

Water 2015, 7, 2728-2752; doi:10.3390/w7062728

OPEN ACCESS

water

ISSN 2073-4441

www.mdpi.com/journal/water

Article

The Costs of Benefit Sharing: Historical and Institutional Analysis of Shared Water Development in the Ferghana Valley, the Syr Darya Basin

Ilkhom Soliev ^{1,2,*}, Kai Wegerich ² and Jusipbek Kazbekov ²

¹ Landscape and Environmental Economics, Technical University of Berlin, Straße des 17. Juni 145, Berlin 10623, Germany

² International Water Management Institute, PO Box 2075 Colombo, Sri Lanka;
E-Mails: K.Wegerich@cgiar.org (K.W.); J.Kazbekov@cgiar.org (J.K.)

* Author to whom correspondence should be addressed; E-Mail: isoliev@daad-alumni.de;
Tel.: +49-303-147-3333; Fax: +49-303-147-3517.

Academic Editor: Marko Keskinen

Received: 9 December 2014 / Accepted: 26 May 2015 / Published: 9 June 2015

Abstract: Ongoing discussions on water-energy-food nexus generally lack a historical perspective and more rigorous institutional analysis. Scrutinizing a relatively mature benefit sharing approach in the context of transboundary water management, the study shows how such analysis can be implemented to facilitate understanding in an environment of high institutional and resource complexity. Similar to system perspective within nexus, benefit sharing is viewed as a positive sum approach capable of facilitating cooperation among riparian parties by shifting the focus from the quantities of water to benefits derivable from its use and allocation. While shared benefits from use and allocation are logical corollary of the most fundamental principles of international water law, there are still many controversies as to the conditions under which benefit sharing could serve best as an approach. Recently, the approach has been receiving wider attention in the literature and is increasingly applied in various basins to enhance negotiations. However, relatively little attention has been paid to the costs associated with benefit sharing, particularly in the long run. The study provides a number of concerns that have been likely overlooked in the literature and examines the approach in the case of the Ferghana Valley shared by Kyrgyzstan, Tajikistan and Uzbekistan utilizing data for the period from 1917 to 2013. Institutional analysis traces back the origins of property rights of the transboundary infrastructure, shows cooperative activities and fierce negotiations on various governance levels. The research discusses

implications of the findings for the nexus debate and unveils at least four types of costs associated with benefit sharing: (1) Costs related to equity of sharing (horizontal and vertical); (2) Costs to the environment; (3) Transaction costs and risks of losing water control; and (4) Costs as a result of likely misuse of issue linkages.

Keywords: transboundary water cooperation; equity; environment; water governance; issue linkage; institutions; Central Asia

1. Introduction

In order to promote cooperation over shared water resources, it is important to highlight the potential for cooperation including the broadest range of possible projects and benefits, options and choices available to riparian parties. In doing so, institutional analysis can be helpful to identify both the accepted norms, traditions, rules, principles and the modes of cooperation [1–3] which could generate greatest net as well as individual benefits [4–11]. This study reviews the benefit sharing approach in the context of international water management from institutional economic, social, environmental as well as power relations perspectives. The major advantage of benefit sharing is its capacity to facilitate cooperation among riparian parties by redirecting the focus from quantities of water to benefits derivable through its use and allocation and therefore turning the zero sum game into a positive sum interaction [4–11].

The article looks into historical data to derive lessons for potential application of benefit sharing in case of the Ferghana Valley, located in the upstream of the Syr Darya Basin and shared by Kyrgyzstan, Tajikistan and Uzbekistan. The Valley is rich in transboundary water resources along with shared infrastructure and because of the unity within one country in the past (until 1991 the republics were soviet socialist republics (SSRs), part of the Union of Soviet Socialist Republics (USSR), the republics have a long history of relationship of initiating, implementing and maintaining the existing infrastructure on various governance levels. We are mindful that the benefit sharing approach was proposed for promoting cooperation among independent states, whereas the analysis in this article covers a period prior to independence. This is done to allow deriving lessons for the countries in the long run, at the same time possibly adding value to the research in application of the approach to riparians, which are part of a federal structure as it was in case of the Soviet Union or are countries in transition.

Although debates on benefit sharing are not as young as those on water-energy-food nexus (e.g., [12,13]), both seem to lack a rigorous historical and institutional perspective. This is at the very core of our manuscript and the analytical approach presented here attempts to fill this gap and expand understanding of the role of institutional settings in shaping the scope and effect of management decisions while viewing these decisions as a process.

The article continues with providing an overview on benefit sharing, which is followed by a background and methodology section. The analysis of the data has shown that there were five distinctive periods, each with a significant shift in the way benefits from the shared water resources were shared influenced by development of different formal and informal institutions (property rights, autonomy in decision-making, sharing criteria, changes and interaction in governance institutions, interests and priorities on different levels). While the prevailing approach has been to look at developments as before

and after independence, findings of our research reveal the value of taking a more detailed look. The results section is therefore structured into these five distinctive periods. Further, the discussion section elaborates on major findings and attempts to systematize them. In the final section key conclusions are provided on implications of the research on broader scholarship of managing shared water resources as well as on possible constructive changes specifically in the Central Asian context.

2. Benefit Sharing—An Overview

In managing shared water resources, benefit sharing has been increasingly proposed as an approach to move from unilateral to cooperative actions by showing greater benefits of doing so. The approach not only redirects attention from volumes of water to benefits related to water, but also from pre-existing tensions or disagreements to new developments and arrangements. However, for sustainability of positive sum, it is central to ensure that the redirection of attention does not result in ignoring or worsening of problems, outweighing benefits in the long run. To understand the power of the benefit sharing approach to make cooperation more attractive one has to clarify: (1) *What benefits are there?* (2) *How can they be shared?* (3) *What are the costs of achieving shared benefits?*

Several studies define and categorize benefits and benefit sharing as follows.

Sadoff and Grey [4] determined four categories of benefits associated with cooperation as environmental (Type 1), with increasing benefits to the river; economic (Type 2), with increasing benefits from the river; political (Type 3), with reducing costs because of the river; and catalytic (Type 4), with increasing benefits beyond the river. The main critique on the typology is its practicality [10,14–17] as well as weakness in prioritization or identification of entry points. The latter is addressed by Phillips [8] whose methodology (Transboundary Waters Opportunity (TWO) Analysis) helps to see areas of priority when brainstormed by riparians. Overall, most scholars agree on the typology [4] as it covers the whole spectrum and allows distinguishing directions for cooperation.

Further, Sadoff and Grey [5] (p.3) define “benefit sharing” as “*any action designed to change the allocation of costs and benefits associated with cooperation*”. The term “any action” can be interpreted as hindering but also enabling factor of the definition, since it broadens the spectrum of processes beyond the water sector [8–11,17,18]. Sadoff and Grey [5] acknowledge the fundamental principles of international water law—equitable and reasonable use—first established in the 1966 Helsinki Rules and then codified in the 1997 United Nations (UN) Convention on the Law of the Non-navigable Uses of International Watercourses. However, they propose the benefit sharing approach as an alternative. Dombrowsky [19] disproved it as an alternative approach showing the importance of underlying property rights if mutual benefits to be achieved and suggested that the approach could be rather complementary in certain cases. This is captured by a more specific definition suggested by Phillips and Woodhouse cited in [20] (p. 1): “*...as the process where riparians cooperate in optimising and equitably dividing the goods, products and services connected directly or indirectly to the watercourse, or arising from the use of its waters.*”

Later, Sadoff *et al.* [21] (pp. 28–29) explaining “*fair sharing of benefits*” refer to Article 6 of the 1997 UN Convention, which enumerates seven non-weighted guiding principles. Theoretically, this seems to translate the already existing dilemma of equitable distribution in the traditional (water volume based) approach into the benefit sharing approach. From practical perspective, Sadoff *et al.* [21] suggest

learning from the actual practices derived from existing international treaties related to management of shared water resources as a starting point of negotiations referring to the database of transboundary agreements developed by Wolf [22]. However, the authors admit that “*the benefits derived from water development have generally not been shared equitably*” [21] (p. 29). The approach seems to be rather future oriented focusing on *ex ante* conceptualization of possible options to facilitate cooperation.

More broadly, the idea of benefit sharing [4,5] seems to replicate the mutual gains approach of the negotiation research introduced earlier [23]. However, one should acknowledge that both strongly relate to and based on the utilitarian concepts of the game theory and welfare economics, particularly to the problems looking for a Pareto improvement. However, unlike the game theoretic concepts, literature on both benefit sharing and mutual gains go beyond computing possibilities and show enthusiasm calling for creativity in problem solving, thinking beyond quantities, issues at the table, sectors involved, and assumptions. While encouragement for cooperation is supported by all means here, the question arises whether the increased emphasis to cooperate and achieve “yes” in a negotiation might overshadow or even cause some possible crucial negative consequences. Especially in a complex environment of shared water resources, broadening the basket and bringing in other, often as complex, issues, thus merging two or more complex resource systems, might easily lead to increased transaction costs by creating even a greater number of potentially conflicting interactions in a longer period.

