THE PROBLEM OF THE WATER-ENERGY NEXUS IN THE ARAL SEA BASIN: IDENTIFYING FEASIBLE POLITICAL-ECONOMIC SOLUTIONS

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ABSTRACT

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Master's Program in Sustainable Energy

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Mechanisms of Soviet centralized planning made it possible to maintain a balance of interests between hydrocarbon-rich Kazakhstan, Uzbekistan, Turkmenistan, and water-abundant Tajikistan and Kyrgyzstan. The key element to this system was large-scale multi-purpose hydropower plants on the Syr Darya and Amu Darya that provided the former, downstream republics with water essential for irrigated agriculture. Power generated at these plants was complemented by fuels from the downstream republics to ensure sustainable electricity distribution within the Central Asian Power System, whereas occurring imbalances were alleviated by coordinated inter-republican supplies of hydrocarbons. Upon the demise of the unified state, the upstream countries had to purchase oil and gas at world prices, while the downstream ones continued utilizing the water coming from the formers' territory for free. By the mid-1990s, operations at Kyrgyz and Tajik HPPs were switched from the designed irrigation to energy modes that resulted in summer droughts, winter floods, and energy disparities. Despite all the efforts inside the region and by the international community to change things, Central Asians now annually lose huge sums due to a lack of closer cooperation on water issues.

This study, based on the benefit-sharing approach, analyzes the use of water and energy resources to ascertain feasible political-economic solutions to the water-energy conflict in the Aral Sea Basin. Through the surveying scholars familiar with the problem, the investigation also evaluates the applicability of various ideas and concepts to tackle the issue. Based on these findings, the study will suggest some suggestions and policy recommendations.

Keywords: Central Asia, conflict, water, energy, nexus, benefit-sharing.

ÖZET

ARAL GÖLÜ HAVZASINDA SU-ENERJİ BAĞLANTISI:
UYGUNLANABILIR SİYASİ VE İKTİSADİ ÇÖZÜMLERİN TANIMLAMASI

Mubarakshin, Bulat

Sürdürülebilir Enerji Yüksek Lisans Programı

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Ocak, 2022

Sovyet merkezi planlama mekanizmaları, hidrokarbon zengini Kazakistan, Özbekistan, Türkmenistan ve su zengini Tacikistan ve Kırgızistan arasındaki çıkarlar dengesini korumayı mümkün kıldı. Bu sistemin kilit unsuru, aşağı havza cumhuriyetlerine tarım için gerekli suyu sağlayan Sır Darya ve Amu Darya nehirlerindeki büyük ölçekli çok amaçlı hidroelektrik santralleriydi. Bu santrallerde üretilen enerji, Orta Asya Elektrik Şebekesi içinde sürdürülebilir elektrik dağıtımını sağlamak için aşağı havza cumhuriyetlerden gelen yakıtlarla tamamlanırken, meydana gelen dengesizlikler, cumhuriyetler arası koordineli hidrokarbon tedarikleriyle hafifletildi. Birleşik devletin sona ermesiyle birlikte, yukarı havza ülkeleri dünya fiyatlarına petrol ve gaz satın almak zorunda kalırken, aşağı havza ülkeleri yukarı havza topraklarından gelen suyu ücretsiz olarak kullanmaya devam etti. 1990'ların ortalarına gelindiğinde, Kırgız ve Tacik hidroelektik santrallarındaki operasyonlar, tasarlanmış sulama modundan enerji moduna çevrildi, bu da yaz kuraklıkları, kış selleri ve enerji eşitsizlikleriyle sonuçlandı. Bölge içindeki ve uluslararası toplumun bu şeyleri değiştirmek için gösterildiği tüm çabalara rağmen, Orta Asyalılar su konularında daha yakın işbirliği eksikliği nedeniyle her yıl büyük meblağlar kaybediyorlar.

Fayda paylaşımı yaklaşımına dayanan bu çalışma, Aral Denizi Havzası'ndaki su-enerji çatışmasına uygulanabilir siyasi-iktisadi çözümler bulmak için su ve enerji kaynaklarının kullanımını analiz etmektedir. Araştırma, soruna haberder olan araştırmacı bilim adamları aracılığıyla, konuyu ele almak için çeşitli fikir ve kavramların uygulanabilirliğini de değerlendirir. Bu bulgulara dayalı olarak, çalışma bazı teklif ve politika önerileri sunacaktır.

Anahtar Kelimeler: Orta Asya, çatışma, su, enerji, bağlantı, fayda paylaşımı.

I dedicate this dissertation to my family.

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LIST OF ABBREVIATIONS

ADB: Asian Development Bank

ASBP: Aral Sea Basin Program

BPA: Bonneville Power Administration

bcm: billion cubic meters

bln: billion

BWO: Basin Water Organization

CA: Central Asia

CAEC: Central Asian Economic Cooperation (organization)

CAPS: Central Asian Power System

CDC "Energiya": Coordination Dispatch Center "Energiya"

CIS: Commonwealth of Independent States

EABD: Eurasian Development Bank

EEU: Eurasian Economic Union

EBRD: European Bank for Reconstruction and Development

EECCA: Eastern Europe, the Caucasus, and Central Asia (region)

EP: European Parliament

ETL: Electric transmission line

EU: European Union

GDP: Gross Domestic Product

GW: gigawatt (capacity)

GWP: Global Water Partnership

ha: hectare(s)

HPP: Hydroelectric power plant

ICWC: Interstate Commission for Water Coordination of Central Asia

IEA: International Energy Agency

IFAS: International Fund for Saving the Aral Sea

IDB: Islamic Development Bank

IJC: International Joint Commission

IWEC: International Water and Energy Consortium

IWRM: Integrated Water Resources Management

kWh: kilowatt-hour (output)

mln: million

Mtoe: million tonnes of oil equivalent

MW: megawatt (capacity)

OECD: Organization of Economic Cooperation and Development

OCAC: Organization of Central Asian Cooperation

SDC: Swiss Agency for Development and Cooperation

SIC ICWC: Scientific-Information Center of the ICWC

SPECA: United Nations Special Programme for the Economies of Central Asia

TPP: Thermal power plant

tU: tonnes of elemental uranium

TWh: terawatt-hour (output)

UN: United Nations

UNDP: UN Development Programme

UNECE: UN Economic Commission for Europe

UNEP: UN Environmental Programme

UNESCAP: UN Economic and Social Commission for Asia and the Pacific

UNRCCA: UN Regional Center for Preventive Diplomacy for Central Asia

USA: United States of America

USAID: United States Agency for International Development

USD: United States Dollar

WB: World Bank

CHAPTER 1: INTRODUCTION

1.1. The water-energy conflict of Central Asia

In Central Asia[1], water and energy resources are intimately intertwined, as, perhaps, nowhere in the world, to form an intricate nexus and play a critical role in the socio-economic development of the region.

In terms of fossil fuel endowments, the regional countries can be divided into two groups. For the resource-rich republics of Kazakhstan, Uzbekistan, and Turkmenistan, energy is the locomotive of economic development and the basis for pursuing multifaceted foreign policies aimed at finding a way out of the region's geographical isolation (SPECA, 2004; Tomberg, 2012). In turn, Kyrgyzstan and Tajikistan are deprived of any significant reserves of hydrocarbons and have to import them from abroad. At the same time, these countries accumulate on their territories 80 percent of the regional water reserves necessary for agricultural development in the latter group of states (Yasinskiy and Vinokurov, 2008).

In the times of the Soviet Union, water and energy resources were part of the inter-republican (intra-regional) integrated resource management system. Water had a major role in ensuring regional development including agricultural security and energy diversification. The foundation of this integrated system was laid down by the construction of large-scale multi-purpose HPPs on the Aral Sea Basin's main water flows – the rivers of the Syr Darya and the Amu Darya (Mamatkanov, Bajanova and Romanovskiy, 2006). Water from these rivers was stored in upstream reservoirs of Kyrgyzstan and Tajikistan to be supplied to vast irrigation systems in downstream Kazakhstan, Uzbekistan, and Turkmenistan for agricultural production in summer. In return, oil, coal, and natural gas were transferred from the latter group of republics to the former in winter (Xenarios et al., 2018; Libert, Orolbaev and Steklov, 2008). In a similar vein, the electricity generated in Kyrgyzstan's and Tajikistan's hydropower plants during the summer vegetation period was provided to all through the Central Asian Power System (CAPS), whose performance throughout the region in winter was supported by centralized hydrocarbon provisions from downstream republics

[1] With the terms Central Asia and the Central Asian region, or just the region, this thesis refers to the five former Soviet republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.

(Kasymova, 2009). Thus, under the Soviet command-and-control system, the supply of water from the upstream republics was being compensated for by means of energy provisions in the opposite direction, thereby sharing and optimizing benefits based on barter relations. Water resources per se were exclusive state-owned assets and provided as a “free good” (WB, 2004). The main idea behind this benefit-sharing mechanism was not to share physical water, but rather the benefits coming out from better water management (Jalilov, Olli and Keskinen, 2015).

Ever since the dissolution of the USSR, the regional states affirmed their rights to dispose of lands, water sources, and natural resources within their lands, not just to produce agricultural goods but also for energy generation, which has resulted in unilateral paths of development (Pohl et al., 2017; Hodgson, 2010). Upstream Kyrgyzstan and Tajikistan have argued that water should be considered as a commodity and for this reason has to be paid for by the downstream riparians (Usubaliev, 1998; Arifov, Negmatullaev and Arifova, 2007). The downstream countries, in turn, have embraced the internationally accepted approach that the water in a transboundary river is a common weal that ought to be shared by all countries of a basin. Nonetheless, they have simultaneously started trading hydrocarbons at world prices. In such circumstances, upstream Kyrgyzstan and Tajikistan, which at that time were living through an economic downturn, could no longer purchase sufficient amounts of fossil fuels to cover their higher electricity needs during winters with money from the sale of their summer surpluses (Kemelova and Zhalkubaev, 2003). For instance, since the early 1990s, the Kyrgyz authorities began discharging fewer volumes of water from the Toktogul HPP in summer and, conversely, increasing winter discharges to produce more electricity to meet the electricity needs in winter (Antipova et al., 2002). This disruption has led to winter floods and summer droughts (the shortage of irrigation water) in the downstream areas along the Syr Darya in Kazakhstan and Uzbekistan (UNECE, 2015; Wegerich et al., 2015). Additionally, the upstream riparians began devising plans with the construction of new HPPs in the hope to expand the electricity exporting capacities instead of seeking benefit-sharing models of cooperation based on existing infrastructure.

Thus, the natural controversies between the subjects of water use – hydropower and irrigated farming – after the collapse of the unified state have resulted in a wide range of inter-state challenges that could be classified under the umbrella term

"Water-energy conflict of Central Asia"[2].

To date, irrigated agriculture remains the primary consumer of water in the region (Mamatkanov, Bajanova and Romanovskiy, 2006). In fact, one of the key reasons behind the emergence of the water-energy conflict was its irresponsible extensive development during the USSR, whose rulers considered moisture-loving cotton as an important export and cash crop (ICG, 2005; Fuzaylov, 2006). Nowadays agriculture in the Aral Sea Basin is still dominated by cotton, but with a growing shift to grains (Granit et al., 2010). Of the total arable land area of Central Asia (about 40 million ha), the irrigated part amounts to 9.1 million ha, the vast majority of these lands lie in the basin (OECD, 2020). It should be noted that since 1960, according to official statistics, the population of the Central Asian states has quadrupled, while the area of irrigated land and the volume of water withdrawals have almost doubled (see Table 3 in Chapter 3). Taking into account the continuing demographic growth, a possible shortage of water for economic and domestic needs is becoming an increasingly serious challenge for all the regional states.

Like elsewhere in the world, water plays here an indispensable role in sustaining local ecosystems and biodiversity. Unfortunately, for the reasons mentioned above, for many decades environmental needs in regional water use were virtually ignored that eventually led to the catastrophic shrinkage of the Aral Sea and irreversible harm to the surrounding areas (Russell, 2018). Among other climatic factors, this is speeding up the melting of Central Asia's glaciers. The long-run impact of the decreasing snow peaks will be permanently reducing river runoffs with consequences for all spheres of economic and social activity in the region (Diebold, 2014).

Another major subject of water use in Central Asia is hydropower. If under the Soviet Union the priority had been given to irrigated farming while hydropower had only played a supporting, secondary role, since 1991 only Kazakhstan, Turkmenistan and Uzbekistan have been maintaining the same standing, whereas Tajikistan and Kyrgyzstan are keen on developing hydropower generation as the core element of their economies (Pohl et al., 2017; Tomberg, 2012). However, its further development under current conditions is constrained by the technological parameters of seasonal streamflow regulation in the interests of the agricultural sector. Large hydropower

[2] The term Water-Energy Conflict in this study imply a set of challenges faced by the Central Asian countries in governing of the regional water management and energy sectors in an integrated mode.

facilities in Kyrgyzstan and Tajikistan, to varying degrees, have to operate mainly to maintain irrigation systems in neighboring Uzbekistan, Kazakhstan, and Turkmenistan This situation impedes the use of water reserves in Kyrgyz and Tajik reservoirs for winter electricity generation and dims the prospects of its export expansion. (Borishpolets, 2007).

Looking at the nature of the water-energy conflict in the Aral Sea Basin[3] one can distinguish somewhat interconnected yet different problem points. In our estimation, the three following challenging issues may be defined (see Figure 1.).

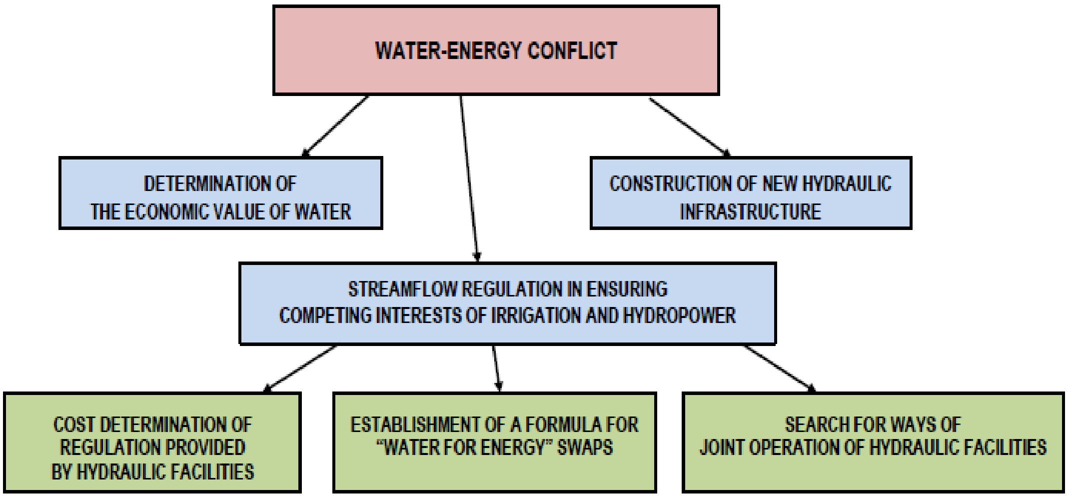

Figure 1. A breakdown of the Central Asian water-energy conflict

The issue of *the streamflow regulation in ensuring competing interests of irrigation and hydropower* are perhaps among the most acute and central ones. The fact is that the seasonal water requirements for irrigation and energy are different. Both of these areas require disparate regimes for regulating stream flow by reservoirs. If, for the purposes of hydropower, it is important to maximize water accumulation in summer and its subsequent intensive release during the heating season, then irrigated agriculture, on the contrary, is concerned with the accumulation in winter and the utilization during the growing season. In Central Asia, the downstream countries insist that the reservoirs built during the Soviet era should operate in the irrigation modes in

[3] The water-energy conflict of Central Asia, in fact, geographically boils downs to the river basins of the Syr Darya and Amu Darya (both belong to the Aral Sea) and are characterized by the linkage of water and energy use issues. Other river basins of Central Asia (Ural, Irtysh, Ili, etc.) are mainly marked by water management problems.

line with their design conditions and release water in summer. The upstream countries in principle agree with these requirements and are ready to abandon the energy (non-design) mode of operation at hydroelectric facilities when the main water releases are carried out in winter (Kemelova and Zhalkubaev, 2003). However, neither Tajikistan nor Kyrgyzstan has any significant reserves of hydrocarbons, and therefore they are forced to purchase energy (electricity or/and fossil fuels) from their neighbors at world prices so as to maintain their power systems during the heating season. For this reason, these states believe that the refusal from the so-called "national" (energy) regulation scheme of river flow is a service provided to Uzbekistan, Kazakhstan, and Turkmenistan. Like every service, it must be paid for, in every case, at least in those proportions of losses and costs they incur (Usubaliev, 1998).

For its part, considering the streamflow regulation in this study we would also divide this issue into three sub-problems, namely: the *cost determination of the regulation* provided by HPPs, the *establishment of a "water for energy swaps" formula*, finding *the way of joint operation of hydraulic facilities*.

The problem of *determining the economic value of water* is another conflict point that is closely related to the abovementioned one. It is widely believed in the upstream states that water is an economic commodity that these states are entitled to trade (Arifov, Negmatullaev and Arifova, 2007). The downstream countries strongly disagree with this statement and believe that water resources are a "free gift of nature" (Duhovny and Sokolov, 2003)

The third problem is related to *building new hydraulic infrastructure* and is inherent to both rivers. In the Syr Darya, the plans of Kyrgyzstan to construct the Kambarata-1 HPP with a reservoir in order to meet the winter peak of domestic power demand have been opposed to a greater or lesser degree by downstream Uzbekistan and Kazakhstan, which are, at least in words, concerned about the sustainability of water supplies and the dam security. The conflict here is not so profound, in part because there is no clarity with regard to necessary investments (Suleimanova, 2018). In contrast, Tajikistan, which lands generate up to 80 percent of the Amu Darya's waters, has been quite successful in constructing the Rogun HPP with the world's tallest dam. Until the change of power in downstream Uzbekistan in 2016, the project had seen strong opposition from the neighboring country including the halting of gas and electricity supplies, as well as transit blockade (Tomberg, 2012).

Attempts to resolve, or at least to approach to the solution of the water-energy conflict have been made since the breakup of the Soviet Union. In order to prevent a radical breakdown of the established water management and electricity flows systems, all countries of the region signed two framework documents regulating relations in the field of joint use of water resources (the 1992 Almaty Agreement) and on the parallel operation of the power systems (the 1991 Ashgabat Agreement). In addition to them, over the 1990s the countries concluded more practical agreements interlinking the use of water and energy resources, inter alia, “On the use of fuel, energy and water resources, construction, operation of gas pipelines of the Central Asian region” (Tashkent, 1996) and “On the use of water and energy resources of the Syr Darya Basin "(Bishkek, 1998).

In the conditions of de facto unexpected independence but ongoing heavy dependence on economic issues, Central Asian governments established several intra-regional bodies to preserve core elements of integrated management in the use of water and energy resources (Pohl et al., 2017). Under the Almaty agreement the Interstate Commission for Water Coordination (ICWC), in which member states have since arranged practical water management issues, was founded. In 1993, for the efficient use of water resources and improvement of the environmental situation in the Aral Sea Basin, the International Fund for Saving the Aral Sea (IFAS) was established. With funds from national and international donors, from 1994 onwards the Fund and its affiliated organizations have been implementing multifaceted action programs to improve the ecology of the Aral Sea Basin (ASBP-1, 2, 3, 4).

Numerous international organizations including the United Nations’ agencies and bodies (UNDP, UNESCAP, UNDP, UNEP), development banks (WB, ADB, EBRD, IDB) and a plethora of international development agencies and sectoral institutions have repeatedly been involved in water-related projects. Starting in the late 1990s, close attention to the development of a regional integrated water and energy system had been paid within regional integration associations (CAEC and EEU). Such documents as the Concept of the International Water and Energy Consortium, the Concept for the Efficient Use of Water and Energy Resources in Central Asia, and the like were drafted. Most recently, in 2017, the UNRCCA came up with the idea of resuming talks on mutually acceptable avenues of water use on the basis of draft conventions for the Amu Darya and the Syr Darya, which was, in all likelihood, left unattended.

All in all, for a variety of reasons ranging from low trust and a high level of political securitization to a lack of competence and financial capacity at the level of ordinary performers, effective inter-state relations on the joint use of water and energy resources have not been established. Along with the unsustainable environmental practices that have persisted since Soviet times, the water-energy conflict has a restraining effect on prospects for regional integration and constitutes serious obstacles to furthering sustainable development of the Central Asian region. Largely as a result of the decaying processes in the once unified water and energy complex[4] of Central Asia, regional states are suffering colossal losses. According to an assessment commissioned by the SDC in 2017, Central Asian states annually lose USD 4.5 billion due to a lack of closer cooperation on water issues (Pohl et al., 2017).

1.2. The aim and the scope of the thesis

This thesis aims to analyze the problems of Central Asian inter-state governance in the use of water and energy resources (the water-energy nexus framework) in the Aral Sea Basin through the prism of the benefit-sharing approach and, thus, identify promising political-economic avenues in addressing them. Taking into account the uneven spatial distribution of water and energy resources throughout the regional countries, such a view of the problem offers a construct consisting of the following research questions:

- Which elements of the water-energy nexus framework and the benefit-sharing approach used in the USSR could be viable in the current political-economic situation in the region?
- How do the regional states' development strategies correlate with the water-energy conflict in the Aral Sea Basin?
- What infrastructural and institutional solutions could be applied to foster closer cooperation between the riparian countries?

The thesis will provide qualitative and quantitative assessments of the use of water and energy resources in the five Central Asian countries – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan – with a particular focus on the inter-state governance over their interconnected use in the Aral Sea Basin. In this

[4] With the terms the Water and Energy Complex or/and Water and Energy Sector of Central Asia, this study refers to a broader meaning of the term Regional Water Management Complex, which, in addition to water bodies and hydraulic facilities, also includes associated electric power installations.

context, relations of the basin countries with the neighboring Chinese Xinjiang, Russia, and South Asia, especially Afghanistan, whose northern part is located in the Amu Darya basin, may be addressed to a certain extent.

The research mainly examines development dynamics since the dissolution of the Soviet Union with retrospective analysis of trends and events in both regional water and energy sectors that occurred before 1991.

The dissertation is organized into six chapters. Chapter 1 initiates the presentation of the water-energy conflict giving insights into its background and defining the scope of the study. Chapter 2 demonstrates a dualistic nature of the nexus framework (benefit-sharing vs securitization) and also explains the difference in the regional states' approaches to International Waters Law (the law of watercourses), all based on a review of the relevant literature. This theoretical part of the thesis also outlines the methodological aspects of the study. It details the research design and research methods employed for the investigation in general and the conducted survey in particular. Chapter 3, in turn, provides the past and present-day of water and energy use in the Aral Sea Basin. Proceeding from the theoretical framework and the practical aspects of water and energy use, Chapter 4 presents promising institutional and infrastructural avenues for solving the regional water-energy conflict and also informs on the various practices from around the globe that may be helpful for Central Asian states. Chapter 5, called Discussion and the survey findings, summarizes the preliminary results of what was analyzed before and enquires with academia, namely scholarly experts, who have specialized knowledge, so as to evaluate and compare with our perspective of the problem and its solutions. Chapter 6 finally reports the theoretical and practical implications of the study. It also presents certain policy recommendations to further improve the performance of the water-energy nexus in Central Asia.

CHAPTER 2: THEORETICAL FRAMEWORK

2.1. Water-Energy Nexus: Benefit-Sharing vs Securitization

In today's world, water, energy, and food are increasingly seen as closely interlinked resources. Water is required to generate power and produce food; energy is needed for food products manufacturing; food can serve as a source of energy. In doing so, both energy and food interact through the medium of water. Thus, all three resources have heavy interdependencies and are influenced by actions in any of these domains.

It was acknowledged at the Bonn 2011 Conference that the term "nexus" can best define the linkages between water, energy, and food, and that their integrated management (hereinafter – the *WEF nexus framework*) is instrumental in the face of increasing concerns over their future availability and sustainability. The protraction of such isolationist policies in their regard, which are especially widespread in most developing countries, will have repercussions for economies and cause further degradations of ecosystems on the whole (Abdul Salam et al., 2017).

In one of the first articles revealing the nature of the WEF nexus framework, Bazilian et al. (2011) stress the necessity to adopt it, noting that "the competing priorities, institutional capabilities, and regulatory regimes within each of these three sectors encourage 'silo-thinking' in decision-making". As a result, these lead to sub-optimal regulatory and policy choices as well as communication failures which, in turn, negatively impact development goals. Whereas the nexus framework, despite its obvious descriptive nature, may serve as an important communication tool bringing together different resources under integrated management policies. As was also noted by the authors, "if the nexus is treated holistically and linkages across boundaries are established, single-sector policies that undermine the delivery of services in other sectors could be avoided and common welfare improved". The nexus framework highlights systemic interactions and the need to consider different sectoral water uses as elements of a system rather than in isolation, argues Muller (2017).

The need for the WEF nexus framework is especially acute for Central Asia with its vast irrigated areas, rapidly growing population, and uneven spatial distribution of hydrocarbon and water resources. As pointed out by Akhmetova (2007) and Pohl et al. (2017), the regional countries, whose economic sectors had for decades been developed within vertically-integrated systems of Soviet line ministries under the command-and-control policy, found themselves in a confusing situation after the collapse of the Moscow-centric management system. Thus, in the early 1990s, there happened to be situations when one department was responsible for irrigation, the second – for water supply and sanitation, the third owned hydropower facilities, the fourth designed environmental policies, and so on. As a result, cases of planning the same water source for different and competing purposes became commonplace.

However, it is important to recognize that the nexus framework is not new to the region. There are many records of well-established irrigation schemes from the region's earlier history. In the 20th century, the potential for water resource development to serve multiple purposes became the basic principle in the development of water resources all over the world (Muller, 2017). The nexus framework, albeit in other terms and understandings, was also adopted by the Soviet leadership as a policy approach for the water resource development in Central Asia. This made it possible to benefit from combining hydropower and irrigation development in the Aral Sea Basin. The Moscow-coordinated directive policy was aimed at achieving outcomes for the entire region rather than developing strategies of individual Soviet republics (Wegerich, 2011). The break-up of the USSR, however, left the Central Asian republics without an arbiter, to whom, as in previous decades, they were always able to turn to for problem-solving; and secondly, they encountered a number of serious challenges which statuses had changed from domestically solvable issues to the matter of inter-state relations.

As a consequence of sweeping socio-political changes in Central Asia, its countries have faced, in our estimation, three clusters of water-related collective action problems, namely in water management, the energy sector, and agriculture. All of them, to varying degrees, are framed with the most acute and headline-making problem of the Aral Sea desiccation. By the beginning of the 1990s, it became increasingly evident that the problem could not be ignored any longer and thus required concerted action to correct decades-long environmental mismanagement. Starting from the late 1950s Soviet planners had been practicing unprecedented water withdrawals geared towards expanding cotton that requires irrigation and ample watering. As a result of this uneconomical water utilization policy, the sea lost half its original size and 75 percent of volume, while the level of its water salinity tripled with dramatic implications for the sea's biodiversity (Micklin, 1991).

First off, the newly-independent countries needed to preserve the regional cooperative framework in the water management and the energy sectors. As we can conclude from Chapter 3, both industries had evolved as regionally-integrated structures. So, the preservation in the water management would entail the establishment of an institutional framework enabling common water governance over the regional waters. The Central Asian energy sector, especially its electric facilities, being partly operated on hydropower resources, was also needed collective action to maintain its functionality. This would overshadow the difference in fossil fuel endowments between the regional countries. And finally, there was a need for reform in agriculture. In addition to the environmental aspects mentioned above, the sector suffered from extremely inefficient wasteful management practices and was based on the so-called extensive farming (Wren, 1975). Although all these issues were interrelated through water, they required different sets of cooperation. As Weinthal (2001) aptly argues, at independence, the regional countries had at least three different negotiation sets on the table, namely: (a) a water set; (b) a water and energy set; and (c) a water, energy, and agriculture set.

On closer inspection, the third set was nothing but the now known WEF nexus approach. In our understanding, in the conditions of post-Soviet Central Asia, this would theoretically have entailed an integrated governance over the water, energy, and agricultural sectors on the regional scope and closely interlinked development agenda at the country level. However, such an approach would have required fundamental reforms in all the sectors including the introduction of market-based instruments, numerous cross-sectoral conciliation platforms, and sweeping changes in managerial practices.

