

## Chapter 9

# From Upscaling to Rescaling: Transforming the Fergana Basin from Tsarist Irrigation to Water Management for an Independent Uzbekistan

Hermann Kreutzmann

**Abstract** The Fergana Valley is regarded as one of the most fertile irrigated oases in Asia. The genesis of these highly productive agricultural lands is the result of a lengthy process that originated long before the Kokand Khanate controlled most of the valley. Major transformations occurred during Tsarist Russian rule when the upscaling of this irrigated land commenced and when Fergana was integrated into long-distance exchange networks. Major water works were planned, but only implemented in a massive fashion during Soviet rule with its major campaigns for modernisation and planning on a large scale. Cross-border management was established in the highly integrated water scheme at the same time. Rescaling is a challenge of contemporary times with the pressures of globalisation, independent Uzbekistan's dependence on water supplies from its neighbours who share the Fergana Valley's hydraulic resources and the conditions governing the cotton world market.

**Keywords** Post-socialist transformation • Modernisation • Path-dependent development • Central Asia • Aral Sea • Fergana Valley • Water management • Water conflicts • Major water engineering projects

## 9.1 Introduction

The waters of the Oxus and Yaxartes still flow into Lake Aral. The great task of the future will provide work until the last drops of these rivers have been diverted to agriculture. Realize this: not until Lake Aral is dry need we expect an end to the development of the country between the rivers; until then we can expect a steady increase of produce and population. Realize this, and you then know what it means to speak of the future of the Duab. (Read on 27 March 1907 by Willi Rickmers (1907, p. 8) at the Central Asian Society in London)

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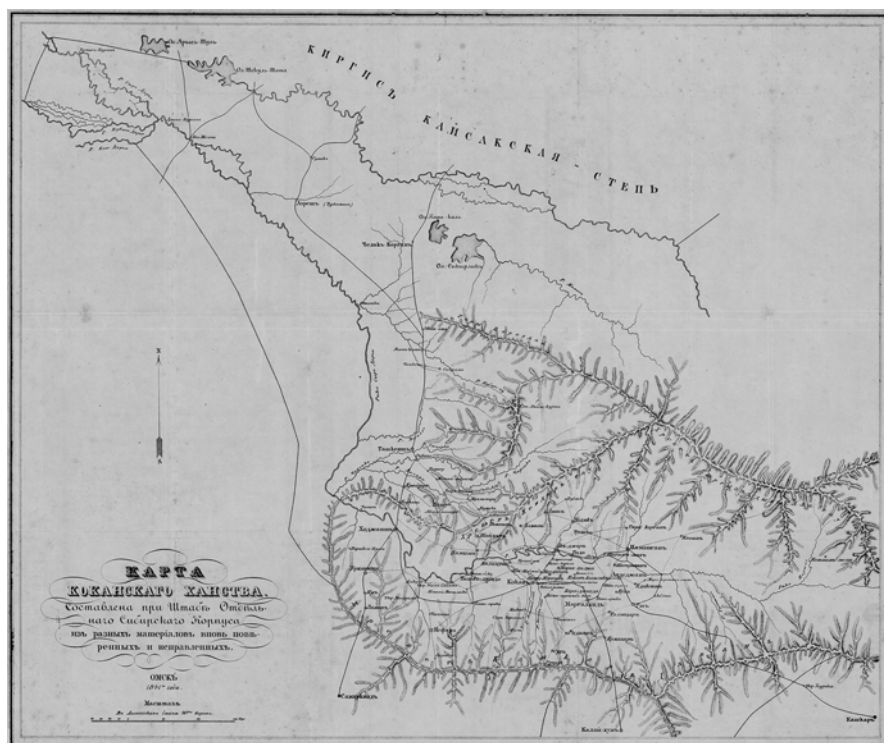
Major water engineering projects (MWEPs) have been held up as significant symbols of modernisation. Technological approaches address the power and potential of ecological and societal transformation. Most of the major projects are located in areas with antecedents. Some of these have been irrigation hubs since ancient times. The Fergana Valley is no exception to this widespread phenomenon (Fourniau 2000; Francfort and Lecomte 2002; Cariou 2004). Known for its fertility in the midst of an arid environment, the utilisation of the Syrdarya waters formed the basis of a success story of the upscaling, expansion and extension of irrigation which, in turn, lead to the drying-up and shrinking of Aral Sea with all its consequences. The nineteenth-century Russian administrator and scholar Aleksandr Fedorovich Middendorff said that