The original mutual gains approach [23] addresses such questions as risks and circumstances under which one should not agree to a deal. In contrast, the studies testing the applicability of the mutual gains as well as benefit sharing in managing shared water resources seem to lack this holistic view. In fact, one of few available studies specifically on mutual gains in international rivers by Grzybowski *et al.* [24] promotes the benefits of the approach (also see: Special Issue “Getting to Yes” in United States–Canadian Water Disputes ed. by Sewell and Utton in 1986 [25]). That study, with a strong international law perspective, provides the case of the Columbia River Basin as one of the successful cases. Although, unlike Sadoff and Grey [5] and similar to Dombrowsky [19], Grzybowski *et al.* [24] argue that the mutual gains approach is complementary to the fundamental principles of international water law, *i.e.*, equitable and reasonable use, prevention of significant harm and obligation to cooperate. However, another paper, with as strong legal perspective [26], views benefit sharing as an artificial substitute to the traditional water sharing approach and concludes that in the long run the Columbia River Treaty could be questioned both on the grounds of equity of sharing and the costs to the environment.

Furthermore, focusing not only on the benefits but also on the costs of the benefit sharing approach, Dombrowsky [19] reveals a number of essential pre-conditions for benefit sharing to be successful. These include clear property rights and enforcement mechanisms, both of which are often problematic, as well as compensatory pay-off structures. However, Dombrowsky [19] seems to look into options to cooperate mostly during the negotiation process, with little emphasis on implementation and assuming that the coordination as well as operation and maintenance come at no cost.

Philips [8] (p. 14) specifically focusing on a practical application with the TWO Analysis mentions “*it [TWO Analysis] also assists markedly in defusing any pre-existing tendencies of riparians in relation to conflict*”. Defusing pre-existing tendencies of riparians in relation to conflict is indeed an advantage of benefit sharing, but it might also be its disadvantage if a riparian has to give up on a critical matter in order to gain immediate (however important those can be) benefits. Hence, what appear to be missing are possible longer-term implications. As Tarlock and Wouters [26] (p. 524) reason, focusing on benefits

might result in “*unequal bargaining among states; the premature “sale” of future use opportunities; and the increased risk of aquatic ecosystem degradation*”. Riparians might be tempted by what can appear as short-term benefits and agree to arrangements that can pre-define or limit the range of decisions in a longer term.

Another study by Dombrowsky *et al.* [27] seems to acknowledge the problem of implementation in a different context, findings of which support the mentioned concerns [26]. Already looking at projects in preparation stages, they provide an example of how, due to “*unforeseen effects*” or because “*some things did not work as it was planned*”, the project-affected population became less satisfied with fairness of compensations provided for resettlement [27] (p. 1096). Concerns of the authors over implications of benefit sharing internationally and locally are timely, but long-term implementation still remains unexplored.

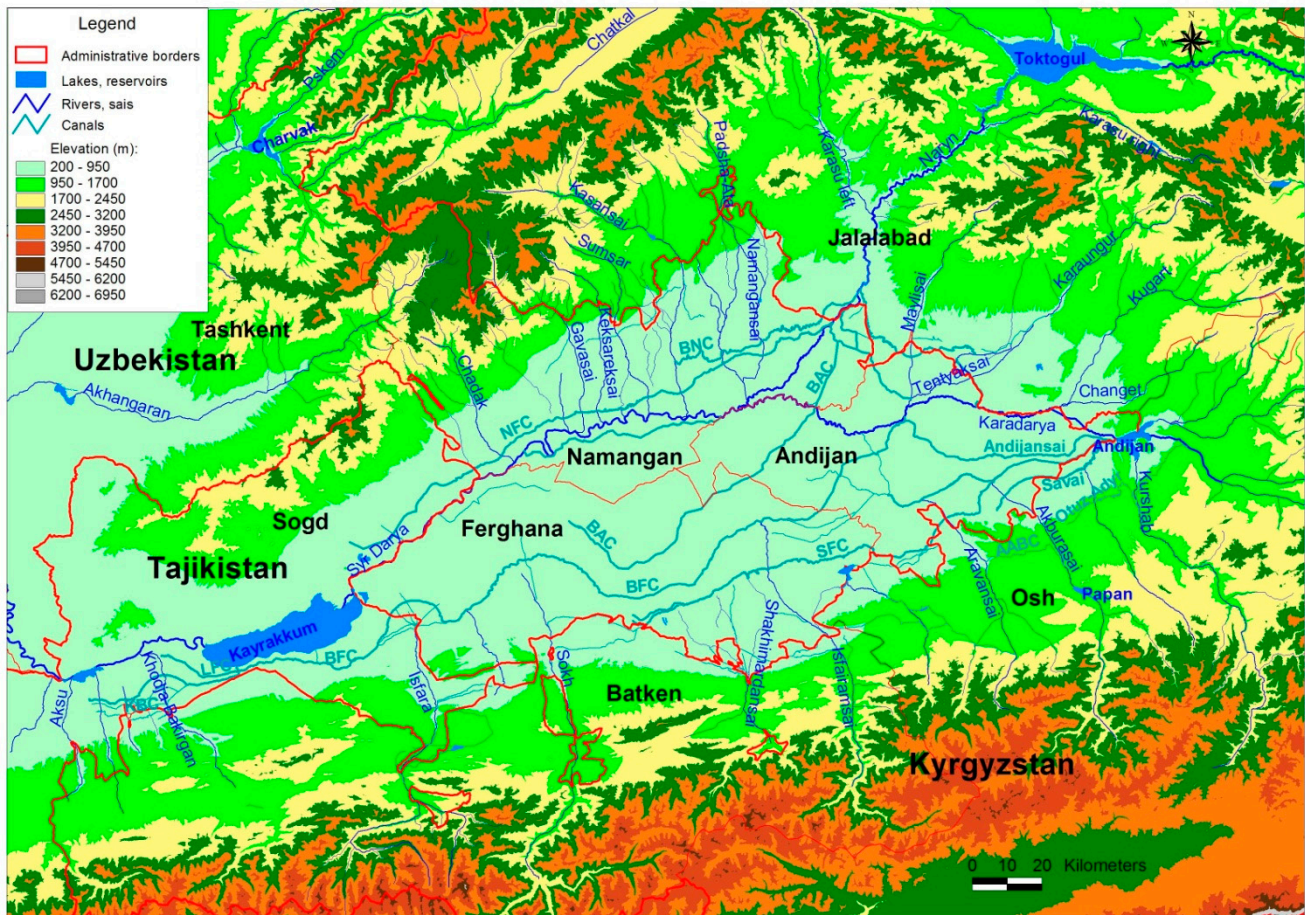
Overall, the long-term problems related to benefit sharing could be summarized as (1) inequitable allocation of benefits (internationally and locally, respectively; thereafter, horizontal and vertical, respectively) as well as (2) likely underestimation of costs to the environment and related implications which are often not immediate [26]. Tarlock and Wouters [26] by benefit sharing refer to monetary compensation in return for a compromise in a shared river basin development (hydropower dams, the Case of Columbia River Treaty between the United States and Canada) or allocation (barter agreements, the Case of the Aral Sea Basin). What is not addressed is another form of benefit sharing—issue linkages. Even though issue linkage can be seen as an in-kind form of compensation, there seem to be two possible problems specifically related to issue linkages: (1) Increased transaction costs and more difficult control over implementation of the agreed terms; and (2) Possible use of issue linkages by a more advantaged party to impose its solution on other issues [9].

Similarly, Hensengerth *et al.* [11] conceptualizing benefit sharing on dams in transboundary rivers and analyzing five dams highlighted that “*the neglect of negative social and environmental concern may lead to conflict and lengthy renegotiations at a later stage*”. They also touched upon the importance of “*a history of cooperation between basin states and of institutionalized cooperation*” as a factor influencing benefit sharing [11] (p. 27). The paper attempts to expand this framework by systematic identification of the costs of benefit sharing as an approach in the long run as well as further exploring the idea that taking these costs into account is important to make cooperation more sustainable, including in river basins with history of cooperation and institutions to build on.

3. Background and Methodology

3.1. Study Area

While the central part of the Ferghana Valley lies mainly within the territory of Uzbekistan, the surrounding mountainous slopes are mostly part of Kyrgyzstan and Tajikistan (Figure 1). More specifically, the Ferghana Valley covers the territories of 7 administrative units (provinces): parts of Batken, Jalalabad and Osh Provinces of Kyrgyzstan, Sogd Province of Tajikistan as well as the entire territories of Andijan, Ferghana and Namangan Provinces of Uzbekistan. The 7 provinces have a total area of 124,000 km² and a population of about 14 million people, which is more than 20% of the whole population of Central Asia.



AABC - Aravan-Akbura Canal, BAC - Big Andijan Canal, BFC - Big Ferghana Canal, BNC - Big Namangan Canal, KBC - Khodja-Bakirgan Canal, NFC - North Ferghana Canal, SFC - South Ferghana

Figure 1. Topography, transboundary water resources and infrastructure in the Ferghana Valley (map by Alexander Platonov, 2015; courtesy of the International Water Management Institute).

The transboundary water resources of the valley consist of the Syr Darya, with an annual average flow of 37 billion cubic meters (BCM), formed from the confluence of the Naryn (13.8 BCM) and Karadarya (3.9 BCM), both of which originate in the mountains of Kyrgyzstan [28]. The flow of the Naryn River is regulated by the Toktogul Reservoir (14 BCM active storage capacity), located upstream in the territory of Kyrgyzstan, and the flow of the Karadarya by the Andijan Reservoir (1.75 BCM active storage capacity), which is on the border between Osh Province of Kyrgyzstan and Andijan Province of Uzbekistan. When exiting the Ferghana Valley, the Syr Darya is regulated by the Kayrakkum Reservoir (2.6 BCM active storage capacity), located in the territory of Tajikistan. Within the valley, there are also about 20 Small Transboundary Tributaries (STTs) with significant combined contribution to the flow of the main stem of 7.8 BCM [29]. Often these STTs have their own smaller reservoirs [30].

