan Determined to Pursue Its Hydropower Plans With or Without Russia," *The Jamestown Foundation*, 2016, available at: https://jamestown.org/program/kyrgyzstan-determined-to-pursue-its-hydropower-plans-with-or-without-russia/ (accessed 25 May 2017); Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, p. 20.

157 Aziz Tarik, "The Upper Naryn hydropower plants cascade: a hopeless project in Kyrgyzstan?," *The Voice of Renewables*, 2016, available at: http://voiceofrenewables.com/hydro/the-upper-naryn-hydropower-plants-cascade-a-hopeless-project-in-kyrgyzstan/ (accessed 23 May 2017).

158 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, p. 20; Halil Sakal, "Hydroelectricity Aspect of the Uzbek – Kyrgyz Water Dispute in the Syr Darya Basin," *Enerji ve Diplomasi Dergisi*, vol. 1, no. 3, 2015, p. 125.

stalled capacity is located on this river, along with the Baylaza, Golovnaya, Perapadnaya, and the Centralnaya dams and HPPs, with a total of 885 megawatts installed capacity.[159] The Nurek HPP consists about 58 percent of the total installed capacity in Tajikistan, as of 2012.[160] The Rogun Dam project with 3,600 megawatts of planned capacity will be the largest in Central Asia, once finished. The biggest challenge for the completion of the nearly 3 billion US dollar Rogun project is financing (Figure 5.7).[161] The project kick-off was recently officially announced, yet the regional experts see it merely as a legend than reality,[162] and the future of the project is still unclear.[163] There are some further projects, such as the Shurob, the Sangtudin-1, and the Sangtudin-2 HPPs, totaling to 1,640 megawatts of installed capacity.[164]

The Eurasian Development Bank recommended the cooperation of the regional governments for resolving issues which emerged from the construction of large HPPs. The Bank also observed that the involvement of the "international community" has been increasing for a while especially for funding or financing.[165] The building of small HPPs is recommended in order not to distract the irrigation water needs of the downstream countries,[166] and also, as they are more beneficial regarding financial, technical and environmental aspects.[167] However, some regional experts argue that the small HPPs are not feasible for Kyrgyzstan and Tajikistan, particularly since the primary concern of these countries are export earnings, rather than meeting local electricity demands.[168] There are also technical reasons. The small HPPs are not efficient in the winter season, when the electricity demand reaches its peak in Kyrgyzstan, especially for heating.[169]

To overcome the energy shortage in Kyrgyzstan, 87 additional small HPPs were proposed. According to a report by the GEF and the UNDP, about 200 megawatts of additional capacity is possible with these new small HPP projects and with the rehabilitation of older ones. Additionally, small HPPs can be constructed on existing irrigation networks.[170] On the other hand, the rehabilitation of the old infrastructure of the hydropower facilities in Kyrgyzstan is necessary. Otherwise, as the Anonymous Expert (3) suggests, "once net-exporter of electricity Kyrgyzstan [may become] net-importer with degradation of existing old facilities."[171]

The hydroelectricity generation plans of the upstream countries and the concerns of the downstream governments can only be balanced through closer cooperation by establishing non-technical regional institutions. The regional electricity market is one of the best examples of such kind of regimes, as this study suggests.

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159 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, p. 18.
160 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, p. 37.
161 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, p. 20.
162 Interview with Atabek Umirbekov, Climate Change Specialist at the CAREC, 17 May 2017, Almaty.
163 Interview with Lydia Parkomchik, Water and Energy Specialist, Eurasian Research Institute, 19 May 2017, Almaty.
164 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, p. 18.
165 Eurasian Development Bank, *Water and Energy Resources in Central Asia: Utilization and Development Issues*, Eurasian Development Bank, 2008, pp. 26-27.
166 Halil Sakal, "Hydroelectricity Aspect of the Uzbek – Kyrgyz Water Dispute in the Syr Darya Basin," *Enerji ve Diplomasi Dergisi*, vol. 1, no. 3, 2015, pp. 125-126.
167 Online distant interview with Anonymous Expert (3).
168 Interview with Lydia Parkomchik, Water and Energy Specialist, Eurasian Research Institute, 19 May 2017, Almaty.
169 Interview with Atabek Umirbekov, Climate Change Specialist at the CAREC, 17 May 2017, Almaty.
170 UNDP-GEF, *The UNDP-GEF Project "Small Hydropower Development": Global Challenges, National Problems and Solutions, 2010-2015*, 2015, p.7.
171 Online distant interview with Anonymous Expert (3).

5.2 Regional electricity network and electricity trade in Central Asia

The ambitious hydroelectricity production schemes of Kyrgyzstan and Tajikistan are meaningful only if the excess power can be transferred to export destinations elsewhere. The CAPS constructed in the Soviet era has the potential of assuming the objective of transferring electricity, yet there are some setbacks to its proper functioning (Figure 5.4).[172] The following paragraphs will summarize those shortly.

Figure 5.4. The Central Asian Power System

Source: Global Energy Network Institute, 2015.

The power transferred in the system was generated by 30 percent hydroelectricity and 70 percent from thermal sources. All five Central Asian countries were connected to the system, except north Kazakhstan. Only the southern part of Kazakhstan was part of the CAPS, and the northern regions were interconnected to the Russian grid. Uzbekistan had a clear dominance in the CAPS. The dispatch center of the system, Energia, is in Tashkent. Also, 51 percent of the total electricity was produced in Uzbekistan,[173] and the greatest consumer of electricity within the grid was, again, Uzbekistan (Figure 5.5). The major setback to the functioning of the CAPS is that the government of Uzbekistan often used its central position in the system for political purposes. Due to disagreements the system is currently not functioning as intended.[174]

Kazakhstan has three zones of electricity grids, the north, the south and the east. The northern part produces the majority of electricity generated in the country from thermal sources,

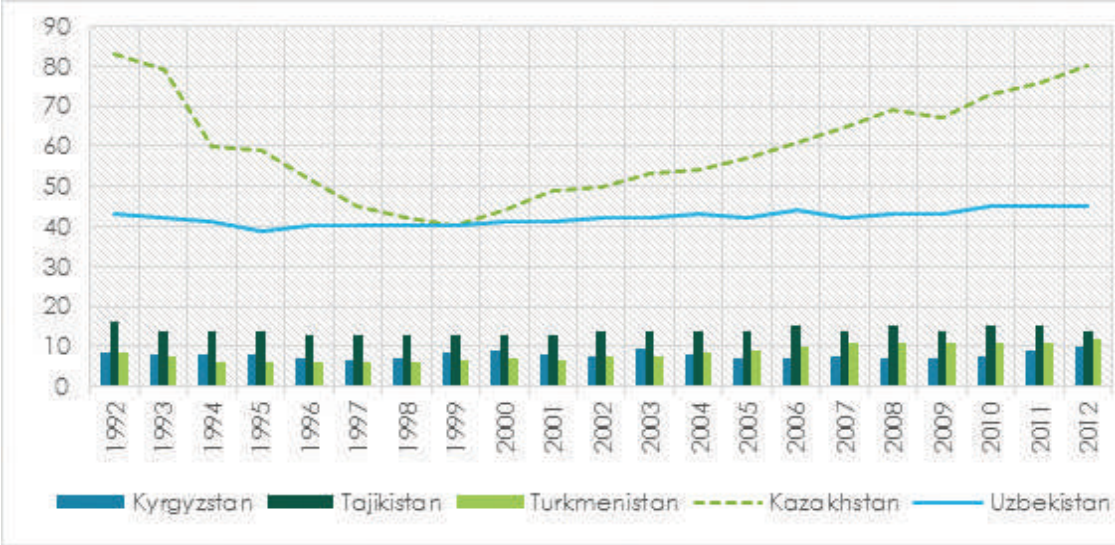
172 Halil Sakal, "Hydroelectricity Aspect of the Uzbek – Kyrgyz Water Dispute in the Syr Darya Basin," *Enerji ve Diplomasi Dergisi*, vol. 1, no. 3, 2015.

173 Farkhod Aminjonov, "Central Asian Countries' Power Systems Are Now Isolated, But Not Everyone Is Happy!," *Eurasian Research Institute*, 2016, available at: http://eurasian-research.org/en/research/comments/energy/central-asian-countries%E2%80%99-power-systems-are-now-isolated-not-everyone-happy (accessed 22 May 2017).

174 Bakhtiar Bakas Uulu & Kadyrzhan Smagulov, "Central Asia's hydropower problems: regional states' policy and development prospects," *Central Asia and the Caucasus*, vol. 12, no. 1, 2011.

especially from coal.[175] Currently, the north and the south of Kazakhstan is connected through a 500 kV transmission line with the aid received from the international donors.[176]

Figure 5.5. Electricity consumption of the CAPS countries (billion kWh)



Source: US Energy Information Administration, 2012.

