water

MDPI

Article

Could Changing Power Relationships Lead to Better Water Sharing in Central Asia?

Aibek Zhupankhan [1,2], Kamshat Tussupova [2,3] and Ronny Berndtsson [2,*]

1 Department of International Affairs, Eurasian National University, Kazhymukan Munaytpasov Street 13, Astana 010000, Kazakhstan; zhupankhan@bolashak.gov.kz
2 Department of Water Resources Engineering & Center for Middle Eastern Studies, Lund University, Box 118, SE-221 00 Lund, Sweden; kamshat.tussupova@tvrl.lth.se
3 Department of International Cooperation and Bologna Process, Karaganda State Medical University, Gogol Street 40, Karagandy 100048, Kazakhstan
* Correspondence: ronny.berndtsson@tvrl.lth.se; Tel.: +46-46-222-8986

Academic Editor: David K. Kreamer
Received: 7 December 2016; Accepted: 16 February 2017; Published: 20 February 2017

Abstract: Even though Central Asia is water rich, water disputes have characterized the region after crumbling of the Soviet Union in 1991. The uneven spatial distribution and complex pattern of transboundary water sources with contrasting national water needs have created an intricate water dilemma. Increasing national water needs, water claims by surrounding countries, uncertainties in renewable water volumes, and effects of climate change will put further strain on the future water use in Central Asia. We argue that the present power distribution with three downstream hegemons (Kazakhstan, Turkmenistan, and Uzbekistan) and two upstream much poorer countries with less political influence (Kyrgyzstan and Tajikistan) is not likely to lead forward to a greater willingness to share water. We discuss this situation with the analogue Egypt-Sudan-Ethiopia in the Nile Basin. Thus, as in the case of Ethiopia in the Nile Basin, gradually economically stronger upstream countries Kyrgyzstan and Tajikistan due to hydropower development are likely to eventually re-define the hydropolitical map of Central Asia. As in the case of the Nile Basin, a more even power balance between upstream and downstream countries may lead to an improved political structure for a much needed better collaboration on water issues.

Keywords: Central Asia; hydropolitics; water management; water conflict; transboundary water; climate change

1. Introduction

Central Asia, including Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, represents an important strategic geopolitical region. Historically, the area is known as the "The Great Game" in terms of describing the political and diplomatic skirmishes that occurred between Britain and Russia during most of the 19th century. During recent years, this term has again surfaced as the region is in the center of the triangle China, Russia, and India [1]. The sudden renewed interest in the area became obvious after the collapse of the Soviet Union in 1991. The region is in general water rich as well as rich in hydrocarbon resources but is still economically underdeveloped with a strong ethnic diversity [2].

Throughout the Soviet Union era, the region's natural resources were managed in a system that would maximize the regional economic output. For example, downstream riparians like Uzbekistan and Kazakhstan would grow cotton using water supplied by the upstream riparian Kyrgyzstan [3,4]. In return, Uzbekistan and Kazakhstan supplied Kyrgyzstan with coal and gas to compensate for less water for hydropower [2]. The sudden crumbling of the Soviet Union in 1991 and appearance of the five independent Central Asian states changed the geopolitical landscape and the views on how to

manage the natural resources. Even though different multilateral treaties have been agreed upon between the Central Asian states over the years to ascertain this resource-sharing regime, conflicts have arisen. For example, repeated conflicts between Kyrgyzstan and Uzbekistan have occurred due to problems in this resource sharing. For a more detailed discussion on this topic, see Dinar [4]. Once the Soviet Union had disintegrated, water resources became politicized and part of the national interests [5]. For example, during a presidential meeting in Astana in 2012, the Uzbek president Islam Karimov emphasized that water resources problems could cause wars [6]. Recent research on the possible reduction of water supply from melting of the Tien Shan glaciers (Figure 1) has resurfaced the fear of water wars in Central Asia [7]. The passing of president Karimov on 2 September 2016 raises important questions for the future of the region with the intertwined water issue.

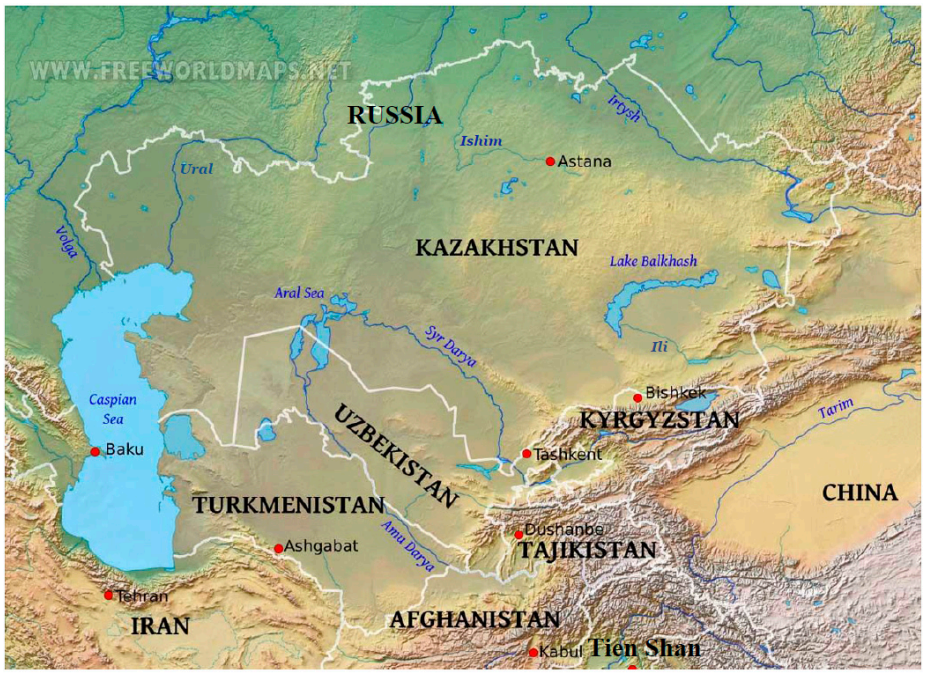
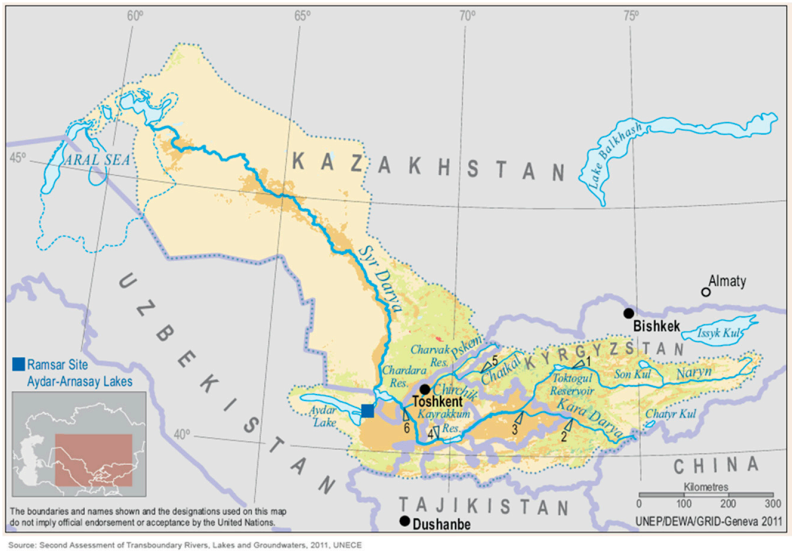


Figure 1. Central Asia with major regional water resources [8].