According to the Scientific Information Center of the Interstate Commission for Water Coordination (SIC ICWC) [31], the total irrigated area under command of irrigation canals in the Valley is 1.3 million ha (no data provided for Batken province). The breakdown on population, territories and irrigated lands by the countries and their associated provinces are presented in Table 1. The main economic activities

are agriculture and livestock. The main crops are cotton, wheat, maize, orchards, tobacco, rice and vegetables in irrigated farming [31,32].

Table 1. Brief information on the Ferghana Valley, upstream of the Syr Darya Basin.

Country	Province	Population, Inhabitants	Population Density, Inhabitants/km ²	Territory, km ²	Irrigated Lands Data for 2010 [31], Thousand ha
Kyrgyzstan (KG)	Batken	469,700 Data for 2012 [33]	27.6	17,000 [34]	no data
	Jalalabad	1,099,200 [35]	31.6	33,700 [35]	125.6
	Osh	1,199,900 [36]	41.1	29,200 [36]	126.8
Sub-total (KG)		2,768,800	34.7	79,900	252.4
Tajikistan (TJ)	Sogd	2,349,000 Data for the period 2000–2010 [37]	93.2	25,200 Data for the period 2000–2010 [37]	178.0
		Sub-total (TJ)	2,349,000	93.2	25,200
Uzbekistan (UZ)	Andijan	2,805,500 As of 1 January 2014 [38]	668.0	4,200 [39]	269.5
	Ferghana	3,386,500 As of 1 January 2014 [38]	498.0	6,800 [39]	357.7
	Namangan	2,504,100 As of 1 January 2014 [38]	316.0	7,900 [39]	282.1
Sub-total (UZ)		8,696,100	460.1	18,900	909.3
Total		13,813,900	111.4	124,000	1,339.7

3.2. Data

The data were gathered through archival research during several projects of the International Water Management Institute between 2010 and present (see acknowledgment). The specific geographical focus is on the relationship between Osh Province of Kyrgyzstan and Andijan and Ferghana Provinces of Uzbekistan, however, developments in the neighboring provinces and republics are also studied to illustrate wider issues. Since we look at historical data, it should be noted that the current Jalalabad Province (established in 1939) was part of Osh Province between 1959 and 1990 [35], whereas Batken Province was established only in 1999, which, until then, had been part of Osh Province as well [34]. Similarly, Andijan and Namangan Provinces were established in 1941 and Namangan was part of Ferghana and Andijan Provinces between 1960 and 1967 [40,41].

The data mainly represent interactions between the republics signed or prepared to manage the shared land and water resources and other related matters as well as higher level (regional) laws, decrees, agreements, declarations, *etc.*, reflected in 203 pieces of various documents covering the period between 1917 and 2013 (please see Tables S1 and S2). To refer to a specific document from Tables S1 and S2, the following acronyms are used in parenthesis [S1:N], where N is the corresponding number of the document as listed in the supplementary table (in this example, Table S1). In addition, the data with main characteristics of transboundary infrastructure were derived from the earlier studies of Wegerich *et al.* [28] for the smaller infrastructure (Table S3) as well as from the above documents and other sources for the larger infrastructure (Table 2).

3.3. Analytical Approach

The case study is based on in-depth qualitative analysis of the documents particularly from benefit sharing perspective: according to the types of benefits considered (Type 1, 2, 3 and 4) [4] and the ways sharing was envisioned, benefit-sharing mechanisms applied (compensations: monetary or in kind, issue linkages: outside or within water sector, across different basins), location of the object(s), property rights associated with the object(s), implementation of the agreed terms when relevant, and other information to see the connection and reference between the documents. Both direct costs of the developments and arrangements (such as cost of construction) and indirect costs of benefit sharing as an approach are analyzed.

The specific focus during the historical analysis was given to institutional changes. To be able to distinguish between different levels of institutions as well as to understand their level of development from temporal perspective it is referred to Williamson's [3] framework of institutional analysis: Informal institutions such as customs, traditions, norms—Level 1; Formal institutions defining the rules such as autonomy in decision-making and property rights—Level 2; Governance institutions such as formation of main principles and organizations—Level 3; and Institutions for resource efficiency such as incentives to continuously improve marginal benefits—Level 4. As a result of the analysis, five distinctive periods of benefit sharing were distinguished where significant shift in establishment of these institutions took place. The results of the analysis form the respective five sub-sections of the following section.

4. Results

4.1. From 1917 to 1953: Border Delimitation and Irrigation Development

During this period under Stalin's strong hand, benefit sharing between the republics was imposed by the central planning government in Moscow; there was no negotiation and benefits from projects involving riparians were shared *de facto*. The republics had only a symbolic autonomy in decision-making. However, the period marks developments, which would have crucial impacts on the types of benefits and the way those benefits would be shared later.

First, a complete nationalization of lands in 1917 [S1:1] was followed by border delimitation (till 1936) forming the new republics decision-making bodies, which eventually would become the present independent states. Due to the complexity of the landscape, varying economic potential, and mixed ethnicities across the valley, the sides had contesting claims and many border questions were left open [30,42–47].

Second, the extensive irrigation development placed emphasis on cotton independence of the USSR. The studies [28,30,31,42–48] indicate that the entire institutional setting was aimed at two types of benefits [4]. The increased agricultural production is assumed to have contributed to the region's economy directly (Type 2). The water infrastructure development was in line with the Soviets' agenda to restore social and political stability in the region by increasing employment and attempts to redirect the attention from political life to implementation of the projects. The combined effect can be classified as benefits beyond the water resources, Type 4.

Third, constructed irrigation canals created the foundations for property rights on the shared water infrastructure. The infrastructure was constructed in areas that were easier to irrigate (within the valley). Since water flows were mainly utilized by downstream collective farms (*kolkhozes* and *sovkhozes*) and

districts, the majority of the projects with shared command area were operated by the authorities in the Uzbek SSR, even though some were located upstream within the territories of the Kyrgyz or Tajik SSR (Table S3). This is the root of why some of the infrastructure with shared benefits within territories of Kyrgyzstan (and Tajikistan) today belong to Uzbekistan and occasionally *vice versa*.

Through 11 shared projects, the republics regulated the water resources with a command area of 57,542 ha (including 10,300 ha in the territory of the Kyrgyz SSR) (Table S3). In 3 out of 6 cases, the Kyrgyz SSR did not have any land irrigated despite the headwork/infrastructure location was in the Kyrgyz SSR. In addition to irrigation, pastures of the republics were re-distributed for long-term use. The data from 1946 indicate that the Uzbek SSR was the main recipient of pasturelands (4 million ha), while the Kyrgyz SSRs was the main provider of pasturelands (1.1 million ha), with a minor input from the Tajik SSR (71 thousand ha). This was connected to the greater number of Livestock Units (LSU) in the Uzbek part of the Ferghana Valley than in the Kyrgyz part: 0.3 million LSU and 0.2 million LSU, respectively.

The costs of construction of the shared infrastructure were financed through the budget of the Uzbek SSR, although the other republics had benefits too. In addition, during this period, a significant movement of labor force took place: first, forced migration before World War Two, second, massive resettlement during and after World War Two, which included highly qualified specialists from Russia and western parts of the USSR to Central Asia, especially Uzbekistan [42]. Thus, even without detailed data on the extent and proportions, it is evident the costs borne in providing the labor force for the construction and ameliorative works were colossal. In addition, the documents within this period do not prioritize environmental preservation or prevention of possible negative impact of the developments on available water quality and quantity.

4.2. From 1953 to 1970: Negotiation and Mega Projects to Boost Water Supply

The year 1953 marked the end of the Stalin period. Although the new leadership of the Soviet government continued with further policies to increase agricultural output, there were the following important differences influencing various aspects of benefit sharing.

First, the republics gradually started to gain autonomy in decision-making. Negotiations over the shares on several projects were held directly between the republics and explicitly documented within the Protocols. For example, after the start of the works on the Toktogul Reservoir, the Kyrgyz SSR claimed and secured compensation for the lands allocated for it through negotiations on the Andijan Reservoir [S1:30] (more details follow). At the same time, the share of the Kyrgyz SSR in the allocated pasturelands increased significantly too, amounting to 834 thousand ha (328% increase compared to 1946) without decreasing the areas allocated to the other republics [S1:8]. Later, the autonomy increased with the 1968 Union-Wide Law on Land, which called for direct dispute resolution between the republics [S1:34].

Second, in 1953–1970, negotiations and construction works of several larger projects were initiated, which led to a sharp increase in issue linkages and closed the basin in the long run (Table 2).

Table 2. Projects with shared benefits in the Ferghana Valley initiated/constructed between 1953 and 1970.