On the other hand, this transmission line is not sufficient to meet the demand in the south. Although the Kazakhstan Electricity Grid Operating Company (KEGOC) claims that there are no significant problems in the north-south connection,[177] Kazakhstan has to import electricity from Kyrgyzstan.[178] The lack or inadequacy of intrastate interconnections, as well as the abundance of thermal power plants, put pressure on the environment-energy nexus in Kazakhstan. As stated above, the country aims to increase its investments in the renewable sector, but the progress is slow.

Perhaps the most affected country from the lack of a regional electricity grid has been Tajikistan (Figure 5.8). As of 2012, Tajikistan produced 99.5 percent of its electricity from water resources.[179] But the level of the generated power fluctuates depending on the seasons of the year, as well as on the wet or dry years. Therefore, the country is dependent on the electricity produced from thermal resources. In addition, the north and the south of Tajikistan are not directly connected. The north-south Tajikistan connection passes through Uzbekistan.

175 Farkhod Aminjonov, "Central Asian Countries' Power Systems Are Now Isolated, But Not Everyone Is Happy!," *Eurasian Research Institute*, 2016, available at: http://eurasian-research.org/en/research/comments/energy/central-asian-countries%E2%80%99-power-systems-are-now-isolated-not-everyone-happy (accessed 22 May 2017).

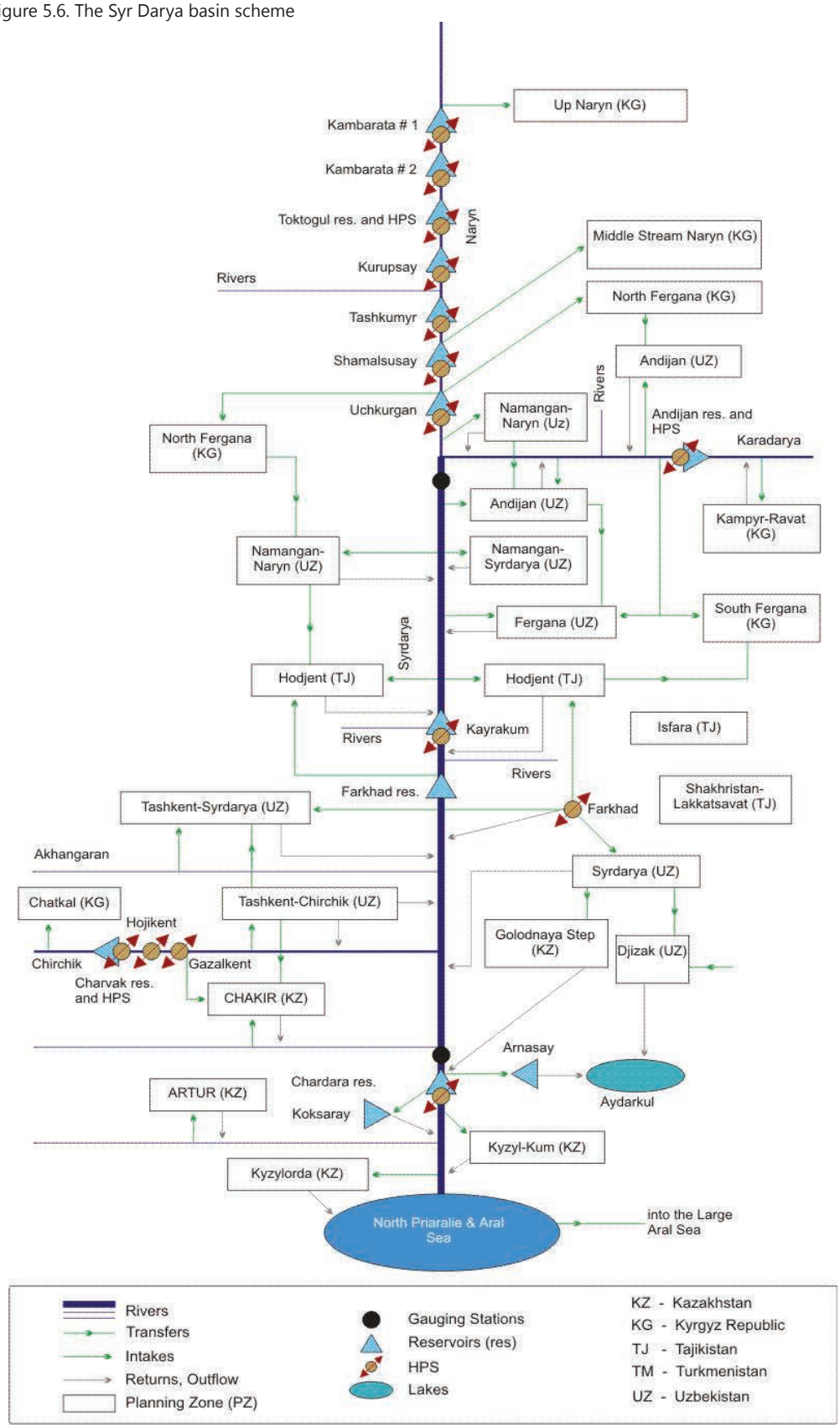
176 World Bank, "North-South Electricity Transmission Project," *The World Bank*, 2012, available at: http://projects.worldbank.org/P095155/north-south-electricity-transmission-project?lang=en (accessed 22 May 2017).

177 Interview with Lydia Parkomchik, Water and Energy Specialist, Eurasian Research Institute, 19 May 2017, Almaty.

178 World Energy Council, *Electricity in Central Asia: Market and Investment Opportunity Report*, 2007, available at: https://www.worldenergy.org/wp-content/uploads/2012/10/PUB_Asia_Regional_Report_Electricty_Market_And_Investment_Opportunity_2007_WEC.pdf (accessed 17 November 2015), p. 22.

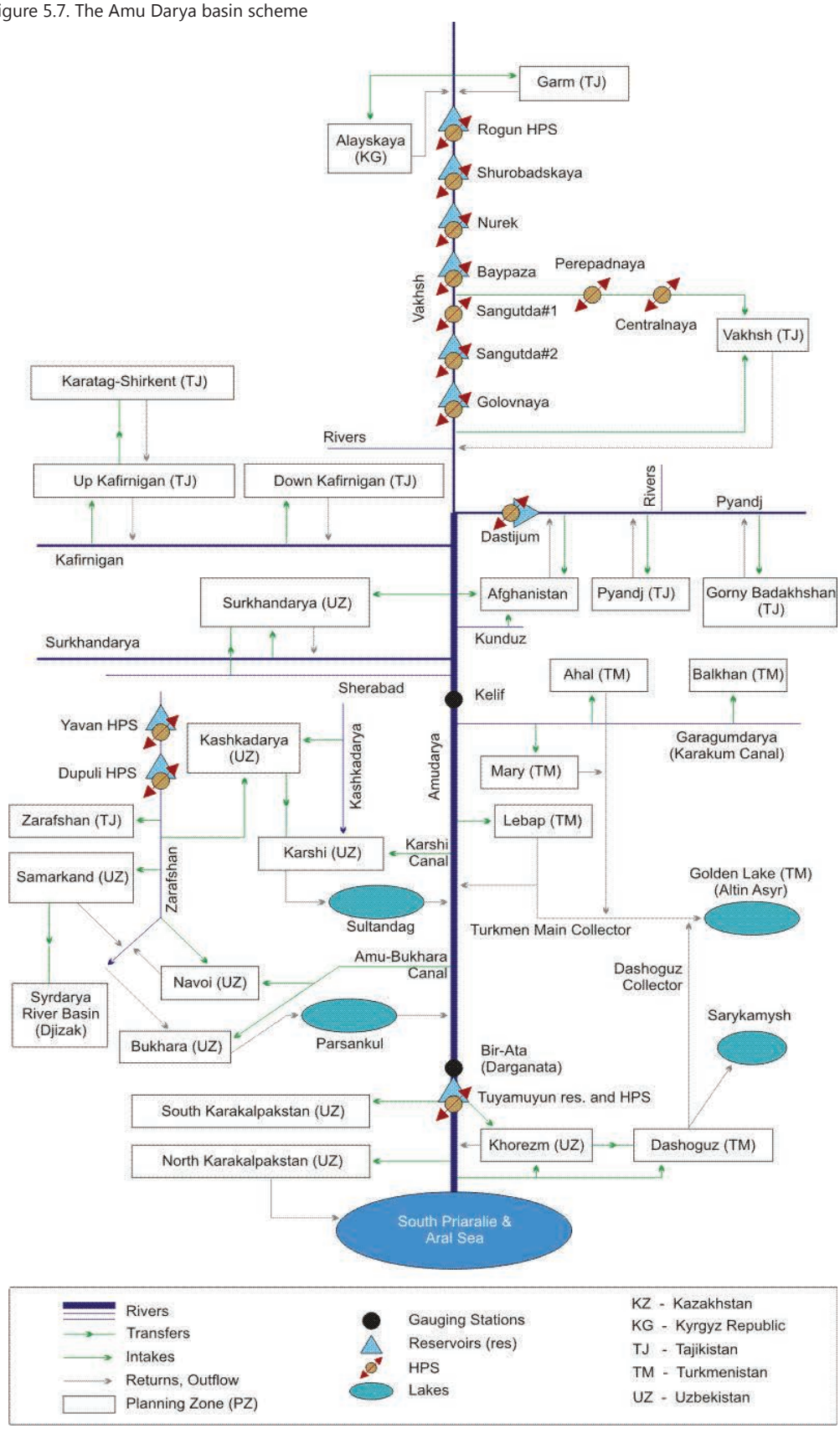
179 World Bank, "World Development Indicators," *The World Bank Databank*, 2017, available at: databank.worldbank.org (accessed 22 March 2017).