[...] over thousands of years the populace had constructed huge water channels, carried out large-scale fertilization and planted whole forests of shade-giving trees for fruits and wood, with 'each individual tree being in need of life-giving water'. The Kokandis planted fields of wheat, barley, millet sorghum, corn, rice beans, sesame, flax, hemp, cotton, and alfalfa while their gardens included melons, water melons, cucumbers, pumpkins, grapes, apricots, peaches, apples, pears, quinces, nuts, plums, cherries, not to mention onions, carrots, beets and other produce. The main grain crop was wheat, which Kirghiz cattle ranchers raised on the lower slopes of the Alai range as a kind of side business. [...] The expansion of irrigation after the early eighteenth century increased the number of villages and reduced the area available for grazing. Cotton growing always had held a special place throughout the Kokand Khanate, but in the nineteenth century farmers also began cultivating American long-fibred hybrids. (Middendorff 1882, pp. 11–12)<sup>1</sup>

This stated diversity of cultivars hints at the enormous fertility attributed to the Fergana Valley, the tradition of cotton cultivation prior to Russian colonisation and an early inclination to produce market-oriented cash crops. In the contemporary context, only cotton and wheat are discussed as the leading cash and subsistence crops of independent Uzbekistan. Cotton has been identified as the most controversial crop, the importance of which Max Spoor (2007) questioned as either a “curse” or “foundation for development”.

Through several transformations, the Fergana Valley has come a long way from the fertile hub of the Kokand Khanate (Fig. 9.1) to a tripartite bone of contention shared by Kyrgyzstan, Tajikistan and Uzbekistan. Looking at the path-dependent development of the growing irrigation systems in the Fergana Valley, the impact of modernisation as the guiding principle for transforming economy and society demands further analysis. The nexus of colonial/imperial domination and the experiment of modernising and expanding the water sector need to be explored to shed some light on the effects of upscaling an irrigation network and the challenges of rescaling in recent times. Imperial attitudes and boundary making during the latter half of the nineteenth century shifted borders as the result of the *Great Game* and have changed scale over time (Kreutzmann 2013a). The reconfiguration of territoriality poses an interesting challenge in understanding the impact on a “fixed infrastructure” such as the MEWP in the Fergana Valley. Borders have been shifted over time; the extent of controlled catchment areas, the size of the water management

<sup>1</sup> Middendorff (1882, pp. 11–12); quoted according to the translation of Dubovitskii and Bababekov (2011, p. 58). See as well Joffe (1995, p. 369).



**Fig. 9.1** One of the earliest maps of the Fergana Valley was produced in Omsk in 1841 and published in St. Petersburg in 1849. It shows the Fergana Valley as a unit and as dominated by the Kokand Khanate (Source: *Zapiski Russkago Geograficheskago Obshchestva* 1849)

system and the socio-economic environment have experienced several transformations. The present-day challenge of adjusting the irrigation network's functioning to new borders, conflicts among neighbours and global relations needs further reflection when taking Neil Brenner's statement into context emphasising the interrelationship of these processes characterised as "[...] the deterritorialisation of social relations on a global scale [that] hinges intrinsically upon their simultaneous reterritorialisation on sub-global scales within relatively fixed and immobile configurations of territorial organisation" (Brenner 1999, p. 62). We will trace and link the effects of globalisation and modernisation to path-dependent developments in the Fergana Valley with its creation of a complex network of interconnected rivers and main canals. We will look at the existing system as a historico-genetic product faced with contemporary challenges differing significantly from the frame conditions and traits they initiated. And based upon the following overview of salient features that frame the modes of operation of this MWEP, we will highlight three aspects to assess the challenges Uzbekistan is confronted with in Fergana. First, the often neglected Tsarist strategy of modernisation, its emphasis on cotton cultivation and its transition and translation into the Soviet cotton-based growth model for "white gold" in the Fergana Valley; second, the challenges of spatial rescaling

following Uzbekistan's independence; and, third, the constraints of operating a system that is presently heavily dependent on good relations with neighbourly and favourable global market conditions.