Project	Negotiation	Commissioning	Irrigation Benefits: Command Area, thousand ha (and/or Share in Water Allocation, %)			Other Benefits
			Uzbek SSR	Kyrgyz SSR	Tajik SSR	
Kayrakkum Reservoir with the active capacity of 1.7 (BCM) on the Syr Darya River [49]	Late 1940s–1950s	1956	At the exit of the Ferghana Valley, benefiting the downstream of the Valley and contributing to 185.3 thousand ha of the Tajik irrigated lands in the Syr Darya Basin [49]. Six thousand hectares in the Arka Massive of the Kyrgyz SSR through pump-stations in the Tajik SSR			No initial data. “For the period of 1990–1998, the Kairakkum hydroelectric power station annually generated about 323 million kWh on average in the growing season” [49] (p. 115).
Toktogul Reservoir (14 BCM of active capacity) on the Naryn River	no data (assumed in late 1950s)	1974	Built for long-term regulation of the Naryn flow. Water supply increase for 918 thousand ha, expansion by 400 thousand ha in the Syr Darya River Basin (exact shares of the republics were not possible to calculate) [50]			Hydropower (4.1 billion kWh a year) initially it was agreed that the flow released as a result of hydropower generation is allocated at the ratio of 85.5% for the Uzbek SSR and 14.5% for the Kyrgyz SSR.
Left-shore Naryn Canal (18 m ³ /s) and Druzhba pump-station	1960s	1969–1970	5.2	3.5	not applicable (n/a) due to its geographic location	–
Tortgul Reservoir on the Isfara STT (0.09 BCM)	1960s	1971	1.6, (8% water) [51] (p. 23).	9.23 (37% water)	21.3 (55% water)	Kyrgyz SSR and Tajik SSR share water from canal Machai (2 km upper than water intake to Tortgul Reservoir) on proportion of 80% and 20%, respectively [51] (p. 24).
Papan Reservoir (0.24 BCM of active capacity) on the Akburasai STT	1960s	1985 [S1:109]	26.6 [52]	10	n/a	1.5 m ³ /s for domestic use of Osh city
Sokh Reservoir (0.32 BCM of active capacity) on the Sokh STT [S1:83]	1960s	Not completed	45.2	18.2	n/a	Compensation for lands provided for the construction of the Toktogul Reservoir. The reservoir would increase its irrigated lands in the Burgandy Massive by 22,000 ha (with 0.2 BCM from the reservoir) in the Kyrgyz SSR and increase water supply for the existing irrigated lands in the Uzbek SSR.
Karkidon Reservoir (0.22 BCM)	1961	1968	87% water	13% water	n/a	–
Andijan Reservoir (1.75 BCM of active capacity) on the Karadarya	1962	1978	247.1	49.6	n/a	Unlimited expansion upstream of the reservoir for the Kyrgyz SSR, hydropower release from the Nurek Reservoir (on the Amu Darya Basin) 85.5% for the Uzbek SSR, 14.5% for the Kyrgyz SSR.
Left-shore Kampyr-Ravat (LSKR) Canal	1965	Not constructed	15.9	8	n/a	Project not implemented.
Right-shore Kampyr-Ravat (RSKR) Canal	1965	1970s	14.57	–	n/a	–
Kasansai Reservoir (0.3 BCM) on the Kasansai STT [S1:83]	1967 (second phase)	1972	28.8	1.3	n/a	–

The table shows issue linkages of increased complexities both within and outside the basin. For the Kyrgyz SSR, who provided lands for the construction of the Toktogul Reservoir, in 1961, Moscow's idea was to compensate the lands by giving expansion rights (15,000 ha) and water for it in the Burgandy Massive through regulation of the Sokh River [S1:87]. However, in the 1962 negotiations of the Andijan Reservoir, the Kyrgyz SSR sought compensation directly from the Uzbek SSR by requesting construction of the Left-Shore Kampyr-Ravat Canal (LSKR) to the Burgandy Massive to irrigate additional 12,000 ha [S1:18]. The Uzbek SSR agreed to 8000 ha and that in addition to the LSKR Canal, the design of the Sokh Reservoir would take into account feeding these 8000 ha [S1:30].

The outcome of the period was that (1) the parties on all levels (regional, national, meso and local) were expecting significantly higher water supplies in the long term and therefore boost in irrigation expansion and (2) the agreed plans were rather ambitious and as was claimed in several cases, would exceed the capacities of the republics to implement the projects within agreed timeframes. In 1965 the Osh province Water Management Department (WMD) proposed to expedite the construction of the Toktogul, Andijan, Papan, Sokh, and Tortgul Reservoirs as water supply was not higher than 50% of water demand in the right shore tributaries of the Karadarya [S1:26]. The ambitious plans resulted in delays: transfer of land for the construction and their compensation were delayed due to administrative, technical and financial constraints [S1:56]. Some projects had delays for several decades, being only partially implemented (the Sokh Reservoir) or not implemented at all (the LSKR Canal). This had unfavorable implications for both sides. The Kyrgyz SSR was left without its expected increase in water supplies from these projects who prepared additional lands in advance [30]. Hence, incentives to look for compensation from other sources were created. The Uzbek SSR would, on the other hand, have to compensate for possible losses related to the latter and would have a weaker bargaining power in future negotiations with the Kyrgyz SSR (more details in the later periods).

The analyzed documents show the continued focus on the economic benefits, *i.e.*, increased water supply and right to expand irrigated agriculture as a result of joint infrastructure development. The costs of the smaller infrastructure were still covered through the budget of the Uzbek SSR (Table S3). There is lack of data on the detailed allocation of the costs of the Toktogul Reservoir. The construction of the Andijan, Karkidon, and Kasansai Reservoirs, Left-Shore Naryn Canal, as well as of not completed Sokh Reservoir and not implemented LSKR canal were the responsibilities of the Uzbek SSR while the Kyrgyz SSR was responsible to contribute with provision of lands for construction. While both monetary compensation, including payments to compensate losses related to population resettlement, and non-monetary compensation mechanisms were practiced within this period, the costs to the environment were still not considered.

4.3. 1970s: Competition, Allocation Criteria and Counter Hegemony

In 1970, the future of benefit sharing was significantly influenced by two important developments. The 1970 Order [S1:40] from Moscow allocated increased investments for further land reclamation as well as regulation and re-allocation of the runoff of the rivers for the next 15 years but pointed out the projects would be approved on a case by case basis. This meant official competition for the right to use land and water resources between the republics. On the other hand, the 1970 Union-Wide Law on Water

[S1:41] formalized the basin approach under which so called “Schemes” of complex use should have been developed for each river basin.

The initial version of the Syr Darya Scheme developed in the beginning of the 1970s [S1:42] (p. 5) explained the principle land and water allocation criteria as:

- Proximity of the lands to the source of irrigation;
- Higher productivity of the lands, lower demand for irrigation, less investments and time;
- Preference for the lands in more southern latitudes suitable for more valuable sorts of cotton;
- Proximity of the lands to the reserve contingents (labor, infrastructure);
- Needs of the republics in connection with the Union’s interests.

The idea was to locate the lands based on the above criteria that would then receive a proportional share of water based on the area, crop pattern and other features. This is how the water allocation criteria tied to the irrigated area started to develop.

The irrigated area in the Valley in 1970 was 1058 thousand ha [S1:42], 720.9 thousand ha (68%) of which was in the Uzbek part [44]. The data in Table S3 show, there was a significant decrease in the number and scope of the shared infrastructure constructed. The new infrastructure was added due to the construction of the canals in early 1970s linked to the Dustlik pump-station which itself had been constructed in 1969. This means that almost no irrigation infrastructure (except the Jiyda canal in 1974 with the capacity to irrigate only 905 ha) was agreed between the riparians on the STTs in this period. Three other projects were the dams with flood control function. The focus shifted from the smaller infrastructure (Table S3) to the implementation measures of the larger infrastructure (Table 2). While a number of projects were completed in the 1970s, the LSKR Canal and Sokh Reservoir for upstream expansion had long delays. The Kyrgyz SSR referred to the agreements reached with the Uzbek SSR on the Andijan Reservoir as an example to persuade Moscow in providing more expansion rights [S1:47], however, Moscow dismissed such requests. Perhaps, the dismissal put the Kyrgyz SSR in the position to raise numerous claims both regarding the irrigation expansion and pasture use unlike in the previous periods. The Kyrgyz SSR had a number of unilateral projects with the potential to irrigate an additional 137,260 ha prepared for implementation within the Ferghana Valley with 66,260 ha being directly connected to shared water resources, *i.e.*, Kayrakkum Reservoir, Khodja-Bakirgan STT, Sokh STT, RSKR Canal, LSKR Canal, and Aravansai STT [S1:58]. In 1974, the Kyrgyz SSR requested Moscow to return the pasturelands used by the other republics within the territory of the Kyrgyz SSR [S1:59].

While there is evidence of monetary (Andijan Reservoir, Karkidon Reservoir) and non-monetary compensation (several cases of land compensation), the Kyrgyz SSR also requested the Uzbek SSR to be connected to gas pipelines as a subsidy (0.5 BCM annually), documenting the first explicit quantitative expression of issue linkages outside the water sector during negotiations [S1:60]. The downstream Uzbek SSR as well as the Kazakh SSR, unlike the Kyrgyz SSR, was to bear the environmental costs as a result of massive expansion. A rapid drop in the level of the Aral Sea and a sharp increase in salinization was expected [S1:42]. There was an estimated 9000-ton loss in fishery from the Aral Sea annually. The impact and the need for diversion of Siberian rivers to the basin was highlighted on the highest level [S1:40], with first design works to be completed in 1971–1975. However, there is no evidence that any design documentation was prepared by that time.

4.4. 1980s: Attempts to Clarify and Solve Conflicting Issues

By 1980, most of the larger infrastructure had been completed and there was a need for new sharing arrangements taking into account all the changes. The following four significant developments were found which shaped the new period of benefit sharing in the 1980s: (1) Increased complexity of issue linkages; (2) Amplified autonomy in decision making and negotiation; (3) Further expansion and basin closure; and (4) Increased cooperation and lost tracks of linked issues previously.

First, the complexity of issue linkages increased to its maximum: while the newer versions of the Schemes connected the infrastructure and developments in the entire Syr Darya Basin in more detail, a new Protocol from 1980 [S1:64] connected all of the STTs in the Ferghana Valley as one package. In addition to the linkages between and across the basins, the non-monetary compensation in the form of land transfer and exchange was discussed and applied more often whereas monetary compensation was no longer observed.