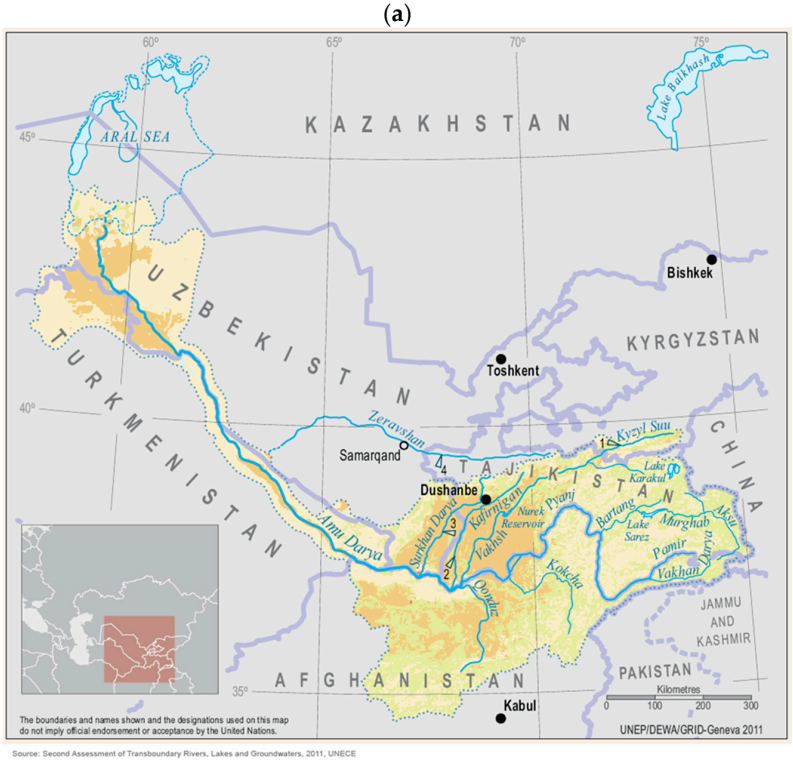
Already four years after the downfall of the Soviet Union, Central Asia was identified as a region close to potential conflict regarding natural resource use [9,10]. Although, Central Asia is not water poor, a major part of the available water resources is concentrated in Kyrgyzstan and Tajikistan. In fact, main surface runoff of the Aral Sea Basin (about 93 km^3/year or 80%) is formed in the upstream Tajikistan and Kyrgyzstan [11]. However, the main use of water (85%) occurs in downstream Kazakhstan, Uzbekistan, and Turkmenistan. The two major rivers of the region, the Syr Darya and the Amu Darya, originate in Kyrgyzstan, Tajikistan, and Afghanistan (Figures 1 and 2). For this reason, Kyrgyzstan and Tajikistan control most of the water resources needed by the other downstream states. However, Afghanistan as well, constitutes an important and up to now a more or less silent riparian. Sharing of the water from the Syr Darya and the Amu Darya has exposed a complex picture of water needs and potential political conflict [12–14]. During the last decades of the 20th century, the Aral Sea, the fourth largest lake in the world, has shrunk significantly [15]. This occurred due to increase of irrigated agricultural area from 4.3 to 8.2 million ha. When the ecology changed, an area of hundred thousand square kilometers containing a population of several million were jeopardized [16,17].

Gleick [18] (see also Dinar [4] for a discussion) notes that four main characteristics decide the graveness of a hydropolitical conflict, namely (1) the degree of scarcity, mismanagement, and misallocation of water in the region and the importance of water to a particular state; (2) the protracted conflict underlying the water dispute; (3) the historical and political claims made by the

disputing countries over water; and (4) the relative power of the countries. A fifth characteristic is probably an upstream or downstream position as developed by Dinar [4]. The most serious conflict between ethnic groups of Kyrgyz and Uzbeks occurred in the Ferghana Valley in the Syr Darya Basin 1990 and 2010 [19]. Even if there is no concrete proof, we speculate that water availability had a significant influence on the conflict. In 2010, the clashes killed approximately 420 people, mostly Uzbeks, and another 80,000 were displaced (see also [20] for a more elaborate text on conflict and cooperation in the Ferghana Valley). The three countries Uzbekistan, Kyrgyzstan, and Tajikistan have all historic and economic claims to the natural resources of the region [21]. At the same time, much work have been devoted by international donors and NGOs to solving the problems in the Ferghana Valley and introduce modern water management techniques.



(**a**)



(**b**)

Figure 2. The Syr Darya (**a**) and Amu Darya River (**b**) Basins [22].

In view of the above, hydropolitical studies may include the five items above, or to simplify, two main factors, riparian position along the river or water course and relative power as considered by Dinar [4]. There are many examples of how these two factors may balance or imbalance each other (see e.g., Dinar [4] for three different major river basins). Militarily or economically stronger states (hydro-hegemons) may be able to by different means, coax weaker states into water agreements or arrangements that is not equitable [23]. Consequently, power balance, as indicated in the title of this paper, is a part of the general hydropolitical map of a water basin. The power balance may or may not be an important aspect of hydropolitics as also the geographical (physiographical) position along the river is important as mentioned above.

In view of the above, it is possible that local water disputes could escalate to regional conflicts. Ethnic tensions and border disputes, could lead to serious international conflict. The International Crisis Group [24] has also noted this. Thus, the objective of this paper is to review the renewable transboundary water resources in Central Asia and effects of climate change. We then analyse the hydropolitical map of Central Asia and some of the more important surrounding transboundary nations. Based on these analyses we suggest a future scenario for the water resources development in Central Asia and changes in regional hydropolitics.

2. Water Access in Central Asia

As mentioned above, Central Asia is in general water rich, though, water is unevenly distributed. The major parts of Central Asia are strongly continental semiarid to arid with a general shortage of freshwater. Mean annual country wide precipitation is 273 mm, varying from 161 mm in Turkmenistan to 691 mm in Tajikistan [25]. Kazakhstan, which is by far the largest country, receives an average annual precipitation of about 250 mm [26]. In general, the steppes and deserts receive less than 70 mm per year and the mountainous areas of Tajikistan can receive up to 2400 mm per year [27–29]. Annual potential evaporation varies from above 2250 mm in the arid region to less than 500 mm in the mountainous areas. Totally available and renewable water resources for each of the countries are given in Table 1 based on various sources [25,30–32]. The first source states, e.g., that the total renewable water resources for Kazakhstan are 117 km^3/year with 34 km^3/year coming from sources outside the country. On the other hand, Ryabtsev [33] states these amounts to be 100.5 and 44 km^3/year, respectively. As seen from the table, quite contrasting water resources amounts are stated by different sources. In general, there seems to be a great confusion how to define the renewable water resources for the different countries in Central Asia. Some of this confusion may be related to uncertainties in observations. The mountainous areas in Tajikistan and Kyrgyzstan, e.g., contain large water storages in form of ice, snow, and glaciers. Parts of this water are annually or semi-annually renewable while the glacial deposits generally are not. Due to difficult observational terrain and few observational points, it is difficult to ascertain general volumes and what water volume that is renewable. There are, however, as well great uncertainties and conflicting views regarding transboundary water resources. The more recent reports from the World Bank, e.g., state that Central Asian river flows from other countries are not included in national estimates due to data unreliability. Groundwater resources in Central Asia are generally stated to constitute about 10%–15% of the surface water resources [12]. However, there are great spatial variation throughout Central Asia as well as great needs to better quantify volumes and quality of sub-surface water.

The general conclusion from Table 1 though must be that there is no country-wide general water scarcity in Central Asia. Uzbekistan represents the smallest per capita amount of water with 1870 m^3/capita and year. A per capita water availability of less than 3000 m^3 per year is usually regarded as economic water scarcity [34]. Out of all countries, only Uzbekistan falls below this threshold. Thus, water scarcity is not a relevant term to indicate potential water conflict at the country level. On the other hand, just two major river basins, the Amu Darya and the Syr Darya contain 73% of the total Central Asian population [35]. In this respect, Porkka et al. [36] found that over 80% of the total Central Asian population experience demand-driven water scarcity and 50%

population-driven scarcity. Demand-driven water scarcity can be defined as water stress related to excessive use of otherwise sufficient water resources. Population-driven scarcity is related to water shortage occurring in areas where a large population has to depend on a limited resource. Thus, the main cause is over-exploitation of available water resources. Siebert and Döll [37] indicate that production of cotton, wheat, and rice consumes 86% of the agricultural water demand in Central Asia. Cotton alone represents 62%.

Table 1. Water use and renewable surface and groundwater resources of Central Asia.

Country	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Average precipitation (mm/year) [30]	250	530	690	160	270
Total renewable water resources (km^3/year *) [30]	117 (34)	58 (0)	99 (16)	25 (23)	59 (34)
Total renewable water resources (m^3/capita and year) [30]	6490	8480	13,500	4090	1870
Total renewable water resources (m^3/capita and year) [38]	7368	9293	12,706	12,706	4527
Total renewable water resources (m^3/capita and year) [39,40]	7061	4263	2338	4901	1854
Total renewable water resources including agreements (m^3/capita and year) [25]	6632	4379	3140	4851	1760
Internally renewable water resources (m^3/capita and year) [32]	3886	8873	9096	275	557
Agricultural water use (%) [25]	81	94	92	98	94
Industrial water use (%) [25]	17	3	4	1	2
Domestic water use (%) [25]	2	3	4	1	4

* Within brackets is share of outside sources.

In view of the above, it is clear that the uneven distribution in space and time of potential water resources in combination with disproportionate and unrestrained irrigation withdrawal cause water scarcity where agriculture is intense. To solve these problems, a political will together with a democratic involvement of all stakeholders are necessary. It would also require an environmentally aware community. These characteristics are not yet well developed in Central Asia and combined with an autocratic leadership this may lead to repeating historical mistakes such the case of the Aral Sea [40–42]. The Amu Darya and the Syr Darya represent about 50% of the annually renewable water in Central Asia. Amu Darya represents a mean annual runoff of about 79.4 km^3 while Syr Darya represents about 37.2 km^3 [13,43].