Figure 5.6. The Syr Darya basin scheme



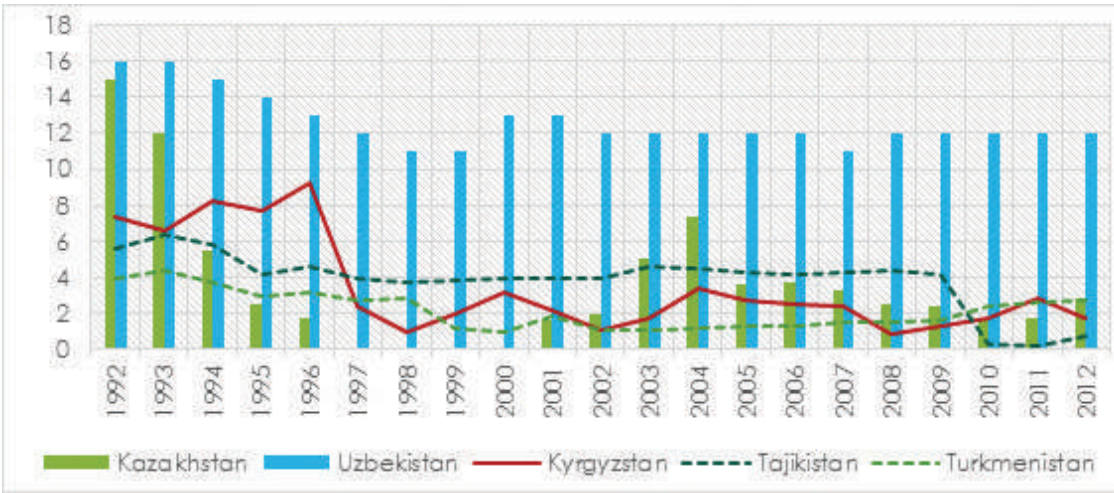
Source: Water Unites, 2017.

Figure 5.7. The Amu Darya basin scheme



Source: Water Unites, 2017.

Figure 5.8. Electricity exports of the CAPS countries (billion kWh)



Source: US Energy Information Administration, 2012.

As Uzbekistan has withdrawn from the CAPS, the thermal electricity supply, as well as the north-south connection of Tajikistan has faced severe danger. This is another major setback to the proper functioning of the system. To overcome this, the government of Tajikistan connected the north and the south through a 500 kV transmission line. In 2008, Tajik President Emomali Rahmon stated that

> At the present time construction of 95 small power stations completed and put into operation, as well as there are 21 more power stations are being built and according to the investment projects construction of 20 small power stations is planned. By the end of this year, there are three last aggregates of "Sangtuda - 1" hydro-power station will be put in commission and constructing works of "Sangtuda - 2" will be enhanced. Now, on the basis of investment projects that are in amount of 1.5 billion somoni, construction of Electricity Transmission Lines 500 kV "South-North", 220 kV "Lolazor-Khatlon", reconstruction of municipal energy sector and decrease of electricity loss is planned.[180]

The construction was completed in August 2009 with the financing of the Chinese government. This somehow secured the power integrity of Tajikistan.

Under these circumstances, Uzbekistan preferred its electricity system to operate in isolated mode. The experts in Kazakhstan assume that the countries in the region seek energy self-sufficiency and all strive to export electricity.[181] Currently, "Uzbekistan, Tajikistan, and Kyrgyzstan have domestic power deficits and shortages and thus unable to contribute to regional electricity trade. Only Kazakhstan and Turkmenistan have excessive power for regional trade."[182] Therefore, there is little room for change in the short term. On the other hand, some experts expect significant change under the presidency of Shavkat Mirziyoyev. President Mirziyoyev recently began his term with a series of meetings with regional leaders, and he is seen as a more accommodative leader than Karimov. This may ease Uzbekistan's

180 Emomali Rahmon, "Annual address to the Majlisi Oli of the Republic of Tajikistan," *President of the Republic of Tajikistan*, 2008, available at: http://www.prezident.tj/en/node/2191 (accessed 24 May 2017).
181 Interview with Lydia Parkomchik, Water and Energy Specialist, Eurasian Research Institute, 19 May 2017, Almaty.
182 Online distant interview with Anonymous Expert (3).

dominant position in the CAPS towards a more cooperative attitude.[183]

As suggested above, the rehabilitation of the CAPS is one of the major steps towards achieving a regional electricity market as suggested by this study. Currently, the only local alternative to the CAPS seems to be the Central Asia – South Asia Electricity Transmission Project (CASA-1000) project, supported by the World Bank. This latter project is expected to connect the hydropower generation spots in Kyrgyzstan and Tajikistan with Afghanistan and Pakistan. This connection is expected to be a major catalyzer for the establishment of the planned Central Asia-South Asia Regional Electricity Market (CASAREM).[184] Some experts argue that exporting electricity towards Afghanistan is a great potential for the hydrocarbon-poor countries in the Aral Sea basin.[185]

Hydroelectricity and power demand is one dimension of the problem, and the use of water is decisive here, which has further environmental impacts in Central Asia. The following sub-section will analyze the environmental aspect of water use in the region.

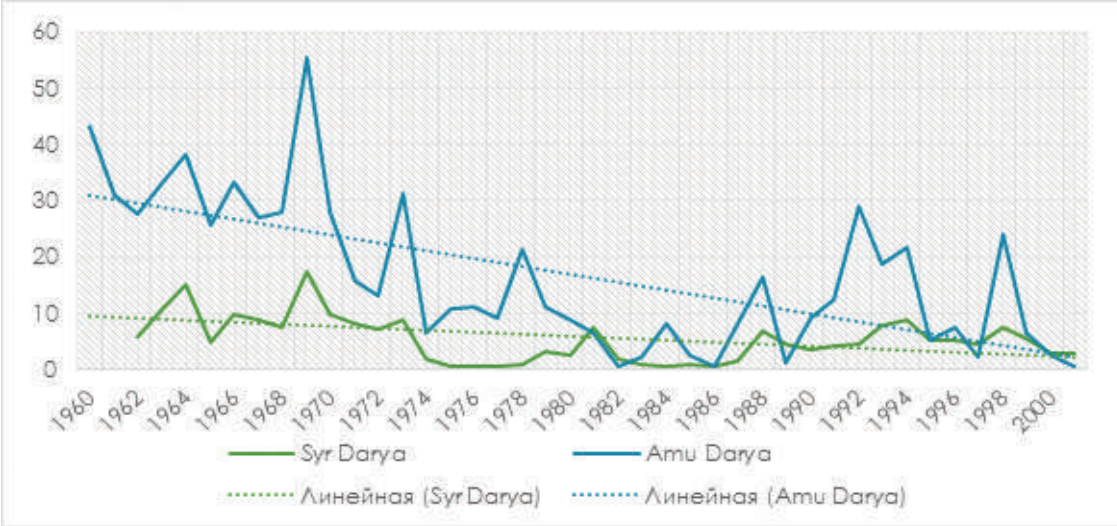
5.3 Environmental aspect of water use and management

One of the most important environmental questions for the region is the inefficient use of water. The clearest consequences of this situation are seen in the reduced size of the Aral Sea.[186] The solution of the environmental problem here is beyond the reach of the individual countries. The experts in the region recommend international cooperation and support of international organizations for a comprehensive and lasting solution to the environmental problems. There is already some basis for collaboration and support is secured mostly from international donors, such as the UNEP, the UNDP, the World Bank, the EU, or the EEC, and from individual countries in the West.[187]