Second, autonomy in decision-making and negotiation amplified further. For example, there is evidence when the Kyrgyz SSR officially contested the decisions approved by Moscow regarding the ways the water shares in the 1980 Protocol were calculated [S1:65]. The design institute argued the main allocation principle was followed [S1:66]. Moscow's purpose to maximize cotton production in the basin had been well established by this period as the Scheme for the basin was in its final stages and discussions were on details rather than on principles. Hence, Moscow gave even more space to the republics for negotiations on the details, as the main purpose with its direct economic benefits for Moscow was more or less secured. On the other hand, the intensifying socio-economic crisis in the USSR during the late 1970s and 1980s [53] was not favorable for Moscow to continue with its active coordination and oversight. In any case, the Kyrgyz SSR kept demanding more water. After the arrangement to share the STTs as one package in 1980 [S1:64], the Kyrgyz SSR, in 7 cases out of 9, including 5 cases where the terms had been implemented, requested to increase its share due to the optimization of water use in the Uzbek part [S1:80].

Third, both the increasing costs to the environment due to basin closure (as the water was utilized to its fullest) as well as the increasing pressure from the Kyrgyz SSR to re-consider allocations implied increased costs for the Uzbek SSR. As of 1 January 1981, the Ferghana Valley had 1227.30 thousand ha of irrigated lands: 255.5 thousand ha (21%) in the Kyrgyz SSR, 124.8 thousand ha (10%) in the Tajik SSR and 847.0 thousand ha (69%) in the Uzbek SSR. The expansion maximum was estimated at 1341.6 thousand ha, which would also change the ratio to 24% (+3%), 10% and 66% (−3%), respectfully [S1:83]. The number of constructed pump-stations in the Uzbek SSR increased rapidly in this period to compensate water to the lands affected by the upstream expansion [54]. Although the lift was unsustainable in the long run due to its high operation and maintenance costs [54], keeping the irrigated lands was important for preventing high social costs at least in a short run and keeping the shares of water tied to the areas of land by the Scheme in a longer run.

Fourth, there was an increased cooperation on the Sokh Reservoir and the Sokh STT, although the construction of infrastructure with shared benefits further slowed down in the 1980s. There were only two shared canals constructed with combined capacity to irrigate 890 ha in the Uzbek part of the Valley (Table S3). The other three projects were flood-controlling dams. In case of the Sokh Reservoir construction, the Uzbek SSR was responsible for the costs, the construction works began and intensified,

but there were still delays to address resettlement issues of the affected population [S1:88]. In case of the Sokh STT, in 1989, the Kyrgyz SSR secured a significant increase in the share from the STT of more than additional 0.2 BCM to irrigate the Burgandy Massive [S1:92]. Expansion in the Burgandy Massive was initially agreed as part of compensation for the lands provided by the Kyrgyz SSR for the Toktogul Reservoir (see the period 1953–1970). The agreement was to irrigate the massive through intakes from the Andijan Reservoir and the Sokh Reservoir. The share from the Andijan Reservoir was 0.2 BCM to be delivered with the LSKR Canal. Although the increased share from the Sokh STT in 1989 exceeded this previously agreed limit, within the same Protocol where this agreement was reached, it was agreed to pursue the projects of the LSKR Canal and the Sokh Reservoir further.

4.5. From 1991 to 2013: Independence and Response to New Old Challenges

From institutional perspective to benefit sharing, the most important distinction of this period is that the republics found themselves between the highest level of autonomy in decision making (sovereignty) by far on one hand, and the highest level of physical (inter-)dependence (shared resources, infrastructure and issue linkages) on the other hand. Irrigation expansion exceeded the planned levels of basin closure, a report from 1991 indicates that the irrigated area in the Ferghana Valley by 1988 was 1382 thousand ha: 290 thousand ha (21%) in Kyrgyzstan, 919 thousand ha (66%) in Uzbekistan, and 173 thousand ha (13%) in Tajikistan [55].

It should be noted, that to date there is abundance of literature on analysis of reforms, problems and opportunities on all possible levels and numerous case studies explaining the situation and possible steps ahead after independence. We do not intend to go through those all but rather maintain our focus on the gap—institutional changes and developments influencing the new period of benefit sharing as well as costs and benefits thereof.

With independence of the states in 1991, the benefit sharing from the existing infrastructure, arrangements and agreements did not stop. In fact, the 1992 Almaty Agreement confirmed the will of all five Central Asian states to adhere to the existing pattern and principles as well as acting regulations of water allocation from interstate resources [S2:1]. This was reinforced within other agreements and declarations later (Table S2). However, implementation of these agreements in a longer run faced a number of challenges.

First, financial difficulties: With problems on how to restore economic and social stability, while the infrastructure built during the Soviet Union was getting outdated and in need of increased investments, the problem was now how to balance between the required more rational use with less finances and meeting the demand for water which became even more crucial for the national economies than before. With the 1998 Syr Darya Framework agreement [S2:7] focusing on the releases from the Toktogul Reservoir, Kyrgyzstan managed to successfully agree with Kazakhstan and Uzbekistan on the compensation mechanisms, which linked water releases with hydropower and fossil fuels between the countries. Tajikistan joined the agreement in 1999. However, due to implementation problems, the Framework Agreement was not renewed after its first five years cycle [29].

Second, although environmental protection received more attention on the regional level agreements (Table S2), implementation of those did not reflect much in the analyzed lower level documents (Table S1), where economic benefits remained dominant. Most of the cooperation on the meso level was

mainly related to maintenance issues—to reconstruct, renovate existing reservoirs (Andijan Reservoir, Papan Reservoir), irrigation and drainage networks. Additional difficulties were observed due to the lengthy clearance processes for crossing the national borders often resulting in delays or indefinite halt of planned maintenance activities. After independence, three shared transboundary projects were constructed (Table S3). While one of them is on the existing canal (Madaniyat-2 pump-station) the other two are flood control infrastructure, hence, all was constructed only to support the existing infrastructure.

Third, no specific interstate organization or framework has been created with focus on managing the shared STTs and their infrastructure. Thus, for the actors on the lower levels in the Ferghana Valley, the institutional arrangement was that the sides were supposed to continue their relationship based on the previous agreements and practice. This implies that there are the following agreements/institutional arrangements in place.

- From transboundary perspective, the latest agreement in place was the 1980 Protocol [S1:64]. However, already during the Soviet period, the sides had disagreements on a number of the agreed terms within the Protocol as described in the analysis of the previous period. A Report from the Kyrgyz side in 2012 [S1:183] mentions the 1989 Protocol [S1:92] as an agreement in place for the Sokh STT. A Report from the Uzbek side of the same year [S1:184] informs that in 2001 an oral agreement was reached to share 3 STTs on a 50/50 basis. However, it is not evident whether it was a one-time agreement to address the drought year. The sides address issues on an ad hoc basis; they exchange requests in case of emergencies such as floods and for annual agreement of decadal allocation from the shared water resources. In addition, with lost linkages behind the LSKR Canal and the Sokh Reservoir, these two continue to be a topic of complaints.
- From a meso level perspective, Uzbekistan has partly shifted from water management according to administrative boundaries (provinces and districts) towards management based on hydrographic/hydrological boundaries of basins and irrigation systems. This was done on the main canals of the Valley (BFC, BAC, SFC). However, the other canals and STTs are left with the WMDs of the provinces [56]. In Kyrgyzstan, in addition to the shift to basin principle, as it was mentioned, Osh province was reorganized into three provinces while the process of restructuring water management in Tajikistan is still in progress [31].

As an outcome of the above challenges and mismatch of institutional arrangements, the incentives of the countries increased to secure more water within their national boundaries, especially since the 1998 Framework Agreement was no longer implemented [29]. With operational change of the Toktogul Reservoir by Kyrgyzstan to meet its energy demand, mid and downstream countries had to find pragmatic solutions increasing internal storage capacities in Uzbekistan and Kazakhstan, re-arranging agreements on certain parts of the Valley as in case of the Isfayramsai, Shakhimardansai and Sokh STTs between Kyrgyzstan and Uzbekistan or the Khodja-Bakirgan STT between Kyrgyzstan and Tajikistan, or attempting to be independent from transboundary infrastructure as the case of Tajikistan on the BFC [29,57].

5. Discussion

Going back to the discussions on water-energy-food nexus, it seems that benefit sharing, as a positive and result-oriented negotiating approach, could be useful to bring about the needed changes and

transition, specifically in managing shared waters. It could serve as a much-needed instrument for what Hoff [12] describes as “stimulating development through economic incentives” (p.37). The historical and institutional analysis, as provided here, seems to offer practical lessons for reconciliation of long-term and global objectives (such as ecosystem stewardship and equity goals) with shorter-term economic benefits, identified as one of the main challenges in the nexus debate [12]. Further, the case study also shows how the isolated focus (e.g., on the Toktogul Reservoir and larger rivers) might have reduced the system efficiency in the long run [12]. Overall, it seems that nexus, which thus far has largely lacked the historical perspective and has not fully viewed management decisions (whether on water, energy, food or their inter-linkages) as a process, could almost entirely borrow the presented analytical approach for assessing evolving institutional settings shaping the scope and effect of the management decisions.