A reform in regional agriculture was supposed to be essential on the road to the WEF approach as its third food pillar. Furthermore, the agricultural reform was indeed the most effective way to address the Aral Sea desiccation. By 1980, for example, 84 percent of all water withdrawals in the Aral Sea Basin were for irrigation (Micklin, 1991). However, as Wienthal (2001) posits, "had the food pillar been launched, the regional countries would have had to replace the cotton monoculture with less water-intensive crops". Nevertheless, the regional authorities reasoned that abandoning cotton-centered agriculture could have had negative socio-political and economic implications. The leaders of the downstream countries, primarily in Uzbekistan and

Turkmenistan, sought to keep people within the system of *kolkhozes* and *sovkhozes* (collective farms in the former USSR) so as to retain control over farmer's social lives (Fuzaylov, 2006). Besides, the cotton production and its sales abroad provided huge foreign revenues. For instance, in 1991, the cotton sector constituted up to 84 percent of Uzbekistan's exports and accounted for upwards of 20 percent of its GDP (IMF, 1992, cited in Wienthal, 2006). So that, to implement "sweeping agricultural reform, the Central Asian leadership would need to compensate or displace a large number of vested interests engaged in cotton production," argues Weinthal (2006). It seems obvious the Central Asian leadership had neither the wish nor the capacity to forfeit such lucrative instruments. For those reasons, the food (agricultural) pillar was seemingly not included in the feasible negotiating set of solutions.

As the idea with the full-fledged water-energy-food nexus had de facto been dismissed due to the aforementioned reasons, there remained a choice between the water and the water-energy sets. Among these two, the former was originally seen as the central one. In the 1980s, when the Aral Sea desiccation became increasingly apparent, the regional water sector underwent a certain advanced transformation that included the introduction of some hydrological principles and also the establishment of basin-wide water management organizations (BWOs "Amudarya" and "Syrdarya"). Hence, by the beginning of the 1990s, the water sector proved to be better equipped in terms of institutional capacity. This allowed water officials and experts to urgently sign a regional agreement on joint use of water resources (i.e., the 1992 Almaty agreement) that included the establishment of a collective water body, the Interstate Commission for Water Coordination (ICWC). Thus, it is therefore not surprising that international organizations (the WB, EU, UNDP), who pledged to meet the challenges of the Aral Sea crisis, started coordinating their projects with the regional water community (Weinthal, 2001).

The prevalence of water in the regional agenda and in communications with international organizations led to the situation when the upstream countries perceived that their interests were de facto underrepresented in the process of building new water governing institutions (Kemelova and Zhalkubaev, 2003). Moreover, the newly-minted Almaty Agreement on joint use of water resources, unlike the Soviet integrated management of water and energy resources (i.e., barter exchanges), did not entail energy supplies to Tajikistan and Kyrgyzstan in the wintertime, whereas the ICWC's mandate over water apportioning didn't cover hydrosites in the upstream riparians

(Weinthal, 2001). In practice, it meant that if, for instance, Kyrgyzstan was willing to employ them to generate power on a priority basis, the BWO "Syrdarya" couldn't do anything, because these dams were administered by the Kyrgyz Ministry of Energy. That is what indeed happened when the Kyrgyz authorities, having faced difficulties with purchasing hydrocarbons at world prices, changed the dams' operations from the irrigation to energy mode so as to meet the demand for power and heat in winter (see Paragraph 3.4.).

From this, one can conclude that the implementation of the water set proved to be insufficient to align the interests of the upstream states with those of the downstream ones. As the Almaty Agreement excluded mechanisms for dealing with disputes across the water and energy sectors, the Central Asian countries had to find other instruments to tackle intersectoral conflicts. Ultimately, a solution came from USAID whose regional experts turned to the Soviet legacy of the economic specialization (Bernauer and Siegfried, 2008; Weinthal, 2001). In 1996, the Agency hold the so-called Water and Energy Uses Roundtable meetings that included one energy and one water official from each Syr Darya riparian state, that is Kazakhstan, Uzbekistan, and Kyrgyzstan (Weinthal, 2006). This endeavor resulted in the 1998 Bishkek Agreement on the use of water and energy resources in the Syr Darya River basin. Central to this multi-year compact was the idea of compensation for energy losses incurred by Kyrgyzstan from storing water during winter for future summer needs (WB, 2004). Simply put, Kyrgyzstan started receiving hydrocarbons from Kazakhstan and Uzbekistan in the wintertime in exchange for electricity generated from water discharges at the Kyrgyz HPPs in the summertime. Thus, by adopting the Bishkek Agreement the Syr Darya riparians openly recognized the effectiveness of the WEF approach (albeit, without the food pillar) with its issue linkages and the *benefit-sharing ideology*.

The benefit-sharing approach, as framed by Sadoff and Grey (2002), offers an analytical framework for fostering cooperation in regions with transboundary water resources. In their article, they identified four types of benefits associated with the collaboration in water issues: 1) benefits to the river – environmental; 2) benefits from the river – economic; 3) reduced cost because of the river – political; and 4) benefits beyond the river – catalytic/transformative. In a later publication, the authors (2005) define "benefit-sharing" as "any action designed to change the allocation of costs and benefits associated with cooperation". As a fairly broad term "any action" makes it possible to accommodate various processes beyond the sector of water management, specifically, arrangements concerning the energy sector.

As Soliev, Wegerich and Kazbekov (2015) point out, the approach allows for moving from unilateral to cooperative actions and also redirects the center of attention from quantities of water resources to benefits emanating from its utilization and proper apportioning. Benefit-sharing, as Jalilov, Olli and Keskinen (2015) postulate, "builds on the assumption that the beneficiaries (the riparian countries in transboundary river basins) are more interested in the economic value and benefits created by water and its development rather than dividing up a fixed quantity of water itself". Tarlock and Wouters (2007) look at this issue more practically, by benefit-sharing they are inclined to imply monetary compensation in exchange for (a) a compromise in a shared river basin development – in our study, the case of the 1964 Columbia River Treaty between the United States and Canada (see Paragraph 4.3.) whereby the former recovered part of costs related to the flow control by Canadian hydropower dams, or (b) resource allocation – the case of the 1998 Bishkek Agreement that entailed water-energy exchanges (see Paragraph 3.4.).

All in all, the basic principle of benefit-sharing boils down to the idea expressed by Grey, Sadoff and Connors (2016) that countries "cooperate when the net benefits of cooperation are perceived to be greater than the net benefits of non-cooperation, and when the distribution of these net benefits is perceived to be fair". A similar thesis is set out by Earle, Jägerskog and Öjendal (2010) who argue that transboundary cooperation on water issues may even bolster region-wide peace development if there is institutional capacity among the riparian countries to manage water resources in a mutually beneficial and collaborative way.

Before proceeding to a discussion of institutional capacity, it is important to note the benefit-sharing approach can be deemed an applied case of the Functionalist theory in International Relations that focuses on common interests, needs, and functions shared by states. As a functionalist approach, it describes the incentives for collaborative actions and argues that partnership in one sphere could bring about greater cooperation in the same as well as other fields (Granit, 2012).

Considering institutions and their role in tackling water-related problems, it is worth dwelling on a couple of propositions suggested by two Neoliberal Institutionalist scholars – Robert Owen Keohane and David Dessler. The former author (1984) in his most famous book "After Hegemony: Cooperation and Discord in the World Political Economy" postulated that regimes (that is a system or a planned way of doing things, especially imposed from above) are quite efficient institutional systems which toolkit create numerous linkages among different issues thus incentivize actors to reach mutually beneficial outcomes.

Dessler, in turn, in the article titled “What’s at stake in the agent-structure debate?” (1989), debating with Neorealism scholars, makes arguments in favor of a so-called transformational model. The model views structures (e.g., institutions, regimes, norms) as a means to action rather than as an environment in which actions take place. In the interpretation suggested by Biresselioğlu (2019), it means that the entrenched system of norms is put forward to create a common framework. It is then employed to support future actions. Ultimately, as their new subsequence is established, either the existing system of norms is changed or new ones are developed.

Unfortunately, the case at issue is not so simple as it looks. The Functionalist approach (i.e., cooperation in one sector leads to cooperation in other sectors) may not work here, at least properly, since the Central Asian countries seem to be too wary and anxious about security matters (Czywilis, Nita and Sobański, 2012). According to the representatives of the Copenhagen school of security studies, who developed the famous Regional Security Complex Theory, if a state has a dispute with another one on other grounds, the former state is also inclined to characterize the water-related challenge as a security issue, in other words, to *securitize* them (Buzan, Wæver and Wilde, 1998). Indeed, there are good reasons for such kind of behavior in Central Asia. The sudden crumbling of the Soviet Union and the consequent disappearance of Moscow's hegemony left the regional countries to face numerous challenges. The newly gained independence required them to take immediate actions for urgent nation-building including aimed at achieving economic self-sufficiency and establishing solid political leadership. These aims were constrained by growing population and unemployment, tensions between peoples divided by arbitrarily drawn frontiers, and breakups in trade chains and other economic bonds – all constituted potential irritants in bilateral relations. That is why it seems quite logical to assume that in the regional states’ perception interactions on water resources was often considered as a matter of national security associated with a threat-defense sequence and ultimately manifested in a game with zero-sum, where one state’s advantage is achieved at the expense of another state’s disadvantage (Mosello, 2008).

The tendency to securitize water-related issues, that is taking them out of the domain of technical management and elevating to the status of national security concerns, has surfaced in the early 1990s with the end of the Cold War and the following corrosion of "traditional security threats" (Phillips et al., 2006). Specialized literature, which has emerged in recent decades, classify water both as a historical and future cause of international wars. Thomas Homer-Dixon (1994), for example, stated that the forthcoming decades will bring a steady increase in the incidents of violent conflicts that are caused, at least in part, by environmental scarcity. Gleick (1993) argues that "water and water supply systems are increasingly likely to be both objectives of military action and instruments of war". In Central Asia, these arguments were reflected in the 2012 speech by then Uzbek President Karimov who warned neighboring countries that unilateral efforts to control water flows could lead to regional confrontation or even war (Lillis, 2012). So, as can be concluded, securitization of water-related issues increases the risks of controversy and, accordingly, decreases the chances of regional cooperation.

Policies pursued in the opposite direction, that is *de-securitization,* could make a difference. In a nutshell, this strategy means that problems associated with water use are removed from the abovementioned threat-defense sequence and returned to the ordinary public sphere (Mosello, 2008). In longer terms, this impetus should lead to arrangements based on benefit-sharing (Daoudy, 2007). Thus, we are again returning to the question of the applicability of functionalist approaches. As a result, we face a vicious circle wherein functionalist means don't work in the region because of the preoccupation with security concerns while much-needed de-securitization depends on instruments of functionalism.

In order to break the circle, water theorists suggest a number of measures geared towards unleashing the cooperation-inducing potential of water. First and foremost, this implies the establishment of basin-wide organizations with clearly articulated objectives (Kliot, Shmueli and Shamir, 2001; Swain, 2004; Daoudy, 2007). Waterbury (1997), who has a little faith in the self-organization of riparian countries, suggests that some initially modest measures such as water pricing may be taken. Wolf and Hamner (2000), in turn, recommend enhancing these modest steps with the signing of respective technical agreements which is useful in terms of mutual confidence-building between parties. According to Philips et al. (2006), the most notable de-securitization process in water resource management relates to the decision to establish a regional integrative framework by a means of neofunctionalist approaches to the problem of national sovereignty. The idea is that of the European Union that has evolved from predominantly a technical agreement on coal and steel into the complex supra-national structure. The so-called "spill-over effect" has a crucial role in this regard since interaction over one narrowly-defined area paves the way towards cooperation in another. The same idea was recently suggested in the report "Rethinking water in Central Asia", which was prepared with the participation of the regional water community (Pohl et al., 2017). They suggest that the main focus, at least initially, should concentrate on smaller unchallenged issues that can yield tangible outcomes in the relatively short run. These may include the issues associated with dam safety, innovational irrigation practices, joint water quality monitoring, agreements on the joint use of water resources on smaller river sub-basins.

2.2. International Waters Law in application to Central Asia: The difference in approaches

All the main rivers of Central Asia are transboundary and used by states simultaneously in several areas of the economy, primarily in irrigation and hydropower. Moreover, if the former one is considered traditional and has existed for several millennia, the latter one began to develop relatively recently, the first hydropower plants were built here in the middle of the 20th century (Petrov, 2009).

As noted above, the Soviet central planning mechanism made it possible to maintain a balance between the interests of the hydrocarbon-rich Kazakhstan, Uzbekistan, Turkmenistan, and the water-abundant Tajikistan and Kyrgyzstan. After the breakup of the unified state, the latter found themselves in a disadvantageous position: They had to purchase oil and gas at world prices, while the downstream countries continued to use the water coming from their territories free of charge. By the mid-1990s the first group of countries, having built export ties on hydrocarbons, achieved sustainable economic growth. Conversely, Kyrgyzstan at that time was facing economic decline while Tajikistan was embroiled in a horrendous civil war (Medvedev, 2006). These uneven economic development paths of the Central Asian countries could not but affect their attitude to the issues of transboundary water use.

At the turn of the century, the Kyrgyz authorities adopted the two contradictory legislative texts, namely the 1997 presidential decree "On the basis of the Kyrgyzstan foreign policy in the use of water resources formed in the republic and flowing through the territories of neighboring states", and the 2001 Law "On the inter-state use of water facilities and water resources of the Kyrgyz Republic". These documents have formulated the following fundamental principles of the state policy of Kyrgyzstan in the use of transboundary watercourses and hydraulic facilities on them:

- recognition of the state ownership over water resources, water bodies, and respective facilities within the territorial boundaries;
- recognition of water as a natural resource that has its own economic value;
- payment for water use in inter-state water relations.

Despite the absence of such normative acts in neighboring Tajikistan, both at the government level and in the scientific circles of the republic, there have been quite a lot of people who have much in common with the Kyrgyz stance (Khalikov, 2008; Arifov, Negmatullaev and Arifova, 2007).

Conceptually, the position of the upstream Central Asians boils down to the following two major principles.

The first principle is *property rights*, which provides the basis to demand a revision of the existing water allocation (apportioning) system in the region. In accordance with that principle, the share of water resources for each Central Asian republic should be determined over the entire area suitable for irrigation, as well as taking into account projected volumes of water use in industry and the household sector (Mamatkanov, Bajanova and Romanovskiy, 2006).

According to one of the main theorists of this approach, a former director of the Institute of Water Problems and Hydropower of the Kyrgyz Academy of Sciences, Mamatkanov, the Soviet system of water distribution based on the principles of limited consumption is discriminatory towards mountainous countries of the region. As a consequence, he posits that Kyrgyzstan could use only 25 percent of the water resources formed on its territory (mainly in the Syr Darya basin). From 1967 to 1987, its irrigated land increased by only 186 thousand ha, while in Uzbekistan – by 1,364 thousand ha. Tajikistan saw a similar situation. Being the main "water supplier" in the Amu Darya basin, this mountainous republic could be eligible for 10–11 percent of the water formed within its boundaries. At the same time, water use intensity and endowment with irrigated areas in these states are the lowest in the region. For example, as of the 1990s, Turkmenistan possessed as much as 0.41 ha of irrigated land per person, Kazakhstan and Uzbekistan – 0.2 ha, whereas Kyrgyzstan – only 0.17 ha (Mamatkanov, 2001). Naturally, Mamatkanov argues that upon the emergence of sovereign states, the current system of regional water apportioning should be revised[5].

The second principle is *payment for water use.* Since the mid-1990s, within the expert community of Kyrgyzstan and Tajikistan, the problem of recognizing water as a full-value product has been actively discussed. Proponents of this approach proceed from the so-called Dublin Principles, which emerged from the 1992 International Conference on Water and the Environment in Dublin. The fourth principle of the Conference Final Statement postulates that “water has an economic value in all its competing uses and should be recognized as an economic good”.

However, the majority of independent experts suggest that, despite individual cases of commercial operations with aquatic resources around the world, the river water does not have the properties of a commodity (Mitchell, 1984; Wodraska, 2006; Boyarkina, 2011a).

Advocates of the idea of introducing water charges (Usubaliev,1998; Arifov, Negmatullaev and Arifova, 2007) believe that water, along with hydrocarbons, is one of the most important economic resources, and should have its cost. No one has any objections to the established prices for energy resources – oil, gas, and coal. The only difference between water resources and them is that hydrocarbons are in a static state within a deposit area, while water resources are dynamic on a catchment area. But when both are utilized, similar costs are incurred for exploration, production (for water, this is the accumulation and regulation of runoff in reservoirs), and transportation to consumers (Kozhakmatova, 2009b). In a number of international agreements, water is regarded as a natural resource, and as an economic good, too. Water charges have long existed in Japan, India, Australia, the Philippines, and several other countries. Market-priced water distribution mechanisms are also in place in some of the western states of the United States. In international relations, water appears as a subject of sale and purchase in agreements between Turkey and Israel, Iran and Kuwait, Greece and Cypris, etc. At the same time, the international water market has not yet been fully formed. International Waters Law does not encourage the *net sale*

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[5] Currently, the water resources of the Aral Sea Basin are estimated at 116 km^3/year, about 90 km^3 of which are consumed by irrigation farming. Of this total quantity, the corresponding limits for the regional countries in using the Syr Darya and Amu Darya waters, which were authorized by Moscow - based central authorities in 1982 and 1987 respectively, are as follows: the share of Uzbekistan accounts for 49.29 km^3, Turkmenistan is eligible for 22 km^3, Kazakhstan - 12.39 km^3, Tajikistan - 11.96 km^3, and Kyrgyzstan - 4.43 km^3 of water (Petrov, 2015b).

The 1992 Almaty Agreement provided that further water allocations (apportionings) should be based on these limits and remain in force until the adoption of a Regional Water Management Strategy (Dukhovny and Sokolov, 2003), which is still lacking.

of water (i.e., the sale of water only), today the so-called *selling services of water supply* is more common (Boyarkina, 2011b).

That is why it seems more feasible in today's Central Asia to use *cost-based pricing methods* for water use. In the view of some hydrologists, namely Shapar and Mamatkanov, the price should be paid not for water itself, but rather for operational costs, losses, and lost profits associated with the flooding of lands, damage to the environment, etc. In that case, the price of water resources will be determined by the incurred costs. Thus, in Kyrgyzstan, as the result of the construction of hydraulic facilities, 47 thousand ha are flooded, including more than 16 thousand ha of irrigated arable lands. In line with the calculations of local experts made in the early 2000s, because of that Kyrgyzstan lost up to USD 3 million per year at then-current prices. The annual maintenance expenditures for hydroelectric facilities cost approximately the same amount. An even more substantial annual USD 61.5 million were lost due to the underproduction of electricity in the heating season (related to the need for water accumulation to the benefit of neighboring countries) at the cascade of Lower-Naryn HPPs (Mamatkanov, 2001; Shapar, 2001).

The downstream countries of the region adhere to a diametrically opposite position. The stance of these republics can be summarized as follows:

- water cannot be considered a commodity, it is a free gift of nature, which, unlike energy resources, has no economic value;

- water resources of rivers, especially transboundary ones, cannot be the property of individual states.

Prominent supporters of this conceptual approach (Dukhovny and Sokolov, 2003; Dukhovny and Stulina, 2010) argue that water, in terms of its importance for humans, nature, and society, is a fateful substance that cannot be replaced by anything. This statement is especially relevant for Central Asia, where, in an arid climate, without water, it is impossible to develop agriculture - the main guarantor of food security and the traditional sphere of employment for the rapidly growing population. Unlike water resources, energy can be obtained from various resources, including solar energy, wind power, nuclear fission, and so forth. All of them are by and large interchangeable. Moreover, water is an essential element for the environment, without which nature cannot exist. Conversely, the world existed and developed without electricity (Dukhovny, 2010). These distinctive features, according to these experts, do not allow equating water and energy, and, therefore, all attempts to call water a commodity are untenable.

International legal regulation of transboundary water use is another issue on which the views of Central Asians differ significantly. In the practice of international watercourse law, there are several guiding legal principles:

1) The doctrine of *absolute territorial sovereignty (or the Harmon doctrine*[6]*)*. According to it, upstream countries can independently utilize water resources, including transboundary ones, originated within their boundaries. The so-called *principle of prior water use* is close to the Harmon doctrine; however, it doesn't give particular preference to either upstream or downstream countries, but rather protects the interests of states that were the first to start using water resources (Kozhakmatova, 2009a).

2) The doctrine of *absolute territorial integrity* considers transboundary rivers to be the common property of riparian countries. As per the doctrine, downstream countries have the right to demand a continuous, uninterrupted flow of water from the territory of upstream countries, regardless of existing priorities.

3) Along with potentially conflict-generating and often the absolutist kinds of water apportioning, the legal principle *sic utere tuo ut alienum non laedas* (i.e., use your property in such a manner as not to injure that of another) is also commonplace. In International Waters Law, this doctrine is reflected in the principles of *limited territorial sovereignty* and *limited territorial integrity* (they can be called a kind of compromise versions of the absolutist models). According to them, each state has the right to use water resources on its territory, provided that this does not significantly damage the interests of other states (Kozhakmatova, 2009a).

4) The most progressive doctrine of international watercourse law is that of *community of interest*. Within its framework, a river is considered an integral hydrological unit, which should be managed as a whole (Leb, 2013). The conceptual provisions of this approach are at the core of the most important contemporary acts of International Transboundary Water Law, such as the Berlin Rules on Water Resources (2004), the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992), and the UN Convention on the Law of the Non-Navigational Uses of International Watercourses (New York, 1997).

[6] The doctrine is named after US Attorney General, Judson Harmon, who, in 1985, established the American claim in the dispute with Mexico over the waters of the Rio Grande River, which originates in the United States.

The key tenets of these documents are *equitable and reasonable use* of water resources, *obligations not to cause significant harm*, and *cooperation in the joint management* of river basins.

In the conditions of Central Asia, the above doctrines take on a specific interpretation. The upstream countries – Kyrgyzstan and Tajikistan – proceed from the *principle of inalienable sovereignty of states over natural resources* and prefer to adhere to the doctrine of limited sovereignty. In these republics, it is believed that, for example, the state's right to ensure its energy security (through the generation of hydropower at HPPs) is one of the manifestations of independence. Various mechanisms can be used to achieve concrete results in strengthening sovereignty, including the rational use of natural resources. Therefore, to ensure energy security in the face of a shortage of hydrocarbons, it is advisable for these states to make the most of the available water resources potential and complete the construction of large hydroelectric power plants as soon as possible: the Rogun HPP in Tajikistan and the Kambarata-1 HPP in Kyrgyzstan (Mubarakshin, 2014).

The completion of these hydropower projects, as noted in Tajikistan and Kyrgyzstan, will solve two problems at once. First, their accomplishment will automatically remove the controversy between hydropower and irrigation. Under the new conditions, the water required for irrigation in the downstream countries will be at least partly accumulated in the Toktogul and Nurek reservoirs during the winter season, which lies downriver to the new ones. This will make it possible to operate the Rogun and Kambarata-1 HPPs in the energy mode all year round, covering the respective winter power shortages, and at the same time giving these republics opportunities to generate considerable revenues from exporting surplus summer electricity (Petrov, 2015a). Secondly, with the completion of the dams, the water availability in the middle and lower reaches of the Amu Darya and the Syr Darya will significantly increase. Arguing that, the Tajik authorities, for example, often cite the 1990 report of the Tashkent-based institute “Soyuzgiprovodhlopok”, which stated that the construction of the Rogun HPP is a mandatory measure to eliminate the water shortage in the Amu Darya. The same idea was emphasized in the report of another Uzbek design center “Tashgidroproekt” dated 1993. Regulation of the runoff by the Rogun reservoir, according to these reports, will make it possible to irrigate 4.6 million ha and additionally harness 480 thousand ha of land in the Amu Darya basin (Borisova, 2015).

In contrast to Tajikistan and Kyrgyzstan, downstream Uzbekistan, Kazakhstan, and Turkmenistan are leaning towards the principles of International Environmental Law, namely, the *inadmissibility of causing transboundary harm* and *environmentally sound reasonable use of natural resources*. All three states have ratified the 1992 Helsinki Convention. Uzbekistan is a party to the 1997 New York Convention. The Tajik and Kyrgyz authorities, in turn, despite repeated calls of various international organizations, are in no hurry to accede to these international treaties. This position is explained by the fact that both of these documents, in relation to Central Asia, de facto urge the regional countries to comply with (think to accept) the status quo in the Amu Darya and the Syr Darya basins, which, in other words, means imposing some restrictions on the implementation of large hydraulic facilities (Mubarakshin, 2014).

Until a few years ago, the Uzbek authorities strongly opposed the construction of large dams in the upper reaches of the rivers. They used to largely reason that the erection of gigantic hydro facilities[7] in seismically complex areas creates a high risk of man-made disasters. Most eloquently the Uzbek stance on this issue was expressed in September 2012 by then-President of Uzbekistan Karimov: "These hydro projects were devised in the 1970-1980s when the Soviet Union suffered from gigantomania ... For the last few centuries in the area where Kambarata-1 is planned to be built, there have been three strongest earthquakes with a magnitude up to 9-10. And if this dam bursts, another 19 km^3 of water from the Toktogul reservoir will be added there. What will happen when a 50-100 m high wave goes down?" (MK-Asia, 2012). As an alternative to the construction of such power plants, Uzbekistan recommended constructing medium and small-size hydroelectric power plants (Gazeta.uz, 2013). In response, Tajik pundits used to point to the fact that Uzbekistan, in violation of the aforementioned international conventions, without any consultations with its neighbors, had built dozens of reservoirs, which allow for concentrating significant volumes of the Amu Darya and Syr Darya runoff, thereby aggravating the already disastrous situation of the Aral Sea (Chorshanbiev, 2012).

Against this background, the opinion expressed by hydropower development specialist Petrov seems particularly noteworthy. He argues that the main reason behind

[7] The projected height of the Rogun Dam on the Vakhsh, a tributary of the Amu Darya, is 350 m, which makes it the tallest one in the world. The dam of the Kambarata - 1 HPP on the Naryn, the main tributary of the Syr Darya, is to be slightly lower - 275 m.

the water-energy conflict in Central Asia is the immanent crisis of irrigated agriculture. The dynamics of the use of water and land resources in the Aral Sea Basin, as he suggests, provides a telling manifestation of this situation. Just to name a few: the area of irrigated land in the region increased from 4.5 million in 1960 to 7.6 million ha in 1990, the water usage correspondingly rose from 60.6 up to 116.3 km^3, thus achieving the average long-term runoff of the whole basin (Petrov and Akhmedov, 2011). Taking into account the sharp increase in the population (14.6 million in 1960, at least 60 million people within the basin at present), this crisis has all chances to get more intensified. Therefore, the further focus on the use of water mainly for irrigated agriculture is a dead-end development path. Other water-related activities should also be harnessed. And hydropower is for sure the main front-runner here. Hydropower, if handled properly, is not only not a competitor to irrigation, but, on the contrary, can be its ally, he posits. It is significantly more profitable than irrigation. Thus, the profits from the operation of the Nurek HPP at today's electricity tariffs are greater than the cost of the entire cotton crop in Tajikistan. The development of hydropower, according to Petrov, may help to reasonably reduce the irrigated areas sown with industrial crops that, in turn, will contribute to the improvement of the environmental situation in the Aral Sea Basin (Petrov, 2009).

Naturally, with this approach at hand, the development of hydropower will be carried out mainly in the upstream countries, while the irrigated areas will decrease in the downstream republics, which will only exacerbate the conflict between them. This is true if the proposed strategy is only implemented within a national framework. But in today’s reality, neither Tajikistan nor Kyrgyzstan can build any large hydropower facilities at their own expense. Therefore, for the development of hydropower, it is necessary to attract external investments. As Petrov notes, “the joint property created as a result of this endeavor will contribute to the integration of the Central Asian countries, and make it possible to achieve national objectives for each of them” (Petrov, 2009).

At present, scientific communities and government circles of different Central Asian countries hold completely disparate, polar perspectives on the development of the regional water and energy sector. In downstream countries, the prevailing view is the prioritization of water use for the needs of irrigated agriculture, which is called to be a guarantor of the socio-economic stability of the entire region. Conversely, less developed mountainous upstream countries see the most promising avenues for their economies in the construction of new hydropower plants. In the meantime, the plain fact that the region's water-energy sector is an integrated system and therefore must be developed as a single process is often overlooked or simply ignored.

2.3. Research methodology

This thesis builds on interpretative research methodology. As a research pattern, it rests on the presumption that social reality is rather subjective and formed by a variety of human characters. For this reason, this reality ought to be examined within the framework of social history, thereby uniting the subjective interpretations of its numerous participants (Bhattacherjee, 2012). This methodology, in our judgment, is convenient for studying unseen motives behind complicated, interlinked, and multidimensional processes, such as, in our case, the relationships between the Central Asian nations, where quantitative evidence may be to some degree biased or inaccurate. Interpretive design is also appropriate for studying context-specific and unique processes.

Since the thesis mainly examines development dynamics in Central Asia starting from the dissolution of the Soviet Union with retrospective analysis of trends and events in the regional water and energy sector that occurred prior to 1991, it will rely on a case study-based research design. The use of this research strategy can help study the Central Asian water-energy conflict from the perspectives of different participants (i.e., individual countries, international actors) and also use several levels of analysis (e.g., national, intra-regional, and international) by virtue of its ability to capture a rich array of contextual data.