One of the primary reasons for the deterioration of the environment in connection with water use is the inefficient use of water for cotton cultivation, especially in Uzbekistan.[188] Some academicians confirm the conclusion in the relevant literature that all countries in the region have different opinions and different priorities for water use. For Uzbekistan, the main concern has been agriculture, but for Kazakhstan, the top priority is the environment.[189] Furthermore, all sectors, i.e., water, energy, and agriculture, have their financial structures and their priorities. Under these circumstances, green economic solutions can only be achieved through cooperation.[190] One suggestion for improving the efficiency of water use is "market-based water pricing" and switching gradually from water-intensive to less water-intensive crops.[191]

183 Interview with Atabek Umirbekov, Climate Change Specialist at the CAREC, 17 May 2017, Almaty.
184 CASA-1000, "Main objective," *CASA-1000 Project*, 2017, available at: http://www.casa-1000.org/MainPages/CASAAbout.php#objective (accessed 21 May 2017).
185 Online distant interview with Zauresh Atakhanova, Associate Professor, Nazarbayev University, School of Humanities and Social Sciences.
186 Interview with Barbara Janusz-Pawletta, Kazakh-German University, Natural Resources Institute, 18 May 2017, Almaty.
187 Interview with Marat Narbayev, Head of Water Resources Department, International Fund for Saving Aral Sea, 18 May 2017, Almaty.
188 Interview with Barbara Janusz-Pawletta, Kazakh-German University, Natural Resources Institute, 18 May 2017, Almaty; Online distant interview with Zauresh Atakhanova, Associate Professor, Nazarbayev University, School of Humanities and Social Sciences.
189 Interview with Anonymous Expert (1), 17 May 2017, Almaty.
190 Interview with Anonymous Expert (2), 17 May 2017, Almaty.
191 Online distant interview with Zauresh Atakhanova, Associate Professor, Nazarbayev University, School of Humanities and Social Sciences.

Figure 5.9. Water inflow in Priaralye, cubic kilometers, mid-annual values



Source: Ashirbekov & Zonn, 2003.

Besides inefficient water use, the amount of fertilizers and pesticides used in Central Asian agriculture is a serious concern. Thus, agricultural use of water poses a significant risk to water quality.[192] According to the data of 2010-2014, the Syr Darya water quality in the Upper Naryn part is quite high, while the level of pollution increases downstream of the Osh in Kyrgyzstan and downstream of Tashkent in Uzbekistan. For the Amu Darya (Figure 5.10), the deterioration of water quality begins downstream of the Karakum Canal in Turkmenistan, and in the Zarafshan river, downstream of Navoy. The pollution of water rises from moderate to a high level in the Amu Darya Delta on the mouth of the Aral Sea.[193]

Figure 5.10. The Amu Darya basin

Source: Basin Water Organization "Amudarya"

Some experts and policymakers observe adverse impacts of climate change on water in

192 CAREC, Environmental Agency of Austria, Zoi Environment Network, *The State of Environment in Central Asia: Illustrations of Selected Environmental Themes and Indicators* (Almaty: FLERMONECA, 2015), p. 12.

193 CAREC, Environmental Agency of Austria, Zoi Environment Network, *The State of Environment in Central Asia: Illustrations of Selected Environmental Themes and Indicators* (Almaty: FLERMONECA, 2015), p. 14.

Central Asia.[194] Umirbekov estimates that climate change would exacerbate water problems and environmental issues in the future. In the rivers of the Aral Sea basin, especially in the Amu Darya and the Syr Darya, there is less and less water than it used to be in the past, according to the measurements (Figure 5.9). Also, water quality is being severely affected by the impacts of climate change. Unless necessary measurements are taken, the situation tends to get worse in the upcoming 30-50 years.[195] If the cotton production of Uzbekistan decreases, or if the efficiency of water use in this country increases, some believe that this would help to achieve a solution for the water-energy problems in the Aral Sea basin.[196]

According to Juraev,

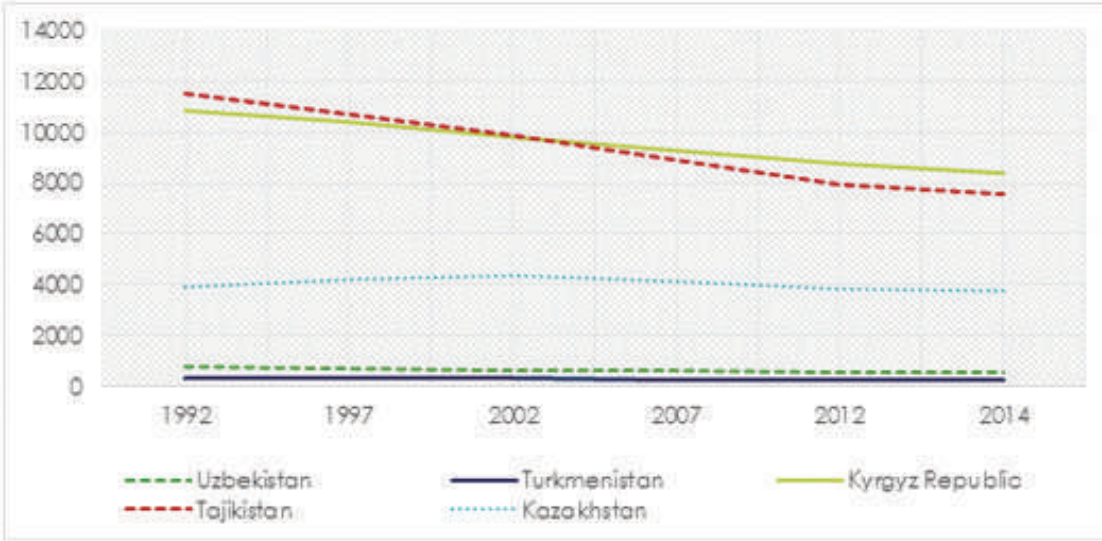
> Water-related projects have long turned into big part of domestic political agenda, particularly in Kyrgyzstan, Tajikistan, and Uzbekistan who are currently deadlocked on the question of new large water reservoirs. The best chances for progress can come through domestic political changes in any of Central Asian states that may create a window of opportunity.[197]

On the other hand, some experts are optimistic about the change in the water use practices in the region.[198] The experts at the Regional Environmental Centre for Central Asia (CAREC), who base their works on water-energy-food nexus[199] and the principles of IWRM, expect some changes in the future. In Turkmenistan, which is one of the most isolated and stable countries in the region, a new water code was put into force, which is based on the IWRM approach. According to the experts, this change is prolonged, but it is a fact in Central Asia. Together with national and regional partners, experts at the CAREC see that there are platforms and opportunities to implement the IWRM and nexus approaches.[200]

The use of water has some further impacts on the energy-environment nexus. First of all, inefficient irrigation systems are serious electricity consumers, especially in Uzbekistan. For supplying power to irrigation networks, i.e., to pumping stations, Abdullayev suggests the usage of small HPPs.[201] He estimates that the irrigation water demand will increase by 20 percent in Central Asia due to the impacts of climate change. Also, increased number of natural environmental disasters would distort farming, power, and rural infrastructures in the region.[202]

194 Interview with Saparov Abdulla, General Director, Republic of Kazakhstan Ministry of Agriculture, Kazakh Research Institute of Soil Science and Agrochemistry named after U.U. Uspanov, 17 May 2017, Almaty.
195 Interview with Atabek Umirbekov, Climate Change Specialist at the CAREC, 17 May 2017, Almaty.
196 Online distant interview with Ainur Kokimova, Project Coordinator, Natural Resources Institute, UNESCO Chair on water resources management in Central Asia.
197 Online distant interview with Shairbek Juraev, Marie Curie Fellow, University of St Andrews, United Kingdom.
198 Online distant interview with Shokhrukh Jalilov, Research Fellow, Institute for the Advanced Study of Sustainability, United Nations University (UNU-IAS).
199 Interview with Lyudmila Kiktenko, Manager of the Environmental Management Programme at the CAREC, 17 May 2017, Almaty.
200 Interview with Yekaterina Strikeleva, Chief of Party of Smart Waters Project at the CAREC, 17 May 2017, Almaty.
201 I. Abdullaev & S. Rakhmatullaev, "Setting up the agenda for water reforms in Central Asia: Does the nexus approach help?," *Environmental Earth Sciences*, vol. 75, no. 10, 2016.
202 I. Abdullaev & S. Rakhmatullaev, "Setting up the agenda for water reforms in Central Asia: Does the nexus approach help?," *Environmental Earth Sciences*, vol. 75, no. 10, 2016, p. 7.

Figure 5.11. Renewable internal freshwater resources per capita (cubic meters)



Source: World Bank, 2017.

Inevitably, the adverse environmental impacts of water use influence the situation in food and agriculture in Central Asia. This, in turn, poses a significant risk to the socioeconomic conditions of the people and the sustainable and environment-friendly economic growth for the countries in the region.