Carrying on with more specific case study findings and looking particularly from benefit sharing point of view, it becomes evident that from one period to the other the benefit sharing increased and incorporated more benefits to the both riparian states (Table 3). Notably, if to follow the typology [4] (Type 1—Environmental; Type 2—Economic; Type 3—Political; and Type 4—Catalytic benefits), the Type 2 benefits remained dominant throughout the entire analyzed period (one should note that here the costs and benefits are deliberately not provided in any explicit way; it is questionable whether issues with this level of complexity and over such long period of time would allow quantifying costs and benefits with any accuracy at all). This highlights the concerns for sustainability of water resources and ecosystems, also discussed in the nexus literature where water is seen as a source or at least as a central factor of economic growth [12,13].

Overall, taking a historical/dynamic or comparative approach highlights that there is a clear gap of how to show differences, particularly since most of the agreements are within Type 2. In addition to the direct costs of benefit sharing development or arrangement (such as construction costs), the analysis pointed to four other possible concerns in the long run, which we term as indirect costs of benefit sharing. In turn, looking at the nature of the lessons on long-term costs, one can state these costs do not necessarily have to limit to benefit sharing, but could be similarly taken into account in the discussions of the nexus approach [12,13].

5.1. Costs Related to Equity of Sharing

Here we are proposing to include “equity” within these particular types/categories so that it would be possible to highlight an increase, stagnation or decrease of these particular types. It could cover the concern pointed out by Tarlock and Wouters [26] regarding transboundary (horizontal) equity in allocation of benefits and it might work well with the social concern of Hensengerth *et al.* [11], which addresses the equity of development vertically. It supports findings of the study by Dombrowsky *et al.* [27] specifically focusing on this aspect of benefit sharing.

Table 3. Summary of the periods.

Periods		Benefits	Benefit Sharing	Mechanisms	Institutions Established
From 1917 to 1953	Types 2 and 4	Increased through boost in smaller infrastructure, pasture exchange	Existed only technically (not voluntarily), founded the shared infrastructure	Central government	Republican borders, property rights on land and infrastructure (Level 2 institutions)
From 1953 to 1970	Type 2	Increased through boost in larger infrastructure, pasture exchange	Emerged with the initiation of larger shared projects, autonomous bilateral negotiation, specific shares of each republics	Monetary and non-monetary compensation, issue linkages within and outside (pastures) water sector, across basins (Nurek Reservoir)	Autonomous negotiations, irrevocable commitments (Toktogul, Andijan and other projects) for revocable ones (Sokh Reservoir, LSKR Canal)
1970s	Type 2	Increased through basin scheme development to use the basin resources to their fullest	Existed and challenged by further autonomy of the republics, increased claims (counter-hegemony) of the Kyrgyz SSR	Monetary and non-monetary compensation, issue linkages within and outside (pastures, gas pipelines) water sector	Proportional water allocation tied to irrigated areas (Level 3 institutions), competition for expansion
From 1980 to 1991	Type 2	Increased through basin closure, rise in pump-stations	Strengthened by further autonomy and official disputation of the Moscow's decisions	Non-monetary compensation, issue linkages within (linking all STTs together) and outside water sector	Governance institutions (Level 3 institutions): managing through sub-basin allocations
From 1991 to 2013	Types 2 and 1	Partly maintained through operation and maintenance of existing infrastructure, enhancement of flood control	Encouraged and tested on regional level but failed (1998 Framework Agreement), practiced on meso level (linked infrastructure and financial incentives), being replaced by national solutions	Issue linkages within and outside water sector (framework of compensations linking water releases, hydropower generation and fossil fuels)	Level 1 (traditions, customs, norms) and Level 2 institutions (above) carried over, Level 3 partly valid, Level 4 (allocative and resource efficiency) attempted by national reforms

The case study brought forward that for the transboundary infrastructure within the Ferghana Valley, property rights and therefore long term sustainability of operation and maintenance of infrastructure are key. Furthermore, while the benefits generated through the infrastructure were shared, the obligation (costs) of operating and maintaining the infrastructure were and are still (except occasionally) not shared. This point highlights the additional need for clearly emphasizing not only benefits but also costs. Looking only at the sharing of benefits might show, that benefit sharing is not equitable.

Besides, in cases when the decisions on forced labor were made solely for the purpose of constructing and operating the infrastructure (1917–1953) internalization of these costs would change the ratio of costs and benefits. Another example, increased unilateral ambitions of the Kyrgyz SSR starting in 1970s emerged because it appears that the Kyrgyz SSR was unsatisfied with the equity of sharing due to the delayed and non-implemented projects. At the same time, the Kyrgyz SSR often argued that the Uzbek SSR increased its water supply levels through unilateral optimization works and therefore requested to re-consider shares to achieve proportional supply levels. This seems to have created a strong disincentive for increasing efficiency as well as incentives for misrepresenting data. In general, such an approach, penalizing a good manager, seems to be a result of serious mismatch between the allocation criteria and improving efficiency.

In addition, looking at Williamson's concept [3], it appears that although there have been tremendous changes regarding the water scarcity situation and the external environment (financial overflow 1960s and 1970s, withdrawal of Moscow and basin closure in the 1980s, independence and financial collapse in 1990), which have triggered adaptation in negotiations and changes of water agreements, so far these changes have not altered the official property rights situation. Besides, the region presents a possibly unique, or at least, very rare case of property rights where a country's infrastructure is located beyond its national boundaries. Further studies are necessary to clearly determine in which case property rights and therefore the obligation to operate and maintain have been altered and the consequences thereof.

5.2. Costs to the Environment

Environmental concern highlighted in the literature [11,26] proved to be absolutely valid throughout the analyzed periods. Given the scales of the developments, integration of "the costs to the water resources" (or "negative benefits to the river") would likely reduce the net economic benefits (Type 2). Even though there are a number of intergovernmental agreements after independence on a national level calling for cooperation in the area of environment and rational use of natural resources the data indicate that the parties focusing on benefits (irrigation expansion) on lower levels have only occasionally considered rising water tables where in fact the focus was on potential economic damage. Institutionalization of a water allocation principle that did not prioritize environmental flow appears to be the main factor in this respect.

5.3. Transaction Costs and Risks of Losing Water Control

Development of uneconomic lift irrigation to secure benefits from water sharing arrangements showed how focusing on benefits might lead to higher costs in the long run especially in a case of multiple interconnected issue linkages.

Similarly, the analysis showed that although there was a clear issue linkage in the beginning (regarding LSKR Canal and the Sokh Reservoir), the two uncompleted infrastructures appeared in

different contexts. Furthermore, today's cooperation appears to be based on a tit-for-tat approach because of the multiple integrated infrastructures. Hence, there is a dynamic of issue linkages within the context of Ferghana Valley. Therefore the original issue linkages (documented in agreements) appear to be in constant flux and utilized as bargaining positions whenever necessary.

Because of the interdependence on transboundary infrastructure cooperation appears to be the most viable option taking a more holistic approach for all infrastructure. It is a likely reason why many projects in the Valley with isolated focus did not succeed as expected. Bigger donors such as the World Bank, Asian Development Bank and United States Agency for International Development focused on the larger rivers without going into details of the lower level inter-dependencies [47,58]. The initiatives of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on the Isfara and Khodja-Bakirgan STTs focused on signing bi-lateral agreements, which led to exclusion of Uzbekistan from the Isfara STT [47,51,58]. The projects of the Swiss Agency for Development and Cooperation (SDC) on the Shakhimardansai and Khodja-Bakirgan STTs, although focused on bottom up cooperation, basically did not succeed due to a weak link up with higher frameworks [47,58].

One should note that all that transboundary tributaries, where the previous agreement was challenged, are within the same 'newly created' administrative unit (Batken Province), similarly, the small reservoir (Kasansai), which appears to have the most problems regarding cooperation [30] is also located in a "newly created" administrative unit (Jalalabad Province). This puts into question whether decentralization as practiced by Kyrgyzstan has decreased cooperation, since it decreased the possibility of issue linkage. Similarly, the water reforms in Uzbekistan (the partly implemented hydrographization [56]) might have negative effects on cooperation, since it reduced the bargaining positions of the former players (Andijan and Ferghana Provinces). In this respect, it might be important to highlight that the practice of honoring past agreements (national level) might be put into question, particularly if lower levels are tasked with the implementation and these lower levels cease to exist or have reduced bargaining power. Having stated this, one could also question whether the national level in Kyrgyzstan has control over the meso level administrative units [59].

5.4. Costs Resulting from Misuse of Issue Linkages

The issue linkages, on one hand, have helped to achieve cooperation and conclude multiple agreements. On the other hand, it created a number of linkages between asymmetric issues. The Toktogul was linked during the Andijan Reservoir negotiations to compensate the lands under the Toktogul by expansion rights in the Burgandy Massive. The Burgandy Massive was linked to the LSKR Canal and Sokh Reservoir. While the Toktogul and Andijan Reservoirs became irrevocable commitments the LSKR Canal and Sokh Reservoir were revoked and never completed. The significant increase in the share from the Sokh STT, which boosted irrigation in the Burgandy Massive for Kyrgyzstan, did not stop them from continuing or even reconsidering the claims on the LSKR Canal and Sokh Reservoir. Hence, both the scope and symmetry of issues to be linked are important to be able to follow through and implement the agreements in a longer period.

Similarly, what seems to be not explored enough from benefit sharing perspective is the focus beyond the river, which entails the brokering (including financial incentives and issue linkages) as well as

arbitration role of third parties, in this case of Moscow. As the analysis suggests, the interests and influence of third parties might completely re-design the structure of both benefits and sharing.