As for data analysis, certain elements of thematic analysis and critical discourse analysis (CDA) were employed. Since the thesis considerably rests on various interpretations of certain topics pertaining to the regional water and energy sector provided by relevant experts, thematic analysis allows identifying common ideas, patterns that come up repeatedly and then using them to classify and systematize their content to identify trends for future. CDA, in turn, was used to describe and explain various conflicts on water and energy use in Central Asia. The purpose of CDA is to describe and explain inequalities that exist between social structures and their positions concerning certain issues. As has been said, different Central Asian countries hold polar perspectives on the development of the regional water and energy sector. The approach enables to analyze these positions proceeding from the aspects of power and dominance, ideologic tenets, as well as uncovering implicit motives of riparian countries.

The main data collection techniques employed in this study included literature reviews, that is secondary sources that provided the conceptual guidance in understanding latent developments and trends of the regional water and energy sector's evolution as well as in building the theoretical framework of the thesis. The pronounced international interest in Central Asia after 1991 and a considerable amount of scientific literature both in the English and Russian languages devoted to the local water and energy problems create a breeding ground for secondary data analysis.

The study benefited from numerous quantitative and qualitative assessments of the regional water and energy resources and their past and current use presented in materials of international scientific conferences, reports of the ICWC, regional institutes for strategic studies, and relevant analytical units of international financial institutions. An important methodological role in doing this research was played by conceptual documents on the rational use of natural resources in the region, published by the CIS Electric Power Council, the UN Special Programme for the Economies of Central Asia (SPECA), and by various UN agencies, the World Bank and the Asian Development Bank.

Meanwhile, some parts of the dissertation are based on information from primary sources. For them, I have used statistical data from regional state statistical committees, ministries of energy, agriculture, and water resources of Central Asian states. In a similar vein, reference materials provided by the Portal of Knowledge for Water and Environmental Issues in Central Asia (e.g., CAWater-Info, 2021) and the Regional Network of Water Management (Basin) Organizations of the Countries of Eastern Europe, the Caucasus, and Central Asia (e.g., EECCA-water, 2021) were particular instrumental. The legal framework for the study is represented by international conventions on the joint use of water resources, numerous water-related treaties signed in third countries, and water legislation of the Central Asian republics.

The primary mode of data collection in the study was expert surveying. As Maestas (2016) posits, expert surveys can be regarded as a practical technique for determining concepts that would be rather complicated to do through other strategies, and thus it allows scholars to elaborate criteria that can be compared in different contextual situations. Moreover, by nature, these surveys resemble in-depth interviews but are conducted in the form of online questionnaires. As a type of exploratory research, they are aimed at obtaining new clues, ascertaining various perspectives on processes underway for which scholars don’t always have theoretical explanations (Rashid, 2020).

The expert survey in this study, matching with the topic of the thesis, i.e., “The water-energy nexus in the Aral Sea Basin: Identifying feasible political-economic solutions” aimed to increase our understanding of the Central Asian water-energy conflict as well as synchronizing watches on key avenues of its resolution. Since this issue belongs to the category of specific knowledge, we opted for developing an expert survey in the form of a multi-choice questionnaire with the option of leaving comments. The term “expert” in our case refers to academic scholars with specialized knowledge on Central Asian water, energy, and environmental problems. Among the reasons for this ‘academic choice’ were their relative availability, open-mindedness, and keen interest to take part in discussing the issues under consideration. All these features, unfortunately, are almost non-existent when it comes to open communication with decision-makers in nowadays Central Asia – line ministerial employees, let alone high-ranking government officials. Within rigid hierarchal structures, such as regional state institutions, front-line personnel tended to refrain from passing any judgments without explicit instructions from superiors. This is a problem for governments run by leaders with lingering non-transparent Soviet-style mindsets and habits (Stronski and Zanca, 2019).

The creation of relevant questions to the survey is seen as one of the most important parts of survey design. Within this process, the author was guided by the general concept of this thesis. To illustrate, let us say, there is a well-known problem, it consists of several interconnected pillars. Furthermore, respective literature suggests various options of how the problem might be tackled. So, the general idea of a study is to synthesize, bring all elements together and look at them through the prism of a specific approach. Such an understanding paved the way for the ordering of questions in our survey. So that we started with the general assessment of the current situation in the area at issue and then proceeded with institutional and infrastructural ways at hand within which the problem could be resolved. At the final stage, the intention was to look to the problem’s future by asking respondents to share with an optimal paradigm wherein respective efforts should be made. Ultimately, our survey has ended up with carefully prepared, highly specialized questions relating to the issue at hand.

The survey's data collection technique was constructed as an online questionnaire using Google Forms. The list of potential respondents was prepared according to the literature review, i.e., based on the academic articles, monographs, and other scientific materials read by the author in the English and Russian languages. The original English questionnaire was translated into Russian. It was sent to authors who have written their works in English, whereas the translated version was conveyed to Russian-speaking scholars. Invitation letters to take part in the survey were sent via the author's email with all necessary information on the subject provided. All participants were provided with the information sheet regarding the survey and they all were supposed to sign a consent to take part in the research. The respondents were guaranteed full anonymity of data. Any information about the respondent would have some number or any other identifier on it instead of their name or true identity. In order to conduct this survey, a proper permission was sought out from the Research Ethics Committee of the Izmir University of Economics.

The data collection took place between April to September 2021. The invitations to participate in the survey were sent to 27 scholars from around the globe. The researcher employed additional letters to politely remind some scholars about the survey. As per our calculations, in total 17 scholars surely received the invitation letters. Nine of them agreed to answer the survey questions. So, the response rate was just over 50 percent. Of all these responses, five were received from respondents living in Central Asian countries or of the local background (there is a scientist who currently works for an Australian science agency), while four – from European scholars who have worked in the region or visited it on scientific missions, according to their biographies available on the Internet. As was mentioned, all the respondents can be regarded as active scholars since they continue to publish in scientific journals and take part in academic conferences all over the world. As regards their professional background, those of them who live in Central Asian countries (Uzbekistan, Kazakhstan, Tajikistan) had or continue working as hydrologists and power engineers, whereas the respondents from Italy, Greece, Sweden, and Australia can be qualified as university professors or/and scientific researchers.

Table 1. The respondents' profiles

	Country of origin	Experience in CA problems (in years)	Profession/Current Occupation
Respondent 1	Tajikistan	50	Hydropower engineer/ Lecturer in Russia
Respondent 2	Greece	N/D	Environmental Economist/ Lecturer in Kazakhstan
Respondent 3	Italy	13	Human geographer/ Lecturer in UK
Respondent 4	Sweden	N/D	Water resources engineer/Lecturer in Sweden
Respondent 5	Italy	11	Environmental geographer/ Lecturer in UK
Respondent 6	Kazakhstan	49	Hydro ameliorator/ Researcher in Kazakhstan
Respondent 7	Uzbekistan	44	Hydrologist/ Researcher in Uzbekistan
Respondent 8	Uzbekistan	40	Official in Uzbekistan
Respondent 9	Tajikistan	13	Environmental economist/ Researcher in Australia

CHAPTER 3: WATER AND ENERGY USE IN THE ARAL SEA BASIN

3.1. History and the present day of water management in the region

The Central Asian region is located in the central part of the Eurasian continent and it is a vast drainage area of the closed Caspian Sea and Aral Sea basins. The arid nature of the regional climate caused by its geographic location determines the special importance of water resources for the socio-economic development of Central Asian countries (Akhmetova, 2007).

The heartland of the region is occupied by the Turan Lowland, which is bordered in the south and east by the Pamir and Tien Shan mountains, and in the west and north-west by the Kara-Kum and Kyzyl-Kum deserts. The extensive Kazakh Uplands is situated in the north. This geography is highly conducive to the penetration of humid air masses from the Atlantic. In wintertime, owing to the Arctic air, they accumulate in the form of large glaciation areas in the Pamir and Tien Shan, whereas in summer the masses quickly evaporate with little precipitation. This altogether determines a great amplitude of temperature fluctuations and uneven distribution of precipitation throughout the year (Alamanov et al., 2006).

In view of the foregoing, almost all regional rivers are fed by glaciers. In the mountain ranges of the Pamir and Tien Shan, mainly on the territory of Tajikistan and Kyrgyzstan, there are about 20 thousand large and small glaciers with a total area of more than 17,000 km^2 and with water reserves of about 11,000 km^3, which produce about 150 km^3 of water runoff annually. Its maximum values are indicated during the growing season (April – September) when the ablation of glaciers is maximally intense (Alamanov et al., 2006). Such an intra-annual distribution of water flows creates the most favorable conditions to use rivers for irrigation (Yasinskiy, Mironenkov and Sarsembekov, 2010; Akhmetova, 2007).

However, the region's snow-and-ice resources are not stable. Observations of the Tien Shan and Pamir glaciers, which were carried out in the new millennium, indicate their steady reduction due to global warming. According to the most pessimistic forecasts, the ice cover of the region's mountain ranges may disappear completely in the second half of the ongoing century (Bukhari-zade, 2007; Diebold, 2014). Degradation of mountain glaciation will also lead to an increase in the interannual variability of runoff and a change in its intra-annual distribution. It is anticipated that the river runoff is going to change within the limits of natural variability until 2030, but then it may reduce by 7–17 percent by the year 2050 (Yasinskiy, Mironenkov and Sarsembekov, 2010).

The water resources of Central Asia consist of renewable underground and surface waters, as well as return waters formed as a result of anthropogenic activity. The region as a whole has several hydrological basins, the largest of them being the Aral Sea Basin, with a catchment area of 1,778,000 km^2. The basin itself is composed of two major river basins of the Syr Darya in the north and the Amu Darya in the south, respectively. The total mean annual runoff of these river basins is estimated at about 116 km^3. This amount comprises the runoffs of the Amu Darya at 79.4 km^3/year and of the Syr Darya at 36.6 km^3/year. A large share of that is formed in the territories of Tajikistan and Kyrgyzstan: 51.5 percent and 25.2 percent, respectively. The share of Uzbekistan from the total runoff of the Aral Sea Basin is 10.6 percent, of Kazakhstan – 2.2 percent, and of Turkmenistan – 1.2 percent (see Table 2).

Table 2. The surface water resources of the Aral Sea Basin (mean annual runoff, km^3/year) (Source: CAWater-Info, 2021)

Country	River basins		Aral Sea Basin, in total	
	Syr Darya	Amu Darya	km^3	percent
Kazakhstan	2.5	-	2.5	2.2
Kyrgyzstan	27.5	1.7	29.2	25.2
Tajikistan	1	58.7	59.7	51.5
Turkmenistan	-	1.4	1.4	1.2
Uzbekistan	5.6	6.8	12.4	10.6
Afghanistan and Iran	-	10.8	10.8	9.3
Total Aral Sea Basin	36.6	79.4	116	100

An important hydrological feature of the river basins is the division of its territory into three areas: 1) the zone of flow formation; 2) the zone of transit and water dissipation; 3) delta zones. The formation zones of most of the runoff include high-altitude glaciers in Tajikistan and Kyrgyzstan. As a rule, there are no significant anthropogenic changes in there. In the transit zone, the hydrological cycles of the rivers are subject to significant externalities, characterized by the intensive withdrawals of water for the needs of irrigated agriculture and the discharge of return flow with agrochemicals and other pollutants into rivers. In this vein, a special role in the hydrology of the region is assigned to the tributaries of the main rivers, which are more valuable for irrigation than the principal rivers. As soon as the latter leaves mountains and enters a wide plain, it no longer has tributaries, and thus loses significance for agriculture (CAWater-Info, 2021).

The Amu Darya is the most water-abundant river in the Aral Sea Basin with the largest catchment area of 309,000 km^2. Its total length from the headwaters of the Pyandzh River to the Aral Sea is 2540 km. It is called the Amu Darya from the point where the Pyandzh joins with the Vakhsh River. Farther in the middle reaches the river is fed by the waters of Kunduz, Kafirnigan, Surhan Darya, Sherabad, and then it has no more tributaries. While crossing from Kerky, Turkmenistan, to Nukus, Uzbekistan, the majority of the river's streamflow is being lost by infiltration, evaporation, and withdrawals for irrigation (UNECE, 2011). About 74 percent of the Amu Darya's total waters originate in Tajikistan within the Vakhsh basin. After the confluence with the Pyandzh the river flows along the Uzbekistan–Afghanistan border, across Turkmenistan, and then again returns to Uzbekistan where it ultimately discharges into the Aral Sea.

The Syr Darya River is the second-largest watercourse in terms of water availability, but the first in length. From the headwaters of the Naryn River in Kyrgyzstan to its estuary it is 3,019 km long, with a basin area of 219,000 km^2. The river is known as the Syr Darya after the confluence of the Naryn with the Kara Darya in the Fergana Valley. Approximately three-fourths of its runoff forms in Kyrgyzstan. The river runs through the territories of Uzbekistan and Tajikistan and discharges into the Aral Sea in Kazakhstan.

As can be seen from the above table, the key characteristic of the Aral Sea Basin is that the main sources of fresh water here are concentrated in the mountainous part of the region – in Tajikistan and Kyrgyzstan. At the same time, most of the runoff is consumed within the territories of the downstream countries – Uzbekistan, Turkmenistan, and Kazakhstan. Specifically, the soils of Kazakhstan form approximately 2.5 percent of the Syr Darya's streamflow, whereas as many as 38 percent are withdrawn (SPECA, 2004). 9.3 percent of the total streamflow of the

Aral Sea is formed in Iran and Afghanistan These specific geographic features of the distribution of water resources determine the transboundary nature of their use, thereby complicating the processes of managing regional water potential.

Another key observation that can be drawn refers to water availability in the Aral Sea Basin. In comparison with the late Soviet period, let alone earlier periods of the 20^{th} century, the annual per capita water withdrawals (this is the indicator of water availability) have dropped dramatically from 3,500 to 1,400 m^3 per person, thus rapidly approaching the UN's water stress threshold of 1,000 m^3 (Vinokurov et al, 2021). Along with remarkable population growth in the region, this situation seems to be largely due to the historically determined methods of water management in Central Asia.

Conventionally, the water management history of the region can be divided into four stages. At *the first stage*, the development of the water economy was largely localized and implemented by involving the population in construction works of local importance. This stage lasted until the Russian colonization of most of the region's territories in the 19^{th} century. *The second stage*, during the Russian imperial rule and the first decades of the Soviet Union, was characterized by active engineering construction and the creation of a unified water management system (Valentini, Orolbaev and Abylgazieva, 2004; Suleimenova, 2018).

However, the most pivotal changes in the development of the regional economy started in the 1960s (*the third stage*) with the beginning of a "reclamation boom" – the problem of ensuring the USSR's cotton independence from the USA required a ramping-up of reclamation systems in the southern regions of the Union, primarily in the vast and climatically comfortable territories for planting cotton in Central Asia. To this end, at the Plenum of the Soviet Communist Party in May 1966, a program for land reclamation in the Soviet Union was adopted. Based on the decisions of the Plenum, the Central Asian republics prepared plans for the commissioning of hundreds of ha of irrigated land and construction of large hydraulic facilities (Ryabtsev, 2003). To solve the set tasks in the water sector, a so-called *limited water consumption policy* began to be gradually introduced. In line with it, the priority in water supply was given to agriculture aimed at producing highly profitable crops of cotton and rice.

The apportioning of water resources was entrusted to the USSR Ministry of Water Resources and its local departments. They implemented a centralized, top-down water allocation management in consultation with the governments of the five Central

Asian republics (Akhmetova, 2007). It is fair to mention that this strict centralized management of water resources in the Aral Sea Basin had many positive implications, specifically: a) an extensive network of irrigation infrastructure (canals, dams, pump stations, other waterworks) was built; b) huge hydropower station cascades were constructed, thereby paving the way to the establishment of the CAPS (Mamtkanov, 2003).

A key element to water management was the so-called "Schemes of complex use and protection of water resources". In western practice, this is known as a "Basin Master Plan" (GWP, 2014). According to these Schemes, in the context of each republic, quotas of water intake volumes, irrigation norms, and irrigation areas were set up. The distribution principle of limited water resources was as follows. First of all, a guaranteed water supply was ensured for public utilities, industry, heat and power engineering, and fisheries. Most of the water resources, which is about 90 percent of the total water withdrawals, accounted for irrigated agriculture and was distributed among the republics in proportion to the irrigated areas (Yasinskiy, Mironenkov and Sarsembekov, 2010).

The implementation of the Schemes brought millions ha of irrigated lands under cultivation. Thus, in the period from 1960 to 1990 the area of such land in Central Asia increased from 4.5 million to 7.6 million ha. Simultaneously with them, the river water intake also increased (from 60.61 km^3 in 1960 to 116.27 km^3 in 1990 (see Table 3.).

Unfortunately, these impressive development gains in the agricultural sector have led to serious negative consequences for the environment. The extensive natural resource utilization has resulted in a systemic crisis of water and land resources (Mubarakshin, 2012). By the end of the 1980s, the reserves of the Aral Sea Basin's water fund had turned out to be practically exhausted. The consequences of this ill-considered water management policy are most clearly manifested in connection with the disaster of the Aral Sea, which by 2010 lost more than 90 percent of its original volume and about 80 percent of its area (Yasinskiy, Mironenkov and Sarsembekov, 2010). The gradual drying up of this once large water reservoir has brought about increased salinization and waterlogging of soils, reduction of biodiversity for many kilometers around, and also intensive melting of the Pamir and Tien Shan glaciers due to atmospheric transport of salt and dust from the exposed seabed (Kulmatov, 2008).

Table 3. The dynamics of water and land usage in the Aral Sea Basin (Source: Compiled on the basis of CAWater-Info, 2021; Vinokurov et al.,2021)

Indicator	Unit of measure	1960	1970	1980	1990	2000	2020
Population	million	14.6	20.3	26.8	33.6	41.5	74.4
Irrigated area	thousand ha	4,510	5,150	6,120	7,600	7,990	8,040
Irrigated area per capita	ha/person	0.31	0.27	0.26	0,23	0,19	0,11
Total water withdrawals, Including for irrigation	km^3/year	60.6 56.2	94.56 86.84	120.69 106.8	116.3 106.4	105.0 94.7	104.6 94.1
Water use (availability) per capita	m^3/person	4,270	4,730	4,500	3,460	2,530	1,405
Total water discharge into the Aral Sea	km^3/year	55	30	5	8	~8	~10

Both technological and managerial factors have also contributed negatively to the water crisis. The situation with an increasing water shortage today is aggravated by the fact that substantial amounts of withdrawn water have been wasted for filtration, not reaching the end-users. For instance, in many regions of Central Asia, outdated technologies were used due to a lack of building materials or accelerated commissioning deadlines for hydraulic facilities. So, in Turkmenistan, during the 1960-1980 period, the 1,445 km long earthen-bed Karakum Canal was built; even today about a quarter of the water flowing through it is lost because of infiltration and evaporation (Wikipedia, 2021b).

The regional water management system based on the Schemes did not meet some modern *integrated water resources management* (IWRM[8]) requirements, in particular, they did not fully take into account the requirements of environmental water

[8] Integrated Water Resources Management is a term introduced into the international lexicon by the Global Water Partnership (GWP). IWRM constitute a continuing process when all types of water use are considered jointly to ensure sustainable development, allocation as well as monitoring of water resources use in the framework of societal, economic and environmental objectives.

discharges for the needs of the Aral Sea and its surrounding area (Akhmetova, 2007). The internal logic of the Schemes dictated strict adherence to the top-down command principle and did not allow for the possibility of establishing strong feedback mechanisms between the subjects of water use (GWP, 2014).

Being aware of the limitations of this management model and, in particular, the loss of its effectiveness in the last years before the collapse of the USSR, the Soviet government established autonomous Basin Water Organizations (BWO) in 1987-1988. The “Amudarya” and “Syrdarya” BWOs were authorized to manage water facilities on the Amu Darya and the Syr Darya and their main tributaries with a flow rate of more than 10 m^3/sec. Based on hydrological forecasts, the BWOs could reduce or increase the water limits for each republic up to 10 percent (SPECA, 2004).

With the breakup of the Soviet Union (the start of *the current fourth stage*), the crisis in the Central Asia water sector only intensified. The political and socio-economic transformations that were in place in the region since the beginning of the 1990s had negative impacts on the water sector and the discipline of water use, significantly reducing the efficiency of water resources utilization compared to the Soviet period (Mamatkanov, Bajanova and Romanovskiy, 2006). The technological wear-and-tear of water bodies, the outflow of qualified specialists from the region, difficulties in attracting investments have become serious challenges for the sector (OECD, 2020). Water management issues passed into the competence of various state services, sometimes with diametrically opposite tasks (Akhmetova, 2007). Serious problems have arisen at the inter-state level. The principles of water management (the aforementioned limited water consumption policy) began to contradict the interests of the newly emerging states located now on the international transboundary rivers. Each state started devising independent, self-supporting, long-term water and land use strategies (Mubarakshin, 2012).

Realizing that the imminent closing-down of the USSR Water Ministry could lead to the disorganization of the inter-republican water sector, heads of all Central Asian water management organizations started consultations on retaining the regional water regulation under a single coordinating body. In 1992, they signed the intergovernmental Almaty agreement on cooperation in the field of joint management of water resources, based on which the Inter-State Commission for Water Coordination (ICWC) was established. The new intergovernmental body included both BWOs, as well as several analytical and monitoring departments. And together they represent regional bodies of the International Fund for Saving the Aral Sea (IFAS).

Nowadays within the framework of the ICWC, the water ministries of the five Central Asian states jointly formulate the water management policy in the region, take measures to maintain the operability of existing infrastructure, resolve issues related to the operational management of water resources, and address problems of water supply to the crisis-hit Aral Sea and its surrounding area (SPECA, 2004).

At the same time, despite the significant successes achieved since the establishment of the ICWC in maintaining "water peace", its ability to influence the problems of the regional water sector is severely limited. The ICWC decisions are de facto recommendatory, and the legal norms elaborated by it do not apply to the entire territory of the Aral Sea Basin (Rysbekov, 2012). The same holds true for BWOs. Specifically, the area of responsibility of the BWO "Syrdarya" extends only from the Uch-Kurgan HPP in Kyrgyzstan to the Chardara HPP in Kazakhstan leaving the regulation of the upstream and downstream waters outside its control (Kayumov, 2016). Moreover, due to never-ending quarrels about country representation and staffing designs the ICWC and the IFAS have gained a reputation as a place of constant inter-state feuding. The fact that most institutions of the IFAS system (ICWC, BWOs' offices) are situated in Uzbekistan raises questions regarding a possible bias in favor of their host country (Mosello, 2008). The situation around the IFAS even got to the point when Kyrgyzstan suspended its participation in the organization in 2016 (Silkroad, 2016).

This situation is largely due to the unresolved issues of joint use of transboundary water resources. Instead of a coordinated approach to increasing the efficiency of water use and related hydropower potential of the rivers as a whole, Central Asian countries are mainly focused on developing their own water use strategies that do not always take into account the legal rights and interests of neighboring states.

3.2. CA-5: Resource endowment and energy mixes

The Central Asian region has a significant and diversified, albeit unevenly distributed energy resource base. In this regard, it is one of the most promising territories for development in the world. The region contains 12 percent of the world's proven natural gas and 2 percent of proven oil reserves, and also approximately

33 billion tonnes of coal. The total hydroelectric potential of all regional river basins is estimated at up to 1 quadrillion watt/hours of annual electricity production, including about half of which is of technically exploitable capability. By geography, Kazakhstan has colossal deposits of oil, coal, and uranium, Turkmenistan possesses one of the largest natural gas resources in the world, while Uzbekistan is self-sufficient in all fossil fuels (see Table 4). By contrast, Kyrgyzstan and Tajikistan do not have sufficient reserves of fossil fuels and are completely dependent on oil and gas supplies from abroad, but they accumulate about 90 percent of the regional hydropower potential (SPECA, 2004).

It is also widely claimed that Central Asian countries have substantial untapped solar and wind energy potential. The incremental harnessing of these resources in the future could be a part of country-led programs on clean energy development and transition (WB, 2020b).

Table 4. The potential of conventional energy resources in Central Asia[9] (Compiled on the basis of BP, 2019, and the countries' energy profile information from IEA, 2020; WNA, 2020; IHA, 2020)

Country / Resource	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Region in total
Oil[1] mln tonnes	3,900	5	2	100	100	4,107
Natural gas[1] bln m^3	2,700	6	5.7	19,500	1,200	23,412
Coal[1] bln tonnes	25.6	2.2	4.6	marginal	1.95	33.5
Uranium[2] thsnd tonnes	842.2	30	20	marginal	139.2	733

[9] The table does not contain data on renewable energy resources because the sector is taking only initial steps and there are no reliable data related to their performance in the Central Asian region.

Table 4 (Continued). The potential of conventional energy resources in Central Asia (Compiled on the basis of BP, 2019, and the countries' energy profile information from IEA, 2020; WNA, 2020; IHA, 2020)

Hydro-electric potential[3] TWh/year	61.9	99	317	4.8	27.4	510.1

1. Total proved reserves. As regards coal – anthracite, bituminous, and lignite reserves are included.
2. Based on the World Nuclear Association's (WNA) assessment of total recoverable identified resources.
3. Technically exploitable capability. Gross theoretical potential can be much higher.

In terms of energy endowment, Kazakhstan is among the top ten countries in the world. In 2018, the republic was the world's 19th-largest coal producer (108 million tonnes). It ranked17th in the world for crude oil production (91.9 Mtoe, including gas condensate), and 24th for natural gas (38.7 bcm). Kazakhstan is also a major energy exporter. In 2018, it was the world's 9th-largest exporter of coal, 9th of crude oil, and 12th of natural gas (IEA, 2020). Most of them are exported to Russia, China, and Europe through a wide network of pipelines built in recent decades. In 2019, Kazakhstan produced 43 percent of the world's uranium (22,800 tU), and now it is the world's leading uranium producer (WNA, 2020). Kazakhstan's total energy production in 2018 (178 Mtoe) covered more than twice its energy demand of 76 Mtoe. Coal represents around half of the republic's energy mix (50 percent in 2018), followed by oil and natural gas (both with 25 percent shares) (IEA, 2020).

The power system of Kazakhstan had been developed as part of the Interconnected power grid of the USSR, within which power plants were located under the principle aimed at obtaining a system-wide effect – in areas of large hydrocarbon deposits. This brought about its territorial division into three subsystems of North, West, and South Kazakhstan. Thus, the first two subsystems are interconnected and exploited in the parallel operation mode with the power grids of Russia's Urals and Siberia regions. The southern subsystem, which comprises the Almaty, Dzhambul, Kyzyl-Orda, and Turkistan regions, is connected with the power grids of Kyrgyzstan and Uzbekistan within the framework of the CAPS.

As of 1 January 2019, electricity was generated by 138 power plants with a total installed capacity of 21.9 gigawatts (GW). In 2018, Kazakhstan's power generation reached 106.8 TWh, roughly 80 percent of which was produced at TPPs and around 12 percent at HPPs. 103.2 TWh were consumed, about 9 TWh in total accounted for export-import operations (CIS Energo, 2020).

Kyrgyzstan is poorly endowed with fossil fuel resources and heavily dependent on oil and gas imports. The lands of the republic, however, contain some deposits of coal, which are located in hard-to-reach places. The country's main wealth is hydroelectric resources, which gross potential is estimated at 142.5 TWh of yearly production. Thus far only about 10 percent of it is utilized (IHA, 2020).

In 2018, domestic energy production was 2.3 Mtoe, consisting mostly of hydropower (53 percent) and coal production (37 percent). Kyrgyzstan also produces very little oil and natural gas. Coal production has more than quadrupled since 2010, driven by a decision to boost it in order to decrease the dependence on hydrocarbon imports from Russia and Kazakhstan. In the same year, total final consumption equaled 4.2 Mtoe (IEA, 2020).

Domestic electricity production relies heavily on hydropower. The productive base of the energy sector includes 18 hydropower plants, the most famous of which is the Toktogul HPP that plays an extremely important role in ensuring the water-energy balance in the Syr Darya basin (Antipova et al, 2002). As of 1 January 2019, the installed capacity of the republic's power plants was 3.9 GW (3GW at HPPs and 0.9 GW at TPPs). In 2018, Kyrgyzstan produced 15.7 TWh of electricity, of which about 92 percent were generated at hydroelectric power plants (CIS Electro, 2020). The bulk of thermal energy came from the Bishkek combined heat and power plant.