5.4 Environmental water stress and its impacts on local communities and agricultural production

One of the biggest environmental problems in Central Asia is water scarcity caused by the adverse consequences of climate change. This environmental stress on water level affects both the agricultural output, and in parallel, the lives of the ordinary people, especially those living in rural and impoverished regions. Uzbekistan faced the most unintended and negative impacts of this situation as the greatest agricultural producer and the most populous nation in Central Asia.

During the Soviet era, settling water and energy issues in Central Asia was less complicated. The dissolution of the Soviet Union politicized the energy and environment policies. On the other hand, Zhumatay argues, it should be acknowledged that roots of economic policies, water mismanagement, and disastrous ecological catastrophes are directly linked to the Soviet period.[203] As a legacy of the Soviet Union, nearly all economic infrastructure in Uzbekistan is cotton-oriented. This does involve not only cottonseed harvest and production of fabrics, but also other products from cotton, such as cotton oil, and other industries. As water use in Uzbekistan is usually seen as ineffective, and the level of water scarcity is severe (Figure 5.11), there are some efforts to improve water use and increase efficiency. But it is hard to implement these methods under current institutional barriers.[204]

Under the Soviet administration, many reservoirs were constructed to irrigate vast areas of agriculture in Central Asia. The number of reservoirs with more than 10 cubic kilometers

203 Online distant interview with Gabit Zhumatay, Senior Lecturer at the Department of Regional Studies at the Kazakh Ablai Khan University of International Relations and World Languages.
204 Interview with Atabek Umirbekov, Climate Change Specialist at the CAREC, 17 May 2017, Almaty.

exceeded 80 during the planned economy era. About 44 cubic kilometers of this capacity is usable currently. As a general property of the hydraulic works in Central Asia, the irrigation schemes are huge and have a low efficiency. The Karakum Canal, the largest irrigation canal in the world, irrigates one of the driest regions in the world.[205] As Jalilov et al. remind, the massive Rogun Dam was initially planned as a reservoir for irrigation purposes in the 1970s.[206] But this project was transformed into one of the world's most ambitious hydroelectricity generation projects with potential benefits, as well as potential stress on environment and agriculture. The Vakhsh river, where the construction of the Rogun Dam is planned, contributes one-third of the Amu Darya runoff. Tapping water of this river poses significant risks to the environment of the Aral Sea basin, as well as to the local ecosystem. The Nurek and the Rogun together will have the potential of holding an entire runoff of the river in a year.[207]

Throughout the Aral Sea region, experts and bureaucrats in Kazakhstan alike observe that water quantity is getting less, the soil salinity and desertification are increasing, and the soil productivity is getting worse.[208] This pessimistic attitude of water and agriculture professionals is quite interesting. They argue that, in addition, the ecology and ecologic diversity has been damaged as a result of the environmental problems. The solution of the problem is getting harder day by day.[209] This issue is a primary source of many social and economic problems, including poverty,[210] loss of income, shrinkage of national wealth.[211]

The decrease of the Aral Sea basin waters is a trend observed by the regional experts.[212] Due to adverse impacts of the climate change in the Aral Sea basin, specialists in the region expect that cotton production in the downstream countries, especially in Uzbekistan, will decrease in the future.[213] Calculations support these observations. The water of the Amu Darya and the Syr Darya are estimated to decline by 10-15 and 6-10 percent, respectively, by 2050 due to the impacts of the climate change.[214] Bekchanov and Lamers calculated that the effects of the water shortage would mostly influence cotton and wheat production in Uzbekistan. This would lead to the abandonment of at least 250 thousand hectares of land, unemployment of 150 to 240 thousand people in the agricultural sector, and 710 to 870 thousand people in total. Consequently, the loss of national income would be between 3.6 and 4.3 percent.[215]

According to Lamers, there is "a false understanding of the causes" of the water and environment issues in Central Asia. This situation complicates the definition of the problems.

205 Jakob Granit, et al., "Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin," in V. Stucki, K. Wegerich, M.M. Rahaman & O. Varis, eds. *Water and Security in Central Asia: Solving a Rubik's Cube*, 2012, p.423.

206 Shokhrukh-Mirzo Jalilov, et al., "Managing the water–energy–food nexus: Gains and losses from new water development in Amu Darya River Basin," *Journal of Hydrology*, vol. 539, 2016, p.650.

207 Shokhrukh-Mirzo Jalilov, et al., "Managing the water–energy–food nexus: Gains and losses from new water development in Amu Darya River Basin," *Journal of Hydrology*, vol. 539, 2016, p.653.

208 Online distant interview with Shokhrukh Jalilov, Research Fellow, Institute for the Advanced Study of Sustainability, United Nations University (UNU-IAS).

209 Interview with Saparov Abdulla, General Director, Republic of Kazakhstan Ministry of Agriculture, Kazakh Research Institute of Soil Science and Agrochemistry named after U.U. Uspanov, 17 May 2017, Almaty.

210 Max Spoor & Anatoly Krutov, "The 'power of water' in a divided Central Asia," Perspectives on Global Development and Technology, vol. 2, no. 3/4, 2003, p.605.

211 Maksud Bekchanov & John Lamers, "Economic costs of reduced irrigation water availability in Uzbekistan (Central Asia)," Regional Environmental Change, vol. 16, 2016.

212 Interview with Atabek Umirbekov, Climate Change Specialist at the CAREC, 17 May 2017, Almaty.

213 Online distant interview with Ainur Kokimova, Project Coordinator, Natural Resources Institute, UNESCO Chair on water resources management in Central Asia.

214 Maksud Bekchanov & John Lamers, "Economic costs of reduced irrigation water availability in Uzbekistan (Central Asia)," Regional Environmental Change, vol. 16, 2016, p.2370.

215 Maksud Bekchanov & John Lamers, "Economic costs of reduced irrigation water availability in Uzbekistan (Central Asia)," Regional Environmental Change, vol. 16, 2016, pp.2376-78.

He suggests that "increasing public awareness in the region on downstream economic and ecosystem effects of unilateral water use development is vital for promoting an integrated basin-wide coordination of water and energy resources that would benefit all riparians."[216]

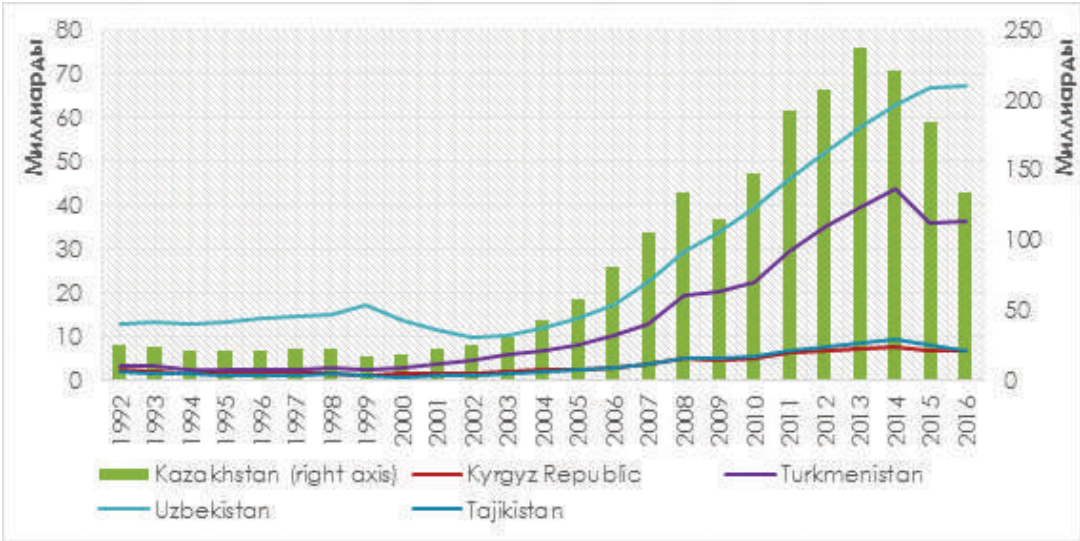
All in all, all these research are conducted through collection and classification of hydrological data. One of the main subjects that were on the agenda during the field research was the quality of and access to relevant data on environment and other related areas of study. The following sub-section summarizes the main findings.

5.5 Data and statistics on energy and hydrological developments

One of the critical aspects of the situation in Central Asia is reaching and analyzing correct, unbiased and integrated data on the economy, energy, water, and environmental topics. As the issue of energy, especially the production and trade of hydrocarbons, is more attractive for international investors and multinational corporations, access to energy data is effortless.

The scholars and experts in Central Asia have to base their research on the official figures provided by the governmental bodies.[217] Some of the experts think that the current data on environmental issues are correct and adequate,[218] while some experienced difficulties in gathering data during their fieldwork and research for academic studies. For instance, on the subject of floods and water regime in Aral Sea basin, some of the missing data must be calculated by the academicians because of missing information.[219]

Figure 5.12. Gross domestic product, current US dollars



Source: World Bank, 2017.