6. Conclusions

Countries need dialogue and coordinated actions to address dynamic challenges and to shift towards more holistic views in managing shared water resources. While the water-energy-food nexus is the most recent way to promote more holistic views, it seems to largely lack both historical and institutional perspectives: this study has emphasized the importance of such perspectives. Our research indicated evolution and implications of institutional settings for shaping management decisions and revealed multiple factors limiting as well as enabling cooperation in a highly complex environment. The focus on benefit sharing as an approach demonstrated that new arrangements and developments with shared benefits and mutual gains provide a good platform for the needed dialogue. Yet, the research findings also brought to attention possible indirect costs associated with benefit sharing in the long run, which might have been overlooked in the literature. It seems incorporations of these costs could contribute to making cooperation and dialogue more constructive and informed and therefore new arrangements more stable.

The case study has identified five different periods of development in the relationship related to management of the shared water resources in the Ferghana Valley between 1917 till present between Kyrgyzstan and Uzbekistan. A particular focus has been placed on what can be learned from benefit sharing perspective. From the earlier Soviet period under the Stalin's strong regime when the property rights on land and more importantly on shared infrastructure were established, the analysis showed that the institutional transformation between the republics took place already in the period from 1953 to 1970 in time of heroic engineering projects targeting cotton independence of the USSR. However contradictory, already then the republics got to negotiate whether to construct, what to construct and how to share benefits. A very strong top down administration started to transform into a bottom up hierarchy. In the 1970s, the republics gained even more autonomy when Kyrgyzstan claimed its major expansion and return of pasturelands. Ambitious plans to boost the water supply resulted in increased expectations leading to new water shortages. Later in the 1980s, the official disputation of the decisions approved by Moscow became acceptable; Uzbekistan had to compensate the loss caused by Kyrgyz expansion in the previous decade. Finally, the period of independence continued with what was left from the Soviets but with significantly less financing, which led to both some cooperative and some national solutions.

Along the entire analyzed period, institutions that are still, at least partly, valid were established. In addition to the property rights, proportional allocation principle is still referred as the central principle for allocation of water. The principle is biased to the criteria of the time it was developed. That is partly why the governance institutions do not function effectively. In addition, the principle itself is contradictory to increasing efficiency, as it requires reconsideration of the allocation with any disproportional change in water supply, which in turn contradicts with the closure of the basin and fixed shares. Without taking into consideration these concerns, benefit sharing might become prone to inequity both horizontally and vertically, failure to internalize environmental costs, loss of water control due to the scope of issue linkages as well as vulnerability in implementation due to asymmetrical commitments.

Separation of the issues on border crossing due to the security concerns from the water and land management sectors is indeed one of the constraints for successful cooperation because of the nature of

property rights for infrastructure located beyond the national boundaries. In this regard, a similar case of the Tuyamuyun Reservoir with the pump-stations on the Amu Darya River shared by Turkmenistan and Uzbekistan could be studied for possible lessons. An additional framework agreement on passing the borders at least for operations and maintenance purposes would reduce the *ad hoc* nature of the issues and bring more stability to the existing cooperation. The case of the Chu and Talas Rivers seems to be relevant for further comparative studies from issue linkages perspective as well as to learn more successful agreements of maintenance sharing.

Overall, the situation is extremely complex: geographically, infrastructure-wise as well as institutionally. However, it is necessary for the complexity to be taken into account in the development of appropriate policy. Simplification of issues might have actually led to the decline in cooperation, since the later arrangements in the Syr Darya, as well as Amu Darya and larger Aral Sea basins, were mainly brokered by donors, which did not engage comprehensively with the big picture. One lesson from the historical complexity is the desire for each state to have independence in water management—with each nation focusing on its own water resources. However, the possible gains from further dialogue and cooperation are clear.

Supplementary Materials

Supplementary materials can be found at <http://www.mdpi.com/2073-4441/7/6/2728/s1>.

Acknowledgments

The data analyzed in this article were gathered during the IWMI's Irrigation Bureaucracy project in Central Asia, the Integrated Water Resource Management—Ferghana Valley project funded by the Swiss Agency for Development and Cooperation, the Water Security project funded by the Ministry for Foreign Affairs of Finland and the Water Cooperation in the Ferghana Valley work package funded by the Consultative Group on International Agricultural Research (CGIAR-wide) Research Program on Water, Land and Ecosystems. Funding for the doctoral studies from the German Academic Exchange Service (DAAD), within which this research was carried out, as well as from the IWMI's Irrigation Bureaucracy project in Central Asia is gratefully acknowledged.

We are grateful to Volkmar Hartje, Head of Chair of Landscape and Environmental Economics at Technical University of Berlin, Germany, for his valuable advice and insights on various aspects of benefit sharing and Alexander Platonov, GIS and Remote Sensing Specialist at the IMWI Central Asia, for developing the map. We thank three anonymous reviewers and the editors of the Special Issue, whose constructive comments helped to improve the quality of the paper.

Author Contributions

Ilkhom Soliev developed the initial and final versions of the framework, analyzed the data, organized the systematic discussion of the costs and led the drafting process of the study incorporating the contributions from co-authors as well as from the reviewers and editors; Kai Wegerich proposed the initial idea of testing the approach in case of the Ferghana Valley, contributed by interim editing of the paper, drafting the initial version of the discussion section, structure of the study and raising critical

questions on the approach; Jusipbek Kazbekov contributed by providing his expertise and insights on the study area and historical-institutional arrangements as well as clarifications in understanding complications and connections of the collected data, facilitated the development of the updated map.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. North, D.C. *Institutions, Institutional Change, and Economic Performance*; Cambridge University Press: New York, NY, USA, 1990.
2. Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press: New York, NY, USA, 1990.
3. Williamson, O.E. Transaction cost economics: How it works; Where it is headed. *Economist* **1998**, *146*, 23–58.
4. Sadoff, C.W.; Grey, D. Beyond the river: The benefits of cooperation on international rivers. *Water Policy* **2002**, *4*, 389–403.
5. Sadoff, C.W.; Grey, D. Cooperation on international rivers: A continuum for securing and sharing benefits. *Water Int.* **2005**, *30*, 420–427.
6. Phillips, D.; Daoudy, M.; McCaffrey, S.; Öjendal, J.; Turton, A. *Trans-Boundary Water Cooperation as A Tool for Conflict Prevention and Broader Benefit Sharing*; Ministry of Foreign Affairs of Sweden: Stockholm, Sweden, 2006.
7. Phillips, D.; Allan, J.A.; Claassen, M.; Granit, J.; Jägerskog, A.; Kistin, E.; Patrick, M.; Turton, A. *The TWO Analysis: Introducing a Methodology for the Transboundary Waters Opportunity*; Report No. 23; SIWI: Stockholm, Sweden, 2008.
8. Phillips, D. *The Transboundary Water Analysis as a Tool for RBOs*; Report No. CSIR/NRE/WR/ER/2009/0124/B; SADC Water Division under contract to GTZ: Gaborone, Botswana, 2009.
9. Dombrowsky, I. *Conflict, Cooperation and Institutions in International Water Management: An Economic Analysis*; Edward Elgar Publishing Limited: Cheltenham, UK, 2007.
10. Qaddumi, H. *Practical Approaches to Transboundary Water Benefit Sharing*; Overseas Development Institute: London, UK, 2008.
11. Hensengerth, O.; Dombrowsky, I.; Scheumann, W. *Benefit-Sharing in Dam Projects on Shared Rivers*; Deutsches Institut für Entwicklungspolitik: Bonn, Germany, 2012.
12. Hoff, H. Understanding the Nexus. In *Proceedings of the Bonn 2011 Conference: The Water, Energy and Food Security Nexus*; Stockholm Environment Institute: Stockholm, Sweden, 2011.
13. Allouche, J.; Middleton, C.; Gyawali, D. *Water and the Nexus, Nexus Nirvana or Nexus Nullity? A Dynamic Approach to Security and Sustainability in the Water-Energy-Food Nexus*; STEPS Working Paper No. 63; STEPS Center: Brighton, UK, 2014.
14. Tafesse, T. *The Nile Question: Hydropolitics, Legal Wrangling, Modus Vivendi and Perspectives*; Lit: Münster, Germany, 2001.