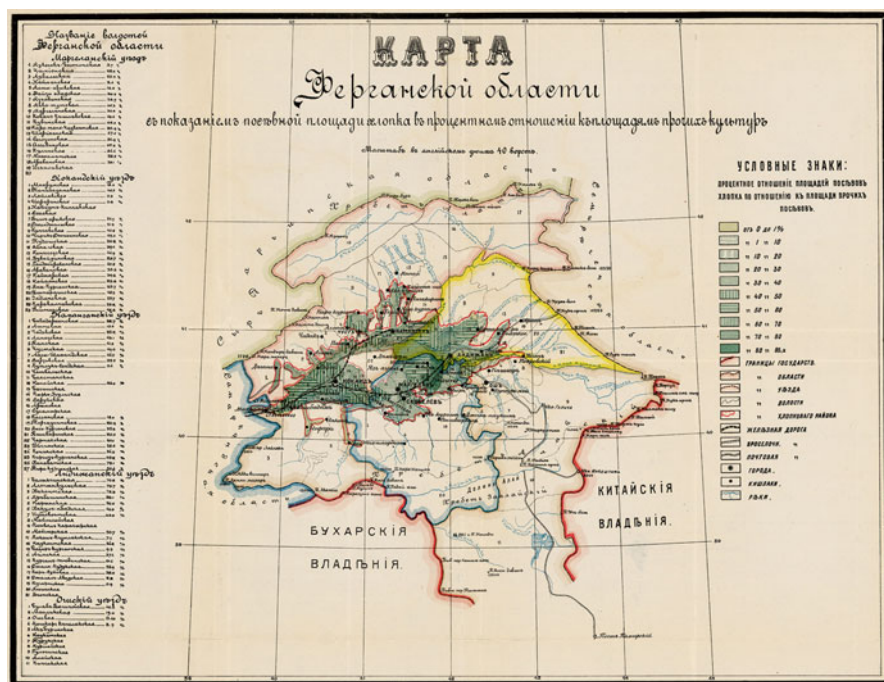
## 9.2 Salient Features of Fergana's Irrigation System

Among the six major Asian river basins – Brahmaputra, Indus, Ganges, Mekong, Amudarya – the Syrdarya with a catchment of 402,760 km<sup>2</sup> with a mean annual flow of 39 km<sup>3</sup> is by far the smallest, but with operational challenges in maintenance and constraints similar to the others (Savoskul and Smakhtin 2013, p. 2). During the last half century, the flow characteristics of the Syrdarya have significantly changed: snowmelt contribution decreased by one-fifth, while the share of glacier runoff increased. Various calculations suggest a marginal impact on future annual water flows and quantities available, but changes to seasonal irrigation water availability with less water in spring and summer and higher shares in autumn and winter (Savoskul and Smakhtin 2013, p. vii, 35). Such a shift will detrimentally affect the cultivation patterns that depend on summer cultivation and winter flooding for drainage.