Until 2015 the power system of Kyrgyzstan was heavily dependent on parallel operations with those of Uzbekistan, Kazakhstan, and Tajikistan within the CAPS. Before the commissioning of the Datka – Kemin electric transmission line (ETL), the republic's power grid was divided into the southern and northern zones, connected by only one 500 kV ETL, the Toktogul HPP – the Frunze Substation. Its transmission capacity was not enough to supply electricity to northern regions. To ensure the missing amounts of load, an intercountry scheme was used, within which Kyrgyzstan, through the networks of the CAPS, provided electricity to consumers in the Fergana Valley of Uzbekistan, whereas electric power generated by Uzbek TPPs was transmitted through South Kazakhstan to northern regions of Kyrgyzstan under a replacement scheme (Mercados, 2010).

In the past decades, Kyrgyzstan’s power system has been facing a crisis. The energy sector is characterized by an aging infrastructure and significant losses. Since 2007, only 120 MW in hydro and 146 MW in thermal generation have been commissioned. At the same time, electricity demand has risen by one quarter (CIS Energo, 2020). This is exacerbated with the denunciation in January 2016 of the Russian-Kyrgyz agreements on the construction and operation of the Kambarata-1 HPP and four plants of the Upper-Naryn cascade and the related search for new investors to construct these HPPs.

Tajikistan currently relies on imports for most of its hydrocarbon needs. However, it is one of the world leaders in terms of hydroelectric resources, but only 5 percent of them are being currently utilized. Generating electricity at HPPs is the most cost-effective way of obtaining energy in the country (IHA, 2020).

As of 1 January 2019, the total installed capacity of power plants in Tajikistan was 6.2 GW (5.5 GW at HPPs and 0.7 GW at TPPs). In the year 2018, the republic generated 19.7 TWh of electricity, of which 93 percent fell on hydropower plants (CIS Electro, 2020).

Since the late 2000s, Tajikistan's energy sector has been going through serious challenges. This coincided with the deterioration in regional relations. In 2009, under the requisition of neighboring Uzbekistan, the republic's power grid was disconnected from the CAPS because of the violations in technological regimes and the following overvoltage in the system. After a couple of years, Uzbekistan also cut off its gas supply to the republic. Additionally, unfortunately for Tajikistan, at that time its power balance was skew: In summer, the country had a surplus in electricity generation while in wintertime, there was a deficit of about 2.5–3 TWh (Mercados, 2010).

Against this backdrop, all the efforts of the national economy have been devoted to the accelerated modernization of the energy sector. Over the past several years, thanks to mainly the Asian Development Bank (ADB) investments, some new backbone ETLs, connecting remote regions of the country into a loop-flow grid, were constructed; likewise, key power generating facilities are currently under renovation. Thus, to date the problem of seasonal shortages is generally solved, furthermore, owing to the normalization of the relations with Uzbekistan, Tajikistan is quite successful in constructing its main hydro project – the Rogun HPP on the Vakhsh River. Moreover, the republic is regarded as a vital part of ground-breaking Central Asia – South Asia (known as CASA-1000) ETL, which is currently under construction.

The subsoil of Uzbekistan is rich in oil, gas, coal, and uranium. For natural gas, it ranks 11th in the world for production and 14th for reserves (BP, 2019). The country's most important export destinations for energy commodities (first of all, natural gas) are China, Russia, and Kazakhstan.

Uzbekistan fully meets its electricity and heat needs from its own energy resources. In 2019, it generated 61.6 TWh of electricity, mostly from natural gas (>85 percent). The share generated from coal is expected to increase in the future to around 10 percent (currently, it is around 3 percent). The total installed capacity of Uzbekistan is currently 15.9 GW, with TPPs making up 88 percent or 14.0 GW, and HPPs – the remaining 12 percent or 1.9 GW (IEA, 2020).

The configuration of Uzbekistan's power grid was built in Soviet times, taking into account the interests of all the Central Asian republics, and was exploited in the parallel operation mode with their power systems. Until 2009, the structure of Uzbekistan's grid had envisaged the use of Kyrgyzstan's soil for supplying power to districts in the Fergana Valley. After the commissioning of the 500 kV ETL New-Angren TPP – the Uzbekistan Substation, the republic created its own loop-flow grid with a voltage of 500 kV and became energy independent (CIS Energo, 2020). The power system of Uzbekistan is the central part of the CAPS and functions currently in parallel with Kazakhstan and Kyrgyzstan.

Turkmenistan has colossal reserves of natural gas (19.5 trillion m^3) and is one of the main exporters of this commodity in the world (BP, 2019). The gas produced in the republic is exported to Russia, China, and Iran. There are projects to expand the geography of energy supplies to South Asia and towards the European Union through the Caspian Sea.

In the mid-2000s, the abundance and high prices for natural gas enabled the Turkmen authorities to begin large-scale construction of new electricity generation and transmission facilities. This ensured a steady growth in power generation by 10–20 percent annually above the domestic needs. In 2018, the installed capacity of all power plants (all of them are gas-fired) was 5.5 GW, with 25.8 TWh of electricity generated while 3.4 TWh of which was exported to neighboring countries (CPC, 2019).

In recent decades, the importers of Turkmen electricity have been Iran (in 2003, Turkmenistan left the CAPS to function in the parallel operation mode with the power grid of the Islamic Republic), Afghanistan, Uzbekistan, and Turkey (through Iran). Nowadays, great hopes lie in the implementation of the Turkmenistan-

Afghanistan-Pakistan (TAP) ETL, which will be constructed alongside the TAPI pipeline aimed at transporting Turkmen gas to India (Khan Saif, 2021).

3.3. The Central Asian Power System: History and recent developments

The figures quoted in the previous paragraph indicate that in terms of the total amount of energy resources, Central Asia can be considered one of the most energy-rich regions in the world. However, when it comes to resource endowment, regional countries can be divided into two groups. The first group comprising Kazakhstan, Turkmenistan, and Uzbekistan has large reserves of fossil fuels, which make it possible to independently meet the needs of national energy sectors, and sell them in significant volumes on international markets. On the contrary, Tajikistan and Kyrgyzstan, which make up another group, do not possess substantial hydrocarbon reserves and have to buy the missing quantities abroad. At the same time, these republics have a colossal hydropower potential, which currently remains poorly realized.

Taking into account the uneven distribution of energy resources across the region and the associated operational characteristics of the countries' energy sectors, one can say that Central Asia is destined to be a region with a complementary power economy. Indeed, as was noted above, during Soviet times the energy security of the region had been ensured by the mix of hydropower resources of Kyrgyzstan and Tajikistan and hydrocarbons of Kazakhstan, Uzbekistan, and Turkmenistan. The central cohesive element to this system was the Central Asian Power System that redistributed electricity flows between the republics.

The configuration of the CAPS began taking shape in the 1970s based on the least cost criterion and included the power grids of South Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan, and functioned in isolation from the rest of the Interconnected power grid of the USSR. By the end of the 1980s, at the time of the highest level of its functionality, the CAPS was a highly automated constellation of power plants and electric grids with a common mode of operation, equipped with centralized dispatch and emergency management, as well as the integrated economic, legal and informational toolbox (Kasymova, 2005).

The process of building the CAPS was completed in 1991 when its core element – the 500 kV loop-flow transmission line, passing through the territories of four out of the five Central Asian republics in the Fergana Valley region, was put into operation (see Figure 2). Structurally, the CAPS consisted of 83 power plants with a total installed capacity of 25 GW, including 29 TPPS with a total capacity of 16 GW and 48 HPPs with a capacity of 9 GW. Most of this capacity (about 52 percent) was generated in Uzbekistan. The power plants of Tajikistan, Kyrgyzstan, and Turkmenistan accounted for 16, 15, and 11 percent of the capacity, respectively. The remaining 6 percent of the total capacity was provided by the power system of South Kazakhstan (Kasymova, 2005). At the same time, HPPs in Kyrgyzstan and Tajikistan were used to regulate variable peak (maximum and minimum) loads in the grids of Kazakhstan, Uzbekistan, and Turkmenistan, whereas TPPs of the former, operating on coal, oil, and gas, would cover the basic demand from the Kyrgyz and Tajik grids (Kravtsov, 2008).

Besides, the automatics of the CAPS made it possible to regulate the operation modes of all the HPPs along the Syr Darya, thanks to that, the coordinated functioning of the regional energy and water sector was ensured. The work of the CAPS was coordinated from so-called the Unified Dispatch Administration (UDA) of Central Asia, established in Tashkent in 1960 (in 1994, it was renamed into the Unified Dispatch Center (UDC) “Energiya”). The choice of the Uzbek capital as the management center was dictated by the border position of Uzbekistan to all other republics. Even though the CAPS was functioning in the autonomous mode, its management was subordinate to the Central Dispatch Department in Moscow (Shamsiev, 2009).

The dissolution of the USSR and the establishment of independent states had a very serious impact on the Central Asian countries' energy sectors. With the collapse of the unified state, the once well-functioning system of centralized energy supply has ceased. All republics were concerned about taking urgent measures to ensure energy independence, which was erroneously understood as a focus on the maximum use of their own resources (Mubarakshin, 2013). However, sectoral officials had the understanding that none of the grids was capable of independently providing reliable power supply to consumers. In November 1991, heads of the Central Asian energy departments gathered in Ashgabat to sign an agreement on maintaining parallel operation within the CAPS.

Before 1991, the Central Asian Power System (CAPS) was isolated from the rest of the Interconnected power grid of the USSR. For that reason, the indicated transmission line did not exist.

This loop-flow 500 kV transmission line (dubbed as a 'power ring') was the core element of the CAPS, uniting the power grids of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan around the Fergana Valley.

Tashkent, the capital of Uzbekistan, was chosen as the headquarters of the CAPS because of the republic's central position in relation to others. Nowadays, Coordination Dispatch Center "Energiya" is also situated there.

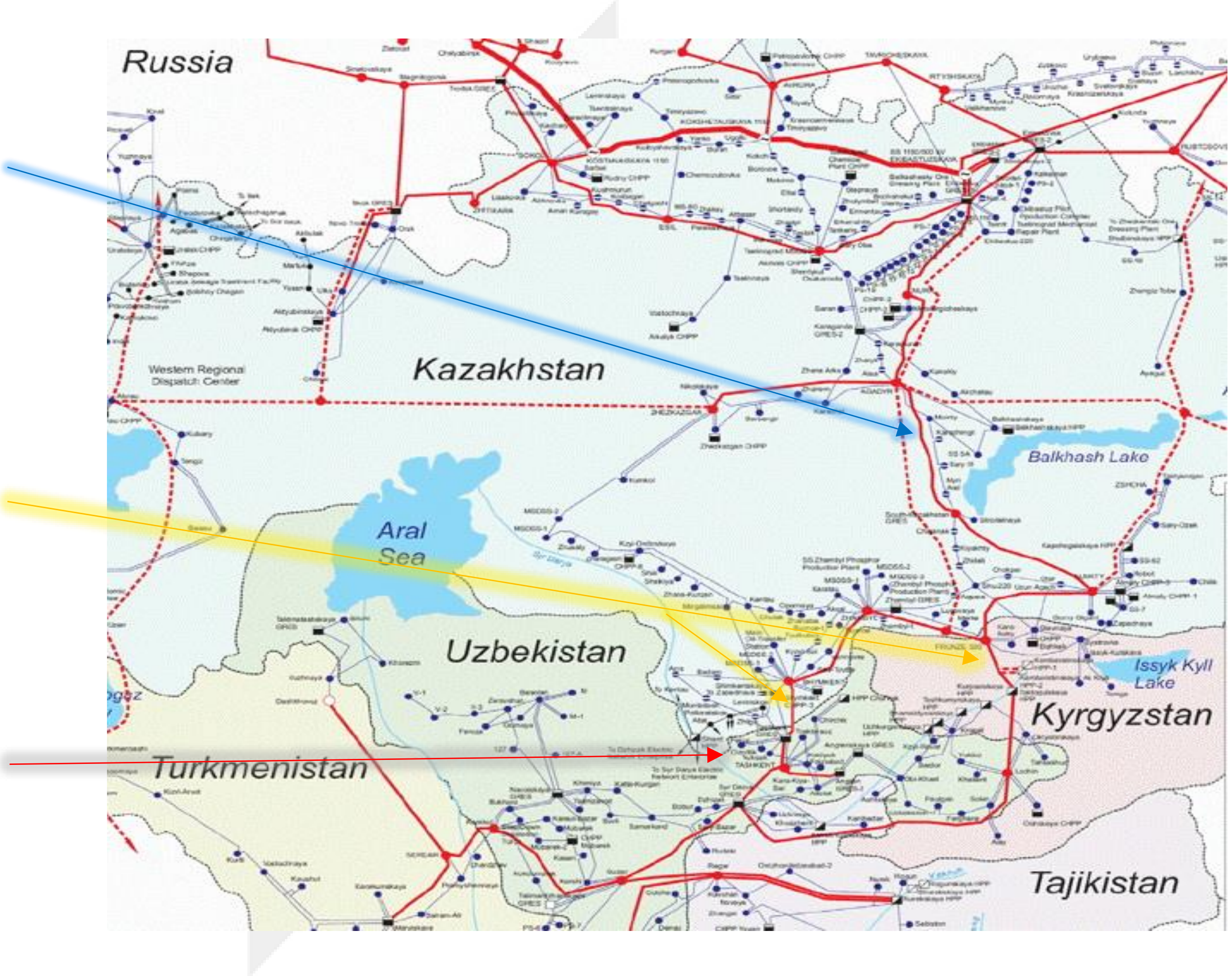

Figure 2. A map of 220-500 kV electricity mains of the Central Asian Power System (CAPS)

A couple of new documents signed in the late 1990s have institutionalized countries' relations in this sphere. In 1998, within the framework of CIS Electric Power Council, eleven countries of the Commonwealth, including five Central Asian states, signed an agreement on ensuring the parallel operation of electric power systems. The next year, intending to strengthen its regional dimension, heads of the energy departments of Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan signed a separate intergovernmental document on the same issue. This new agreement determined practical measures to ensure the efficient and reliable operation of the CAPS, and also envisaged the creation of a full-fledged Electropool (common power market) in Central Asia in the future.

The realization of such an ambitious goal required the preparation of relevant regulatory documents and road maps designating specific rights and obligations of its parties. And although some of this paperwork soon emerged, the regulatory and legal framework necessary for the CAPS' full-fledged operation has not been formed. The reforms of its management were also more cosmetic. So, instead of improving the management system in line with market principles, the Unified Dispatch Center was transformed into the Coordination Dispatch Center (CDC) "Energiya", endowed, as before, with minimal executive functions to coordinate the operational and technological functioning of the CAPS (Petrov and Akhmedov, 2011). To provide overall guidance to the CDC, the Coordination Electric Power Council of Central Asia comprising regional transmission system operators was established in 2004.

The functional limitations of the CDC, such as the absence of a single command center (similar to the all-Union Ministry of Energy) and problems with the financing of power infrastructure facilities, have negatively affected the reliability of the CAPS with serious technical failures in its functioning have begun to emerge. Since the early 1990s, a steady downward trend in the amount of intraregional electricity flows has been witnessed. Following 1990, when the CAPS was at the highest level of its functionality, the amounts of regional trade has decreased tenfold: from 25.5 TWh to 5.6 billion kWh in 2000 and 2.7 TWh in 2018 (see Table 5).

Table 5. The dynamics of electricity trade between Central Asian republics/countries in 1990-2018 (in GWh) (Source: Compiled on the basis of Shamsiev, 2013; 2019)

	1990	the Soviet Socialist Republic (SSR) receiving electricity					Total
		Kazakh SSR	Kyrgyz SSR	Tajik SSR	Turkmen SSR	Uzbek SSR	
the SSR transmitting electricity	Kazakh SSR		227.4			309.9	537.3
	Kyrgyz SSR	697.5				2,383.6	3,081.1
	Tajik SSR		324.1			2,344.2	2,668.3
	Turkmen SSR					6,066.1	6,066.1
	Uzbek SSR	8,139.8		3,926.9	1,113.1		13,179.8
	Total	8,837.3	551.5	3,926.9	1,113.1	11103.8	**25,532.6**
	2000	**Imports**					**Total**
		Kazakhstan	**Kyrgyzstan**	**Tajikistan**	**Turkmenistan**	**Uzbekistan**	
Exports	Kazakhstan						
	Kyrgyzstan	1,252.9		154.4		1,925.6	3,332.9
	Tajikistan		125.7			243.9	369.6
	Turkmenistan	34.8		818.7		67.8	927.3
	Uzbekistan		194.6	728.8	32.5		955.9
	Total	1,287.7	320.3	1,701.9	32.5	2,237.3	**5,579.7**
	2018	**Imports**					**Total**
		Kazakhstan	**Kyrgyzstan**	**Tajikistan**	**Turkmenistan**	**Uzbekistan**	
Exports	Kazakhstan		6.1	12.1			18.2
	Kyrgyzstan	3.3		24.8		754.9	783.0
	Tajikistan	12.1	2.8			1,480.9	1,495.8
	Turkmenistan					356	356,0
	Uzbekistan		6				6.0
	Total	15.4	14.9	36.9	0.0	2591,8	**2,659**

The change in the design conditions of HPPs (from the irrigation to the energy operation modes) imbalanced the operation of Kyrgyzstan's and Tajikistan's power systems. This led to the unsanctioned siphoning of electricity from the CAPS. Thus, due to an unscheduled siphoning of about 0.1 TWh of electricity by the Tajik power system, the grid of Kazakhstan had to operate in the isolated operation mode from the CAPS for two weeks in February-March 2009 (Smirnov, 2009). Another accident that happened due to a violation of the technological mode at the Nurek HPP in Tajikistan on November 9, 2009, for some time virtually completely de-energized the southern parts of Tajikistan and Uzbekistan. The energy authorities of Uzbekistan, placing all the blame on Tajikistan for what had happened, announced their temporary withdrawal from the CAPS. After dismantling a part of the 500 kV Guzar – Regar ETL that had connected the two republics, the power grid of Uzbekistan rejoined the CAPS, whereas the grid of Tajikistan was forced to switch to the isolated mode of operation (Ibrahimova, 2010).

The termination of parallel operation of four power systems (except for the Turkmen one, which had always been somewhat remote) meant the actual disintegration of the CAPS with serious consequences for their functioning. This state of things required the adoption of urgent measures to loop back the grids. So, in recent years, Kazakh energy authorities commenced operational use of the Moynak HPP and the Ekibastuz HPP-2. Besides, the 500 kV North – East – South ETL was phased in, which enabled to cover most of the power shortage that had typically been occurring in the southern regions of the country. In Uzbekistan, the New Angren and Navoi TPPs were streamlined, the Uzbekistan Substation, providing power to the Fergana Valley, and the 500 kV Guzar – Surkhan ETL, covering the energy needs of the Surkhandarya region, which were previously provided by Tajikistan, were put into operation. In 2015, the 500 kV Datka – Kemin ETL was commissioned in Kyrgyzstan, connecting the southern Jalal-Abad region (where the main power generation facilities are located) with the most-populated northern part of the country (CIS Energo, 2020).

Against this background, Tajikistan found itself in the most difficult situation. Having switched to the isolated operation mode, its power system began to experience acute winter shortages, and vice versa, summer surpluses of electricity. In the early 2010s, due to the impossibility of selling electricity on foreign markets, idle water releases from the Nurek HPP exceeded 50 percent. Specifically in 2010, in the first year of isolated functioning outside the CAPS, the total losses of the Tajik power sector exceeded 5 TWh, which amounted to 25 percent of the average annual production (Petrov, 2009). Fortunately for the republic, just a few days before the power connection with Uzbekistan was cut off, the high-mountain 500 kV South – North ETL was put into operation to connect the county's southern part with the northern energy-deficient Sogd region, which previously received electricity through the Uzbek power system. With the construction of the 500 kV Dushanbe – Regions of Republican Subordination ETL, the power system of Tajikistan has finally obtained own loop-flow grid (CIS Energo, 2020).

Faced with the problem of power supplies within the CAPS, the Central Asian countries have also been concerned about finding new markets for their surplus electricity outside the region. In recent years, a close relationship has been established between the power systems of Russia and Kazakhstan, there is likewise an increase in export supplies of electricity from Uzbekistan, Tajikistan, and Turkmenistan to Afghanistan (Shustov, 2017). In particular, since the late 2000s, ADB has been funding the project called "Afghanistan: Energy Supply Improvement Investment Program" (also known under the acronym of TUTAP, consisting of initial letters of the countries involved: Turkmenistan, Uzbekistan, Tajikistan, Afghanistan, and Pakistan). The project is geared towards supplying the country with electricity from Central Asian republics, as well as interconnecting numerous separate power grids within Afghanistan (Wikipedia, 2021a). So, under this program, several 220 kV ETLs connecting the latter with Uzbekistan, Tajikistan, and Uzbekistan have already been commissioned, some more 500 kV ETLs are currently under construction (Shamsiev, 2019).

In a similar vein, since the mid-2000s, at the suggestion of the United States, who was interested in restoring the Afghan economy by employing the resources of Central Asia, the CASAREM initiative (Central Asia – South Asia Regional Energy Market) has been promoted. One of the key components of this plan is the development of a cross-border ETL to export surplus summer electricity from Tajikistan and Kyrgyzstan to Pakistan and Afghanistan (the CASA-1000 project). After its completion, the ETL will allow for exporting 3 TWh of Tajik and 2 TWh of Kyrgyz electricity to the countries of South Asia in the period from April to October (WB, 2020b). However, to ensure the design capacity of the ETL, Tajikistan and

Kyrgyzstan will have yet to complete the construction of the Rogun HPP and Kambarata-1 HPP, respectively.

It is anticipated that the CASA-1000 and TUTAP projects will be, to some extent, synergetic: If summer electricity will be mainly exported from Tajikistan to Pakistan via CASA-1000, then predominantly Turkmenistan will supply Afghanistan and Pakistan with power during winter months (Saleem, 2018).

The thaw in relations between Uzbekistan and its neighbors that began after the change of the republic's leadership in 2016, opens a window of opportunity for a full-fledged restoration of the CAPS. Specifically, at the 4th meeting of the Uzbek-Tajik Intergovernmental Commission on Trade and Economic Cooperation in late 2016, it was decided to restore the 500 kV Guzar – Regar ETL, which had connected both countries before the cut-off in 2009. In 2019, Turkmenistan, which had left the CAPS in 2003 to function its power system in the parallel mode of operation with the Iranian power grid, expressed its wish to return to the CAPS (Shamsiev, 2019).

3.4. The system of integrated water and energy management and the post-Soviet attempts of its restoration

Problems with joint use of the regional water potential and energy base are among the most important factors determining the performance of the economy in Central Asia. During the Soviet period, the region was distinguished by high water and energy synergies, which were geographically and historically predetermined by the hydrological and geological conditions.

The integrated water and energy management in the Aral Sea Basin began taking shape in the 1960s. In the late 1950s, when the natural irrigation capacity of the Amu Darya and the Syr Darya had been exhausted, the Union leadership adopted a program for the construction of large-scale HPPs with reservoirs capable to ensure the needs of ever-increasing demand by irrigation (Petrov and Akhmedov, 2011).

In the 1960s-1980s, 26 reservoirs with a total volume of around 35 km^3 and a usable storage of 27 km^3 were put into operation in the Syr Darya basin, including the five HPPs of multi-purpose use: the Toktogul (total volume 19.5 km^3, including a usable storage of 14 km^3) on the Naryn, the Kayrakkum (3.4 km^3) and the Chardara (5.2 km^3) on the mainstream, the Charvak (2 km^3) on the Chirchik River, and the

Andijan (1.9 km^3) on the Kara Darya River. All of them had both irrigation and energy orientation, but at the same time were solving the issues of water supply (Charvak, Kayrakkum, Andijan), flood control (Chardara and Toktogul), and fishing. With their commissioning, the streamflow of the Syr Darya became almost completely regulated (the corresponding coefficient today is 0.94) This has allowed for seasonal and, what is more important, long-term streamflow regulation and has ensured a guaranteed water supply (excluding return waters) of about 32 km^3 (Starikov, 2012).

It is worth noting that such a cascade configuration of these facilities, redistributing water resources in time, enables to accumulate and then release it from reservoirs during periods of low water and, conversely, to entrap its surpluses in the times of floods. The high degree of river control in the Syr Darya made it possible to achieve significant efficiency in the management of its water resources. Largely because of that, agricultural production in the river basin has grown by more than two and half times, which in turn made it possible to employ a significant part of the rural population, reaching about 60 percent of the inhabitants of the river basin (Akhmetova, 2007).

During the same period in the Amu Darya basin, 17 regulating reservoirs were built with a total volume of 25.8 km^3 and a useable storage of 17.1 km^3. Two multi-purpose reservoirs are located on the mainstream and its largest tributary, the Vakhsh River. These are the Nurek HPP on the latter with a useable storage of 4.5 km^3 and the Tuyamuyun HPP on the Uzbek-Turkmen border with the same working storage. Together, these facilities allow for regulating the streamflow of the Amu Darya river basin by 78 percent (Khudaybergenov, 2003).

In order to achieve the maximum technical effect, the largest hydraulic facilities such as the Toktogul and Nurek HPPs were constructed in the upper reaches of the Aral Sea Basin. Built on the territory of the mountainous republics – Kyrgyzstan and Tajikistan, respectively, these facilities were designed to regulate the streamflows exclusively in the interest of irrigated agriculture in the downstream republics of Kazakhstan, Uzbekistan, and Turkmenistan. Such an operation mode of HPPs implied their maximum utilization during the growing season (April – October) and minimum – during the rest of the year when the water had to be accumulated in reservoirs. At the same time, the electricity generated at HPPs was centrally distributed in the networks of the CAPS. In the winter months, when water was being accumulated in the respective reservoirs, regional electricity needs were covered mainly by TPPs located in the downstream republics. Besides, the involuntary losses of upstream republics from the irrigation operation mode at HPPs were additionally compensated by the central government in Moscow in the form of managed energy supplies and agricultural products (Mamatkanov, 2003) (see Figure 2).

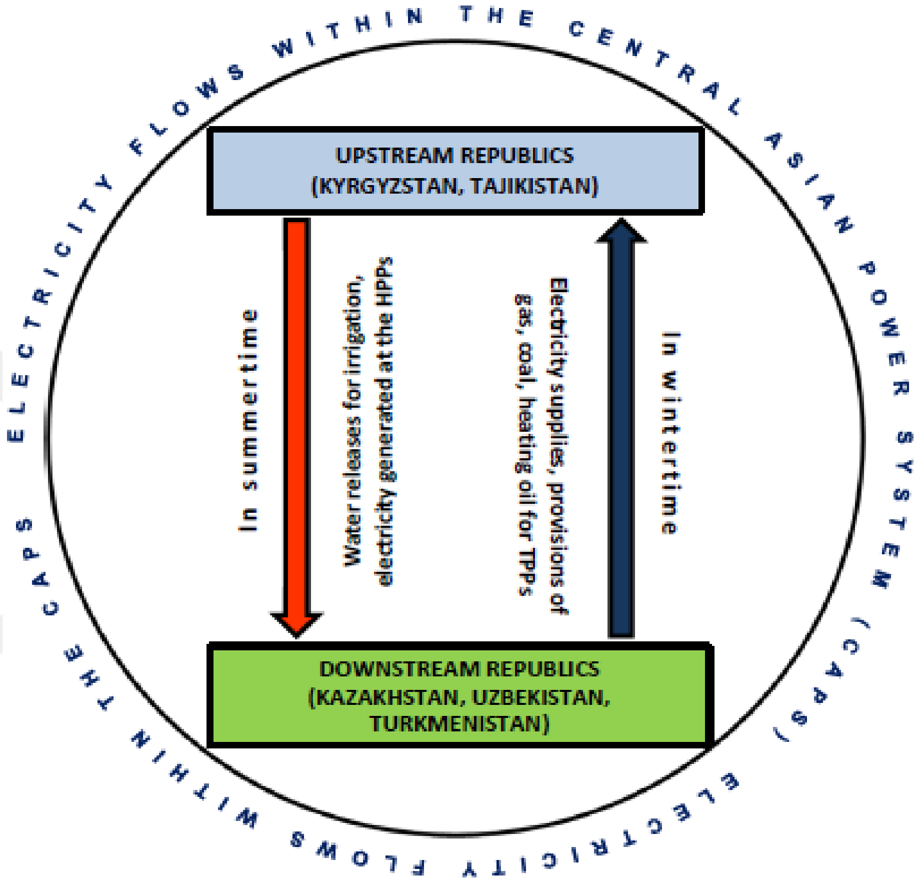

Figure 3. A scheme of integrated water and energy management during the USSR

As can be seen, the main objective of this integrated water-energy management was to maximize cost-effectiveness. The interests of individual republics in ensuring independent development were of secondary importance. The maximum benefit was considered for the USSR as a whole, regardless of the specific contribution of a particular republic or industry. Therefore, it was considered legitimate that the development of irrigated agriculture should take place in the downstream republics, whereas the needs of Tajikistan and Kyrgyzstan, both in terms of water apportioning limits and energy use of river flows, were compensated for through hydrocarbon supplies from neighboring republics distributed by directive (non-market) methods.