Wasteful irrigation can be tremendous. It has been estimated that on average, the Central Asian states use 1.5 times more water on the fields than recommended [24]. ICG [24] states that 8000–10,000 m^3 of irrigation water (except water for leaching) can be used for one hectare of cotton [44,45]. Thus, there is a huge potential for water saving in Central Asia. In general, more than half of the withdrawn irrigation water is lost through seepage loss and evaporation from irrigation channels. The predominant use of wasteful flooding and furrow irrigation is another area that can be made more efficient by use of modern and water-saving irrigation techniques.

3. Hydropolitical Map

In view of the above, more than 90% of the totally used water in Central Asia are used for irrigation [46,47]. Farming irrigation corresponds to one-third of GDP and more than two-thirds of employment. Uzbekistan and Kazakhstan are the two dominating economic powers of Central Asia. The Uzbekistan population is largest with about 30 million inhabitants and Kazakhstan with about 18 million inhabitants (Table 2; Central Asian total population equals about 68 million). Thus,

the upstream population represents 15 million (Kyrgyzstan and Tajikistan) and the downstream population 53 million (Kazakhstan, Turkmenistan, and Uzbekistan). The total population of Central Asia will increase to about 89 million by 2050.

Kazakhstan has by far the largest economy with a GDP of USD 195 billion (Uzbekistan GDP equals USD 66 billion) [48]. Uzbekistan, however, appears to have the ambition to become the region's hegemon [49]. This is in line with the deployment of 1500 US troops (2002–2005) together with USD 160 million in US aid in 2002 to act against transnational terrorism [50]. Uzbekistan, due to its downstream position and dependence on agricultural economy with mainly cotton production, views irrigation as one of its key security issues [49]. Uzbekistan is a strong military power and together with its natural gas resources, it has reinforced its position as a hegemon in relation to the upstream Kyrgyzstan [4]. For example, it has attempted to convince Pakistan not to import generated electricity from a hydropower project involving both Kyrgyzstan and Tajikistan [4].

Irrigation is also a security issue to Kazakhstan. However, Kazakhstan has a self-sufficient economy with a well-developed agriculture [49]. Kazakhstan is a major energy producer in the Commonwealth of Independent States. It produces oil, gas, and coal, and it is the leading producer and exporter of uranium ore in the world [49].

Turkmenistan is politically stable and stresses its neutral position. The country has the fourth largest natural gas reserve in the world. However, it still depends on agricultural production for its economy (Table 2; 15% of GDP). Being a downstream riparian and aiming at developing food self-sufficiency it considers water availability a national security issue. Cotton production employs 44% of the country's work force [51].

Kyrgyzstan and Tajikistan are the poorest and the two upstream countries in Central Asia (Table 2). Tajikistan suffered from a civil war in 1992–97 that damaged infrastructure and economy [49]. Tajikistan relies heavily on agriculture for its economy (25% value added to GDP; Table 2). The country has the largest water resources in Central Asia due to its upstream location for both Amu Darya and Syr Darya. During recent years, Tajikistan has increased its hydropower capacity in order to become energy independent. Both Russia and Iran have supported hydropower dams along the tributaries of the Amu Darya. The Tajik language is a Persian dialect. In addition, Pashto and Dari, which are the official languages of Afghanistan, belong to the Persian language family. For this reason, Tajikistan is closer to Iran and Afghanistan as compared to other Central Asian states [49]. Kyrgyzstan also relies much on agriculture (16% value added to GDP; Table 2). The Kyrgyzstan population with a native Turkic language is constituted by mainly three ethnic groups: the indigenous Kyrgyz, the Russians, the Uzbek population. These population groups have different cultural and economic characteristics, however, 67% of the total population live in the Ferghana, Talas, and Chu valleys. Episodes of civil unrest have characterized especially the Ferghana Valley [52].

Russia has an important relationship with Central Asia due to its history and it is the region's largest trade partner [53]. On 15 May 1992 an intergovernmental military alliance Collective Security Treaty Organization (CSTO), was signed focusing on economic and military regional coordination. The members include Russia, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan [53–55]. This has been interpreted as a way for Russia to re-establish its hegemony position in the area and counterbalance Chinese and American influence. During recent years, Russia has been reluctant in supporting upstream countries' hydropower ambitions. An interpretation of this is that it is trying to balance its relationship with downstream Uzbekistan and at the same time preserving its hydropower interests in Kyrgyzstan and Tajikistan.

As mentioned in the introduction, China can also be described as part of the new "great game" [56]. As in Africa, China has mainly invested by providing funds for infrastructure such as dams, roads, and power transmission lines. China's strategy appears to be to secure natural resources [57].

As indicated above, besides irrigation, water resources are very important for energy production in the region. Hydropower accounts for 27% of the region's general power generating capacity [50,58]. For Tajikistan and Kyrgyzstan, this percentage exceeds 90% [59]. Thus, their economies are more or

less entirely dependent on available water resources. Changes affecting water resources in Central Asia are therefore directly affecting the economies and their social and socioeconomic development [59].

The Ili River is especially important for the Lake Balkhash in Kazakhstan. The Ili River originates in the Chinese Tien Shan mountains, crosses the border to Kazakhstan, and discharges into the southern part of Lake Balkhash. About 85% of the river basin lie within Kazakh territory and about 15% in China. The river, which is fed mainly by melting snow and ice, contributes about 80% of total inflow to the endorheic lake [60]. The discharge from Ili River entering the lake was 11.9 km^3/year as an average for 1953–1969 [61]. The average flow decreased to 10.4 km^3/year for the period 1970–2009. Causes for gradually decreased flow of the river are development of irrigated agriculture, industrial use, and development of the Kapshagai hydropower station [62]. The Lake Balkhash is one of the largest in Asia with an area of 16,400 km^2 and a volume of 112 km^3. The lake is rather shallow, however, with an average depth of 5.8 m and thus, the lake area is sensitive to changes in inflow.

Another regionally important river is the Irtysh River in Kazakhstan. It originates in the Altai Mountains between Mongolia and China, enters Kazakhstan, and continues to Russia to join the Ob River. When it enters Kazakh territory from China the average flow is about 9 km^3/year. When it leaves Kazakh territory to Russia the average flow is about 27 km^3/year [62]. Both the Ili and Irtysh River water are likely to be used for expansion of Chinese agriculture and industry. Thus, first of all, Lake Balkhash and secondly downstream Irtysh will be affected. Allouche [63] indicates that China expects to use as much as 40% of the Irtysh flow. No agreement has been achieved between Kazakhstan and China on the Ili River flow. However, so far Kazakhstan has been able to mitigate China's aspirations to use the Ili River flow by sending big quantities of free or greatly subsidized foodstuff to China [63].

In view of the above, it is clear that Central Asian hydropolitics are complex and involve major powers such as China and Russia. Thus, several water related agreements, mainly involving the five Central Asian states have been signed (Table 3).

Table 2. Central Asia socioeconomic characteristics.

Country	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Population (million; population 2050) [64]	18 (23)	6 (8)	9 (14)	5 (7)	30 (37)
GDP (billion US$) [64]	184.4	6.6	7.9	35.9	66.7
Population undernourished (%) [65]	<5	6	33	<5	<5
Agriculture, value added (% of GDP) [64]	5	16	25	15	18
Irrigated area (% of agricultural area) [25]	9	75	85	100	89
Principal agricultural products [25]	Wheat, livestock	Livestock	Cotton, wheat	Fruit, vegetables, cotton	Cotton, wheat, fruits
Hydropower production (TWh) [66]	7.9	14.0	17.1	0	6.0
Potential hydropower production (TWh) [66]	27	99	317	2	15
Dependence on transboundary water (%) [67]	42	0	0	94	77

The Almaty Agreement in 1992 (Table 3) was followed by among other things the creation of two important interstate organizations, the Interstate Coordinating Water Commission (ICWC in 1993) and the International Fund for the Aral Sea (IFAS in 1999). This can be seen as an effort to institutionalize the water management in the region [49]. However, due to lack of transparency and weak political commitment, this has not resulted in a decrease in water related tensions [24]. On the other hand, one of the IFAS activities, to save the Aral Sea, is perhaps the most successful so far. Kazakhstan has played a leading role in this endeavor.

Table 3. Select water related agreements within Central Asia (after Volovik [68] and Soliev et al. [69]).