While studying the Syr Darya, the researchers often have to reconstruct the missing data with their calculations. The missing part of the data depends on the observation stations and the

216 Online distant interview with John Lamers, Senior Researcher at the University of Bonn, Department of Ecology and Natural Resources Management.
217 Interview with Yekaterina Strikeleva, Chief of Party of Smart Waters Project at the CAREC, 17 May 2017, Almaty.
218 Online distant interview with Ainur Kokimova, Project Coordinator, Natural Resources Institute, UNESCO Chair on water resources management in Central Asia.
219 Interview with Anonymous Expert (2), 17 May 2017, Almaty.

physical conditions of the stations. One of the reasons why some of the data is missing is the malfunctioning observation stations, according to the experts.

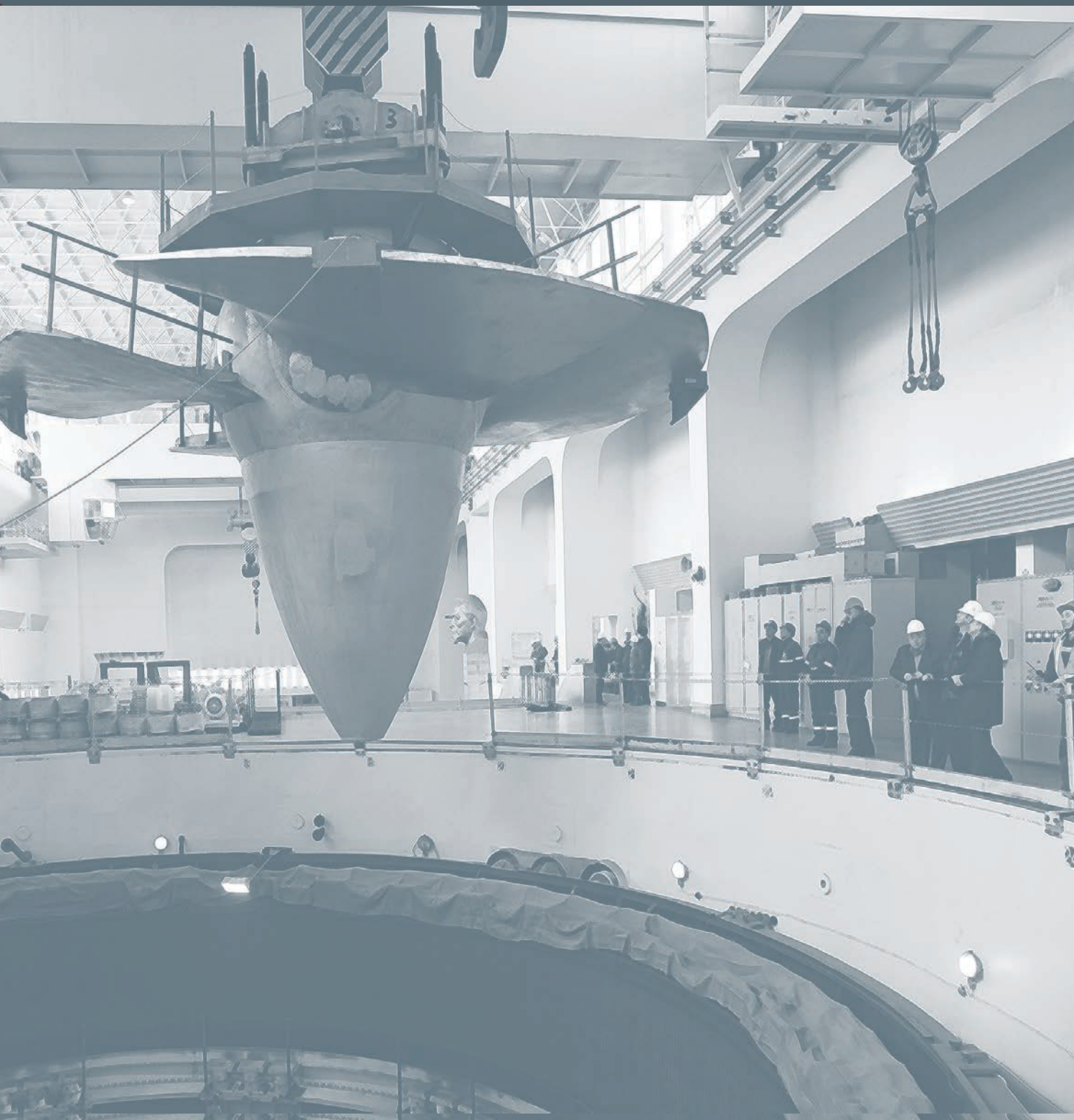
The reason why some observation stations do not function properly is that after the collapse of the Soviet Union, there has been a crisis in most of the observation stations. Some observe that the observation stations in Kazakhstan are more reliable than the other stations in the Syr Darya basin.[220] The biggest problems of measuring hydrological data in the rivers of the Aral Sea basin are, according to Kokimova, lack of specialists, lack of hydro posts, and lack of transparency in data sharing.[221]

This section recapitulated the observations and the main findings of the field research under five sub-sections. In Central Asia, there have been some efforts to address these interrelated and complex subjects on national, regional and international levels. The following section will summarize and analyze these efforts.

220 Interview with Anonymous Expert (2), 17 May 2017, Almaty.

221 Online distant interview with Ainur Kokimova, Project Coordinator, Natural Resources Institute, UNESCO Chair on water resources management in Central Asia.

6. Approaches to the management of environment and energy nexus



6. Approaches to the management of environment and energy nexus

6.1 State-level framework

Since independence, the states in Central Asia have been following more state-centric actions than endeavors for regional cooperation.[222] The actions of the states often ignored the environmental concerns in the region for the sake of economic gains. Among the countries, Kazakhstan pays the most attention to environmental concerns by prioritizing renewable energy production.

Kazakhstan's particular focus on renewable electricity generation found reflection in its 2050 strategy. The following are the words of Nazarbayev in 2012:

> Maintaining the status of a big player on hydrocarbon commodity market, we must develop the production of alternative energy sources, actively seeking to introduce technologies using solar and wind power. By 2050 alternative and renewable energy sources must provide for at least a half of country's total energy consumption.[223]

The progress of implementation of this strategy remains below projections. By the mid-2017, only 1 percent of the total electricity is produced from the renewable sources in Kazakhstan, as one of the interviewees in Kazakhstan stated.[224] The hydroelectricity production amounts to 11 percent of the total electricity production in the country, but only small HPPs are considered as renewable, and a majority of funding is allocated to the wind and solar systems.[225]

Other countries have some initiatives in terms of addressing the energy needs of the people by investing in environment-friendly and low-cost hydropower technologies. In the mountainous Tajikistan, the settlements are close to small streams, and there are 105 active small HPPs as of 2011 that generated 2,328.3 MWh of electricity to meet the energy demands of the people.[226] The total installed capacity of small HPPs are 132 megawatts as of 2012, which corresponds to 2.54 percent of the total.[227] Studies show that about 900 small HPPs are technically and economically feasible to construct throughout the country. According to the UNDP, a total of 200 megawatts can be added to the small HPP inventory of Tajikistan until 2020. The government has passed the Law on the Use of Renewable Energy Sources in 2010 and amended the Energy Law in 2007.[228] Furthermore, there is a long-term program for building small HPPs between 2009 and 2020, in the Target Programme for the Widespread Use of Renewable Energy Sources of Tajikistan.[229] The investments in small HPPs and other renewables have the potential of meeting the energy demands of the people, especially in the

222 I. Abdullaev & S. Rakhmatullaev, "Setting up the agenda for water reforms in Central Asia: Does the nexus approach help?," Environmental Earth Sciences, vol. 75, no. 10, 2016; Virpi Stucki & Suvi Sojamo, "Nouns and numbers of the water–energy–security nexus in Central Asia," International Journal of Water Resources Development, vol. 28, no. 3, 2012, p.409; Online distant interview with Shokhrukh Jalilov, Research Fellow, Institute for the Advanced Study of Sustainability, United Nations University (UNU-IAS).

223 Nursultan Nazarbayev, "Address by the President of the Republic of Kazakhstan, Leader of the Nation, N.Nazarbayev "Strategy Kazakhstan-2050": new political course of the established state," *Kazakhstan 2050*, 2012, available at: https://strategy2050.kz/en/multilanguage/ (accessed 24 May 2017).

224 Interview with Lydia Parkomchik, Water and Energy Specialist, Eurasian Research Institute, 19 May 2017, Almaty.

225 Interview with Lydia Parkomchik, Water and Energy Specialist, Eurasian Research Institute, 19 May 2017, Almaty.

226 H. Liu, D. Masera & L. Esser, *World Small Hydropower Development Report 2013: Tajikistan*, United Nations Industrial Development Organization; International Center on Small Hydro Power, 2013, p.1.