Water resources per se were exclusive state property and provided as a "free good". The main idea behind this benefit-sharing mechanism was not to share a fixed quantity of water, but rather to distribute the benefits arising from water management.

After the collapse of the USSR and the emergence of five independent states, the impending division of the once unified water and energy complex became increasingly clear. İn the face of disorganization and risks of conflicts, as noted earlier, sectoral officials managed to preserve the status quo in both the water and energy sectors, on which specific inter-state agreements were signed. Besides, the ICWC was entrusted with practically all issues related to inter-state water allocation (apportioning) based on the agreed soviet-era principles. In fact, it took over the functions of the USSR Ministry of Water Management in Central Asia. The CAPS and its dispatch center continued to operate as before.

On the other hand, maintaining the status quo in the sector had some significant shortcomings, the existence of which became clearly manifested with the development of market relations in the newly independent states. With the incremental destruction of former economic ties, the integrated water-energy management system based on the swap mechanism began to degrade. The geopolitical changes immediately made internal watercourses transnational and transferred issues related to their use into the category of inter-state ones. If during Soviet times irrigated agriculture was the top economic priority in the region whereas the hydropower industry was, in fact, of subordinate importance, after 1991 the previous guidelines remained relevant only for Kazakhstan, Turkmenistan, and Uzbekistan, while for Tajikistan and Kyrgyzstan the hydropower rose to the fore (Mubarakshin, 2014).

İn this regard, arguably the most problematic situation developed in the Syr Darya basin. Since the late 1970s, the role of the river's main regulator had been played by the Toktogul HPP[10] in Kyrgyzstan with an installed capacity of 1,700 MW. The hydrosite was equipped with a huge reservoir capable of storing water to meet the needs of irrigation in Uzbekistan and South Kazakhstan during the cotton growing season employing multi-year streamflow regulation. Under Protocol No. 413 of the Scientific and Technical Council of the USSR Ministry of Land Reclamation and

[10] The Toktogul hydroelectric station is the upper hydrosite of the Lower-Naryn Cascade (chain) of HPPs. The cascade also comprises the Kurpsay (800 MW), Tashkumyr (450 MW), Shamaldysay (240 MW), and Uchkurgan (180 MW) HPPs They are all located in Kyrgyzstan and managed by the local OJSC "Electric Stations".

Water Resources dated 7 February 1984, in the years of average water availability, 75percent of the total volume of water releases from the Toktogul reservoir were to be carried out in growing season (April – September) (WB, 2004). In other words, the functioning of the station and the whole cascade of Lower-Naryn HPPs was to be operated in the irrigation mode. The electricity generated under this mode was sufficient to cover the basic needs of Kyrgyzstan, while its surplus was transferred to the neighboring republics through the CAPS.

İn the early 1990s, trade in fuel and energy resources between the Central Asian countries (coal, oil, and natural gas) switched to hard currencies and began to be implemented at world prices, while residential and export electricity tariffs, due to the difficult socio-economic situation in the region, remained artificially low. Under these circumstances, Kyrgyzstan, generating much more electricity than it needed in summer, could no longer purchase a sufficient amount of fuel to cover its higher winter needs for electricity and heat with the money raised from the sale of surplus electricity. The aforementioned 1992 Almaty Agreement, however, did not stipulate the provision of energy supplies to Kyrgyzstan and Tajikistan for their use over the winter when their energy needs are highest (Libert, Orolbaev and Steklov, 2008). The continuation of the previous irrigation mode at the Lower-Naryn HPPs under the ongoing conditions did not meet the interests of the republic's national security (Kemelova and Zhalkubaev, 2003).

For that reason, the Kyrgyz authorities started changing Toktogul’s operation from the irrigation to the energy mode with increased water releases to produce more electricity and meet the needs of the republic during the heating season (see Figure 4). By the end of the 1990s, the average volume of summer water releases decreased to 45.6 percent (instead of the 75 percent as was designed), while winter releases, on the contrary, increased from 25 percent to 55.4 percent (WB, 2004).

Attempts to resolve the problem with the operation modes have been undertaken many times. Only in the period from 1993 to 1997, the regional states signed about a dozen of inter-state protocols and agreements, which established the supply of fuel and power from Uzbekistan and Kazakhstan to Kyrgyzstan and the volume of “vegetation releases” (during the growing season) from the Toktogul HPP’s reservoir (Fuzaylov, 2006). They were ad hoc by nature and concluded on a bilateral basis and for a short period. Water use planning in them was based on a seasonal forecast of the hydrological situation and the actual availability of water resources in the reservoirs, which caused a steady tendency towards a reduction in the river's water reserves in the longer run (Akhmetova, 2007). However, the barter exchanges introduced by these documents clearly demonstrated the determination of the republics to minimize inter-state tension at the time when each country de facto wanted to pursue a strategy of energy independence (Weinthal, 2001).

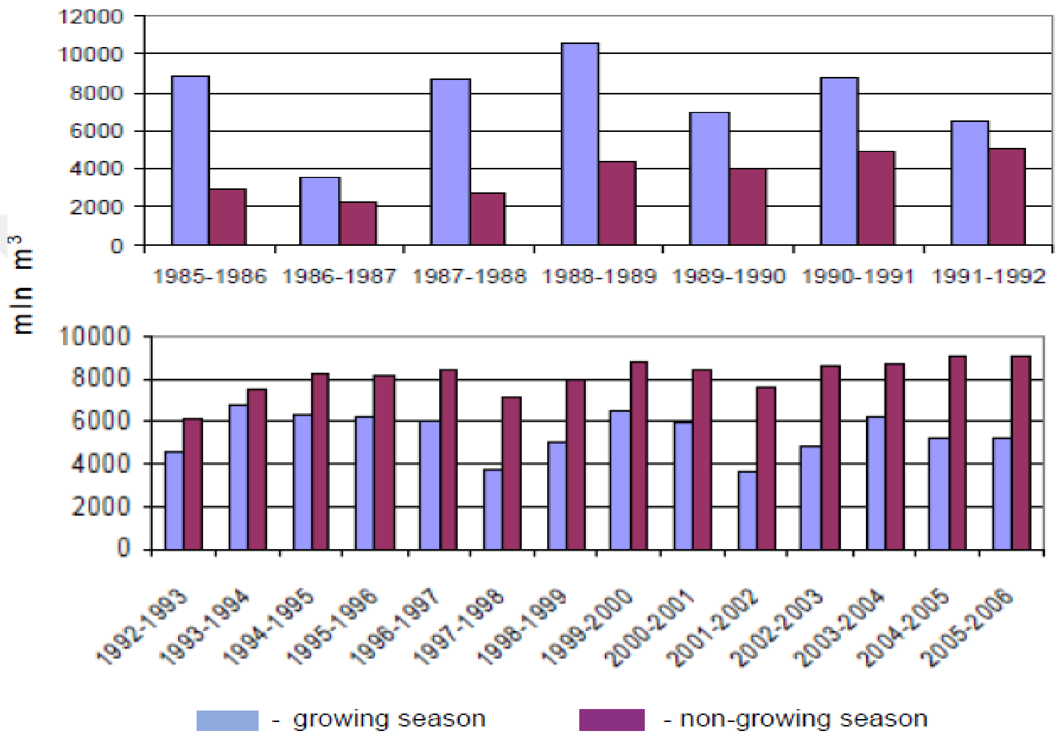

Figure 4. The water releases from the Toktogul HPP in 1985-1992 and in1992-2006 (Source: Sorokin, 2012)

As was discussed in paragraph 2.1., a significant breakthrough was achieved in 1998 with the signing of the Bishkek Agreement. The document was of a framework nature and was designed for five years with possible prolongation. It also provided for the conclusion of annual agreements concerning water releases from the Lower-Naryn cascade and compensatory payments in the form of oil, coal, gas, and electricity to Kyrgyzstan for its "lost opportunities" so as to allow her to generate electricity in winter.

The central provisions of the first such protocol, which was signed on the same day as the framework Bishkek Agreement, were as follows. Kyrgyzstan guaranteed to release 3.25 km^3 of water in the summer from the Lower-Naryn cascade. Kazakhstan and Uzbekistan, in turn, pledged to purchase in equal amounts 2.2 TWh of electricity in total generated in Kyrgyzstan in the summer and exceeding its own needs. The cost of this electricity was to be paid back by fuels supplies to Kyrgyzstan (gas and fuel oil from Uzbekistan, coal from Kazakhstan, or in cash equivalent) in the quantities necessary to cover its winter power demand. The total estimated value of exchange was USD 48.5 million (Weinthal, 2001).

Unfortunately, the water-for-energy scheme, which had proved effective in Soviet times, turned out to be difficult to implement in the face of independent states and market relations. Giving due recognition to the positive role of the 1998 Agreement in stabilizing the situation in the regional water and energy sector, it should be noted that it also had several significant drawbacks.

Specifically, the Agreement envisaged similar quantities of energy supplies regardless of the level of water content in the Syr Darya. The supply provisions of the Agreement did not suit the downstream countries in dry years, the upstream countries were not satisfied during the years of average water content. Furthermore, those contractual provisions did not meet the interests of all parties in the years of higher water content. For example, during the years of high-water availability, the need for the downstream countries for additional releases from the Toktogul HPP was virtually absent, which in turn impeded the export of electricity from Kyrgyzstan under the Agreement (Rysbekov, 2005). So, for example, even within the first year of its implementation, due to the high level of water content in the Syr Darya during 1998, Kazakhstan delivered to Kyrgyzstan only 150.4 thousand tonnes of coal instead of the agreed 566.7 thousand tonnes and respectively received only 0.15 TWh of electricity instead of 0.25 TWh. Uzbekistan also received only 0.075 TWh from Kyrgyzstan in the same year, instead of the agreed 0.2 TWh. In the following 1999, Kazakhstan exceeded its coal obligations, but Uzbekistan did not supply 169 million m^3 of gas. In the dry year of 2000, Uzbekistan exceeded its gas obligations, but Kazakhstan did not supply coal by 31.4 thousand tonnes (ADB, 2006).

Secondly, the documents determined only the general principles of interaction between the countries, these included the provision of services for regulating the Syr Darya streamflow by Kyrgyzstan and the corresponding compensation for the associated losses by Uzbekistan and Kazakhstan. Both the main framework agreement and the annual protocols were not supported by appropriate methods for calculating the number of services and compensations, as well as their equivalent cost. This is what became a constant subject of disputes between the parties - over the volume of water and energy supplies, their cost, payment schemes, etc. (Rysbekov, 2005). The situation was aggravated by the lack of a conflict-solving mechanism and corresponding guarantee obligations to the parties in the event of force majeure.

Thirdly, the implementation of the Agreement was hampered by the shortcomings in the administrative structures of the water and energy sector. To date, there is no a permanent joint center for the integrated management of water and energy sectors in Central Asia. The ICWC and CDC "Energiya" offices are significantly limited in their rights. Moreover, they function according to different principles. The CDC is, in fact, only an executive body that coordinates the work on fulfilling requests from regional power companies. In contrast, the ICWC has certain command functions. However, these organs do not practically interact with each other. The result is a paradoxical situation: All operation modes at the Aral Sea Basin’s HPPs are developed and approved by the ICWC (based on data received from BWOs) without any participation of power engineers. At the same time, it is the latter who is solely responsible for its implementation. Another drawback of these organizations is that having the status of inter-state organizations, in principle, they do not provide for either the rotation of leading personnel or the participation of specialists from other republics in the work. All of them are located in Uzbekistan, mainly in the city of Tashkent, and are almost entirely formed by local national personnel (Petrov and Ahmedov, 2011).

As a result, the obligations of the parties to adhere to the multiyear regulation of the Syr Darya de facto remained only on paper. Experiencing a shortage of energy resources during the heating non-growing season, Kyrgyzstan continued to use the waters of the Toktogul HPP mainly for energy purposes. Instead of balanced use of water resources in line with a long-term plan, the reservoir turned out to be able to perform only the function of seasonal regulation. The signing of similar multilateral protocols was practiced with varying success until 2003 when the parties to the Agreement declined to extend it and returned to bilateral “separate agreements” (Vinokurov et al., 2021).

As can be observed, from the very beginning the Agreement was implemented with serious violations. Ultimately, its inadequate performance and the lack of effective resource management did not fail to affect the water situation in the river basin, which continued to deteriorate, reaching the climax in the 2007–2008 cold season. By the start of the growing season in 2008, the Toktogul reservoir, which had been operated during the entire autumn-spring period in the energy mode, remained close to critical volumes of water. In order to raise the water level in the reservoir and increase the energy efficiency of the Toktogul HPP, the power sector was forced to switch to a limited mode of power consumption, accompanied by 10-12 hour rolling blackouts throughout Kyrgyzstan (Mubarakshin, 2013).

Under these conditions, the states of the region made another attempt to establish multilateral cooperation based on the "water-energy exchange" scheme. In October 2008, the governments of all the regional countries signed a Protocol on the use of water and energy resources of the Central Asian region for the 4 fourth quarter of 2008 and the 2009 year. According to the document, Kazakhstan agreed to provide Kyrgyzstan in 2009 with 0.25 TWh electricity and also with coal for the Bishkek TPP, while Uzbekistan undertook to supply an additional 150 million m^3 of gas to the republic. The Kyrgyz authorities, in turn, committed themselves to providing 5.25 km^3 of water releases from the Toktogul reservoir during the 2009 growing season. The signing of the document made it possible to avoid repeating the 2007–2008 crisis, and in 2010 the water level in the reservoir began to recover (Kayumov, 2012).

Analysis of the above plots allows us to conclude that the scheme of "water-energy exchange" remains one of the most optimal mechanisms for ensuring the water-energy balance in the Syr Darya river basin. Its main advantage lies in the fact that compliance with the requirements for winter supplies of Uzbek and Kazakh energy resources to Kyrgyzstan makes it possible to operate the Lower-Naryn cascade of HPPs in the irrigation mode and thus ensure the much-needed multiyear streamflow regulation in the river.

Besides, some studies reveal that the net benefits for the riparian states' economies from this mode of operation are several times higher than from the currently implemented energy mode. For an illustration, let us s dwell on the 2004 World Bank's analytical report “Water energy nexus in Central Asia. Improving regional cooperation in the Syr Darya basin”. It outlines a methodology for valuing costs and benefits involved in both the irrigation and energy modes at the Lower-Naryn cascade of HPPs so that decisions could be made based on a sound cost-benefit analysis. It uses the following introductory provisions:

- For the baseline scenario of the streamflow in the Syr Darya, the 20-year rolling average value of 9 km³ is used, of which 6 km³ is the summer discharge in the years of average water content and 3 km³ is minimal discharges in the dry years that is to roughly meet the needs of Kyrgyzstan in providing its own summer electricity needs. At the same time, winter discharges for all years are limited to 3 km³;

- The costs of electricity generation in Kyrgyzstan, Kazakhstan, and Uzbekistan are important for assessing the costs and benefits of various modes of operation at the HPPs. The corresponding costs include: (a) short-run marginal costs (SMC) of generating winter electricity at the Bishkek coal-fired power plant (instead of utilizing electricity from the HPPs) is taken at the level 0.15 US cents/kWh; (b) SMC of generating electricity at the Dzhambul gas-fired power plant, South Kazakhstan, and at the Angren coal-fired power plant, East Uzbekistan, if hydropower from the HHPs is supplied to these republics in summer, are 2 and 2.3 cents/kWh, respectively;

- 1 m³ of water passing through all HPPs generates 0.86 kWh of electricity at the end of the cascade. In other words, 1.16 m³ of water is needed to produce 1 kWh of electricity. Accordingly, with summer water discharges of 6 km³, the quantity of generated electricity amounts to 5.17 billion kWh, and with winter discharges of 3 km³ - 2.59 billion kWh.

- The cost of water used to grow cotton is accepted at USD 20 per 1000 m³ in line with international prices in the early 2000s. Further, for cotton cultivation, Uzbekistan used 37 percent of the irrigated land of the Syr Darya basin, and Kazakhstan - 28% at that time.

Taking into account the input data set forth, the alternative (opportunity) costs are determined by establishing the difference between the costs incurred by Kyrgyzstan while operating HPPs in the irrigation mode compared to the costs in the energy mode.

Table 6. Costs and benefits when operating the Lower-Naryn cascade of HPPs in the irrigation and energy modes, in USD mln (Source: WB, 2004)

	Irrigation mode	Energy mode	Difference
Costs for Kyrgyzstan	48.5	13.4	35.1
Benefits for Kazakhstan and Uzbekistan	86.2	18.9	67.3
Net benefit for the Syr Darya basin	37.7	5.5	32.2

As can be seen from Table 6, when the operation of the cascade changes from the energy to the (initially designed) irrigation mode of operation the costs increase by 3.6 times, while the benefits increase by 4.6 times. At the same time, the net benefits for the entire Syr Darya basin are increasing almost 7-fold as a whole. At the same time, all the costs of switching to the irrigation mode are borne by Kyrgyzstan. On the other hand, Uzbekistan and Kazakhstan, even with a conservative assessment of the benefits from irrigation (the cost of growing only one crop – cotton), receive benefits from the irrigation mode that are almost twice the total costs of Kyrgyzstan. Therefore, it is quite logical that to ensure the benefits to Uzbekistan and Kazakhstan and, conversely, unprofitable for Kyrgyzstan irrigation mode of operation at the HPPs, the former republics should compensate the corresponding costs of Kyrgyzstan.

All in all, the rationale behind the scheme of water-energy swops is that it is benefit-sharing and quite feasible. However, the proper implementation of this scheme requires a deep consideration of multiple criteria, including long-term factors.

CHAPTER 4: PROMISING AVENUES FOR SOLVING THE REGIONAL WATER-ENERGY CONFLICT

4.1. Institutional mechanisms for intersectoral governance

Along with the “water-for-energy” model of compensatory exchanges discussed in Chapter 3 regional expert community proposed several other mechanisms of settling relations in the water-energy sphere. Some of these developments seek institutional models of streamflow regulation and reservoir management for the benefit of all countries in the Aral Sea Basin.

The economic measurement of water in the world is rather ambiguous and often unnecessarily politicized. In today's international law, the view of water as a common good prevails, and therefore it cannot be treated like other commercial kinds of goods. At the same time, this approach overlooks the fact that a certain part of the world's water resources, under certain conditions may be considered as “productive water" and used in economic activities, for example, in industry or rural farming (Petrov and Akhmedov, 2011). In the Central Asian region, this argument has received special relevance. The upstream countries of the Amu Darya and the Syr Darya, at the highest state level, call for the recognition of water as a sort of commodity and the setting of market prices for it.

To this end among the most discussed mechanisms is the idea of introducing *a cost-based fee for water resources in transboundary rivers* imposed on states that use them to the benefit of countries in which these resources are generated. One of the most interesting techniques in the determination of water prices was proposed by the Institute of Water Problems and Hydropower of the Kyrgyz Academy of Sciences (Asanbekov et al., 2000). It is based on an institute’s pricing concept under which water resources, despite their physical characteristics and distinctive role for nature and humanity, are considered as an economic good.

In the concept, the economic assessment of water resources is determined by the division of river flow into three zones:

1) Runoff formation area. It includes surface water resources from the headwaters to the main water intake structures. In this part of the watercourse, water already has its economic value since the relevant country finances a number of

organizations carrying out: bank protection activities, monitoring, management, and scientific research of water resources. So that to replenish this public spending, according to the Concept developers, it is necessary to introduce *a tariff for water as a natural resource*.

2) Area of water distribution and supply by means of main and inter-farm *canals*. For water resources flowing through this zone, authors of the Concept propose to establish a *domestic tariff (for internal water users*) that should cover expenditures on maintenance of water management organizations providing water to rural users;

3) Area of supply where water regulating structures, i.e., hydroelectric power plants with seasonal and long-term streamflow regulation are exploited. On this level, it is proposed to establish *an inter-state tariff (for neighboring states)* comprising water price as natural resource and service costs for its supply (the amount of costs for the maintenance of reservoirs/HPPs) to downstream states.

The Concept is based on the cost-based principle of value determination when the main pricing elements are actual exploitation costs and profit margin of state-financed organizations in the water sector. With this in mind, the average tariff of water as a natural resource is determined by the following formula:

$$T_{n.r.} = \frac{\Sigma_{\ i=1}^{\ n} \times C_i}{\sum w} \quad (1)$$

where C_i is annual costs of a state-financed organization dealing with water resources, $\sum w$ – the total volume of water resources formed within the territory of a respective country.

The annual costs of an organization are calculated by the following formula:

$$C_i = [C_{i_{exp.}} + R_i \times (a_{curr.} + a_{cap.} + a_{ret.})] \times C_{w.r.} \times (1 + P_i) \quad (2)$$

where $C_{i_{exp.}}$ is the annual exploitation costs of the state-financed organization for the target year, R_i – the replacement costs of its fixed assets for the target year, $a_{curr.}$ $a_{cap.}$ $a_{ren.}$ – the allocation rates for current, capital repairs, and retrofitting, $C_{w.r.}$ – the coefficient to the costs for water resources formation, P_i – the profit margin of the organization.

The coefficient to the costs for water resources formation is calculated as follows:

$$C_{w.r.} = \frac{N_i}{\Sigma_{N_i}} \quad (3)$$

where N_i *and* Σ_{N_i} – the number of employees dealing with water problems to the total number of employees in the organization.

The average tariff for water as a natural resource (in the Kyrgyz Republic) calculated on the basis of the above formula for the 2002 year and was USD 0.14 per 1000 m^3 (Asanbekov et al., 2000).

Calculated by the same token, the inter-state tariff $T_{int.}$ for water, which flow is regulated by single-purpose irrigation reservoirs, is determined by summing $T_{n.r.}$ to service costs for flow regulation by a reservoir $T_{irr.svcs.}$ and multiplied by the coefficient of water quality before its using $C_{qlty.}$ (taken equal to 1):

$$T_{int.} = (T_{n.r.} + T_{irr.svcs.}) \times C_{qlty.} \quad (4)$$

$$T_{irr.svcs.} = C_{res_{exp.}} \frac{C_{res_{oper.}} + C_{res_{ins.}} \; R_{res} \times (a_{curr.} + a_{cap.} + a_{ret.})}{w_{irr.}} \times \; P_n \quad (5)$$

where $C_{res_{exp.}}$ – the annual exploitation costs for the reservoir, $C_{res_{ins.}}$ – the annual costs for creating an insurance fund for dry years and elimination of emergencies, R_{res} – the replacement costs for fixed assets of a reservoir, P_n – the profit margin, $w_{irr.}$ – the annual volume of water supply (released to consumers) from a reservoir after deducting sanitary and environmental water discharges.

Using the above formulas by the Institute of Water Problems and Hydropower calculated inter-state tariffs on water regulated by single-purpose (irrigation) reservoirs of the Kyrgyz Republic. Taking into account exploitation features of these reservoirs inter-state tariffs at the 2000 prices varied from USD 0.53 per 1000 m^3 for the Orto-Tokoy reservoir on the Chu River for neighboring Kazakhstan to USD 1.27 for The Papan reservoir on the Ak-Bura river for Uzbekistan (Mamatkanov, Bajanova and Romanovskiy, 2006).

Notwithstanding the simplicity and rationality of such calculations, they are not devoid of noticeable shortcomings. This is primarily about the so-called “costs of state-financed organizations that deal with water problems”. Even a casual overview of the given formulas aimed at calculating “the costs” demonstrates that they may be arbitrarily determined by the country interested in the sale of its water resources abroad. At the same time, if one doesn’t take into account this subjective definition of water as a natural resource $T_{n.r.}$, the *method based on the calculation of exploitation* *costs* ($T_{irr.svcs.}$) might be possible for practical use, however only for a single-purpose irrigation reservoir.

The problem is that this technique is not suitable for power plants with reservoirs (HPP) of multi-purpose (irrigation and energy) nature, which include large power plants on the transboundary rivers of Central Asia - the Toktogul and the Nurek HPPs, as well as the future Rogun (under construction) and Kambarata-1 (under consideration) dams. Such hydrosites create two products: electricity – for national consumers, and water – for residents of downstream countries. That's why the expenses of these waterworks ought to be attributed to both resources. As will be discussed below, it is very complicated for multi-purpose hydrosites to single out the elements that provide water and to determine operational costs for them.

Here we can refer to the history of the Toktogul HPP. According to its feasibility report, the water (irrigation) part in the plant's exploitation costs accounts for 40 percent, and, accordingly, 60 percent falls on the hydroelectric part (Mamatkanov, Bajanova and Romanovskiy, 2006). So, the corresponding amount of the HPP's exploitation costs attributed to, say, irrigation can be calculated taking into account the plant's original construction cost (P_{hpp}), the irrigation part in the exploitation costs ($S_{irr.}$), and the proportion of the exploitation costs to the construction cost ($D_{exp.}$) by the following formula:

$$P_{irr.} = P_{hpp} \times S_{irr.} \times D_{exp.} \quad (6)$$

As a result, we obtain the irrigation share in the exploitation costs at te Toktogul HPP: $P_{irr.}$= USD 1.2 billion × 0.4 × 0.02 = USD 9.6 million. Further, this amount can be divided in accordance with the annual volume of water resources received by each downstream country.

As can be expected, if applied the described approach would require harmonization of all parameters used in it with downstream countries, who might have a lot of remarks to the host country. The very fact of recognition of the irrigation component in the total costs of a hydrosite will mean the presence of certain property rights of downstream countries to a jointly used object. In other words, cost-sharing will give them a right to claim on profits made from the operation of a hydrosite, in particular, on income from electricity. It is logical to assume that the host country of the HPP would be unlikely to agree to such a deal, given that the profit of large HPPs from electricity generation is many times higher than the costs of their maintenance and operation.

Another problem – the mode of supplies. As a former employee of the Tajik Academy of Sciences Petrov (2015a) rightly points out, “if water is a product, then its supply to buyers should be carried out only at the proper time and in adequate quantity”. If we follow this generally fair logic, it turns out that what if Uzbekistan, Kazakhstan, and Turkmenistan do not order water in the wintertime, will it be necessary to cease the operation of the Toktogul HPP, which provides a significant share of Kyrgyzstan's energy supply in this period? Otherwise, concludes Petrov, “water supplied without order will be a commodity expansion or sabotage, for which it will be necessary pay heavy fines”.

It is not hard to guess that the outlined models and approaches are lobbied by water experts and hydropower specialists from the region’s upstream states. Ultimately, they are all aimed at the revision of the existing scheme of transboundary water use in the region.

As a counterweight to them, specialists from the downstream states propose models based on maintaining the status quo in the use of water resources. As an example, one can take the *Aral Sea Basin Management Model* (ASBmm[11]) developed in collaboration with SIC ICWC. The model proposes to consider the water and energy sector of Central Asia as a single whole and optimize its activity based on maximizing regional income (UNESCO-IHE, 2014). Having read and analyzed the model’s basic provisions, we cannot but agree with some commentators (Petrov, 2009; Petrov and Akhmedov, 2011) who criticize this model for being virtually completely focused on the interests of irrigation. In particular, authors of ASBmm consider the value of produced electricity as a sole economic result of the regional hydropower sector while analyzing outputs in irrigation the same indicator is made up of all agricultural and corresponding processed products.

It is difficult to disagree with Petrov and Akhmedov (2011), who aptly argue that there is no reason to choose between irrigation and hydropower since any such comparison is always in favor of the former. The fact is that total power generation in dams located upstream of irrigated lands depends only on the volumes of water that

[11] Aral Sea Basin Management Model is a software including a range of information modules, such as Water Allocation model (WAM), Planning Zone model (PZM), Socio-economic model (SEM) implementing together interconnected algorithms for the distribution of water resources in time and space, flow regulation by HPPs and assessment of basin development scenarios by economic sectors.

are always the same regardless of the operation modes. That's why the maximum total revenue from hydropower and irrigation will always be achieved at the point of the maximum income for irrigation. Ultimately, the overall optimization of a river’s streamflow depends only on irrigation – the optimal model for it will be automatically optimal for the whole water and energy sector.

Moving from theory to practice, it is worth mentioning that there is a practice of successful implementing the equity participation (i.e., the cost-sharing model analyzed above) mechanism in the region. For its application, downstream countries should reach an agreement on the costs of hydroelectric facilities of upstream countries and determine the corresponding coefficients of countries' participation in their reimbursement. The distribution of income from the operation of the facilities, of course, must remain outside the deal. The viability of such a model was clearly demonstrated by the implementation of the 2000 Kazakh-Kyrgyz agreement on the use of water management facilities of intergovernmental status on the rivers Chu and Talas under which the parties agreed that operation and maintenance costs for the facilities (located in upstream Kyrgyzstan) would be shared on a pro-rata basis in proportion to the water volumes received by each country. To implement the Agreement, in 2006 the Chu-Talas Water Commission was established (UNECE, 2021). From the very beginning, the project has received significant attention and goodwill from international and development organizations. However, as some experts (Zinzani and Menga, 2017) argue that despite international organizations from the very beginning tend to portray the CTWC as a success story based on the principle of benefit-sharing, the idea of creating equitable collaboration between the countries has failed, and Kazakhstan has finally gained the upper hand in the management of the river basins.