A century ago the Fergana Valley (Fig. 9.2) constituted one-third of all irrigated lands in the territories that are now Uzbekistan and provided nearly two-thirds of all Central Asian cotton for the Russian textile industry (Pierce 1960, p. 169; Thurman 1999, pp. 11–12).<sup>2</sup> The expansion of cultivated land has been substantial: in 1930 the irrigated land in Fergana accounted for 530,000 ha and was increased to 650,000 ha by 1950. In the post-Stalin era, a major boost during the *Virgin Lands Campaign* and subsequent developments led to an irrigated area of 1.5 million ha by 2005. The share of Uzbek Fergana alone doubled between 1924 and 1985 to 800,000 ha (Bichsel and Mukhabbatov 2011, p. 254; Wegerich et al. 2012, p. 550).<sup>3</sup> While the share of cotton was only 9.6 % in the Fergana Oblast' in 1885, it increased to 42.0 % by the end of the Tsarist rule. Within the Fergana Districts of the Uzbekistan Socialist Soviet Republic, its share was more than three quarters in 1930 and fell to 62.3 % by the end of the Soviet rule (Bichsel 2009, p. 17). Overall, Fergana mirrors the trend in cotton production which itself seems to have been defined as the backbone of Soviet agrarian science and proof of technological development. For the time between 1913 and 1990, Uzbekistan's record contains a four-fold expansion in the area of cotton cultivation, an increase in output by a factor of ten, and the yield per hectare rose from 1.2 to 2.8 t/ha (Spoor 2007, pp. 58–59). In contrast, wheat production decreased during the Soviet period. Emphasis was put

<sup>2</sup>By the turn to the twentieth century, the Russian textile industry imported 36 % of its raw cotton from the three Central Asian cultivation areas in Bukhara, Fergana, and Khiva (Joffe 1995, p. 369).

<sup>3</sup>For the earlier periods a growth in irrigated lands took place in Fergana Oblast from 593,246 ha in 1885 to 833,850 ha in 1916; during the transition a decrease to 322,640 ha from a share of 42.0–5.7 % of cotton cultivation occurred until 1922, and a subsequent recovery with high growth rates was on record (Thurman 1999, pp. 264–265).



**Fig. 9.2** Map of Fergana Oblast showing the percentage shares of cotton (green shading in the legend) in comparison to other crops in the irrigated lands in 1913. The urban centres within the cotton-growing areas were Andijan, Kokand, Margilan, Namangan and Skobelev (Source: Ponyatovsky 1913)

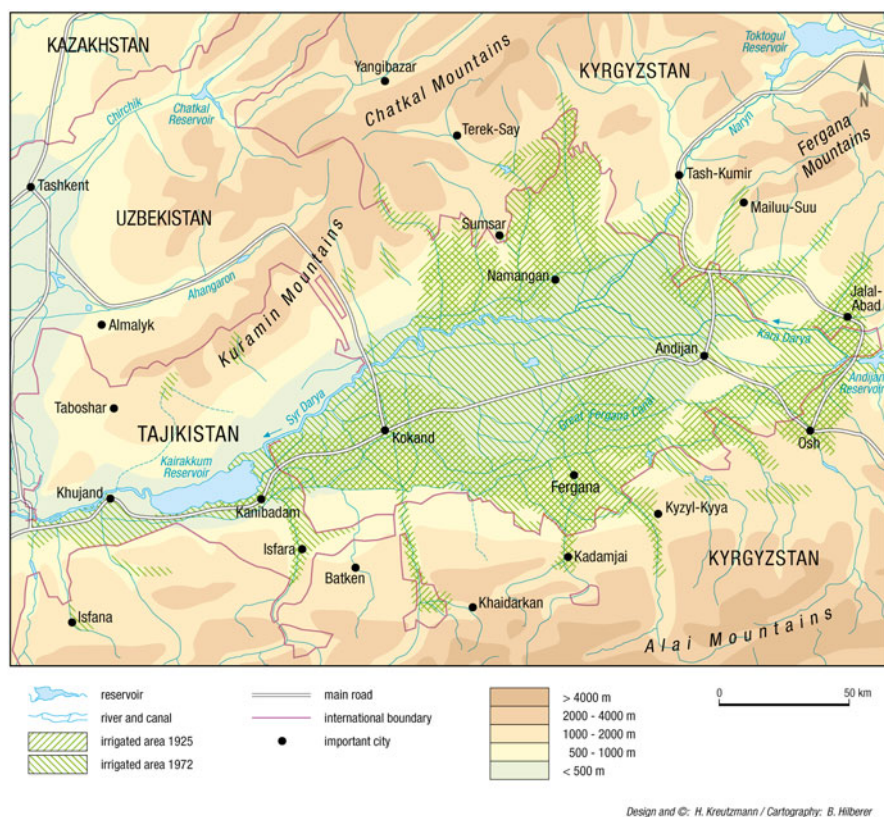
on cotton cultivation, which has remained the leading crop under state conditions, despite wheat production share significantly increasing in recent years. Uzbekistan is setting an impressive example by presently generating 82.9 % of its wheat consumption from domestic production, while this share from own production was only 14.3 % when it became independent. In 2011 Uzbekistan remained ranked sixth among world cotton suppliers with 983,000 t (Perekhozhuk et al. 2013). Fergana has remained one of the prime suppliers of raw cotton as the processing industries were mainly located far away in the industrial centres of the West.