Date	States	Agreement (Agreement Highlights)
18 February 1992 Almaty Kazakhstan	Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	Cooperation in the field of joint water resources management and conservation of interstate sources (not to cause harm; joint decision making; preserving Soviet Union period water allocation).
26 March 1993 Kzyl-Orda Kazakhstan	Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	Joint activities in the Aral Sea (collaboration for joint development and preserving of the Aral Sea).
16 January 1996 Charjev Turkmenistan	Turkmenistan Uzbekistan	Cooperation on water management issues (sharing Amu Darya flow by 50/50 at Kerki).
17 March 1998 Bishek Kyrgyzstan	Kazakhstan Kyrgyzstan Tajikistan Uzbekistan	Use of water and energy resources of the Syr Darya Basin (focus on irrigation and energy use, Tajikistan joined in 1999).
9 April 1999 Ashgabat Turkmenistan	Kazkhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	Ashgabat Declaration (Funding of joint interstate research on environment, rehabilitation, and monitoring for the Aral Sea, involves IFAS, EC EFAS, and the 5 states' centers of hydrology).
17 June 1999 Bishkek Kyrgyzstan	Kazakhstan Kyrgyzstan Tajikistan Uzbekistan	Cooperation in the sphere of hydrometeorology and parallel operation of the energy systems of Central Asia (sharing of data and information and collaboration on energy development).
21 January 2000 Astana Kazakhstan	Kazakhstan Kyrgyzstan	Use of water management facilities of intergovernmental status on the Rivers Chu and Talas (equity financing and use of water facilities of interstate use).
6 October 2002 Dushanbe Tajikistan	Kazakhstan Kyrgyzstan Tajikistan Turkmenistan Uzbekistan	Addressing problems of Aral Sea Basin, monitoring and information sharing (collaboration on the Aral Sea environment).

Kazakhstan was the first country in Central Asia to make efforts towards developing a comprehensive national plan for integrated water resources management (IWRM) [70]. Other Central Asian States have followed by incorporating various elements of IWRM such as, e.g., participatory approach and water user associations in Uzbekistan [71]. Major work in donor-related IWRM have been focused towards the politically complex Ferghana Valley. Compared to East and South East Asia, however, Central Asia as a total is ranked lowest regarding indicators for monitoring, information management, and dissemination, and low stakeholder participation. These are major components in efficient IWRM [70].

Tables 3 and 4 focuses on a select number of water related agreements established after 1991. For a broader list of existing international water law in Central Asia refer to works by, e.g., Soliev et al. [69], Pak and Wegerich [72], Pak et al. [20], and Holmatov et al. [73]. Other general international agreements involving Central Asian States are described in detail by Ziganshina [74].

Table 4. Select water related agreements involving Central Asian states and other countries (after Volovik [68], Ziganshina [74], and Berdiev [75]).

Date	States	Agreement (Agreement Highlights)
27 August 1992 Orenburg Russia	Kazakhstan Russia	Shared use and protection of transboundary water bodies (working groups were established for Ishim, Irtysh, Tobol, Ural, and Uzeni River Basins).
Mar 2000	Kazakhstan	Complying to 1992 UNECE agreement (UN Economic Commission for Europe, Guidance on water and adaptation to climate change to convention on the protection and use of transboundary watercourses and international lakes).
20 October 1999 Ashgabat Turkmenistan	Iran Turkmenistan	Cooperation in building and use of the "Druzhba" (Friendship) dam on the Tejan River (construction and operation of Druzhba dam and reservoir).
12 September 2001 Astana Kazakhstan	Kazakhstan China	Cooperation in the use and protection of transboundary rivers (implementing cooperation in the use and protection of the water resources of the transboundary rivers).
4 November 2003 Teheran Iran	Azerbaijan Iran Kazakhstan Russia Turkmenistan	Framework for protection of marine environment of the Caspian Sea (exchange of information and cooperation on environment).
4 July 2005	Kazakhstan China	Early warning on natural disasters on transboundary rivers (including flooding and icing, and the modalities of monitoring of such natural disasters).
16 August 2007 Ashgabat Turkmenistan	Turkmenistan Iran	Joint exploitation of Dostluk Water Reservoir (joint construction and management of Dostluk water reservoir and dam).
2007	Uzbekistan	Complying to 1992 UNECE agreement (UN Economic Commission for Europe, Guidance on water and adaptation to climate change to convention on the protection and use of transboundary watercourses and international lakes).

A country that is not included in Table 4 is Afghanistan. A substantial amount (22 km^3/year or about 27.5%) of the Amu Darya annual flow is generated in Northern Afghanistan that belongs to the Amu Darya Basin [76]. About 5 km^3/year of this flow are used for irrigation in Afghanistan. However, due to the turmoil in Afghanistan and little attention from the international community, Afghanistan has to a great extent been left out from international discussions and agreements. Tajikistan, however, has been instrumental in involving Afghanistan in international water collaboration. Two protocols (2007 and 2010) and a Memorandum of Understanding (2007) involving collaboration on water use and capacity building were signed by Tajikistan and Afghanistan [76]. However, still no formal regional agreement on collaboration between the five Amu Darya riparian countries has been reached. Afghanistan can potentially develop both hydropower and irrigation in upstream Amu Darya and this is likely to affect downstream riparians. Consequently, formal agreements on the water sharing between all riparians are in great need.

The Almaty Agreement in 1992 (Table 3) was the first major joint water management agreement between the Central Asian states after the downfall of the Soviet Union. The agreement meant in practice that the old Soviet Union water-sharing regime safeguarding the downstream cotton growing systems was agreed upon [77]. The agreement was passed despite protests from Kyrgyzstan.

At the time, Tajikistan was on the verge of a civil war. Thus, it appears that the three major economic powers of Central Asia (Kazakhstan, Uzbekistan, and Turkmenistan) acted as hydro-hegemons and pushed through the agreement that would guarantee the downstream irrigation industry. The old management system involved dams and reservoirs in upstream Kyrgyzstan and Tajikistan for use as either hydropower generation and/or downstream irrigation, mainly in Uzbekistan, Kazakhstan, and Turkmenistan. The main aim was to maximize economic output [13]. In most cases, this meant irrigated agriculture, especially cotton. After independence, Kyrgyzstan and Tajikistan have seen opportunities to develop their economies by expanding hydropower production. The hydropower needs are greatest during the winter period. However, this would mean less water for irrigation during summer and hence a conflict situation with downstream countries [13]. The conflicts have repeatedly involved the Toktogul reservoir in Kyrgyzstan along the Syr Darya and irrigation in mainly Uzbekistan and Kazakhstan and the Nurek and possible Rogun reservoirs along the Amu Darya in Tajikistan for hydropower and irrigation in downstream Turkmenistan and Uzbekistan.

Details on the history, management, and related conflicts of these reservoirs are well described in a series of papers by Wegerich [3], Wegerich et al. [78,79] Dinar [4,5], Bichsel [12], and Menga and Mirumachi [80] and will thus not be repeated herein. A common misconception in the scientific and national discourse, however, appears to be that hydropower and irrigation demand is conflicting and incompatible [80,81]. Many examples prove the opposite. By applying upstream hydropower efficiency, expansion of downstream reservoir capacity, and downstream irrigation efficiency, often a win-win situation can be achieved [79,82,83]. In any case, we recognize that much or most of the international tension regarding water sharing in Central Asia concerns the irrigation-hydropower nexus. For this reason, we come back to this problem in the below chapter on the future of water management in Central Asia.

4. Climate Change

It is generally recognized that observed temperature has risen twice as fast in Central Asia as compared to global levels since the 1970s [84]. IPCC projections show a clear increase in future temperature by 2–4 °C for 2050 and 3–5 °C for 2080 for most of the region [85–87]. Precipitation projections are less certain and as well as less clear but indicate a small increase until 2050 and then a small decrease until 2085. In general, a small increase in observed annual precipitation has been noted for Central Asia even if spatial and temporal variations are large [59]. This is in line with the IPCC projections. Overall, small changes in future precipitation are probably to be expected.

Melt from glaciers in Tajikistan plays an important role in the Amu Darya and Syr Darya discharge. This contributes between 10%–20% of the total discharge of the two rivers. However, for dry years this contribution can increase up to 70% [59,88,89]. Due to increasing temperature, ice melt from the glaciers in this region, the Tien Shan, has tripled from 1950 levels. The total glacier mass from 1961 to 2012 has decreased by about 27% [90]. This corresponds to about four times the global average. Following this pattern, 50% of the total glacier volume in the Tien Shan of today, would be lost by 2050 [90,91]. The consequences for the Amu Darya and the Syr Darya would be a decrease in flow by 10%–15% and 6%–10%, respectively [59]. In addition, the Ili River and other rivers feeding the Lake Balkash would also be severely affected by the disappearing glaciers in the basin [59].

The typical pattern for the runoff that is fed by melting glaciers is that runoff could increase for a period up to 2020–2050 during intense melting. After this, a decrease would set in due to disappearing glacial volume. An example of this is Kyrgyzstan. For this country, surface runoff would increase until 2020–2025 because of glacial melt. After this period, runoff could decrease [59]. Similarly, for the most advantageous climate scenario, the overall hydropower potential of the rivers discharging into the Lake Issyk Kul may drop by 50% up to 2100 [59].