As mentioned above, cost-sharing models are unlikely to work in multi-purpose structures influencing not only the distribution of water resources but also concerning the matter of energy security of individual countries. As was shown in Chapter 3, downstream Uzbekistan and Kazakhstan had to pay compensation to Kyrgyzstan in order to ensure the functioning of the Toktogul HPP in the irrigation mode and thus attained favorable for them the over-year streamflow regulation of the Syr Darya. The relevant 1998 Bishkek agreement collapsed because of disruptions in compensatory energy supplies that, in turn, as we suggest, occurred due to imperfect mechanisms of assessing compensations and, most importantly, the lack of a structure capable to provide sustainable water and energy swaps.

The idea to create such an entity in the form of the so-called International Water and Energy Consortium (IWEC) had been actively discussed since 1997 when a concept on the principles of interaction in establishing international consortia was developed by a decision of Kazakh, Kyrgyz and Uzbek leaders.

The creation of the IWEC was set out in the 1998 Agreement, Article 8 of which states that before the establishment of the International Water and Energy Consortium the BWO “Syrdarya” and the CDC “Energiya” shall be appointed as executive bodies responsible for water releases regimes and energy transfers, respectively (Gusev, 2013). Later, with the assistance of the World Bank within the framework of the Organization of Central Asian Cooperation (OCAC), it was carried out significant work to develop the Consortium's functionality, and in 2004, at the summit of the CAEC, the regional states approved a draft concept of the IWEC.

According to the Concept (Ziganshina, 2005), the Consortium was charged with performing the following financial and insurance functions:

- solving the problem of inadequate funds among buyers of electricity and fuels to provide compensations for water;

- coverage of damages caused by force majeure;

- collection of penalties for violation or improper execution of agreements on water and energy exchanges.

As was conceived by the developers of the document, at later stages the spectrum of the IWEC’s activities could be supplemented with the following functions:

- formation of Central Asian common energy mix and water budget;

- establishment of a structure for the implementation of projects of regional significance.

The ultimate goal of establishing the IWEC seemed to be the formation of a single market for water, energy resources, and related services, capable to ensure the sustainable functioning of the regional water and energy sector.

Following the consolidation of the OCAC with the Eurasian economic cooperation (EAEU), Russia, as a member of the new organization, also joined the creation process. Within the framework of the EAEU, a High-Level Panel (HLP) was convened to develop a coordinated mechanism for solving the region’s water-energy conflict. However, when Uzbekistan in 2008 decided to suspend its membership in the organization, the work of the Panel became severely constrained for objective reasons.

Despite the setbacks that attended the project from its launch, the organizational and legal form of a consortium, that is the combination of economically independent organizations of different countries formed to carry out various inter-state projects, can be considered as one of the most effective tools for solving the water-energy conflict. However, taking into account the complexity of a big bang option for the entire spectrum of related issues, it seems appropriate to divide the process of forming such a supranational authority into several stages.

At the initial stage, it is important to found a strong institutional basis for the establishment of the future multifunctional body. As was noted in Chapter 3, the existing regulating organs of the water and energy sectors, the ICWC and the CDC “Energiya”, weakly interact and make their decisions without taking into account the interests of each other. To solve the water-energy conflict these two bodies, in our view, should be united into a single whole, say, a novel *Coordination Water and Energy Council (CWEC) of Central Asia*.

It seems expedient to organize the work of the CWEC in the following way:

- It shall include ministers (or supervising deputy ministers) of energy and water management from all the regional states, as well as representatives of regional stakeholders working in the sectors. The membership in the Council may be open to organizations of other states (for example, Afghanistan) that share its goals and objectives. The work of the Council shall be steered by its co-chairs – energy and water ministers of the country where its meeting is held.

- Every year the steering committees of the water management and energy sectors, namely the ICWC and the Coordination Electric Power Council of Central Asia, shall provide the CWEC with requirements for water and electricity in terms of timing and necessary quantities. Based on this data, the CWEC draws up an optimal scheme of functioning at HPPs and TPPs within the CAPS taking into account the water needs of farmers and for keeping the Aral Sea alive. These schedules shall be summited to BWOs “Syrdarya” and “Amudarya”, and to the CDC "Energiya" for execution, which transform these schedules into plans of water distribution and releases from HPP reservoirs. Decisions of the CWEC shall be made based on the principle of consensus and be binding for all members.

- Taking into consideration objective seasonal differences between the sectors, it would be advisable to establish a novel commercial entity under the CWEC – say, call it a *CWEC-Operator* (hereinafter – the Operator), which would ensure payments and earnings between the members. These transactions shall be carried out based on agreed prices for fuel and electricity set by a decision of CWEC. The working pattern of the Operator could initially be designed in the simplest way, that is to ensure commercial water-energy swops between riparian counties. One can implement the scheme of the 1998 Bishkek agreement on the use of water-energy resources in the Syr Darya river basin, altering its layout somewhat.

In accordance with Figure 5, the Operator's general working pattern may run as follows. During the vegetational season, the Operator purchases surplus electricity (excessing the actual needs) from Kyrgyzstan and Tajikistan, which they have to generate at HPPs to provide irrigation for downstream lands. The cost of this power is always lower than the cost of electricity generation at TPPs of Uzbekistan, Turkmenistan, and Kazakhstan. So that these purchases can also be made at a discount compared to the average market price of summer electricity in the region at which the electricity will be sold by the Operator to the downstream republics. In turn, the water discharged during the work of the HPPs shall be nominally and at no charge transferred to the Operator, which will receive the right to realize (de facto sell) it to Kazakhstan, Uzbekistan, and Turkmenistan (through annually concluded agreements).

In the non-vegetational wintertime, the Operator shall purchase from the downstream states more expensive electricity, and if necessary, gas, fuel oil, and coal, and to sell them to Tajikistan and Kyrgyzstan at the price (for an equivalent amount) for which it purchased their summer electricity. The amount required to cover the discount will be met by funds received from the water trading and saved from buying cheap summer electricity in Tajikistan and Kyrgyzstan. As a result, employing the Operator, the upstream riparians will be able to sell their surplus summer electricity and purchase much-needed winter electricity (or fossil fuels for its generation) with the money raised, whereas the downstream riparians will be able to receive guaranteed volumes of water for the development of their rural farms in the summer.

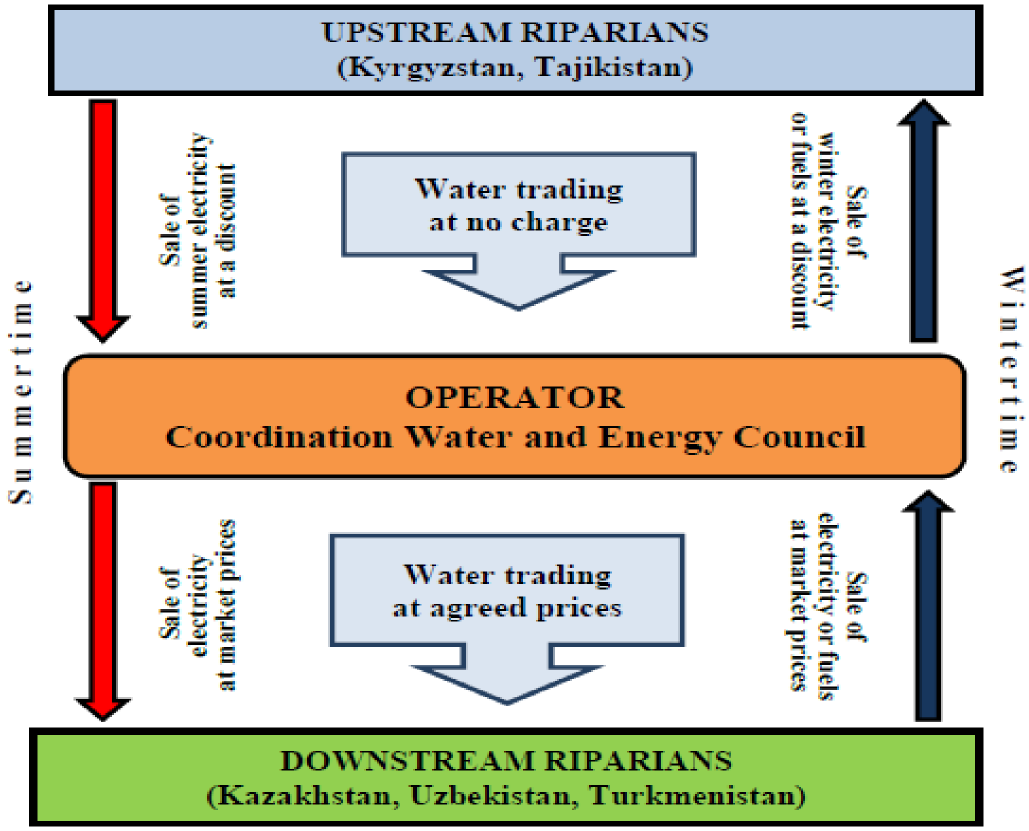

Figure 5. A Scheme of ensuring water-energy swops through the Operator of the Central Asian Coordination Water and Energy Council (CWEC)

The main advantage of this model is that it uses the already proven scheme of relationships between the regional states on the use of water and energy resources, but instead of barter swops the more transparent monetary relations are utilized.

At later stages of the CWEC development, its working methods can be enhanced by the introduction of an *insurance fund* from which damages arising from objective (environmental) grounds could be covered, and in which various payments will be accumulated– for instance, fines collected from regional states or other participating sides for failure to comply with rules of the CWEC. After a while, the business paradigm of the CWEC might be transformed into a sort of special *exchange for trading water and energy resources*. Another novelty may be a creation of a *directorate of hydroelectric power plants* of Central Asia to manage all multi-purpose HPPs in a concerted way. The Directorate might also act as an ordering customer in construction (later – a major shareholder) of new hydrosites of inter-state importance, attracting funds from states and other organizations and private investors that are interested in the construction and operation of such facilities.

Analysis of the institutional models proposed by the regional expert community for solving the regional water-energy conflict reveals that it is quite complicated to implement most of them under the current political and economic realities of Central Asia. In our estimation, the sustainable solution seemingly lies in a comprehensive approach which may only be realized within the framework of supranational institutions endowed with broad administrative as well as financial capabilities in managing water and energy resources of the Central Asian region.

4.2. Economic viability of infrastructural projects

The main characteristic of hydropower and irrigation in the Aral Sea Basin is that they use the same water resources of transboundary rivers, but at the same time are interested in the disparate modes of their regulation. If the former has a stake in accumulating water in the summer and utilizing it in the coldest, energy-deficient period, then irrigated agriculture, on the contrary, in accumulating water in the wintertime and using it during the cropping season. With the existence of independent states within a territory, this leads to an inter-state conflict of interests between them.

Among the options of tackling that conflict, the infrastructural solutions can be regarded as the most sweeping ones. It includes the construction of new HPPs and TPPs, excavation of compensating (reregulating) reservoirs and irrigation canals, and erection of power transmission lines that optimize the distribution of electricity.

The region's water-energy conflict is largely attributable to the fact that there is only one large regulating reservoir on each of the regional rivers. In the Syr Darya basin it is the Toktogul Dam in Kyrgyzstan, and in the Amu Darya – the Nurek Dam in Tajikistan. Both hydropower facilities are designed to function under the irrigation mode of operation. The energy component in their operation is rather collateral. This problem may be solved by building at least one more large hydrosite in each river basin. If a new dam is built upstream of the existing ones, the upper HPPs will operate in the energy mode and generate electricity for Tajikistan and Kyrgyzstan, while the lower ones will provide the over-year streamflow reregulation for irrigation in Kazakhstan, Uzbekistan, and Turkmenistan.

To illustrate this approach, let us turn to the situation in the Amu Darya basin.

Today, in the Vakhsh River (the main tributary of the Amu Darya) the main streamflow regulation is carried out by the Nurek HPP. The Rogun Dam is being built upstream. Within the system of the Vakhsh Cascade which, in addition to the two mentioned, also includes the Sangtuda-1 and 2 HPPs, the Baypaza, Shurob, Golovnaya, Perepadnaya, and the Central hydroelectric power plants, only the Nurek Dam, owing to its huge reservoir, can carry out the terminal (final) streamflow regulation for the downstream irrigation in the Amu Darya basin (Petrov, 2012)[12]. At the same time, relatively small storage of its reservoir does not allow to steadily level vegetation releases and fulfill perennial (over-year) streamflow regulation in the river. Taking into account an uneasy water situation downstream, particularly alternating high water and especially protracted low water years this situation may only be reversed by the erection of a dam with a quite large reservoir, such as the Rogun HPP (Petrov and Akhmedov, 2011).

For a better understanding of the aforementioned statements, let us take a look at the two graphs below. As can be seen from Figure 6 the biggest discharges from the Nurek reservoir are carried out from May to October. It is this irrigation mode of the streamflow regulation by the dam that is underway today. Such a mode of operation at the HPP doesn't meet the energy interests of Tajikistan, since it is during the winter period when the republic experiences the greatest need for electricity, but its smallest amount is generated.

The erection of the Rogun Dam may help solve this problem. If the dam is built, it will work in tandem with the Nurek HPP, that is to generate power in the winter instead of the latter and thus allow it to keep working in the designed irrigation mode. In that case, the water discharged from Rogun will be collected by Nurek for summer irrigation releases. Moreover, such cascade regulation will be optimal in terms of balanced electricity generation throughout the year.

[12] Irrigation regulation of a river's streamflow is used to smooth out flood flows and to provide the greatest utilization of water resources during the cropping season. It is important that irrigation releases during the growing season should be constant and not depend on the water content of the year.

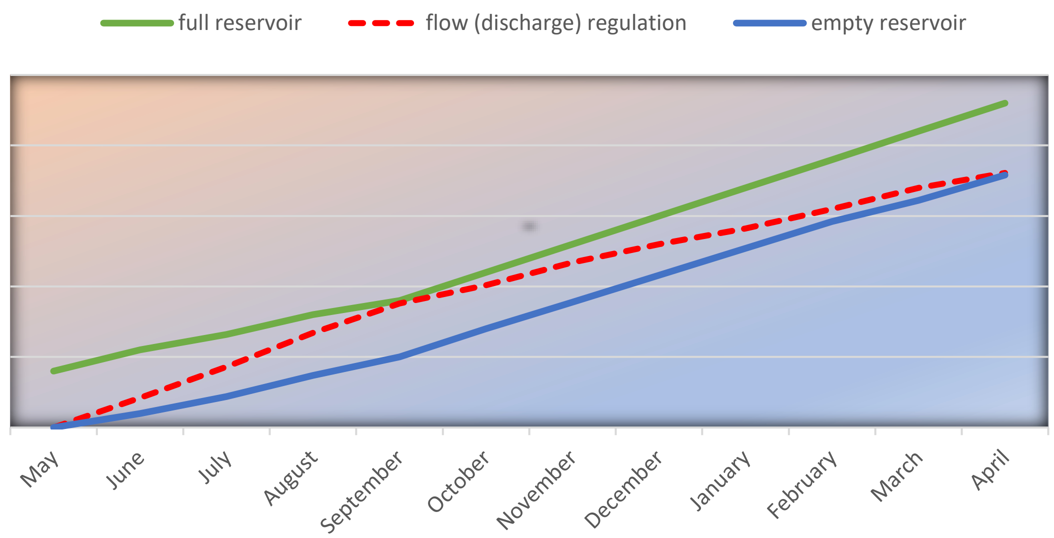

Figure 6. The streamflow regulation in the Amu Darya (the Vakhsh) adjusted by the Nurek Dam in the irrigation mode of operation (the diagram is completely schematic) (Source: Compiled by the author using data from Petrov, 2012)

This will be achieved by the leveling of average water discharges from the cascade of reservoirs (see Figure 7). All in all, the operation of the Rogun Dam in the energy mode and of the downstream Nurek Dam in the irrigation mode could safeguard the interests of both irrigation (i.e., of Uzbekistan and Turkmenistan) and energy (of Tajikistan itself).

At the same time, the joint operation of the Rogun and Nurek HPPs will not be able to level electricity generation on a multi-year basis. Their total usable storage equals 14.8 km^3 that accounts for about 73 percent of the average multi-year streamflow of the Vakhsh River that is 20.22 km^3/year (Gulakhmadov et al., 2020). That is why the erection of the Rogun Dam alone cannot ensure the sustainable work of Tajikistan's energy sector. This task will require the construction of other large and middle-size hydroelectric power plants.

The Central Asian region has all conditions for the successful development of hydropower. The hydroelectric sector has a massive energy potential, the cumulative amounts of which are estimated, as was noted above, in 510 TWh of electricity per year. Most of this technically exploitable amount is related to Tajikistan, that is 317 TWh/year, the figure of neighboring Kyrgyzstan is more modest – 99 TWh/year. Despite the renewability of this natural resource, its relative environmental friendliness, and its low cost in comparison with fossil fuels and nuclear power, the level of utilization of hydropower resources in the region today varies around 10 percent (Vinokurov et al., 2021).

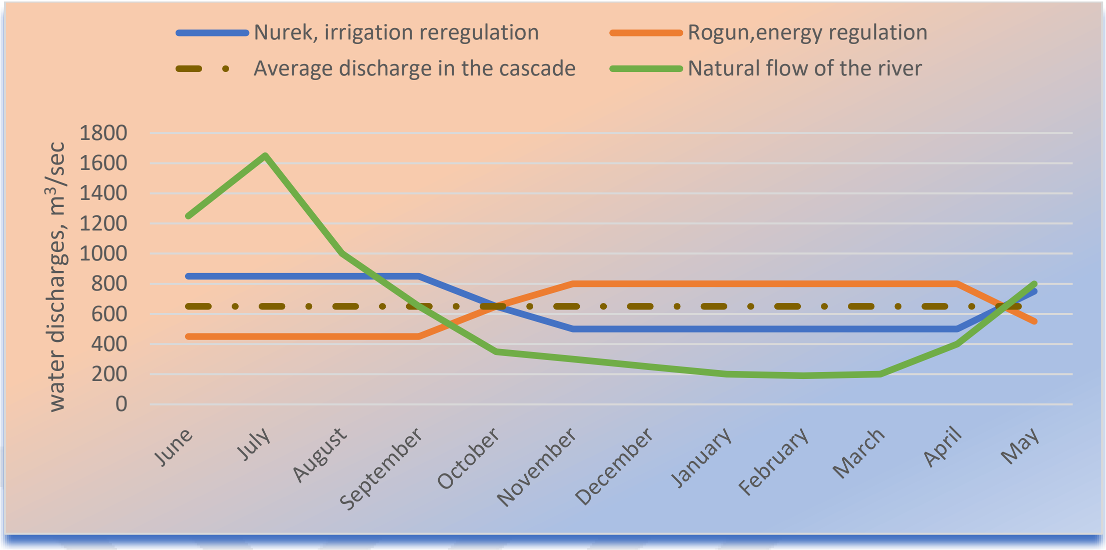

Figure 7. The cascade regulation in the Amu Darya (the Vaksh) adjusted by the Nurek Dam and the Rogun Dam (the diagram is rather schematic) (Source: Compiled by the author using data from Petrov, 2012)

The program of large-scale hydropower construction had been designed since the 1960s. Along with the Vakhsh Cascade of HPPs in Tajikistan and the Lower-Naryn cascade in Kyrgyzstan, which was built in the 1970s, the program envisaged the erection of other large hydrosites including the Rogun, Sangtuda, Shurob HPPs on the Vakhsh and the cascades of Kambarata 1, 2, 3 and Upper-Naryn HPPs on the Naryn in Kyrgyzstan. The number of allocations invested in these objects by 1990 had exceeded USD 1 billion. They were all characterized by high economic efficiency, among others, the unit cost of an HPP equaled to USD 500–1000 per kilowatt of installed capacity, the prime cost of electricity was less than 0,1 cents for kWh (Petrov, 2012).

After the demise of the USSR, the development of the regional hydroelectric sector has practically stalled. In the early 1990s, because of the difficult socio-economic situation (in the case of Tajikistan – the beginning of the civil war), all works at the objects were frozen. Serious discussions on their restoration resumed only in the middle of the 2000s. Then the governments of Tajikistan and Kyrgyzstan adopted priority hydropower development programs and opted for attracting foreign investment to implement them. In Tajikistan, with assistance from Russian energy companies, the Sangtuda-1 HPP was commissioned in 2009, the joint Tajik-Iranian project of the Sangtuda-2 HPP was realized a few years later. In Kyrgyzstan, the local authorities revived the construction of Kambarata-2 HPP in 2010; the first of its three hydroelectric units were put into operation.

However, despite the first successful steps to restore hydroelectric construction, the development of the hydropower sector has still been facing a number of systemic challenges and contradictions. This is primarily due to the low investment attractiveness of hydroelectric construction. The erection of large HPPs requires long-term diversion of financial and material resources. So, for example, the completion of the Rogun HPP with a 335-meter-high rock-fill embankment is estimated at USD 4 billion. The construction of the Kambarata-1 HPP in Kyrgyzstan with a comparable dam (its height is 275 m) would need USD 3 billion (Vinokurov et al., 2021). These amounts are comparable with the size of Tajik and Kyrgyz economies (in 2020, the GDP of the former was worth 8.2 billion, the latter one's amounted to USD 7.7 billion). Because of the long construction time (10–15 years) and the extremely low credit ratings of these republics, it is hard for them to count on the attraction of long-term money. In addition, both states are characterized by a high level of external and internal risks, as well as constraints of transport and logistics infrastructure (Chorshanbiev, (2019). As a result, many promising construction projects, especially in distant mountainous areas with undeveloped infrastructure, are often recognized economically ineffective and have very slim chances to be implemented.

There are several other infrastructural alternatives to erecting dams that, in theory, may alleviate the regional water-energy conflict. One of them is the construction of reregulating reservoirs (the so-called counter-regulators) in downstream countries. The erection of such counter-regulators aims to collect the surplus water discharged in the autumn-winter-spring period from upstream dams with its subsequent use in the growing season. A classic example is the Koksaray counter-regulator in Kazakhstan that was built in 2011 after a couple of devastating floods in the middle reach of the Syr Darya. It accumulates the waters released from the Lower-Naryn cascade of HPPs in winter and carries out seasonal flow regulation for the benefit of irrigation in summer (Wikipedia, 2020). In a similar vein, over the years of independence, Uzbekistan has built more than 30 such run-of-river and off-stream reservoirs (Mezentsev, 2011).

A noticeable disadvantage of these counter-regulators is their low economic efficiency. Because their operation is mainly performed in the mode of water accumulation for 8–9 months of the year, power generation at them is impractical. It is also important to take into account the factor of natural losses of water due to seepage and evaporation which under local conditions may be as high as 30–40percent (Kamalov, 2012).

According to another widespread opinion, the water-energy conflict may be solved by the forced development of small and mid-sized hydropower. Such a settlement of the problem is insisted upon by those who oppose constructing large hydrosites. Specifically in Tajikistan, the potential resources of small-scale hydropower generation are estimated at 185 TWh (Petrov et al., 2007). In recent decades, with support from international organizations and private companies, there has been incremental work on the construction of new and modernization of previously built small and medium hydroelectric power plants.

However, on the other hand, it must be admitted that with all the positive qualities of small hydroelectric power plants – short construction time, low total cost (with the same, if not greater, unit cost), even the massive construction of small scale HPPs will not be able to meet the needs for industrial energy, this is exactly what Tajikistan and Kyrgyzstan actually need. Firstly, small HPPs do not have reservoirs, that is why they cannot regulate streamflow. Secondly, the capacity of small hydropower plants usually varies between 0.5 – 1.0 MW, which is only sufficient to supply electricity to small villages, but not to cities, let alone industrial complexes. To meet the demand of a whole country there should be many thousands of them. For example, with a capacity of 0.5 MW, in order to replace an HPP such as Rogun, it is necessary to build more than 7,500 small hydropower plants (Petrov, 2015).

A variety of water management experts see the so-called Northern (Siberian) rivers reversal as another, probably, the most cardinal way of solving water problems of Central Asia, including the water-energy nexus issue, growing scarcity of water resources, and the Aral Sea desiccation. In recent years both in the Central Asian region and in Russia there have been proposals to revive this project. At the same time, the very idea of turning Siberian rivers gives rise to many opinions with convincing arguments both for and against its implementation.

The plan, discussed on a large scale in the 1960-1980s, involves inter alia the construction of a 2,550 km long canal aimed to divert a part of the Ob river's runoff to Kazakstan and Uzbekistan. It is assumed that this hydro scheme will make it possible to irrigate an additional 1.5 million ha of land in Russia and about 2 million ha in Central Asia. Water diversion from the Ob will amount to 27.2 km^3, i.e., about 7 percent of its total runoff (Wikipedia, 2022). In addition to economic preferences, proponents of the project often give geopolitical arguments, claiming that its implementation would strengthen integration processes in the post-Soviet territory. Opponents of turning Siberian rivers, in turn, note that the implementation of the project is fraught with a wide range of negative consequences for the environment in Siberia and Central Asia (e.g., climate change, groundwater rise, loss of valuable fish species, etc.) (Zherelina, 2003). Nevertheless, the most acute problem that will ultimately be faced by constructors would be a financial one. To implement the project, it would be required up to USD 300 billion. According to a former Director of Water Problems Institute of the Russian Academy of Sciences Danilov-Danilyan, "no one doesn't have and will never have such a great deal of money" (Zen'kovich, 2003). It is difficult to disagree with such an assessment of the project's investment prospects.

In our estimation, more realistic infrastructural solutions to the water-energy conflict, at least in the short- and medium-term, rest on boosting projects related to existing energy resources within their current interconnectedness. As noted above, the total amount of generated hydropower does not depend on streamflow regimes and remains the same in both energy and irrigation operation regimes of HPPs. The water-energy nexus has nothing to do with the total amounts of power, rather, our issue is associated with the distribution of electricity by seasons of the year. Within the irrigation mode, a larger part of electricity is produced in summer, while the energy regime requires its even generation throughout the year, or even more power to be generated in winter. Therefore, when HPPs are switched from the energy to the irrigation mode, countries have losses of much-needed winter power, and conversely, receive their equivalent surplus in summer. In other terms, having resolved the problem of seasonal electricity redistribution, one could also resolve the water-energy conflict.

On the other hand, if one looks at the situation from another angle, the existing energy infrastructure coupled with interconnections within the CAPS could be well enough to provide seasonal flows of electricity between hydropower facilities of Tajikistan and Kyrgyzstan and thermal power objects in the rest of the region. However, this scenario would require some enhancements.

As was noted in Chapter 3, both Kyrgyzstan and Tajikistan cannot be regarded as energy self-sufficient, they need electricity and heat power in the wintertime, which cannot be wholly provided by HPPs. A mere 5–10 percent of their energy mixes are made up of thermal power, and the power systems urgently need diversification. Therefore, it makes sense to think of, alongside modernization of existing TPPs, an increase in the use of coal. Moreover, both countries have some options for that. In Tajikistan, there are at least three large coal mines: the Zidda, Shurab, and Fon-Yagnob occurrences. The proven coal reserves in them are estimated at 500 million tonnes, which is enough for the supply of four new coal-fired plants with a total capacity of 1,300 MW (WB, 2012). The Kara-Keche field in Kyrgyzstan has significant reserves of lignite, the balance reserves of which are suitable for opencast mining with 432 million tonnes. According to expert calculations, a condensation power plant with a capacity of 1,200 MW might be built here. Assuming its fuel consumption of 3.3 million tonnes per year, these reserves could be well enough for up to 140 years of operation (Economist.kg, 2019; GEM Wiki, 2021). Despite the high cost of its construction (estimated at USD 2 billion), if implemented, the plant will allow for covering the deficit of basic generating capacities to pass autumn-winter peak demands in Kyrgyzstan. Then the operation of the Lower-Naryn cascade during this period could be returned from the energy to the irrigation mode, painlessly for the republic’s power system.

To assess the economic efficiency of constructing coal-fired plants, it is worth presenting a comparative analysis of building the Kambarata-1 HPP and the Kara-Keche TPP in Kyrgyzstan. Both projects are similar in their main characteristics: Despite the difference in the installed capacities, they can annually generate approximately the same amount of electricity. Furthermore, their construction costs are also comparable – USD 2 and 3 billion respectively. The main difference between the projects is timing. The completion of the HPP would need ten years whereas a typical TPP can be built in five years (see Table 7).

For the analysis, we will use the method of direct financial flows, which, as noted by the Tajik hydropower engineers Normatov and Petrov in their monograph

“Economic issues of hydropower development in Tajikistan” (2007), notwithstanding its simplicity, allows for evaluating the effectiveness of implementing power plants with a long life-cycle.