227 UNDP, *Renewable Energy Snapshot: Tajikistan*, UNDP, 2012.

228 H. Liu, D. Masera & L. Esser, *World Small Hydropower Development Report 2013*, United Nations Industrial Development Organization; International Center on Small Hydro Power, 2013, pp.2-3.

229 UNDP, *Renewable Energy Snapshot: Tajikistan*, UNDP, 2012, p.2.

rural and mountainous regions of Tajikistan. The excess electricity may be exported through transboundary transmission lines to the Central Asian and the neighboring countries, which may support the economy of the country.

Kyrgyzstan is also working on the development of the small hydro sector.[230] The country possessed 41.4 megawatts of small hydroelectricity capacity as of 2012, and has a potential of 1,800 megawatts, corresponding to 1.1 percent of the total. Like Tajikistan, Kyrgyzstan passed the Law of the Kyrgyz Republic on Renewable Energy Sources in 2009. The country officially prioritizes the protection of the environment, but the implementation of laws and policies on renewable energy and environment is at a low level.[231] Kyrgyzstan focuses on the development of private sector to invest in renewable energy industry.[232]

Atakhanova suggests that the subsidies for fossil fuels for generating electricity in hydrocarbon-rich countries are adding to the problems of environment-energy nexus in Central Asia. Reducing these subsidies would help to divert the investments into the renewable sector and to increase the energy efficiency.[233]

6.2 Regional framework

The CAREC has since a while undertaken an initiative that brings together the local people from different countries that share rather smaller transboundary streams in Central Asia. The project of the CAREC is titled "Smart Waters" and began in 2015.[234] This is a five-year project supported by the US (USAID), which involves eight small transboundary river basins. Previously, between 2012 and 2015, the experts at the CAREC conducted a similar project under the name of "Stakeholders' partnerships in collaborative policymaking: Fostering transboundary cooperation on small watersheds in Central Asia"[235] that involved small transboundary basins. The rivers were the Aspara,[236] the Ugam, and the Isfara[237] rivers.[238]

The experts at the CAREC tried to apply the principles of river basin management schemes and basin plans in the small transboundary rivers and establish basin councils with representatives on a regional level, representatives from ministries of foreign affairs, and minis-

230 UNDP, "Small Hydro Power Development," *United Nations Development Programme in the Kyrgyz Republic*, n.d., available at: http://www.kg.undp.org/content/kyrgyzstan/en/home/operations/projects/sustainable_development/small-hydro-power-development.html (accessed 24 May 2017); UNDP, "Kyrgyzstan is working on a concept to develop small hydro energy," *United Nations Development Programme in the Kyrgyz Republic*, 2015, available at: http://www.kg.undp.org/content/kyrgyzstan/en/home/presscenter/pressreleases/2015/02/17/kyrgyzstan-is-working-on-a-concept-to-develop-small-hydro-energy.html (accessed 24 May 2017).

231 UNDP, *Renewable Energy Snapshot: Kyrgyzstan*, UNDP, 2012.

232 UNDP-GEF, *The UNDP-GEF Project "Small Hydropower Development": Global Challenges, National Problems and Solutions, 2010-2015*, 2015, p.6.

233 Online distant interview with Zauresh Atakhanova, Associate Professor, Nazarbayev University, School of Humanities and Social Sciences. See also: Peter Howie & Zauresh Atakhanova, "Household Coal Demand in Rural Kazakhstan: Subsidies, Efficiency, and Alternatives," forthcoming.

234 USAID, "Smart Waters," *USAID*, 2017, available at: https://www.usaid.gov/kyrgyz-republic/fact-sheets/smart-waters (accessed 20 May 2017).

235 CAREC, "Stakeholders' partnerships in collaborative policymaking: Fostering transboundary cooperation on small watersheds in Central Asia," *CAREC*, 2015, available at: http://www.old.carecnet.org/programmes-and-activities/water-initiatives-support/stakeholders%E2%80%99-partnerships-in-collaborative-policymaking-fostering-transboundary-cooperation-on-small-watersheds-in-central-asia/?lang=en (accessed 21 May 2017).

236 CAREC, "Aspara River," *CAREC*, n.d., available at: http://www.old.carecnet.org/programmes-and-activities/water-initiatives-support/stakeholders%E2%80%99-partnerships-in-collaborative-policymaking-fostering-transboundary-cooperation-on-small-watersheds-in-central-asia/aspara-river/?lang=en (accessed 21 May 2017).

237 CAREC, "Isfara River," *CAREC*, n.d., available at: http://www.old.carecnet.org/programmes-and-activities/water-initiatives-support/stakeholders%E2%80%99-partnerships-in-collaborative-policymaking-fostering-transboundary-cooperation-on-small-watersheds-in-central-asia/isfara-river/?lang=en (accessed 21 May 2017).

238 Interview with Yekaterina Strikeleva, Chief of Party of Smart Waters Project at the CAREC, 17 May 2017, Almaty.

tries of agriculture of the relevant countries. During the projects, the CAREC tried to apply the principles of IWRM and embraced a "basin approach." As a consequence, small basin councils were established with the participation of the local communities, water ministries, water users associations, water management and control authorities. These people meet and communicate to each other on a smaller scale and a local level, at least twice a year. Bringing people together on the local level and making them interact, as the experts at the CAREC argued, facilitated the solution of some minor local problems, particularly in the case of the Isfara river. The local communities of the Isfara river were unwilling for communication, and the endeavors of bringing them together to discuss the shared water management issues in the basin took some 1.5 years. For the Aspara river, on the other hand, it took only months to bring the local communities together. For the Isfara, ethnic, political and historical factors were involved in the issue, as the basin of the Isfara includes Osh and Batken regions. The presence of enclaves of Uzbekistan in this basin makes the solution of water problems even more challenging. In some places in the basin, there is even no border demarcation signs and cross-border conflicts, even shootings are likely to occur on each side of the border. With the help of the regular meetings, the risk of such kind of conflicts was decreased, according to the experts, to a significant degree.[239]

The importance of and achievements gained through working on micro-level is explained by the local experts as follows: The projects demonstrated that cooperation is possible on a regional level, if not on macro and intergovernmental levels. Implementing and encouraging cooperation on macro-level is more difficult as governments and other decision-making mechanisms are involved in the process, which is not real catalysts for cooperation.[240] In the past, there have been endeavors of working on macro-level with governments. The experts at the CAREC tried to push the governments in the basin to reach new agreements on water use and management, but the agreements lacked approval of the political leaders. As these processes do necessarily involve political decision-making mechanisms, currently, the experts decided not to push for new agreements. They think that there are already enough agreements signed during the Soviet era that may be applied to the current water and environment issues.[241]

The experts at the CAREC believe that as a consequence of such kind of small-scale regional cooperation efforts, where the local organizations act solely as facilitators, the governments realize how problems can be solved. In that way, there is no skepticism from the side of governments as the regional environmental actors are not involved in the political issues and are neutral in such subjects. The governments, on the other hand, send representatives to the meetings from their water ministries as observers of the situation.[242]

Involving Afghanistan into the solution of environment and energy nexus problems in Central Asia is an important aspect of the regional framework as Afghanistan supplies a substantial share of water of the Amu Darya.[243] Local organizations have some initiatives to involve Afghanistan into the picture, although on a subtle scale and initial stage.[244]

239 Interview with Yekaterina Strikeleva, Chief of Party of Smart Waters Project at the CAREC, 17 May 2017, Almaty.
240 Interview with Lyudmila Kiktenko, Manager of the Environmental Management Programme at the CAREC, 17 May 2017, Almaty.
241 Interview with Lyudmila Kiktenko, Manager of the Environmental Management Programme at the CAREC, 17 May 2017, Almaty.
242 Interview with Anna Inozemstva, Water Initiatives Support Program Leading Specialist at the CAREC, 17 May 2017, Almaty.
243 Online distant interview with Shokhrukh Jalilov, Research Fellow, Institute for the Advanced Study of Sustainability, United Nations University (UNU-IAS).
244 Interview with Yekaterina Strikeleva, Chief of Party of Smart Waters Project at the CAREC, 17 May 2017, Almaty.