5. Future of Water Management in Central Asia

As seen from the above, the present total population of about 68 million in Central Asia will have grown to about 89 million inhabitants by 2050. The per capita water volume per year will not decrease as dramatically by 2050 as for, e.g., some Middle Eastern water scarce countries. However, since irrigated agriculture and food security is of main concern to in principle all Central Asian states, it is reasonable to expect a much higher irrigation demand by 2050. The present irrigation systems are highly inefficient and wasteful [92]. However, changing irrigation management and increasing overall irrigation efficiency are complex socioeconomic processes that are expensive and will take long time to modify. Even though irrigated agriculture must increase the production of food to an increasing population, the production of irrigated lands and available water are decreasing. At the same time, increasing the water use efficiency in general results in reduced harvests [93]. Thus, it is difficult to foresee any major changes in the increasing irrigation needs for the coming decades. Climate change is likely to further increase the irrigation needs by increasing evaporative losses. However, due to melting glaciers, river discharge is likely to increase up to 2020–25 for Kyrgyzstan but leading to an irrevocable and substantial decrease beyond this point as mentioned above.

Developing IWRM has seen some success at the small scale, e.g., in the politically tense Ferghana Valley [94] and through EU donor-related projects in Kazakhstan [95]. However, on a whole for the region, the IWRM concept has not had much of a success regarding better water sharing. The reason for this appears to be that the three downstream countries have not seen any real motivation to change the original Soviet Union arrangement that was re-iterated in the Almaty agreement 1992. Several authors have noted that the collaboration between the future independent states in many instances was quite elaborate under the Moscow hegemon [20,78]. However, after independence, the tendency has rather been towards trying to become more independent in relation to other riparians particularly within the Syr Darya Basin. In any case, the two politically weaker upstream countries have experienced that the old arrangement with energy for water has not been working in the new market economy. Thus, they are desperately trying to develop their own advantageous upstream location for energy production. In this sense, the largest reservoirs that store water for downstream irrigation are represented by Toktogul in Kyrgyzstan and Kayrakum in Tajikistan on the Syr Darya with 19.5 and 4.2 km^3 in storage capacity, respectively. The Nurek in Tajikistan on the Amu Darya similarly has a storage volume of 10.5 km^3 [96]. These reservoirs were designed during the Soviet Union period to provide water during the irrigation season for downstream areas (mainly Uzbekistan, Turkmenistan, and Kazakhstan). However, they were also intended for hydropower production. Thus, Toktogul produces 93% of the electricity used in Kyrgyzstan and Nurek 70% of the electricity used in Tajikistan [97–99].

The above, much follows the analogue of the Nile Basin, with downstream countries (Egypt and Sudan) that for historical reasons use the major part of the Nile water in well-developed irrigation agriculture [100]. The hegemon Egypt has felt very little motivation to change its negative stance regarding the building of the Grand Ethiopian Renaissance Dam in the politically and economically weaker Ethiopia. Ethiopia, however, has managed to raise funds outside of the well-established international funding agencies and has very much presented the project as fait accompli.

The Rogun Dam project in Tajikistan displays some similarity with the Grand Ethiopian Renaissance Dam. Both are large hydropower projects in economically and politically weaker upstream countries. The Rogun Dam reservoir in the Amu Darya Basin holds a water volume of 13.3 km^3 and a planned hydropower production of 13.1 TWh. The construction started already in the middle of the 70ies but halted after the Soviet Union collapse. In 1993, a flood wave destroyed much of the construction [63]. The construction started again in 2008 using Tajikistani funding. In 2012, the project halted due to a World Bank assessment [101]. On 1 July 2016 the Tajikistani commission in charge of the project selected the Italian company Salini Impregilo to proceed with the construction estimated at $3.9 billion [102]. Interestingly, the same company is in charge of building the Grand Ethiopian Renaissance Dam [103]. The Rogun project has continuously been condemned by mainly the Uzbek authorities for constituting a strong threat to downstream irrigation projects [104]. Studies indicate, however, that hydropower could be produced in the Rogun Dam with only minor effects for downstream users [82]. This, however, would require a close cooperation between upstream hydropower and downstream irrigation water users. In a similar way as for the Grand Ethiopian Renaissance Dam the entire population of Tajikistan has mobilized to build the Rogun hydropower plant by sale of plant shares [74,103]. Consequently, the resemblance of large-scale hydropower development in poor upstream countries with downstream hegemons is striking when comparing the Nile and the Amu Darya where both the Great Renaissance Dam and the Rogun Dam are portrayed as national symbols and parts of regional projects [80,104].

Similar, though smaller-scale development, is recently taking place in Kyrgyzstan. In 2013, Kyrgyz authorities accepted bidding to rehabilitate the 1200-MW Toktogul hydroelectric project, the largest hydropower project in Kyrgyzstan [105]. The same year and supported by the Russian state-owned RusHydro, Kyrgyzstan commenced projecting the $727 million Upper Naryn series of dams including four hydropower stations with a total capacity of 240 MW. Another venture is the proposed 1900 MW Kambar-Ata project. This is a planned project on the Naryn River including one of six planned dams to be built on the river. Together, they would equal 2140 MW to Kyrgyzstan's hydropower output [106].

As in the case of the Nile Basin, the possibilities for water sharing between the Central Asian states are largely locked in a stalemate between historical heirloom and development needs. The more advantaged downstream countries are not likely to yield in this respect. This might be a reason why IWRM neither has been successful in the case of the Nile Basin nor in the major basins of the Central Asia [107–109]. Bichsel [12] notes that it may be questionable if the IWRM goals of economic decentralization, self-government, and empowerment can be achieved within strongly centralized and autocratic governance systems. She also notes that alternative approaches to IWRM may be necessary.

The inability of downstream basin hegemons to participate in a more fair basin-wide water resources development might trigger a unilateral hydropower development as seen in both the Nile and the Amu Darya Basins. This may not be a negative tendency. As a more even power distribution develops among the riparians this may lead forward to a better collaboration in the basin. This means that the upstream countries will develop the much needed hydropower resources without the consent of the downstream countries. However, in view of the risk to lose water the former hegemons would be more willing to act as collaboration partners, e.g., in IWRM.

In addition, more powerful neighbors such as China will likely withdraw increasing amounts of water that will affect mainly Kazakhstan [62,63]. Along with climate change and population increase, available water resources are bound to decrease in a steady manner. This does not necessarily mean increasing risk for regional conflict. The chances for conflict are probably larger in local communities with ethnical tension.

As mentioned in the beginning of this paper, the passing of the Uzbek president Karimov on 2 September 2016 raised important questions for the future of the region with the intertwined water issue. It appears, however, that signs a few years before the Uzbek president's death, indicated gradually improved relations between Uzbekistan and Tajikistan [110]. President Karimov visited Dushanbe in September 2014 and his Minister of Internal Affairs (Adkham Akhmedbayev) visited Tajikistan in June 2015. The Uzbek Foreign Minister (Abdulaziz Kamilov) visited Dushanbe on 29 September 2016 and expressed views to reset relations with Tajikistan. Similarly, the new Acting President Shavkat Mirziyoyev has offered to improve relations [110]. Even if it is too early to draw any concrete conclusions, this may be the start of better collaboration between the two countries. In a parallel manner in the Nile Basin, the Tripartite National Committee (Ethiopia, Sudan, and Egypt) appears to frame a starting collaboration by technical development [100,111], where the underlying functionalism through technical collaboration can generate positive effects in a broader political sense.

6. Concluding Remarks

Central Asia has a population of 22 million that directly or indirectly depend on irrigated farming [31]. The irrigation consumes 90% of the sustainably available water resources. Thus, it can be summarized that the present water disputes are results of allocation policy rather than scarcity of water in the region [112].

Deviating national priorities have not favored regional cooperation and hence there is no shared vision how to collaborate on water. In this sense, the main cause of instability in Central Asia is poor governance and divisive self-sufficiency politics. The autocratic regimes of Central Asia seem in general to be more interested in holding on to power than the well-being of their populace. Regional leadership is needed, while bottom-up processes and eventually democratization are necessary steps to build a stable equitable water resources plan for the region.

IWRM has seen some success at the local level. However, at regional level, results are scarce and with the present hydropolitical map with downstream hegemons are not likely to change the situation. However, the gradual build-up of hydropower capacity in Kyrgyzstan and Tajikistan may eventually alter that map. Economic development of these two countries through gradual hydropower buildup will change the power balance in Central Asia and thus induce possibilities for a more equitable sharing of water resources.

Consequently, the answer to the question in the title to this paper is "Yes, however ... ". The process is likely to take time and require unilateral development of hydropower as a first step. Changing hydropolitics in the Nile Basin appears to indicate a similar development in Central Asia.