Table 7. Main features of the Kambarata-1 HPP and the Kara-Keche TPP construction projects

Power plant	Capacity, MW	Electricity generation, TWh/year	Construction time, years	Needed investment, billion USD
Kambarata-1 HPP	1,940	5.1	10	3
Kara-Keche TPP	1,200	6	5	2

In the case of the Kambarata-1 HPP, the investment in construction I_{hpp} is estimated at 3 billion USD. The plant will be able to generate 5.1 TWh a year (G_{hpp}). Given that the unit maintenance cost of 1 kilowatt-hour at HHPs in Kyrgyzstan amounts to USD 0.004, we can calculate the general maintenance costs MC_{hpp} for the plant, which is US 20.4 million per year.

As regards the Kara-Keche TPP, the investment in construction I_{tpp} equals to USD 2 billion, the annual generation rate will be 6 TWh (G_{tpp}). The unit maintenance cost of 1 kWh at thermal plants is much higher and amounts to USD 0.022, so the general maintenance costs MC_{tpp} will be USD 132 million per year. The average market price p for a kWh of electricity in Kyrgyzstan have been hovering around USD 0.02 – 0.025 (2 – 2.5 cents) during the last 10 years, subject to the Kyrgyz som exchange rate.

$$P_{hpp} = (G_{hpp} \times p - MC_{hpp}) \times t - I_{hpp} \tag{7}$$

$$P_{tpp} = (G_{tpp} \times p - MC_{tpp}) \times t - I_{tpp} \tag{8}$$

Taking into account the above formulas one can calculate the total profit P (in USD billion, excluding taxes) which Kyrgyzstan can make over t years after the commissioning these power plants (see Table 8).

Table 8. The comparative analysis of the profits generated by the Kambarata-1 HPP and the Kara-Keche TPP employing the method of direct financial flows

	The lifespan of projects, years			
	20	30	40	50
Profit of Kambarata-1 HPP, USD bln	(0,858)	213	1,284	2,355
Profit of Kara-Keche TPP, USD bln	(1,640)	(1,460)	(1,280)	(1,100)

As can be seen from Table 8, the case with the implementation of the Kara-Keche TPP project is a priori unprofitable under current conditions. The situation with Kambarata-1 is not much better, the plant will be recouped and start making profit only 28 years after the commissioning.

In fact, the existing electricity tariffs in Kyrgyzstan and the region as a whole (probably, excluding Kazakhstan where they are currently around 4 cents) are too low and insufficient to cover massive construction costs. The calculations commissioned by the Asian Development Bank show that for the implementation of, for instance, the Kambarata-1 HPP, the average retail tariff of electricity in Kyrgyzstan should be at least USD 0.045 – 0.05 per 1 kWh (see Table 9). The financial assessment of investment projects aimed at constructing coal and gas-fired TPPs in Kazakhstan and Uzbekistan (the Kara-Keche TPP was not included in this sample) demonstrates that they become profitable at the tariff level of 7–8 cents per kWh. According to analysts from Fichtner (ADB, 2012), who did the research, a doubling of existing tariffs is unlikely in the medium term.

In our opinion, taking into consideration the high investment costs of constructing new generation facilities and the indefinite terms of their implementation, further deployment of the CAPS and restoration of full-fledged intraregional electricity flows seem to be the best option for solving the region’s water-energy conflict in the short term.

Table 9. Financial indicators of the Kambarata-1 HPP investment project (Source: ABD, 2012)

Generation tariffs	Financial Internal rate of return (IRR)	Net present value (NPV) at Weighted average cost of capital (WACC)		
		4 percent	6 percent	8 percent
	percent	USD mln	USD mln	USD mln
Current tariff 2.5 cents/kWh	0.8	(1,001)	(1,220)	(1,303)
Cost-recovery tariff 4 cents/kWh	4.0	0	(521)	(798)
Sustainable tariff 5 cents/kWh	6.0	746	0	(422)

The thing is that bilateral agreements, which are signed today in place of the 1998 Bishkek Agreement to arrange the use of water and energy resources and thus allow riparians to ensure the seasonal (not a multi-year) streamflow control of the Syr Darya, already include electricity exchanges between upstream and downstream countries. More specifically, until 2009 during the growing season Tajikistan supplied Uzbekistan with the surpluses of own generated electricity. In turn, the latter paid back the former an equivalent amount of electricity during wintertime. After the expulsion of Tajikistan from the CAPS and the breakup of the 500 kV loop-flow in late 2009, the inter-state electricity flows de facto reduced to zero (Shamsiev, 2013). As a result, Tajikistan has lost the incentive to adequately provide the downstream countries with summer irrigation releases. That is why the resumption of the CAPS comprising the power systems of southern Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and possibly Turkmenistan could at least partially ensure water-energy swops and thus contribute to the alleviation of the water-energy conflict.

The findings of ABD (2012) regarding the national power systems of the Central Asian republics demonstrate that their parallel operation within the framework of the CAPC enables them to achieve a significant synergistic effect and save on both operating and investment costs (see Table 10).

Table 10. The comparative analysis of transaction costs of the national power systems operated in the isolated mode and the parallel mode within the CAPS, in USD mln[13] (Source: ABD, 2012)

2015	Isolated operation (1)		Parallel operation (2)		Savings from the operation within the CAPS (2) – (1)		
Country	F&OC	UME	F&OC	UME	F&OC	UME	TOTAL
Kyrgyzstan	58.4	231.6	74.1	0	15.7	-231.6	-215.9
Kazakhstan (south)	508.1	49.8	698.8	0	190.7	-49.8	140.9
Tajikistan	97.8	291.3	96.2	0	-1.6	-291.3	-292.9
Uzbekistan	4,184.4	34.7	3,921.7	0	-262.7	-34.7	-297.4
GRAND TOTAL	4,848.7	607.4	4,790.8	0	-57.9	-607.4	-665.3
F&OC – fuel and operating costs Positive value – extra costs				UME – unmet (unserved) electricity Negative value – cost saving			

Cost-saving from the operation of the power systems in the parallel mode occurs due to optimization of power plant's operation modes and savings on fuel costs. Instead of using power plants generating electricity from the combustion of fuel oil, coal, or natural gas, the countries can use the opportunity afforded by the CAPS to import cheaper hydroelectricity from neighboring states. Even greater savings can be achieved through the reduction of so-called load loss cases. Parallel operation with power systems of other countries allows minimizing cases of forced (emergency or rolling) blackouts (Petrov, 2010). As a result, the costs associated with the acquisition and operation of backup generators decrease. The cost of 1 kWh of unmet energy in the region was estimated at USD 0.2 (ABD, 2012). With the reduction of reserve capacities for thermal (coal and gas) power plants, it becomes possible to maximize

[13] The table provides a comparative analysis of the operating costs at the power systems of Kyrgyzstan, the southern region of Kazakhstan, Uzbekistan, and Tajikistan, taking into account the expected fuel prices for the 2015 year. It does not include savings in investment costs, since by 2015 new power generation facilities (Kambarata-1, Rogun HPPs, the Balkhash TPP in Kazakhstan) will not be put into operation yet.

the use of hydroelectric power plants and thus avoid the so-called escapages, idle water discharges, in Tajikistan and Kyrgyzstan.

However, it is important to note that the aforementioned advantages can only be harnessed through sustainable work of the CAPS including the strict discipline of dispatching control, the existence of well-defined protection mechanisms against unsanctioned siphoning, and contractual obligations to ensure unhindered electricity flows between countries.

Analysis of today's realities in the water and energy sector of the Central Asian region reveals that a drastic solution to the water-energy conflict lies in the enlargement of infrastructure, primarily in the construction of hydroelectric facilities. Their implementation, however, involves multi-billion-dollar investment and may be realized in the long term. In the medium and short term, it is economically more expedient for the regional countries to focus on resuming the work of the CAPS and modernizing existing HPPs and TPPs.

4.3. Exploring practices on the water-energy conflicts from around the globe

In the dispute over the sharing of water resources, all Central Asian states actively appeal to international legislation. Unfortunately, International Water Law, first of all, pertaining to the joint use of transboundary watercourses, is still being developed and is largely advisory. Against this background, precedents, case law has become increasingly important.

There are currently 263 international river basins crossing state borders of two or more countries. Difficulties and controversies associated with the use of water resources man often cause serious international conflicts. In the last half-century, there have been more than 500 conflicts and more than 40 mutual grievances on the brink of violent conflicts on the use of transboundary waters (Beloglazov, 2007). Issues of transboundary water management have been a source of controversy because of the uncoordinated construction of hydraulic facilities, environmental pollution, and many other cases. At the same time, according to the Institute of Water Problems of the Russian Academy of Sciences, more than 160 agreements have been signed on these matters. Moreover, most of these documents (about 80 percent) deal with the issues of joint water use and hydropower (Rysbekov, 2009).

International experience and examples that are given in the paragraph illustrate the challenges, with which various states around the globe face in solving water-related problems, but at the same time indicates a number of success stories of cooperation between them in this area.

In solving the regional water-energy conflict, a positive experience of the International Joint Commission (IJC) of the USA and Canada would be of particular interest to Central Asians. The Canadian-American case exemplifies how institutionalized relations can evolve towards comprehensive infrastructural developments within given territories.

The Commission was established under the bilateral Boundary Waters Treaty of 1909 to deal with issues affecting the waterways along the US-Canada border. As per the document, the organization is an independent body consisting of six commissioners, three from each country. Albeit they are appointed by the governments, the commissioners shall not represent their viewpoints, in other words, to act as objectively as possible. There are around 20 boards affiliated with the IJC that are responsible for specific waterways. The Commission has two main responsibilities: approving projects that affect river runoff and preparing special recommendations on water use in the region. In some cases, if a project is approved by the IJC, the organization may also impose conditions on the project design or operation of hydraulic facilities (Sarsembekov, 2008; IJC, 2021).

In 1961, the United States and Canada signed another agreement on the development of the water resources of the Columbia River basin. Its ratification in 1964 is considered one of the most significant achievements in the history of hydropower of the two states. The document is scheduled to expire in September 2024, after which the parties may prolong it. The Columbia River flows through the Canadian province of British Columbia and the American states of Washington and Oregon before emptying into the Pacific Ocean. Before the construction of dams, the river was characterized by major floods (NWPCC, 2021). After years of studying the possibility of integrated use, the IJC proposed a plan for its development. The aforementioned Treaty mandated the construction of four reservoirs, namely: three in Canada (Mica, Keenleyside, and Duncan) and one in the United States – Libby. The Treaty commits Canada to regulate floods during the entire period of operation of water facilities. In return, the USA agreed to share with Canada half of its hydropower benefits and also made a one-time payment of USD 64.4 million for flood control benefits (NWPCC, 2021).

The Treaty acted as a catalyst for the large-scale construction of new hydroelectric power plants and reservoirs as well as transmission lines in the region. The use of the water resources of the river basin today involves multiple organizations, whose activities are also coordinated by the IJC. One of the most prominent of these is the Bonneville Power Administration (BPA), which is engaged in the sale of electricity generated by 29 HPPs in the Columbia River basin. At the same time, the BPA does not own the facilities, but only sells the electricity they produce. The Administration provides about 28 percent of the electricity consumed in the northwest of the USA. To deliver this energy, the BPA has more than 24,000 km of electric lines and controls approximately 75 percent of the high-voltage capacity in the region (Wikipedia, 2022). The Administration carries out the wholesale of electricity mainly to public utilities in the northwestern states, while the excess is sold to Canada and other American regions. The BPA is also actively engaged in the protection of water resources, including the implementation of environmental projects in the river basin (Anon., 2012).

As the example to follow, it is also worth mentioning the history of relationships between South Africa and Lesotho. The Orange River, the largest waterway in this part of Africa, originates in the mountains of Lesotho but is mostly flowing through the territory of South Africa before emptying into the Atlantic Ocean. In recent decades, because of increasing water intake by industry and agriculture in the western regions of South Africa, the river is getting shallower in the lower reaches. At the same time, Lesotho, surrounded by the territory of South Africa, has significant reserves of water resources, which are used only for 1–2 percent (WaterTechnology, 2021).

Since the 1950s regional experts had been exploring options to arrange a sustainable water supply in the Orange River basin. There were several competing projects aimed at improving the water supply of the industrial region of Gauteng and the Pretoria-Johannesburg metropolitan area. Specifically, the so-called Orange-Vaal Transfer Scheme had been found commercially unattractive due to the high energy costs for water pumping. Eventually, the choice fell on the Lesotho Highlands Water Project (LHWP) envisaging the transfer of 70 m^3/s of water from Lesotho to South

Africa. In 1986, the two countries signed the respective treaty on the Lesotho Highlands water project and established the Joint Permanent Technical Commission, which is nowadays known as the Lesotho Highlands Water Commission. The commission consists of three delegates from each country and is responsible for the overall monitoring of the project that is being implemented by the Lesotho Highlands Development Authority (LHDA, 2021).

Interestingly, under the terms of the Agreement, South Africa agreed to cover most of the project costs, including the construction of hydraulic structures (reservoirs, water supply tunnels) and environmental protection measures. Besides, the republic undertook to pay an annual royalty for using Lesotho's water resources. In turn, the costs of Lesotho are associated with the social and environmental costs of the project.

Under the 1986 Agreement, the implementation of the LHWP is divided into four stages. The first part of the project, Phase IA, worth USD 2.4 billion was completed in 1998 with the commissioning of the 72 MW Muela HPP and the 185-meter-high Katse Dam, which allow transferring 17 $m^3$3/s of water through a system of tunnels to South Africa. Phase IB, comprising the 145-meter-high Mohale Dam on the Senqunyane River (a tributary of the Orange) and the 32-kilometer-long tunnel connecting the Mohale and Katse reservoirs, were erected in 2002 (LHDA, 2021). The implementation of Phase II, including the Polihali Dam and a gravity tunnel, has just started. The total project cost of the LHWP in today's prices is estimated at around USD 8 billion, most of which will be provided by international financial institutions If wholly realized, The Lesotho Highlands water and energy complex will consist of five reservoirs with a total useful volume of 6.5 km^3 and at least two new HPPs with an installed capacity of 110 MW (WaterTechnology, 2021).

From an economic point of view, the implementation of the LHWP is remarkable in that a water user country agrees on a contractual basis to pay for the water resources coming from an upstream country within a transboundary river. It is noteworthy that the royalty paid by South Africa to Lesotho does not depend on the absolute benefits from the project implementation. Rather, it is determined by the difference between the LHWP and the Orange – Vaal Transfer Scheme Water that would cost twice the former project to implement. As per the 1986 Agreement, Lesotho is entitled to 56 percent of this cost savings. As regards the royalty, it consists of two parts. The first part is formed from investment and operating costs saved during the implementation of the LHWP and is determined based on a 50-year annuity discounted at 6 percent. Its second part is calculated for 1 km^3 of delivered water discounted at 6 percent on savings and shipping costs. The royalty is indexed based on inflation, whereas its variable (water) part, related to the costs for pumping water, is adjusted according to electricity prices (WB, 2004).

The future implementation of the Lesotho Highlands Water Project will provide complete energy independence for Lesotho and sustainable water supply for the industrially developed Gauteng Province of South Africa. For its part, the Central Asians could employ the project's economic mechanisms, particularly royalty payments.

Another positive example of successful interaction in the water-energy sector is related to the MERCOSUR – the largest grouping of countries in Latin America, which is also known for integration in the energy field. Its full members are Brazil, Argentina, Uruguay, and Paraguay, as associate members. The MERCOSUR countries are well-positioned for joint development of hydropower resources. Their main potential is located river in the Plata River and its tributaries – the Parana River (flows in Brazil, Paraguay, and Argentina) and the Uruguay River (Uruguay and Argentina). The river basins are subject to quite strong fluctuations in discharges, especially in dry years. Differences in hydrological regimes of these transboundary rivers had become one of the factors that determined the development of economic integration in this part of America (Sarsembekov, 2008). The multi-year operation of the Itaipu Dam is probably the clearest example of this cooperation.

The concept behind the HPP was the result of negotiations between Brazil and Paraguay during the 1960s. The two countries had a long history of conflict, and at that time the countries were in a dispute over borderlands. The 1996 Act of Iguaiçu ended this conflict and laid the groundwork for the Itaipu Treaty signed in 1973. The signature of the document led to conflicts with Argentina over water levels downstream of the dam. The problem was resolved in 1979 by signing a tripartite agreement between the three countries, which sets out downstream flow requirements with which the Itaipu project should comply (gihub, 2020; WaterTechnology, 2021).

The Treaty of Itaipu created a bilateral entity called Itaipu Binacional co-owned by both countries on a parity basis. The HPP was commissioned in 1984. Today the dam with its 14 GW installed capacity and the annual generation of around 100 TWh is the second-largest HPP in the world after the Three Gorges Dam in China. It covers approximately 15 percent of Brazil's and over 90 percent of Paraguay's annual needs in electricity. About 85 percent of the power generated at the HPP is consumed by Brazil. According to the 1973 Agreement, the two countries agreed to share the dam's production equally. However, if Paraguay does not utilize its half, the remainder is to be sold to Brazil under the fixed USD 124 million per year for 50 years until 2023. Under serious pressure from Paraguay, the countries renegotiated the original agreement in 2009, and Brazil agreed to pay triple these payments (gihub, 2020).

With respect to Central Asia, it is worth mentioning that the presidents of Kyrgyzstan and Uzbekistan, Sadyr Zhaparov and Shavkat Mirziyoyev, reached in 2021 an agreement on the construction of the Kambarata-1 HPP (Vinokurov et al., 2021). So, in our estimation, the financial mechanisms employed within the implementation of Itaipu Binacional and the LHWP projects may be helpful for the joint implementation of the Central Asian hydropower plant. Alongside tackling the water-energy conflict in the Syr Darya basin, the capacity of the future HPP will allow for generating around 5.5 TWh of electricity annually, a certain amount of which may be transferred to eastern regions of Uzbekistan.

Unfortunately, success stories of cooperation in sharing water resources are rather rare. There are much more cases when relations between states in this area are burdened with certain problems and conflicts. Particularly intricate situations involving the use of transboundary water resources have been observed in South Asia – in the river basins of the Indus (Pakistan and India) and the Ganges (India and Bangladesh).

The Indus River originates in the Chinese part of the Himalayas, flows through the Indian state of Jammu and Kashmir and along the length of Pakistan before emptying into the Arabian Sea. After the partition of British India into India and Pakistan the situation in the river basin came to resemble that of the Aral Sea Basin, but with fewer participants: Waterheads left in India, while irrigational lands – in Pakistan. In the spring of 1948, almost immediately after the proclamation of independence India demonstrated to her neighbor the effectiveness of the “water weapon” by cutting off the water supply to canals irrigating fields in the Pakistani province of Punjab (MGIMO, 2011). Only the intervention of the world community through the World Bank enabled to ease the growing tensions. With assistance from the financial institution, necessary preparation was carried out during 1952 – 1959, and in 1960, the Indus Waters Treaty (IWT) was signed between India and Pakistan. According to the document, the authority over the three eastern tributaries of the Indus, before they flow into Pakistan, was granted to India, and its three western tributaries to Pakistan (Sarfraz, 2013). The IWT also established the Permanent Indus Commission, consisting of an equal number of representatives from each side, with the responsibility to monitor the river situation and settle disputes.

Despite the positive role of the IWT in stabilizing the water situation in the basin for 60 years, recent upstream water infrastructure projects of India at times rekindle the long-standing conflict. Over the past two decades, Pakistan has repeatedly initiated several attempts with mixed success to prevent India from building dams on both the Chenab and the Neelum rivers because they go against the IWT. Observers from both sides have criticized the agreement for being outdated and inconsistent with the principles of harmonious use of the Indus River's resources (Jayaram, 2016).

In many respects, a similar state of affairs exists in the Ganges River. It rises in the Nepali Himalayas and then runs through the lands of India and Bangladesh. In 1961, despite the harsh objections of the Bangladeshi authorities, India began the construction of the Farakka Dam 17 km upstream from the border of Bangladesh. The purpose of the barrage and a system of canals was to divert water from the Ganges to maintain navigable depths in Calcutta Port. Diversion of the Ganges waters had grave repercussions on water availability in downstream Bangladesh including a critical shortage of water for irrigation and drinking (Yasinskiy and Vinokurov, 2008).

The issues of water apportioning in the river were repeatedly raised by Bangladesh at various international conferences, but a turning point in the relations happened only in 1996 when new political forces came to power in both countries. The treaty is known as the Ganges Water-Sharing Treaty and regulates water distribution from Farakka Barrage with validity until 2026. However, the agreement was based on average streamflow at the Farakka Dam between the years of 1949 and 1988. Since the signing of this document, climate change impacts on rainfall, coupled with more extensive water uses in farming and hydropower within the upstream Ganges in Nepal, have altered water levels, thus, impacting models of water distribution stipulated by the 1996 treaty (Jayaram, 2013).

Obvious parallels with the Central Asian water-energy conflict are seen in the situation around the Nile River basin. The origins of the conflict in the basin can be traced to 1929, when, through the mediation of the British authorities, was signed an agreement on the division of the Nile waters between Egypt and Sudan – colonial territories of the British Empire. In 1959 this agreement was supplemented by provisions providing these two countries with 90 percent control over the Nile and thereby establishing de facto a veto right on the construction of hydraulic facilities by other countries within the basin. At the same time, the countries of the upper reaches of the Nile – Ethiopia, Kenya, Uganda, Rwanda, Burundi, and Tanzania – do not feel bound by these treaties. In 2010 some of them signed another document on the use of the Nile's waters. The Cooperative Framework Agreement (CFA) also provides for the establishment of the Nile River Basin Commission with a mandate to review the existing water quotas (CDI, 2021; OWP, 2021).

In the hope to find a mutually acceptable framework for cooperation in the basin, the regional countries established the Nile Basin Initiative (NBI) in 1999. International actors, particularly those representing the World Bank, brought together all regional countries, and almost all riparians joined the Initiative, excluding Eritrea, which has agreed on only observer status. The Nile Basin Initiative was considered an interim construct until reaching a full-fledged Cooperative Framework Agreement. The riparian countries and international actors, such as the World Bank, the USA, and the EU, have undertaken a number of attempts to unlock the impasse around the CFA and to re-engage Egypt and to some extent Sudan, whose position is rather ambivalent in the dispute between Egypt and its main upstream rival, Ethiopia. However, years of negotiations notwithstanding, this ultimate goal has still not been reached (CDI, 2021).

The latter country, on whose territory the majority of Nile's waters are formed, has plans to develop the river's largely untapped potential for hydropower and irrigation. The Grand Ethiopian Renaissance Dam on the Blue Nile, which construction began in 2011, is expected to become a true gem of Ethiopia's hydropower sector. With a planned installed capacity of 6.45 GW, the dam will be the largest HPP in Africa and will be able to generate over 16 TWh of electricity annually. Its concrete gravity dam with a height of 145 m and a length of 1,800 m will allow for creating a large reservoir with a volume of 74 km^3 (IHA, 2021). Ethiopian authorities say the new hydroelectric plant will not have a significant impact on the volume of water reaching Egypt. Egyptians do not agree with this position and demand to stop the construction of the hydroelectric complex. In turn, the Sudanese authorities are taking a cautious position – they hope to receive tangible dividends from the construction of the Ethiopian station in the form of cheap electricity imports. Ethiopia's position is also supported by upstream countries for the same reasons. In these conditions, the Egyptian authorities use harsh rhetoric, unequivocally threatening the neighboring state with war. “If the Nile shrinks even by a drop, then our blood will replace it,” said Egyptian President Morsi in 2013. Ethiopia rejects all attempts of pressure and declares that the construction of the dam will be completed under any circumstances (Avesta.tj, 2013).

The given examples of tackling transboundary river problems, which are, as can be seen, predominantly associated with the hydropower vs. irrigation controversy (the water-energy conflict), indicate that such situations are typical for almost all continents of the world. Currently, in international practice, there are no generally accepted principles and approaches towards the joint use of water resources. The positive experience in dealing with water-related conflicts in various corners of the globe points to the fact that the solution to water-energy conflicts in most cases depends on the political will of states to cooperate, the presence of which, as a rule, guarantees the finding of specific economic instruments for their resolution.

CHAPTER 5: DISCUSSION AND THE SURVEY FINDINGS

This chapter aims to draw preliminary conclusions concerning the current state in the Central Asian water and energy complex, to discuss the results of the survey conducted with experts on regional water and energy problems, to finally compare the judgments of the author with those of the survey participants.

The conflict of interest between the upstream and downstream states of Central Asia over the management of the regional water and energy sectors is currently lying dormant. Its governing bodies, the ICWC and the CDC "Energiya" do not have sufficient powers to implement regulatory functions, there is no adequate coordination between them. The attempts undertaken since the mid-1990s to restore the "water for energy" scheme on the basis of the 1998 Bishkek Agreement have proved ineffective. Numerous projects aimed at a comprehensive solution to the controversy have been developed within the framework of the integration associations, such as the Organization of Central Asian Cooperation (the idea with the International Water and Energy Consortium) and Eurasian Economic Union (the concept on the efficient use of water and energy resources in Central Asia, its roadmap), remained unfulfilled.

Against the backdrop of a frozen controversy, the Central Asian countries have undertaken a range of unilateral steps geared towards ensuring complete self-sufficiency and independence in the water and energy fields. For instance, Tajikistan is building the giant Rogun Dam in the Amu Darya basin, Kyrgyzstan is not giving up the plans on erecting the Kambarata-1 Dam and the Cascade of Upper-Naryn HPPs. With the construction of these waterworks and new transmission lines, the two states seek to become large producers and exporters of electricity to South Asia. This trend is also typical for the downstream countries of the Aral Sea Basin. All three states take active measures to create additional reservoirs for water accumulation or streamflow counter-regulation (most famous ones are Golden Age Lake in Turkmenistan, the Koksaray counter-regulator in Kazakhstan, as well as smaller reservoirs in the Fergana Valley of Uzbekistan).

On the one hand, the focus on such one-sided solutions allows the governments of Central Asian republics to cope with selected economic and energy problems at the national level. On the other hand, it complicates the prospects for their integrated solution for the sake of the whole region. Such a "tactical approach", modus operandi to the solution of the water-energy conflict has a number of negative aspects:

First off, it is costly. In today's Central Asia, there are a plethora of costly infrastructural projects underway – for example, new power lines in Kyrgyzstan and Tajikistan, the construction of which in other conditions would be considered inappropriate.

Secondly, the selected modus operandi is fraught with conflict situations with hard-to-predict consequences. In particular, the construction of Rogun and Kambarata – 1 HPPs have been criticized to a varying degree by the authorities of the downstream countries for potential dam failure risks, as well as threats to water and food security.

Ultimately, this tactic leads to the aggravation of the region's environmental problems. The broader use of hydrocarbon, for example, in coal-fired power plants, contributes to the melting of glaciers in the Tian Shan and the Pamir. The construction of new water reservoirs, in case of their inconsistent operation afterward, may lead to a reduction in the water inflow into the Aral Sea and its further desiccation.

Alongside the lack of a strategic vision in tackling the water-energy conflict of the Aral Sea Basin within the internal arena, one can observe a patchwork of vested interests expressed by external actors. The water and energy sector of Central Asia attracts the attention of almost all leading world powers and neighboring countries likewise. The efforts of extra-regional actors in this field tend to be going in different directions. Despite the declared interest in strengthening regional cooperation, external players seem to be hiding behind declarations their real plans to achieve their own geopolitical and commercial goals in the region, namely: seeking assistance in the reconstruction of Afghanistan (USA); solving electricity shortage problems and/or obtaining commercial benefits (Pakistan, Iran, China, etc.); formation of a common energy market within the framework of the Eurasian Economic Union (Russia) and the like (Borishpolets, 2007; Tomberg, 2012; Mustafinov, 2019; Vinokurov et al, 2021).

Since the emergence of the regional water problems there were certain expectations that the role of change agents in the sector would be played by international organizations. Given the limited capacity within the region to revamp the water and energy sectors, the technical expertise and resource capabilities of development and financial institutions seemed to be instrumental. Some achievements (e.g., the USAID assistance in signing the 1998 Bishkek Agreement) notwithstanding, their activities have been limited to certain projects at the national and at times sub-regional levels (Sehring, 2020). Whereas the projects aimed at seeking a comprehensive solution and entailing an integrated approach have been eventually rejected or remained unattended by the countries. Specifically, the efforts of some UN agencies to elaborate a joint regional strategy on efficient use of water and energy resources in the late 1990s and early 2000s (within SPECA efforts), and recent conventions developed by UNRCCA on the joint water use in the Amu Darya and Syr Darya basins, seems to be failed.