15. Nicol, A. The dynamics of river basin cooperation: The Nile and the Okavango basins. In *Transboundary Rivers, Sovereignty and Development: Hydrological Drivers in the Okavango River Basin*; Turton, A., Ashton, P., Cloete, E., Eds.; African Water Issues Research Unit: Johannesburg, South Africa, 2003; pp. 167–186.
16. Zeitoun, M. Hydro-hegemony theory—A framework for analysis of water-related conflicts. In *Proceedings of the First International Workshop on Hydro-hegemony*, King's College, London, UK, 21–22 May 2005.
17. Turton, A. A South African perspective on a possible benefit-sharing approach for transboundary waters in the SADC region. *Water Altern.* **2008**, *1*, 180–200.
18. Klaphake, A. Cooperation on international rivers from an economic perspective: The concept of benefit-sharing. In *Transboundary Water Management in Africa: Challenges for Development Cooperation*; Scheumann, W., Neubert, S., Eds.; German Development Institute: Bonn, Germany, 2006; pp. 103–173.
19. Dombrowsky, I. Revisiting the potential for benefit sharing in the management of trans-boundary rivers. *Water Policy* **2009**, *11*, 125–140.
20. Southern African Development Community (SADC). SADC Concept Paper on Benefit Sharing and Transboundary Water Management and Development, 2010. Available online: http://www.orangesenqurak.org/UserFiles/File/SADC/SADC%20concept%20paper_benefit%20sharing.pdf (accessed on 4 June 2015).
21. Sadoff, C.W.; Greiber, T.; Smith, M.; Bergkamp, G. *Share: Managing Water across Boundaries*; IUCN: Gland, Switzerland, 2008.
22. Wolf, A.T. Criteria for equitable allocations: The heart of international water conflict. *Nat. Resour. Forum* **1999**, *23*, 3–30.
23. Fisher, R.; Ury, W. *Getting to Yes: Negotiating Agreement Without Giving in*; Penguin: New York, NY, USA, 1981.
24. Grzybowski, A.; McCaffrey, S.C.; Pailey, R.K. Beyond international water law: Successfully negotiating mutual gains agreements for international watercourses. In *Symposium Issue, Proceedings of the Conference “Critical Intersections for Energy & Water Law: Exploring New Challenges and Opportunities”*, Calgary, AB, Canada, 20–21 May 2009.
25. Sewell, D.; Utton, A. Special issue on A. US—Canada Transboundary Resource Issues. *Nat. Resour. J.* **1986**, *26*, 2.
26. Tarlock, A.D.; Wouters, P. Are shared benefits of international waters an equitable apportionment? *Colo. J. Int. Environ. Law Policy* **2007**, *18*, 523–536.
27. Dombrowsky, I.; Bastian, J.; Daeschle D.; Heisig, S.; Peters, J.; Vosseler, C. International and local benefit sharing in hydropower projects on shared rivers: The Ruzzi III and Rusumo Falls. *Water Policy* **2014**, *16*, 1087–1103.
28. Wegerich, K.; Kazbekov, J.; Kabilov, F.; Mukhamedova, N. Meso-Level cooperation on transboundary tributaries and infrastructure in the Ferghana Valley. *Int. J. Water Resour. Dev.* **2012**, *28*, 525–543.
29. Wegerich, K.; Kazbekov, J.; Lautze, J.; Platonov, A.; Yakubov, M. From monocentric ideal to polycentric pragmatism in the Syr Darya: Searching for second best approaches. *Int. J. Sustain. Soc.* **2012**, *4*, 113–130.

30. 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.
31. Dukhovny, V.A.; Sokolov, V.; Galustyan, A.; Djalalov, A.A.; Mirzaev, N.N.; Horst, M.G.; Stulina, G.V.; Muminov, S.; Ergashev, I.; Kholikov, A.; *et al.* *Report on Comprehensive Hydrographic Study of the Ferghana Valley*; SIC ICWC: Tashkent, Uzbekistan, 2011.
32. Musabaeva, A.; Moldosheva, A. *The Ferghana Valley: Current Challenges*; United Nations Development Fund for Women (UNIFEM): Bishkek, Kyrgyzstan, 2005.
33. Osmonaliev, A.; Bayjumanov, D.; Kasymbekov, B.; Tekeeva, L.; Isaliev, K.; Koychumanova, K.; Plesovskih, R.; Turdubaeva, C. *Statistical Review of Agriculture of Kyrgyz Republic for 2008–2012*; National Statistics Committee of Kyrgyz Republic: Bishkek, Kyrgyzstan, 2013.
34. Kyrgyz Information Portal. Batken Province. Available online: <http://www.welcome.kg/ru/kyrgyzstan/region/fretrr/> (accessed on 19 November 2014). (In Russian)
35. Kyrgyz Information Portal. Jalalabad Province. Available online: <http://www.welcome.kg/ru/kyrgyzstan/region/dffer/> (accessed on 19 November 2014). (In Russian)
36. Kyrgyz Information Portal. Osh Province. Available online: <http://www.welcome.kg/ru/kyrgyzstan/region/xaaa/> (accessed on 19 November 2014). (In Russian)
37. Hasanova, G.; Shokirov, S.; Asoev, A.; Norov, K.; Silemunshoev, N.; Gukasova, T.; Abdulloev, M.; Kulov, A.; Turaev, B.; Jdanova, L. *Demographic Yearbook of the Republic of Tajikistan*; Agency under the President of the Republic of Tajikistan on statistics: Dushanbe, Tajikistan, 2013.
38. State Statistical Committee of the Republic of Uzbekistan. *Statistics of Permanent population*; State Statistical Committee of the Republic of Uzbekistan: Tashkent, Uzbekistan, 2014. (In Uzbek)
39. Provinces of Uzbekistan. Available online: <http://uzbekembassy.es/index.php/ru/perfil-de-uzbekistan-7/regiones> (accessed on 19 November 2014).
40. Official web-site of the Namangan province administration. Available online: <http://www.namangan.uz/index.php/uz/namangan-viloyati/viloyat-tarixi> (accessed on 10 March 2015). (In Uzbek)
41. Historical and Genealogical Dictionary Directory. Available online: <http://www.defree.ru/publications/p01/p90.htm> (accessed on 20 February 2015). (In Russian)
42. Polian, P.M. *Against Their Will: The History and Geography of Forced Migrations in the USSR*; Central European University Press: Budapest, Hungary, 2004.
43. Weinthal, E. State making and environmental cooperation: Linking domestic and international politics in Central Asia; In *Global Environmental Accord: Strategies for Sustainability and Institutional Innovation*; MIT Press: Cambridge, MA, USA, 2002.
44. Thurman, M. Modes of Organization in Central Asian Irrigation: The Ferghana Valley, 1876 to Present. Ph.D. Thesis, University of Indiana: Bloomington, IN, USA, 1999.
45. Abashin, S.; Abdullaev, K.; Abdullaev, R.; Koichiev, A. Soviet rule and the delineation of borders in the Ferghana Valley, 1917–1930. In *Ferghana Valley: The Heart of Central Asia*; Starr, F., Beshimov, B., Bobokulov, I., Shozimov, P., Eds.; M.E. Sharpe, Inc.: New York, NY, USA, 2011; pp. 94–118.
46. Rahimov, M.; Urazaeva, G. *Central Asian Nations and Border Issues*; Central Asian Series; Defence Academy of the United Kingdom, Conflict Studies Research Centre: London, UK, 2005.
47. Bichsel, C.; Mukhabbatov, K.; Sherfedinov, L. Land, water and ecology. In *Ferghana Valley: The Heart of Central Asia*; Starr, F., Beshimov, B., Bobokulov, I., Shozimov, P., Eds.; M.E. Sharpe, Inc.: New York, NY, USA, 2011; pp. 253–277.

48. Benjaminovich, Z.; Tersitskiy, D. *Irrigation of Uzbekistan II*; Fan: Tashkent, Uzbekistan, 1975.
49. Khamidov, M.; Leshanskiy, A. Review of the Proposal of Constructing an Operation Model for Kairakkum Reservoir. In *Final Report Example Allocations of Operating and Maintenance Costs of Interstate Water Control Facilities Employing the Use-of-Facilities Method*; Hutchens, A., Ed.; U.S. Agency for International Development: Washington, DC, USA, 1999; pp. 110–120.
50. Khamidov, M. Experience of coordinated water resources use of the syrdarya basin states. Presented in Advanced Research Workshop Socio-Economic Stability and Water Productivity: Implications of Food and Water security in the Central Asian Region, Tashkent, Uzbekistan, 18–20 March 2008. Available online: http://www.icwc-aral.uz/workshop_march08/pdf/khamidov_en.pdf (accessed on 28 November 2014).
51. Djaylobaev, N.; Sakhvaeva, E.; Matushkina, O.; Chernikova, T.; Mendikulova, Z.; Neronova, T.; Aytbaev, B.; Mamadiev, K.; Shukurov, J.; Ibraimov, D.; et al. *Basin Plan for the Isfara River, Batken District, Kyrgyz Republic*; GIZ: Bishkek, Kyrgyzstan, 2014. (In Russian)
52. Mirzaev, N.N. Application of the IWRM principles to the Akburasai river basin. In *Problems of Ecology and Use of Water Land Resources in the Countries of Eastern Europe, Caucasus and Central Asia*; Dukhovny, V.A., Ed.; SIC ICWC: Tashkent, Uzbekistan, 2010; pp. 167–176.
53. Shozimov, P.; Beshimov, B.; Yunusova, K. The Ferghana Valley during perestroika, 1985–1991. In *Ferghana Valley: The Heart of Central Asia*; Starr, F., Beshimov, B., Bobokulov, I., Shozimov, P., Eds.; M.E. Sharpe, Inc.: New York, NY, USA, 2011; pp. 178–204.
54. Wegerich, K. Unpacking the disconnect of hydraulic mission and loss of water control: Three decades of external and internal changes and their implication for water management for the irrigation bureaucracy in Ferghana province/Uzbekistan. forthcoming.
55. *Analysis of Contemporary Conditions in the Aral Sea Basin and Use of Land-Water Resources of the Uzbek SSR*; Ministry of Melioration and Water Resources of the Uzbek SSR: Tashkent, Uzbekistan, 1991. (In Russian)
56. Wegerich, K. Shifting to hydrological/hydrographic boundaries: A comparative assessment of national policy implementation in the Zerafshan and Ferghana Valleys. *Int. J. Water Resour. Dev.* **2015**, *31*, 88–105.
57. 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.
58. Strategy and Project Activities to Support Improved Regional Water Management in Central Asia, prepared by the United Nations Development Programme (UNDP), July 2004. Available online: http://waterwiki.net/images/5/53/UNDP-CA-Reg_Water_proposal_and_strategy_for_EU_clean.doc (accessed on 10 March 2015).
59. Czerniecka, K. *The State at Its Borders: The Internal Dimensions of Kyrgyzstan's Border Security*; Central Asia Security Policy Brief No. 4; OSCE Academy in Bishkek, GCSP: Bishkek, Kyrgyzstan; Geneva, Switzerland, 2011.