Acknowledgments: Aibek Zhupankhan acknowledges support from the EU Erasmus+ program for research at Lund University. The Bolashak International Scholarship Program of Kazakhstan supported the second author.

Author Contributions: Aibek Zhupankhan planned the study, analyzed the initial results, and wrote the first version of the paper; Kamshat Tussupova and Ronny Berndtsson contributed in an equal manner to the paper by adding comments and writing parts of the final paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Shams-Ud-Din, M. The new great game in Central Asia. *Int. Stud.* **1997**, *34*, 329–341. [CrossRef]
2. Yildiz, D.; Çakmak, C.; Yildirim, N.; Ekinci, E. *Water, A time bomb in Central Asia*; Regional Report No. 6; Hydropolitics Academy: Ankara, Turkey, 2014.
3. Wegerich, K. Hydro-hegemony in the Amu Darya Basin. *Water Policy* **2008**, *10* (Suppl. S2), 71–88. [CrossRef]
4. Dinar, S. The geographical dimensions of hydro-politics: International freshwater in the Middle East, North Africa, and Central Asia. *Eurasian Geogr. Econ.* **2012**, *53*, 115–142. [CrossRef]
5. Dinar, S. Power asymmetry and negotiations in international river basins. *Int. Negot.* **2009**, *14*, 329–360. [CrossRef]
6. Seksembayeva, S. BNews Kazakhstan Water Problems Can Cause Wars. 2012. Available online: http://bnews.kz/en/news/politika/vnutrennyaya_i_vneshnyaya_politika/karimov_water_resources_problems_can_cause_wars-2012_09_07-749007 (accessed on 29 September 2016).
7. Al Jazeera Are 'Water Wars' Imminent in Central Asia? 2016. Available online: http://www.aljazeera.com/indepth/features/2016/03/water-wars-imminent-central-asia-160321064118684.html (accessed on 20 October 2016).
8. Freeworldmaps.net. Available online: www.freeworldmaps.net (accessed on 23 January 2017).
9. Smith, D.R. Environmental security and shared water resources in post-Soviet Central Asia. *Post-Sov. Geogr.* **1995**, *36*, 351–370.
10. Buck, S.J.; Gleason, G.W.; Jofuku, M.S. "The institutional imperative": Resolving transboundary water conflict in arid agricultural regions of the United States and the Commonwealth of Independent States. *Nat. Resour. J.* **1993**, *33*, 595–628.
11. The European Times. Water-Energy Problems in Central Asia and the Role of Tajikistan in Its Solution. Available online: http://www.european-times.com/countries/tajikistan/water-energy-problems-in-central-asia-and-the-role-of-tajikistan-in-its-solution/ (accessed on 23 January 2017).
12. Bichsel, C. Liquid challenges—Contested water in Central Asia. *Sustain. Dev. Law Policy* **2011**, *12*, 24–30, 58–60.
13. O'Hara, S.L. Central Asia's water resources: Contemporary and future management issues. *Int. J. Water Resour. Dev.* **2000**, *16*, 423–441. [CrossRef]
14. Stucki, V.; Wegerich, K.; Rahaman, M.M.; Varis, O. Introduction: Water and security in Central Asia—Solving a Rubik's Cube. *Int. J. Water Resour. Dev.* **2012**, *28*, 395–397. [CrossRef]
15. Micklin, P.P. The Aral Sea disaster. *Annu. Rev. Earth Planet. Sci.* **2007**, *35*, 47–72. [CrossRef]
16. Khvorog, G.V. Ecological Map of the Near Aral Region. Alma-Ata, Kazakhstan, 1992. Available online: http://bulletin-geography.kaznu.kz/index.php/1-geo/article/view/253. (In Russian)
17. Small, I.; Bunce, N. The Aral Sea disaster and the disaster of international assistance. *J. Int. Aff.* **2003**, *56*, 11–13.
18. Gleick, P. *The World's Water: 1998–1999*; Island Press: Washington, DC, USA, 1998.
19. International Crisis Group. *Kyrgyzstan: Widening Ethnic Divisions in the South*; Report 222/Europe & Central Asia; International Crisis Group: Brussels, Belgium, 29 March 2012. Available online: https://www.crisisgroup.org/europe-central-asia/central-asia/kyrgyzstan/kyrgyzstan-widening-ethnic-divisions-south (accessed on 23 January 2017).
20. Pak, M.; Wegerich, K.; Kazbekov, J. Re-examining conflict and cooperation in Central Asia: A case study from the Isfara River, Ferghana Valley. *Int. J. Water Resour. Dev.* **2014**, *30*, 230–245. [CrossRef]
21. International Crisis Group. *Central Asia: Border Disputes and Conflict Potential*; ICG Asia Report N° 33; International Crisis Group: Brussels, Belgium, 2002.
22. Interstate Commission for Water Coordination of Central Asia (ICWC). Available online: http://www.icwc-aral.uz/ (accessed on 23 January 2017).
23. Zeitoun, M.; Warner, J. Hydro-hegemony—A framework for analysis of transboundary water conflicts. *Water Policy* **2006**, *8*, 435–460. [CrossRef]

24. International Crisis Group Central Asia: Water and Conflict. ICG Asia Report No. 34. Available online: https://www.files.ethz.ch/isn/28347/034_central_asia_water_conflict.pdf (accessed on 23 January 2017).
25. FAO Land and Water Division, Food and Agriculture Organization of the United Nations. *Irrigation in Central Asia in Figures*; AQUASTAT Survey—2012; FAO Water Reports 39; Frenken, K., Ed.; FAO: Rome, Italy, 2013.
26. United Nations Development Programme. *Water Resources of Kazakhstan in New Millennium*; Review of the UNDP; UNDP: Almaty, Kazakhstan, 2004; p. 114.
27. CAWaterInfo. The Aral Sea Basin. 2011. Available online: http://www.cawater-info.net/aral/index_e.htm (accessed on 6 April 2016).
28. Xu, L.; Zhou, H.; Du, L.; Yao, H.; Wang, H. Precipitation trends and variability from 1950 to 2000 in arid lands of Central Asia. *J. Arid Land* **2015**, *7*, 514–526. [CrossRef]
29. Yin, Z.Y.; Wang, H.; Liu, X. A comparative study on precipitation climatology and interannual variability in the lower midlatitude East Asia and Central Asia. *J. Clim.* **2014**, *27*, 7830–7848. [CrossRef]
30. Food and Agriculture Organization of the United Nations. *Review of World Water Resources by Country*; Water Report 23; FAO Land and Water Division, Food and Agriculture Organization of the United Nations: Rome, Italy, 2003; p. 111.
31. World Bank. *Water and Energy Nexus in Central Asia: Improving Regional Cooperation in the Syr Darya Basin*; World Bank: Washington, DC, USA, 2004.
32. World Bank. *World Development Indicators 2013*; World Bank: Washington, DC, USA, 2013.
33. Ryabtsev, A. Chairman, Committee for Water Resources. Ministry of Agriculture, Republic of Kazakhstan, 2016. Available online: http://www.cawater-info.net/5wwf/national_report_kazakhstan_e.htm (accessed on 24 March 2016).
34. Brown, A.; Matlock, M.D. *A Review of Water Scarcity Indices and Methodologies; Food, Beverage & Agriculture*; White Paper 106; The Sustainability Consortium; University of Arkansas: Fayetteville, AR, USA, 2011; p. 19.
35. Klein Goldewijk, K.; Beusen, A.; Janssen, P. Long-term dynamic modeling of global population and built-up area in a spatially explicit way: HYDE 3.1. *Holocene* **2010**, *20*, 565–573. [CrossRef]
36. Porkka, M.; Kummu, M.; Siebert, S.; Flörke, M. The role of virtual water flows in physical water scarcity: The case of Central Asia. *Int. J. Water Resour. Dev.* **2012**, *28*, 453–474. [CrossRef]
37. Siebert, S.; Döll, P. Quantifying blue and green virtual water contents in global crop production as well as potential production losses without irrigation. *J. Hydrol.* **2010**, *384*, 198–217. [CrossRef]
38. World Bank. *World Development Indicators 2004*; World Bank: Washington, DC, USA, 2004.
39. FAO AQUASTAT. 2011. Available online: http://www.fao.org/nr/water/aquastat/main/index.stm (accessed on 21 October 2016).
40. Stucki, V.; Sojama, S. Nouns and numbers of the water-energy-security nexus in Central Asia. *Int. J. Water Resour. Dev.* **2012**, *28*, 399–418. [CrossRef]
41. Gleason, G. *The Struggle for Control over Water in Central Asia: Republican Sovereignty and Collective Action*; RFE/RL Report on the USSR; Radio Free Europe/Radio Liberty (RFE/RL): Prague, Czech Republic, 1991.
42. Black, C.; Dupree, L.; Endicott-West, E.; Naby, E.; Matuszewski, D.C.; Waldron, A.N. *The Modernization of Inner Asia*; M.E. Sharpe: Armonk, NY, USA, 1991.
43. Severskiy, I.V. Water-related problems of Central Asia: Some results of the (GIWA) international water assessment program. *Ambio* **2004**, *33*, 52–62. [CrossRef] [PubMed]
44. Mason, S.A.; Bichsel, C.; Hagmann, T. Trickling down or spilling over? Exploring links between international and sub-national water conflicts in the Eastern Nile and Syr Daria Basin. In Proceedings of the ECPR Joint Sessions of Workshops, Workshop Geography, Conflict and Cooperation, Edinburgh, UK, 28 March–2 April 2003; Available online: http://www.nccr-north-south.unibe.ch/document/document.asp?ID=1141&refTitle=the%20NCCR%20North-South&Context= (accessed on 21 October 2016).
45. De Martino, L.; Carlsson, A.; Rampolla, G.; Kadyrzhanova, I.; Svedberg, P.; Denisov, N.; Novikov, V.; Rekacewicz, P.; Simonett, O.; Skaalvik, J.F.; et al. *Environment and Security—Transforming Risks into Cooperation—Central Asia, Ferghana/Osh/Khujand Area*; Organization for Security and Co-operation in Europe (OSCE): Vienna, Austria; United Nations Environment Programme (UNEP): Geneva, Switzerland; United Nations Development Programme (UNDP): Bratislava, Slovakia; North Atlantic Treaty Organization (NATO): Brussels, Belgium, 2005.