According to some experts, the International Commission on Large Dams (ICOLD) can be a viable platform for cooperation in terms of large dams, such as the Rogun Dam, and the Kambarata project. According to the Anonymous Expert (3),

> [T]he creation of a regional chapter of the [ICOLD] can play a role as a neutral regional platform. [...] Under the umbrella of the Central Asia ICOLD national working groups can cooperate and discuss various [topics] regarding the development of mutually beneficial procedures, regulation norms, and standards on the monitoring of hydro-infrastructure safety.[245]

There are further regional initiatives that are directly or indirectly related to energy, environment, and other relevant issues. Among them is the Shanghai Cooperation Organization, which was initially established as a mutual security organization but currently turning into an organization supporting economic cooperation. The Eurasian Economic Community is another regional organization that includes energy and agricultural issues among its areas of interest. The Central Asia Regional Economic Cooperation is a more specific organization aiming at reducing poverty and ensuring sustainable development in the region.[246]

6.3 International framework

The major international organizations in recent years increased support for projects that may help increase the generation and consumption of sustainable energy. According to Juraev, the "efforts of various international organizations to mediate or facilitate [...] cooperation [in the Aral Sea basin] have been useful at various levels, but they cannot address the problem, since it is essentially a political issue."[247] During the projects conducted by the international organizations and donors, sustainable development is usually an important item on the agenda. But the implementation of the principles of sustainable development has always been problematic.[248]

In 2011, the UN began an initiative "Sustainable Energy for All."[249] Central Asia has been among the major application areas of such initiatives with the support of financial international organizations and aid from the developed countries. The World Bank supported the interconnection between the north and the south Kazakhstan through a 500 kV transmission line.[250] The UNDP and GEF provide technical and financial assistance for boosting renewable electricity production and its export to the countries in the region.[251] Islamic Development Bank has supported the construction of mini HPPs in rural Tajikistan since 2004.[252]

The international bodies such as the Asian Development Bank, the Eurasian Development Bank, the European Bank for Reconstruction and Development, the International Finance Corporation all produce loans to and facilitate financing of renewable industries of Tajikistan

245 Online distant interview with Anonymous Expert (3).

246 Jakob Granit, et al., "Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin," in V. Stucki, K. Wegerich, M.M. Rahaman & O. Varis, eds. *Water and Security in Central Asia: Solving a Rubik's Cube*, 2012, pp.427-28.

247 Online distant interview with Shairbek Juraev, Marie Curie Fellow, University of St Andrews, United Kingdom.

248 Online distant interview with Shokhrukh Jalilov, Research Fellow, Institute for the Advanced Study of Sustainability, United Nations University (UNU-IAS).

249 UNDP-GEF, *The UNDP-GEF Project "Small Hydropower Development": Global Challenges, National Problems and Solutions, 2010-2015*, 2015, p.4.

250 World Bank, "North-South Electricity Transmission Project," *The World Bank*, 2012, available at: http://projects.worldbank.org/P095155/north-south-electricity-transmission-project?lang=en (accessed 22 May 2017).

251 H. Liu, D. Masera & L. Esser, *World Small Hydropower Development Report 2013*, United Nations Industrial Development Organization; International Center on Small Hydro Power, 2013, p.2.

252 Islamic Development Bank, *Mini Hydropower Plants Brighten Rural Tajikistan*, Islamic Development Bank, 2013.

and Kyrgyzstan.[253] In addition, some actors such as Russia, the US and the EU occasionally encouraged the Central Asian states to collaborate in transboundary environment issues. However, as some experts observe, such attempts did not bear fruit.[254]

With the involvement of international organizations and donors from the developed world, some relevant international bodies were established that are specialized in the environment and water issues in Central Asia. Among them, the International Fund for Saving Aral Sea cooperates with the UNECE, GIZ, the World Bank, the USAID, the EU, the Swiss Agency for Development and Cooperation, the OSCE, and the CAREC.[255] Another important organization is the CACENA, an international organization specialized in environment and water issues of Central Asia and Caucasus, established in 2002.[256]

Granit et al. argue that in Central Asia, "there is *demand* for a regional regime that can address cooperation coherently."[257] In general, the projects and initiatives of the international organizations tend to focus on one aspect of the energy and environment nexus. Recently, the nexus approach began to be embraced by the international bodies. The number of initiatives based on the nexus approach is necessary in order to facilitate far-reaching regional environment, water, food, and energy issues, as well as other regions of the world.

253 UNDP, *Renewable Energy Snapshot: Tajikistan*, UNDP, 2012.

254 Online distant interview with Shokhrukh Jalilov, Research Fellow, Institute for the Advanced Study of Sustainability, United Nations University (UNU-IAS)..

255 EC IFAS, "EC IFAS Partners," *IFAS*, 2011, available at: http://ec-ifas.waterunites-ca.org/about/partners/index.html (accessed 23 May 2017); Interview with Marat Narbayev, Head of Water Resources Department, International Fund for Saving Aral Sea, 18 May 2017, Almaty.

256 Global Water Partnership, "About GWP CACENA," *Global Water Partnership Central Asia and Caucasus*, 2017, available at: http://www.gwp.org/en/CACENA/ABOUT-GWP-CACENA/who/about-gwp-cacena/ (accessed 25 May 2017).

257 Jakob Granit, et al., "Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin," in V. Stucki, K. Wegerich, M.M. Rahaman & O. Varis, eds. *Water and Security in Central Asia: Solving a Rubik's Cube*, 2012, p.428. Emphasis in original.

7. Conclusions and policy recommendations

7. Conclusions and policy recommendations

This study revealed the importance and relevance of studying the environment-energy nexus from the perspective of the Central Asian countries, in connection and collaboration with the regional experts and policymakers. Instead of focusing on conflict and cooperation in the current water-centric literature, this study suggests concentrating on the environment and energy nexus from a transboundary perspective. Energy and environment are interdependent and should not be scrutinized separately. The study of cooperation and conflict in the nexus studies are also interrelated. As cooperation is difficult to achieve and the social life is composed of both conflict and cooperation, this study suggests focusing on the nexus approach, which stresses multi-centricism[258] and interdependence.

Energy is a must for a sustainable economic and social development in the region, and the resources for producing energy are distributed unevenly between the countries. The demand for energy and electricity is likely to increase in the future due to an increase in the population and economic growth. The grand hydroelectricity schemes planned by Tajikistan and Kyrgyzstan have the potential to meet the demand for energy, but they are likely to increase the pressure on the environment and environment-related water and food issues in Central Asia. As suggested by some scholars, the focus on renewable energy production, as well as the non-political technical integration of electricity markets[259] are central to addressing the regional energy-environment nexus questions.

Further policy recommendations generated as an outcome of this study are listed below.

- The recent tendency in the academia is focusing on cooperation based on the principles of the IWRM. The academic world should focus more on the environment-energy nexus in Central Asia by collaborating closely with the regional experts and policymakers.
- The current literature tends to be water-centric. The literature should pay equal attention to energy, environment, and agricultural aspects of the nexus studies.
- The countries in Central Asia should enhance and develop more channels for cooperation on the transboundary water, energy and environment issues. Interdependence and concessions are the keys to the solution of environmental and other related issues in the region.
- The policymakers should take the policy advice of the academicians and experts into consideration. The recommendations of the international organizations, academicians and think-tanks must find the opportunity of being realized and applied to real political decisions.
- The governments and the international organizations should work in cooperation to produce reliable, integrated, and open access data. This would encourage the academicians who desire to study the nexus in the region.
- The energy needs of the people in the region should be met by taking into consider-

258 I. Abdullaev & S. Rakhmatullaev, "Setting up the agenda for water reforms in Central Asia: Does the nexus approach help?," *Environmental Earth Sciences*, vol. 75, no. 10, 2016, p. 7.

259 Jakob Granit, et al., "Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin," in V. Stucki, K. Wegerich, M.M. Rahaman & O. Varis, eds. *Water and Security in Central Asia: Solving a Rubik's Cube*, 2012, pp.425-27; Virpi Stucki & Suvi Sojamo, "Nouns and numbers of the water–energy–security nexus in Central Asia," *International Journal of Water Resources Development*, vol. 28, no. 3, 2012, p.412.

ation the environmental concerns through regional cooperation.

- The rehabilitation and renovation of the CAPS, as well as the establishment of a functioning power market with pooled resources may be beneficial for achieving economic and technical cooperation. A non-ethnic, technical, region-based cooperation is needed regarding environment and energy issues.
- The international community and organizations should encourage and financially support the regional economic and technical cooperation between the regional countries.
- The international organizations should focus more on the nexus approach than the IWRM for the solution of regional problems as the latter has the potential of separating the issues of water, energy, environment, and food.

8. Acknowledgements

8. Acknowledgements

The researchers would like to thank the Eurasian Research Institute for supporting and funding this research. Also, special thanks to the experts and staff at the Regional Environmental Centre for Central Asia (CAREC), the Kazakh Research Institute of Soil Science and Agro Chemistry Named After U.U. Uspanov, the Institute of World Economics and Politics under the Foundation of the First President of the Republic of Kazakhstan-The Leader of the Nation, the Kazakh-German University, the International Fund for Saving the Aral Sea, the Al-Farabi Kazakh National University, and the Eurasian Research Institute.

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Ainur Kokimova, Project Coordinator, Natural Resources Institute, UNESCO Chair on water resources management in Central Asia, online distant interview.

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