### 9.3 Historical Setting of Tsarist Plans to Utilise Central Asian Water Resources to Large-Scale Soviet Irrigation in the Fergana Valley

With the conquest of the Kokand Khanate in 1876, the Fergana Oblast of the General Governorate Turkestan was established and promoted cotton production for the up-and-coming Russian industry (Thurman 1999). The establishment of major







**Fig. 9.4** Comparison of irrigated areas in the Fergana Valley 1925 and 1972 (Source: own design based on Bulaevskii 1925 and Benyaminovich and Tersitskii 1975)

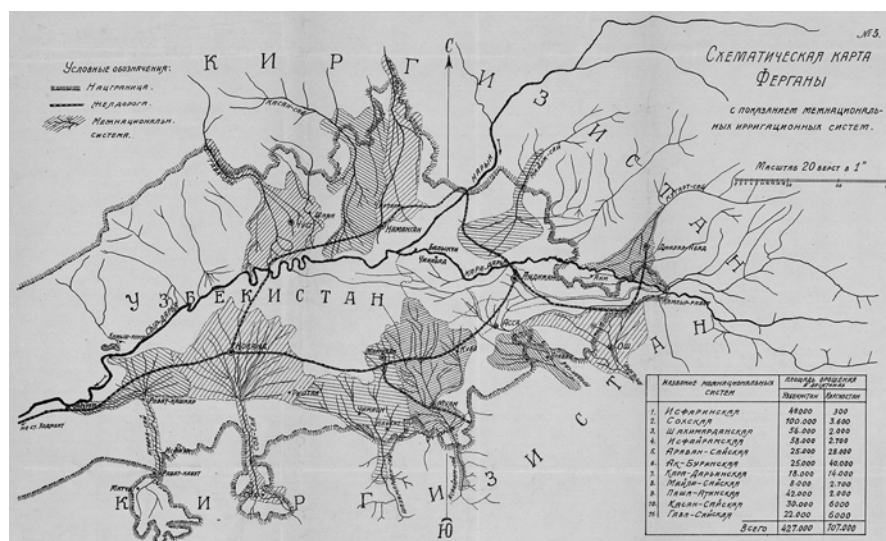
Soviet rule divided existing territorial units, created new republics and, at the same time, integrated them under the roof of a political union. The creation of eponymous republics – meant to respect and to reflect the ethnic divide in Central Asia – and the implementation of autonomy policies that lacked any sense of autonomous decision-making (Kreutzmann 2013b) provided the blueprint for profound interference to the socio-economic structures of the formerly independent khanates and administratively divided the Fergana Valley along newly created and delineated boundaries. Other reforms such as collectivisation of productive resources, the introduction of central planning, and expansion of communication infrastructure on the Soviet Union’s scale and the supply of citizens with similar sets of low-cost consumer goods indicate the centralised approach in state organisation.