46. Abdullaev, I.; Manthrithilake, H.; Kazbekov, J. Water security in Central Asia: Troubled future or pragmatic partnership? In Proceedings of the International Conference on "The Last Drop?" Water, Security and Sustainable Development in Central Eurasia, The Hague, The Netherlands, 1–2 December 2006; Institute of Social Studies (ISS): The Hague, The Netherlands, 2006; p. 11.
47. Myagkov, S. Climate change impact on the river runoff in Central Asia: Risks of water management. In Proceedings of the Asia Capacity Building Workshop "Earth Observation in the Service of Water Management", Bangkok, Thailand, 26–28 September 2006.
48. International Monetary Fund. GDP Report for Selected Countries and Subjects. Available online: www.imf.org (accessed on 29 September 2016).
49. Coskun, B.B. Hydropolitics in Central Asia: Towards a regional water regime? *Interdiscip. J. Int. Stud.* **2004**, *2*, 79–101.
50. Razizade, A. Washington and the Great Game in Central Asia. *Contempt Rev.* **2002**, *280*, 257–270.
51. Horsman, S. Water in Central Asia: Regional cooperation and conflict. In *Central Asian Security*; Allison, R., Jonson, L., Eds.; Brookings Institution Press: Washington, DC, USA, 2001; pp. 69–94.
52. GlobalSecurity Kyrgyzstan Civil Unrest. Available online: http://www.globalsecurity.org/military/world/war/kyrgyzstan.htm (accessed on 8 October 2016).
53. Cooley, A. Behind the Central Asian curtain: the limits of Russia's resurgence. *Curr. Hist.* **2009**, *108*, 325–332.
54. Shahram, A. Keeping Central Asia stable. *Third World Q.* **2004**, *25*, 689–705.
55. Miller, L.R. Fear and Loathing in Central Asia. Foreign Policy Magazine. Available online: http://foreignpolicy.com/2010/08/05/fear-and-loathing-in-central-asia/ (accessed on 23 January 2017).
56. Brill Olcott, M. The great powers in Central Asia. *Curr. Hist.* **2005**, *104*, 331–335.
57. Kaplan, R.D. The geography of Chinese power. *Foreign Aff. Mag.* **2010**, *89*, 22–41.
58. Alaolmolki, N. *Life after the Soviet Union*; State University of New York Press: New York, NY, USA, 2001.
59. Ibatullin, S.; Yasinsky, V.; Mironenkov, A. *Impacts of Climate Change on Water Resources in Central Asia*; Sector Report of the Eurasian Development Bank; Eurasian Development Bank: Almaty, Kazakhstan, 2009; p. 43.
60. Xu, J.; Liu, S.; Guo, W.; Zhang, Z.; Wei, J.; Feng, T. Glacial area changes in the Ili River Catchment (Northeastern Tian Shan) in Xinjiang, China, from the 1960s to 2009. *Adv. Meteor.* **2015**, *2015*, 847257. [CrossRef]
61. Dostay, Z.; Alimkulov, S.; Tursunova, A.; Myrzakhmetov, A. Modern hydrological status of the estuary of Ili River. *Appl. Water Sci.* **2012**, *2*, 227–233. [CrossRef]
62. Stewart raf, D.I. Water conflict in Central Asia—Is there potential for the desiccation of the Aral Sea or competition for the waters of Kazakhstan's cross-border Ili and Irtysh Rivers to bring about conflict; and should the UK be concerned? *Def. Stud.* **2014**, *14*, 76–109. [CrossRef]
63. Allouche, J. The governance of Central Asian waters: National interests versus regional cooperation. *Disarmament Forum* **2007**, *4*, 45–56.
64. World Bank. *World Development Indicators 2016, Featuring the Sustainable Development Goals*; World Bank Group: Washington, DC, USA, 2016.
65. Food and Agriculture Organization of the United Nations. The State of Food Insecurity in the World 2015. Available online: http://www.fao.org/hunger/en/ (accessed on 8 October 2016).
66. Tegini, A.Z. Russian Hydro Policy in Central Asia. Academic Perspective. 2014. Available online: http://en.akademikperspektif.com/2014/03/15/russian-hydro-policy-central-asia/ (accessed on 8 October 2016).
67. Mukhammadiev, B. *Hydropower Flashpoints and Water Security Challenges in Central Asia*; Lecture Notes; US Embassy: Tashkent, Uzbekistan, 2014.
68. Volovik, Y. Overview of Regional Transboundary Water Agreements, Institutions and Relevant Legal/Policy Activities in Central Asia. Promoting Integrated Water Resources Management and Fostering Transboundary Dialogue in Central Asia, EU-UNDP Project (2008–2012). 2011. Available online: http://www.cawater-info.net/bk/water_law/pdf/water-agreements-in-central-asia-2011.pdf (accessed on 10 October 2016).
69. Soliev, I.; Wegerich, K.; Kazbekov, J. The cost of benefit sharing: Historical and institutional analysis of shared water development in the Ferghana Valley, the Syr Darya Basin. *Water* **2015**, *7*, 2728–2752. [CrossRef]
70. UN Water Status Report on Integrated Water Resources Management and Water Efficiency Plans. Prepared for the 16th session of the Commission on Sustainable Development—May 2008. UN-Water. Available online: http://www.unwater.org/downloads/UNW_Status_Report_IWRM.pdf (accessed on 18 October 2016).