These failures are mainly, as was already discussed in this research, attributable to the preoccupation of the political elites with security concerns. In other words, interactions on water resources are regarded here as a matter of national security associated with a zero-sum game rather than an ordinary public issue. The way to de-securitize this issue, as we learned from the literature review, may include measures focused on smaller unchallenged issues that can yield tangible outcomes in the relatively short run and embrace mutually shared interests.

In order to increase our understanding of the Central Asian water problems and particularly the water-energy conflict in the Aral Sea Basin we have decided to do survey research referred to as “The water-energy nexus in the Aral Sea Basin: identifying feasible political-economic solutions”. Since the issue under consideration, belongs to the category of specific knowledge, we opted for developing an expert survey. Ultimately, nine scholars from around the world agreed to answer our questions. The survey consisted of ten carefully prepared, highly specialized questions relating to the issues starting from the assessment of the current situation in the sector to determining possible ways and the paradigm within which the problem is to be resolved.

The first question was about accessing the short to medium-term *prospects for tackling the water and energy conflict into account recent developments in the region*. These mainly implied the U-turn in Uzbekistan’s politics after the passing of President Karimov in 2016 that has opened the door to noticeable political and economic transformations inside the country and also to a thaw in regional affairs. Specifically, the countries started holding the annual consultative meetings of the heads of Central Asian countries, at which the water-energy nexus issues have been an indispensable attribute of agendas. Seven out of nine respondents share the view that, at best, given the willingness of Tajikistan and Turkmenistan to rejoin the CAPS, its relatively full deployment will be considered a success. Five experts also believe that the downstream countries might withdraw claims against constructing the Rogun and Kambarata-1 HPPs, and at least the former might be built over the next decade. Two scholars consider that the level of political securitization would remain too high to expect any significant changes with respect to the status quo.

The following seven questions were devoted to institutional and infrastructural solutions for tackling the water-energy conflict in the Aral Sea Basin. In Question 2 the respondents were invited to answer whether a *return to the system of integrated resource management that existed during Soviet times (in short, to water for energy exchanges) is the most optimal mechanism to solve the conflict*. Three scholars expressed their support for the 1998 Bishkek Agreement on the use of water and energy resources in the Syr Darya basin, which was an attempt to restore the Soviet time system, as the most reasonable option in tackling the problem. The other four respondents considered that the return is not possible for political and economic reasons. Two respondents in general agree with the idea that the 1998 Agreement was a good thing. However, as they noted, the Agreement suffered from a lack of concretization and over-bureaucratization simultaneously[14]. “It is necessary to develop a mechanism for assessing services for the regulation of streamflow. Paying for these services will make it possible to introduce legal responsibility for maintaining the required levels in the reservoirs of multi-year regulation, in other words, it will not permit their uncontrollable discharges”, one respondent concluded.

Question 3, asking the respondents to express their attitude to *establishing a Central Asian water and energy consortium,* was probably the one that stirred up maximum unanimity. All scholars agreed that the idea of creating a kind of intergovernmental body exercising sub- or/and interannual water for energy swaps between the Aral Sea basin riparians is a great suggestion. However, variations of how this can be implemented differ. Some believe the deal should include the region’s major energy companies and be a commercial structure rather than what was proposed in the 1900s[15]. It is also proposed that the exchange commodities might, alongside water and electricity, include hydrocarbons and agricultural goods. Another

[14] It was a framework agreement and required the signing of annual clarifying documents.

[15]The draft project of IWEC was overloaded with numerous functions and conditions that led to a standstill in its realization (Petrov, 2015a).

respondent, who is associated with the regional power system, in turn, considers that the scope of the consortium should be limited only to water and electricity. It is also important to note that there is some scepsis regarding the idea's implementation, namely related to "the lack of political to change things".

Slightly less popularity was gained by Question 4 asking about *the model that entails cost-sharing mechanisms between downstream and upstream countries*. In principle, eight respondents agree that the 2000 Agreement on the use of water management facilities of intergovernmental status on the rivers Chu and Talas, under which downstream Kazakhstan shares a part of facilities' operation and maintenance costs incurred by upstream Kyrgyzstan, is a useful practical mechanism and should be replicated in other river basins. At the same time, this mechanism alone may not be sufficient for more complex cases. As one professor of Energy from the region indicated, "the Chu-Talas situation is a solely irrigational story while in the Syr Darya we have the conflict between irrigation and hydropower". Another scholar, who did a special field research on the state of affairs in the Talas River basin after the signing of the 2000 Agreement, argued that the model "can easily be manipulated by a stronger country that can impose its agenda and will upon a weaker one utilizing both material and bargaining power strategies".

Question 5 concerned the respondents' attitude towards the willingness of the upstream riparians to proceed with *the construction of large-scale hydroelectric projects in the transboundary rivers*. The majority of scholars (six out of nine) found these endeavors fairly logical, since, for example, in the Syr Darya Basin, the construction of the Kambarata-1 HPP in Kyrgyzstan would allow for using it for power generation in winter while the downstream Toktogul HPP would be able to function for the needs of irrigation, storing water at the same time. At the same time, some of them are not entirely sure that the HPPs, particularly Rogun, will guarantee a balance of interests between irrigation and hydropower, the downstream and upstream countries, respectively. "It seems the upstream republics are mainly keen on profit-making by selling the electricity to South Asia", summed up a respondent. One scholar strongly disagrees with the building project and is sure that they pose serious risks (water scarcity, dam safety, etc.) to the downstream republics. The remaining two answerers believe that these hydro projects seem to be redundant in terms of energy security for the upstream republics, and there are many other options to enhance it.

The idea of constructing new coal-fired thermal power plants in Kyrgyzstan and Tajikistan as a means to reduce dependence on hydropower was recognized as the least popular solution. Most respondents (seven out of nine) feel that there is no need to launch such projects. It is much better to keep streamlining existing TPPs. Moreover, new plants may present unnecessary hazards to the Tian Shan and Pamir icy peaks. Some scholars, however, admitting the high costs and the difficulty in finding investors for the projects still think that “at the backdrop of decreasing water reserves the search for ways to replace hydropower in the autumn-winter months is becoming an urgent issue. Taking into account issues of ensuring the country's energy security, this is a necessity”.

Probably, the most dividing question was on the attitude towards the so-called *Siberian river reversal concept.* Four respondents believe that this project could have a positive impact on alleviating the projected water scarcity problem in Central Asia and thus easing, to some degree, the water-energy conflict. Simultaneously they admit that the project would require huge investments of which not the whole region, nor a single country here might afford. Five scholars spoke against the very idea because this would an environmental disaster for the whole of Eurasia. Interestingly, this separation in answers goes through the West – ex-Soviet Union line when western scholars express greater concern about the environment and ecology while the perception of those who have a post-Soviet background regarding this situation is more lightweight.

In Question 8 the respondents were asked to give an opinion whether it is possible to *establish, based on the CAPS’ capacity, a well-functioning Common electricity market of Central Asia* like the NordPool? Four respondents agreed with the statement that the establishment of wholesale power markets not only within the region but also with Russia and South Asia might solve most of the region’s energy problems and alleviate the water-energy crisis. The other four scholars consider that this idea would require major changes including fundamental energy deregulation reforms to which the regional countries are not ready[16]. Another respondent provided an insight that the issue is currently being developed within the framework of the

[16] Among the Central Asian countries, only Kazakhstan can be regarded as an economy with a relatively deregulated power sector and the wholesale energy market. Some deregulation reforms were carried out in Kyrgyzstan. In recent years, the first steps towards the liberalization of the energy sector were undertaken in Uzbekistan and Tajikistan. The energy sector of Turkmenistan is totally regulated and controlled by the state (CIS-Energo, 2020; Mustafinov, 2019).

CAREM – Central Asian Regional Energy Market program.

The next question was compiled as ranking one and invited the respondents to *assess the role of the donor community,* i.e., international intergovernmental organizations, financial institutions, NGOs, individual countries on a scale of 1 to 4, where the higher mark represented better performance. Only one respondent highly appreciated the participation of external actors in tackling regional water problems. Six scholars rated their contribution as 2, the rest gave 1 point, indicating that “the efforts of the community have been rather geopolitically motivated and with vested interests in the process”.

The final question was dedicated to the *determination of the path by which the donor community should follow* in the years ahead. The respondents were offered to select between the focus on technical assistance issues (development of information exchange, dam safety, various forms of capacity building, etc.) and the promotion of regional cooperation (elaboration of comprehensive institutional and legal solutions) as the mainstream activity in finding solutions to the regional water-energy conflict. Three scholars spoke in favor of the former option, another four supported the latter one. One scholar objected to such a way of raising the issue, noting that there is no need to oppose them to each other. “We need both options. The first will have a one-time or irregular nature, while the second will create a normal, working, and, most importantly, transparent mechanism of relations between the upstream and downstream countries”.

The results of the survey reveal that the experts’ expectations regarding the prospects of tackling the Central Asian water-energy conflict within the foreseeable future are more optimistic rather than pessimistic. Despite the high level of political securitization (and hence restraints in decision-making) in Central Asia, the respondents believe that the regional countries will be able to get the CAPS back into a relatively full operation mode. The upstream riparians will also have a chance to complete the building of long-awaited large-scale HPPs without further ado. As regards institutional and infrastructural solutions, the scholars stated their preference for the former ones. As can be seen from Figure 8, among the most popular options are establishing a water-energy consortium, introducing cost-share mechanisms, and returning to the Soviet-era “water for energy” schemes. The infrastructural measures, apart from the construction of the long-anticipated hydropower plants, can be deemed as less favored and are regarded as redundant in many cases. At the same time, the respondents find it hard to decide on the paradigm (small deeds or holistic approach) of which the donor community (i.e., external actors) should choose to help the region in tackling the issues under consideration.

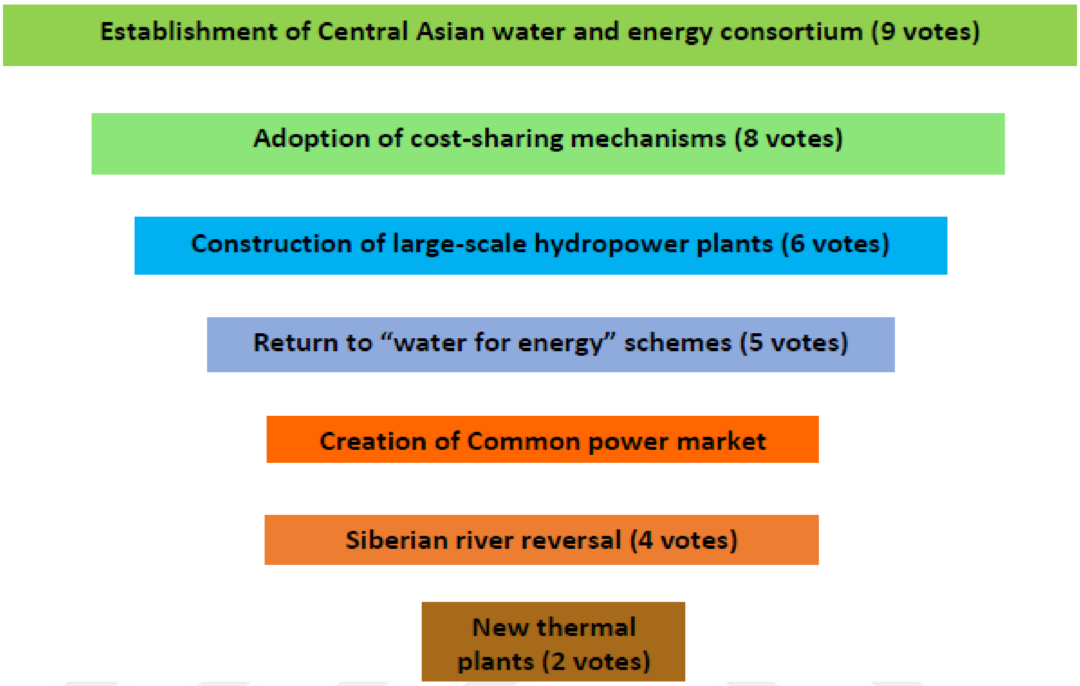

Figure 8. A ranking of the institutional and infrastructural solutions for tackling the water-energy conflict in the Aral Sea Basin based on the survey findings

In general, the survey findings correlate with our judgments about the ways to tackle the water-energy conflict in the Aral Sea Basin. It is encouraging that the majority of experts believe in the priority of institutional solutions, particularly in establishing a consortium. As was noted in Chapter 4, the idea of creating a supranational body capable of making transactions (like a bank or exchange) in a way that is simultaneously independent (third party) and for the benefit of the common good, is the best possible option. At the same, it would require high trust amongst the regional countries, which, in turn, depends on a variety of factors including political will and economic maturity. But then again, in the late 1990s, they were close to the fulfillment of this idea. So, it is the role of economists and engineers, and researchers at large, to propose a feasible mechanism for the idea’s implementation.

It was also fortunate to find out that most scholars support the cost-sharing mechanisms as a viable idea. From the literature review one can learn that despite the realization of this approach in the Chu and Talas basins between Kazakhstan and Kyrgyzstan, it is not widely distributed across the region, especially when it comes to the Aral Sea Basin's rivers and respective facilities on them. The downstream countries are not so far ready, at least openly, even partly reimburse the maintenance costs of the Toktogul and Nurek HPPs, even though these hydrosites are essential in providing water for irrigation. Who knows, maybe the solution lies in this option. Especially as Petrov (2015a) mentions, there is an implicit agreement between Uzbekistan and Tajikıstan under which the former in exchange for agreed water releases reimburses the maintenance costs of the Kayrakkum HPP on the Syr Darya in the form of supplies of water pumps and their repair parts to Tajikistan.

What was somewhat unexpected in the expert's responses is that a significant part of them consider the so-called Siberian rivers reversal concept as a working way to address water problems of Central Asia in general and the water-energy crisis in the Aral Sea Basin in particular. Despite much controversy and media hype around this idea in the last years of the USSR when the authorities were poised to proceed with its implementation, the issue yet resonates for them. They are quite convinced, with evidence-based arguments at disposal, that the project could still be implemented without serious harm for the environment of Central Asia and the Ob River itself, which annual runoff of around 400 km^3 (Brittanica, 2018), that is more than three times bigger than that of the whole Aral Sea Basin.

CHAPTER 6: CONCLUSION AND POLICY RECOMMENDATIONS

An analysis of the problems associated with the use of transboundary watercourses in the Aral Sea Basin of the Central Asian region reveals that over the past three decades, despite all the efforts made – the work of various national and international foundations, institutions, the signing of numerous intergovernmental agreements – the situation in this area, in fact, tends to stagnate.

This state of affairs is largely due to the *unresolved issues of joint use of transboundary water resources*. Instead of a coordinated approach to improving the efficiency of water fund management, the countries of the region are focused on developing their own water use strategies, which do not always take into account the legal rights and interests of neighboring states. This leads to mutual accusations of unfair water use, non-fulfillment of agreements reached and violation of obligations assumed. Ultimately, these factors negatively affect the readiness of the Central Asian republics to transfer part of their administrative powers to inter-state structures and pursue a coordinated regional water policy.

The development of the regional power economies has long indicated *disintegration processes in the evolution of the Central Asian Power System*. Possessing significant, but at the same time, unevenly distributed energy resources across the region, the local authorities are currently making little use of the potential for cooperation laid down in the Soviet era. Instead of developing region-wide approaches geared towards achieving a synergistic effect, Central Asian countries are striving to strengthen energy independence, relying primarily on the maximum use of their own energy resources.

As a result of *centrifugal processes in the regional water and power sectors*, the system of integrated management of water and energy resources (based on water-energy exchanges) that existed since Soviet times, within which the hydropower resources of highland Kyrgyzstan and Tajikistan were supplemented with hydrocarbon reserves from lowland Kazakhstan, Uzbekistan and Turkmenistan while the regional power supply was provided through electricity flows within the CAPS, has undergone serious destruction. If during the Soviet Union the general priority in the region was the development of irrigated agriculture, whereas hydropower was to a certain extent in a subordinated position, then after 1991 only Kazakhstan, Turkmenistan, and Uzbekistan retained the previous guidelines, while for Tajikistan and Kyrgyzstan the hydropower industry became instrumental. Thus, a natural tension between the subjects of water use – hydropower and irrigation – led to the formation of several issues that could be classified as the water-energy conflict.

Currently, in the Central Asian countries, both in the scientific community of water experts and hydropower specialists and in government circles, they often take disparate views on the development of the regional water and energy complex. The lowland countries, located along the middle and lower reaches of the Amu Darya and the Syr Darya, defend the priority of using regional water resources primarily in irrigated agriculture, calling it the guarantor of the socio-economic stability of the entire region. In turn, the upstream states insist on revisiting the established model of water allocation. The opportunity here is seen in constructing new hydropower facilities. Against the background of these contradictions, the fact that the Central Asian water and energy complex is an integral system and therefore should be developed within the framework of a single process is overlooked or simply ignored. Meanwhile, the experience of the positive settlement of water-energy conflicts in various regions of the world indicates that their resolution largely depends on the political will of states to cooperate, in the presence of which there will be always certain economic instruments for conflict management.

In our estimation, the following political-economic solutions could be expedient to tackle the water-energy conflict in the Aral Sea Basin and thus ameliorate the overall situation with inter-state governance of the Central Asian water and energy complex.

Above all, *the issues of using water and energy resources should be considered as a whole*, in an integrated way, not separately. A big omission of many projects implemented in the water and energy sector with the assistance of international institutions and non-regional states is that they have been more about point solutions focused on solving one or several specific project tasks within a single industry. Meanwhile, the problems of the Central Asian water and energy sector should be considered through the "water-energy" link or even within the framework of the "water-food-energy" axis. This relationship should be taken into account in the elaboration of a comprehensive *regional strategy for the rational use of water and* *energy resources in Central Asia*. Along wıth the comprehensive vision of the problem, as our survey research has reaffirmed, the pursuit of lesser, *technical assistance issues*, such as the development of information exchange, joint water monitoring, and the like, should not be disregarded either.

A crucial, if not decisive, role in addressing the water-energy conflict will be played by *institutions*. As was noted in this research, institutions (specifically organizations, then international regimes and other norms) have a transformative capacity to alter the existing set of rules and commons for the better. Moreover, they rest on the benefit-sharing approach and seek ways and means to achieve inclusive prosperity.

While recognizing the rationality of *introducing the cost-sharing arrangements* for the utilization of single-purpose hydro facilities (the success story with the Kazakh-Kyrgyz cooperation in the Chu and Talas basins) one should be aware that dealing with multi-purpose hydrosites in transboundary rivers, producing both water and electricity (these includes all large scale HHPs in the Aral Sea Basin), requires a sort of package solution. In our judgment, this implies the creation of a supranational body in the form of a consortium – a novel *Coordination Water and Energy Council of Central Asia*. Headed alternately by regional ministers of energy and water management, this multifunctional entity should have the executive organ to process a system of payments and cash receipts from the member states. At the initial stage, the scheme of its work may have the simplest nature – to provide “water for energy” commercial exchanges between countries of the Aral Sea Basin. As an economic mechanism for such an exchange, one can accept the scheme provided for in the 1998 Bishkek Agreement on the use of water and energy resources. Later on, the capabilities of this new body could be extended by establishing an *insurance fund* and a special *exchange for trading water and energy resources*. In the longer run, the functionality of the Council might be enhanced by creating a *joint directorate of HPPs* that manages the operation of existing hydrosites. The Directorate could also act as a customer for building new facilities of interstate importance, attracting funds from parties interested in their construction and operation.

Besides, an important part should also be given to the promotion of *integrated water resources management principles* in regional water management. In organizational terms, this task includes the *reforming of the Interstate Commission for*

Water Coordination. Even though the ICWC was established in 1992, the existing structure of the regional water resources management remains practically the same as it was at the time of its creation in the 1980s, and now does not correspond to modern realities. The main proposals for reforming the ICWC should be aimed at raising its status and expanding its rights. Along with the operational functions of elaborating annual limits of water withdrawals, the transformed supranational structure should have some features of market institutions, namely: transparency, free access to information, public participation in decision-making, development of broad both intra- (between water users at all levels) and intersectoral (with other related industries) coordination linkages.

Recipes for tackling the water-energy conflict in the Aral Sea Basin also include infrastructural solutions. In practice, the problem boils down to the fact that there is only one large streamflow regulating dam on each river of the basin. The *construction of an additional dam upstream of the existing one* will enable to distinguish between the interests of irrigation and hydropower, since new HPPs will work to generate power for Kyrgyzstan and Tajikistan while old ones will continue to provide water to the irrigation in Kazakhstan, Uzbekistan, and Turkmenistan. However, the implementation of these projects will require colossal investments and have a middle to long-term perspective.

In the shorter run, with the commissioning of new high-voltage transmission lines, Central Asian countries will have an opportunity to significantly expand electricity trade both within the Central Asian region and on foreign markets. Therefore, it is economically more expedient to focus *on the restoration of a full-fledge functioning of the CAPS* and the *modernization of existing electric power facilities*.

The prospect for addressing the water-energy conflict in the Aral Sea Basin seems to be closely linked with the development of political relations between Central Asian states and the international situation in general. Any major settlement here is only possible through the harmonization of interests of regional states based on the relevant elaborations and expertise from international development institutions.

Nevertheless, notwithstanding objective political constraints at play, these policy suggestions could be used as a methodological resource in the practical activity of Central Asian countries' executive bodies responsible for policy-making in energy and water management. The main findings of the study might also be applicable in managerial decisions of regional and international energy companies on projects related to constructing new hydraulic and electric power structures in the region. The dissertation materials can be helpful in the preparation of courses on Environmental management, Energy industry of Central Asia, Economic processes in the post-Soviet area, and the like.

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APPENDICES

Appendix A – Survey questions

“The problem of the water-energy nexus in the Aral Sea Basin: identifying feasible political-economic solutions”

Thank you for taking part in the survey. It will take max. 15 minutes to complete. While answering the questions, you can tick one or more boxes as well as leave your comments and remarks.

The information that we collect from this research project will be kept private. Any information about you will have a number or another identifier on it instead of your name. Nothing that you tell us will be shared with anybody outside the research team, and nothing will be attributed to you by name.

Dear respondent, please specify your email or name:

Your professional/academic experience on Central Asia or/and its problems:

Your age:

Your gender:

1. Taking into account recent developments[17] in Central Asia how do you assess the prospects for tackling the so-called water and energy conflict between the upstream and downstream countries in the short to medium term?

- At best, given the willingness of Tajikistan and Turkmenistan to rejoin the Central Asia Power Grid (CAPS), its relatively full deployment will be considered a success.
- Besides, the downstream countries might withdraw claims against the Rogun and Kambarata-1 dams in Tajikistan and Kyrgyzstan respectively, and they, at least the former, would be built.
- The level of political securitization in the region would remain too high to achieve significant breakthroughs.
- Other:

[17] The change of authority in Uzbekistan, a reactivation of Central Asian Consultative Meetings of Heads of State.

2. Do you consider that a return in one form or another to the system of integrated resource management that existed during Soviet times (i.e., water-energy exchanges) is the most optimal mechanism to solve the water-energy (prioritized developments of irrigation vs hydropower) dilemma in the region?

- The 1998 Agreement on the use of water and energy resources in the Syr Darya basin is the most reasonable option in terms of benefit-sharing. However, the proposed scheme requires further market-oriented elaboration.
- Given noticeable changes in recent decades (new water infrastructure, especially counter-regulators), it doesn't seem worthwhile.
- The return is not possible for both political and economic reasons.
- Other:

3. How do you feel about the idea of establishing a Central Asian water and energy consortium, i.e., an intergovernmental body exercising sub- or/and interannual water for electricity/hydrocarbons swaps between the Aral Sea Basin riparians but with clear, well-structured legal and financial capabilities?

- It is a good idea!
- Realities of the region will not permit the riparians to do that.
- Other:

4. What do you think about the 2000 Agreement on the use of water management facilities of intergovernmental status on the Chu River and the Talas River under which downstream Kazakhstan shares a part of facilities' operation and maintenance costs incurred by upstream Kyrgyzstan. Could this model be applicable to tackle the water-energy conflict in the Amu Darya and Syr Darya basins?

- These reimbursements seem to be the maximum possible solution by now. Any forms of water trading are out of the question.
- The model could be implemented in the Syr Darya basin between Kyrgyzstan at one end and, say, Uzbekistan, Kazakhstan at the other.
- The model could be implemented in the Amu Darya basin between Tajikistan and Uzbekistan.
- Other:

5. Do you find the willingness of the upstream riparians to proceed with the construction of large-scale hydroelectric projects in the transboundary rivers reasonable?

- Yes, it sounds fairly logical. For example, in the Syr Darya basin, the construction of the Kambarata-1 HPP in Kyrgyzstan will allow for using it for power generation in winter while the downstream Toktogul HPP will be operated for the needs of irrigation storing water at the same time.
- By no means. They pose serious risks (water scarcity, dam safety, etc.) to the downstream republics.
- These plants (Rogun, Kambarata-1) seem to be redundant in terms of energy security for upstream republics, there are many other options to enhance it.
- Other:

6. What is your position on the idea of constructing new coal-fired thermal power plants in Kyrgyzstan (e.g., the Kara-Keche TPP) and Tajikistan as a means to reduce dependence on hydropower?

- With current subsidized prices for electricity, it is not cost-efficient.
- It might be reasonable, but too expensive. The countries will not be able to find investors.
- There is no need to launch such projects. It is much better to keep streamlining existing TPPs. Furthermore, new TPPs may present unnecessary hazards to the icy peaks of the Tian Shan and Pamir Mountain glaciers.
- Other:

7. What is your attitude towards the Siberian rivers reversal concept, which is occasionally reappearing among politicians and the expert community?

- It could have a positive impact on alleviating the projected water scarcity problem in the region and thus the water-energy conflict. However, the project would require huge investments, to attract them seems like something from science fiction.
- That would not be advisable for environmental reasons.
- Other:

8. What do you think whether it is possible to establish, based on the CAPS' capacity, a well-functioning Common electricity market of Central Asia like the Nord Pool?

- The establishment of wholesale power markets not only within the region but also with Russia and South Asia might solve most of the region's energy problems and alleviate the water-energy crisis.
- This would require major changes including fundamental energy deregulation and liberalization reforms to which the regional countries are not ready.
- Other:

9. How do you assess the role of the donor community[18] in finding solutions to the water-energy conflict (a higher mark represents better performance)?

- 1
- 2
- 3
- 4

10. What path should the donor community take in finding solutions in the years ahead?

- The main focus should concentrate on technical assistance issues relating to the development of information exchange, dam safety, various forms of capacity building, etc.
- Top priority should instead be accorded to promoting regional cooperation, including the search for comprehensive institutional and legal solutions.
- Other:

[18] International intergovernmental organizations, financial institutions, NGOs, individual countries.

Appendix B – Information Sheet

Introduction

I am Bulat Mubarakshin - a student of the Sustainable Energy Master's Program at Izmir University of Economics, Turkey. I am conducting a study entitled "The water-energy nexus in the Aral Sea basin: identifying feasible political-economic solutions". I am going to give you information about and invite you to be part of this research.

Purpose of the Project

The like-named master thesis is conducted under the program of "Sustainable Energy" at Izmir University of Economics. This survey will allow us to cast a fresh and critical eye on the interlinkages between water (irrigation development) and energy resources in Central Asia. The ultimate goal of the research is to try to understand institutional and infrastructural dimensions in solving the regional water-energy conflict.

Type of Research Intervention

This research will involve your participation in a survey.

Participant Selection

You are being invited to take part in this research because we feel that your experience can contribute much to our understanding and knowledge of the problem of the water-energy nexus in the Aral Sea basin.

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate or not.

Duration

The research takes place for 6 months in total.

Risks

The research does not entail any risk to you as a participant.

Benefits

There will be no direct benefit to you, but your participation is likely to help us find out more on our research subject.

Confidentiality

We will not be sharing information about you with anyone outside of the research team. The information that we collect from this research project will be kept private. Any information about you will have a number or another identifier on it instead of your name.

Sharing the Results

Nothing that you tell us will be shared with anybody outside the research team, and nothing will be attributed to you by name.

Right to Refuse or Withdraw

You do not have to take part in this research if you do not wish to do so. You may stop participating at any time that you wish.

Whom to Contact

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact me via [redacted]

This proposal has been reviewed and approved by IUE's Ethics Committee, which is a committee whose task is to make sure that research participants are protected from harm. If you do have any further questions about the Committee, please get in contact with Prof. Dr. Murat Bengisu via [redacted]

Certificate of Consent

I have been invited to participate in the research entitled "The problem of the water-energy nexus in the Aral Sea Basin: identifying feasible political-economic solutions". I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions and all the questions I asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Name of Participant

Signature of Participant

Date

Statement by the researcher

I have accurately read out the Information sheet to the potential participant, and to the best of my ability made sure that the participant understands the details of the research. I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this Informed Consent Form has been provided to the participant.

Name of Researcher

Signature of Researcher

Date