71. Food and Agriculture Organization of the United Nations. Uzbekistan, Law No. ZRU-240 Amending Some Laws. FAOLEX Database, Food and Agriculture Organization of the United Nations. Available online: http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC102703 (accessed on 22 January 2017).
72. Pak, M.; Wegerich, K. Competition and benefit sharing in the Ferghana Valley—Soviet negotiations on transboundary small reservoir construction. *Cent. Asian Aff.* **2014**, *1*, 225–246. [CrossRef]
73. Holmatov, B.; Lautze, J.; Kazbekov, J. Tributary-level transboundary water law in the Syr Darya: Overlooked stories of practical water cooperation. *Int. Environ. Agreem.* **2016**, *16*, 873–907. [CrossRef]
74. Ziganshina, D. International water law in Central Asia: Commitments, compliance and beyond. *J. Water Law* **2009**, *20*, 96–107.
75. Berdiev, A. National Report of Turkmenistan on Regional Water Partnership. Republic of Turkmenistan—Country Report. Available online: http://www.gwp.org/Global/GWP-CACENA_Files/en/pdf/turkmenistan.pdf (accessed on 19 January 2017).
76. Klemm, W.; Shobair, S.S. *The Afghan Part of Amu Darya Basin: Impact of Irrigation in Northern Afghanistan on Water Use in the Amu Darya Basin*; Investment Centre Division, FAO: Rome, Italy, 2010; Available online: http://www.unece.org/speca/documents/ecf/2010/FAO_report_e.pdf (accessed on 22 January 2017).
77. Weinthal, E. *State Making and Environmental Cooperation: Linking Domestic and International Cooperation in Central Asia*; MIT Press: Cambridge, MA, USA; London, UK, 2002.
78. Wegerich, K.; Van Roijen, D.; Soliev, I.; Mukhamedova, N. Water security in the Syr Darya Basin. *Water* **2015**, *7*, 4657–4684. [CrossRef]
79. Wegerich, K.; Olsson, O.; Froebrich, J. Reliving the past in a changed environment: Hydropower ambitions, opportunities and constraints in Tajikistan. *Energy Policy* **2007**, *35*, 3815–3825. [CrossRef]
80. Menga, F.; Mirumachi, N. Fostering Tajik hydraulic development: Examining the role of soft power in the case of the Rogun dam. *Water Altern.* **2016**, *9*, 373–388.
81. Bohr, A. Regionalism in Central Asia: New geopolitics, old regional orders. *Int. Aff.* **2004**, *80*, 485–502. [CrossRef]
82. Bekchanov, M.; Ringler, C.; Bhaduri, A.; Jeuland, M. How would the Rogun Dam affect water and energy scarcity in Central Asia? *Water Int.* **2015**, *40*, 856–876. [CrossRef]
83. Moller, L.C. *Transboundary River Conflicts over Hydropower and Irrigation: Can Multilateral Development Banks Help?* CREDIT Research Paper No. 05; University of Nottingham: Nottingham, UK, 2009.
84. German Advisory Council on Global Change (WBGU). *Climate Change as a Security Risk. German Advisory Council on Global Change*; Earthscan: London, UK, 2007; p. 271.
85. Lioubimtseva, E.; Henebry, G.M. Climate and environmental change in arid Central Asia: Impacts, vulnerability, and adaptations. *J. Arid Environ.* **2009**, *73*, 963–977. [CrossRef]
86. Institute for Global Environmental Strategies; Regional Environmental Center for Central Asia. *Technology Needs Assessment for Adaptation in the Water and Agricultural Sector in Central Asia*; Institute for Global Environmental Strategies: Hayama, Japan, 2012.
87. Lutz, A.; Immerzeel, W.; Gobiet, A.; Pellicciotti, F.; Bierkens, M. Comparison of climate change signals in CMIP3 and CMIP5 multi-model ensembles and implications for Central Asian glaciers. *Hydrol. Earth Syst. Sci.* **2013**, *17*, 3661–3677. [CrossRef]
88. Dikikh, A.N.; Sokalskaya, A.M.; Dyurgerov, M.B.; Razek, I.V.; Sinoan, Y. Glacial Water Resources in the Issyk-Kul Region (Kyrgyzstan). In *Glaciers of Tien Shan*; Dyurgerov, M.B., Chaohai, L., Zichu, C., Eds.; VINITI: Moscow, Russia, 1995; pp. 131–167.
89. Sorg, A.; Bolch, T.; Stoffel, M.; Solomina, O.; Beniston, M. Climate change impacts on glaciers and runoff in Tien Shan (Central Asia). *Nat. Clim. Chang.* **2012**, *29*. [CrossRef]
90. Farinotti, D.; Longuevergne, L.; Moholdt, G.; Duethmann, D.; Mölg, T.; Bolch, T.; Vorogushyn, S.; Güntner, A. Substantial glacier mass loss in the Tien Shan over the past 50 years. *Nat. Geosci.* **2015**, *8*, 716–722. [CrossRef]
91. Huss, M.; Farinotti, D. Distributed ice thickness and volume of all glaciers around the globe. *J. Geophys. Res.* **2012**, *117*, F04010. [CrossRef]
92. Bekchanov, M.; Ringler, C.; Bhaduri, A.; Jeuland, M. Optimizing irrigation efficiency improvements in the Aral Sea Basin. *Water Resour. Econ.* **2016**, *13*, 30–45. [CrossRef]
93. Evans, R.G.; Sadler, E. Methods and technologies to improve efficiency of water use. *Water Resour. Res.* **2008**, *44*, W00E04. [CrossRef]
94. Global Water Partnership. *Integrated Water Resources Management in Central Asia: The Challenges of Managing Large Transboundary Rivers*; Technical Focus Paper; Global Water Partnership: Stockholm, Sweden, 2014.

95. United Nations Economic Commission for Europe. *Integrated Water Resources Management in Eastern Europe, the Caucasus and Central Asia*; United Nations Economic Commission for Europe Organisation for Economic Co-operation and Development, European Union Water Initiative National Policy Dialogues Progress Report; UNECE: Geneva, Switzerland, 2013.
96. Severskiy, I.V.; Chervanyov, I.; Ponomarenko, Y.; Novikova, N.M.; Miagkov, S.V.; Rautalahti, E.; Daler, D. *Aral Sea—GIWA Regional Assessment 24*; University of Kalmar: Kalmar, Sweden; UNEP: Nairobi, Kenya, 2005.
97. Laldjebaev, M. The water-energy puzzle in Central Asia: The Tajikistan perspective. *Int. J. Water Resour. Dev.* **2010**, *26*, 23–36. [CrossRef]
98. United Nations Development Programme. *Central Asia Regional Risk Assessment: Responding to Water, Energy, and Food Insecurity*; UNDP Tajikistan: Dushanbe, Tajikistan, 2009.
99. Asian Development Bank. *Proposed Asian Development Fund Grant*; Republic of Tajikistan: Nurek 500 kV Switchyard Reconstruction Project; Asian Development Bank: Manila, Philippines, 2008.
100. Berndtsson, R.; Madani, K.; Andersson, D.-E.; Aggestam, K. The Grand Ethiopian Renaissance Dam: Conflict and water diplomacy in the Nile Basin. In *Water Diplomacy in Action. Contingent Approaches to Managing Complex Water Problems*; Springer-NECSI Complexity Series, Anthem Water Diplomacy Series; Islam, S., Madani, K., Eds.; Anthem Press: London, UK, 2016; Chapter 13.
101. World Bank. *Key Issues for Consideration on the Proposed Rogun Hydropower Project*; World Bank: Washington, DC, USA, 2014; Available online: https://www.worldbank.org/content/dam/Worldbank/document/eca/central-asia/World%20Bank%20Note%20-%20Key%20Issues%20for%20Consideration%20on%20Proposed%20Rogun%20Hydropower%20Project_eng.pdf (accessed on 25 October 2016).
102. The Diplomat Tajikistan's Rogun Dam Rankles Uzbekistan. Available online: http://thediplomat.com/2016/07/tajikistans-rogun-dam-rankles-uzbekistan/ (accessed on 24 October 2016).
103. Abdelhady, D.; Aggestam, K.; Andersson, D.-E.; Beckman, O.; Berndtsson, R.; Broberg Palmgren, K.; Madani, K.; Ozkirimli, U.; Persson, K.M.; Pilesjö, P. The Nile and the Grand Ethiopian Renaissance Dam: Hydrosolidarity vs nationalism. *J. Contemp. Water Res. Educ.* **2015**, *155*, 73–82. [CrossRef]
104. Suyarkulova, M. Between national idea and international conflict: The Rogun HHP as an anti-colonial endeavor, body of the nation, and national wealth. *Water Hist.* **2014**, *6*, 367–383. [CrossRef]
105. HydroWorld.com. Kyrgyzstan Seeks Consultants for Refurbishment of 1,200-MW Toktogul Hydro Project. Available online: http://www.hydroworld.com/articles/2014/09/kyrgyzstan-seeks-consultants-for-refurbishment-of-1--200-mw-toktogul-hydro-project.html (accessed on 24 October 2016).
106. Eurasianet Russia Holds Kyrgyzstan's Hydropower Dreams Hostage. 2014. Available online: http://www.eurasianet.org/node/68741 (accessed on 11 October 2016).
107. Swain, A. Challenges for water sharing in the Nile basin: Changing geo-politics and changing climate. *Hydrol. Sci. J.* **2011**, *56*, 687–702. [CrossRef]
108. Cascão, A.E. Changing power relations in the Nile River Basin: Unilateralism vs. cooperation? *Water Altern.* **2009**, *2*, 245–268.
109. Biswas, A. Cooperation or conflict in transboundary water management: Case study of South Asia. *Hydrol. Sci. J.* **2010**, *56*, 662–670. [CrossRef]
110. The Central Asia-Caucasus Analyst Signs of Improving Relations between Uzbekistan and Tajikistan but Tensions Remain. Published in Analytical Articles by Edward Lemon. Available online: https://www.cacianalyst.org/publications/analytical-articles/item/13405-sings-of-improving-relations-between-uzbekistan-and-tajikistan-but-tensions-remain.html (accessed on 17 January 2017).
111. Aggestam, K.; Sundell-Eklund, A. Situating water in peacebuilding: Revisiting the Middle East peace process. *Water Intern.* **2014**, *39*, 10–22. [CrossRef]
112. Gleason, G. Upstream-downstream: The Difficulties of Central Asia´s Water and Energy Swaps. Eurasianet.org. 2001. Available online: http://www.eurasianet.org/departments/business/articles/eav020601.shtml (accessed on 11 October 2016).