Plans to expand the irrigation system and to integrate the long-distance water management in a scientific approach to agrobusiness and agricultural technologies, as well as raising it to become part of the industrial processing of agricultural goods,

gained significant momentum after 1930 when major economic reforms and social transformations had been accomplished. The construction and maintenance of these complex major irrigation systems were made possible at the highest level of planning and implementation (Fig. 9.4). The Soviet Ministry of Land Reclamation and Water Resources (*minvodkhoz*) was the highest hydraulic authority with regional water resources management departments (*oblvodkhoz*) with several name changes over time: *Turkvodkhoz* (Turkistan Water Management Department of the People's Commissariat of Agriculture 1918–1924), *Uzvodkhoz* (Uzbekistan Water Management Department of the People's Commissariat of Agriculture 1925–1931), *Glavvodkhoz* or *TsJUPR* (Chief Administration of Water Management 1931–1938), *Uzvodkhozi* (Uzbekistan People's Commissariat of Water Management, part of *Narkomvodkhoz* (People's Commissariat of Water Management 1938–1946)) and *Minvodkhoz* (USSR Ministry of Water Management 1946–1991, containing *Uzminvodkhoz* (Uzbekistan Ministry of Water Management, since 1946)). The lower level was structured by district water resources management departments (*rayzemvodkhoz* (1930–1938); *rayvodkhoz*, since 1938) and organised the supply for the collective farms (*kolkhoz*, *sovkhoz*) (Thurman 1999, p. 263). Within the agricultural sector the professional decision-making capacity of the farm worker (*dehqan*) continuously declined, a phenomenon that served the needs of superordinate administrators and made them powerful controllers. Generic bureaucrats made “expert” decisions and instructed the farm workers what they should do on the fields. This approach has persisted until today in the guise of water user associations.

The principle of water management was governed by a hierarchical territorial approach rather than by a hydraulic or catchment area-based one. The centralised economic planning fulfilled two objectives. First, it fitted in the grand plan for the Soviet Union, by attributing certain tasks to individual republics, and even districts, by setting production standards and objectives for resource allocation and production; second, it took into consideration the specific needs of different republics and created a certain degree of lower-level authority. Many statistics and accounts were produced on the administrative level of republics although central rules and regulations were applied. In the case of Fergana, water management followed a holistic approach by integrating territories from three neighbouring republics into one system, but attributing production figures to republics and recording on state levels (Fig. 9.5). The success of Uzbekistan's economy was solely judged upon cotton production (Obertreis 2007, p. 171). Indigenous knowledge and local expertise were completely refuted; modernisation strategies based on science and technology were expected to replace and surpass them. Jonathan Thurman is explicit in stating about Fergana: “[...] the ‘cradle’ of irrigated cotton growing in Central Asia. Indigenous modes of organisation that effectively fostered farmer participation here were undermined by a colonising power, which transformed them into state-dominated organisations incapable of effective management” (Thurman 1999, p. iv). The quest for modernisation was the same in Tsarist Russia and the Soviet Union. Both regimes utilised Central Asia as supplier of raw materials needed for its





**Fig. 9.5** Schematic map of the Fergana Valley [Skhematicheskaya karta Fergany s pokazaniem mezhnatsionalnykh irrigatsionnykh sistem] showing the Soviet Union's trans-boundary irrigation system and the irrigated areas in Kyrgyzstan (107,000 dessiatines, one dessiatine equals 1.0925 ha) and Uzbekistan (427,000 dessiatines) in 1925 (Source: Bulaevskii 1925)

industries in the western parts of the empire.<sup>4</sup> The share of regional processing of cotton never reached significant proportions. The newly introduced boundaries did not significantly affect the everyday life of people, their communication and travel. The effect of these borders became severely felt after the independence of the Central Asian republics in 1991.

## 9.4 Geographical Rescaling After Independence

Independence in the Central Asian republics in 1991 brought about functioning borders, something hitherto unknown. Conflicting interests of independent countries resulted in a multitude of unsolved problems. One was the delineation of international boundaries. In the aftermath of the dissolution of the Soviet Union, the

<sup>4</sup>In his assessment of the Fergana experiment, Jonathan Thurman (1999, p. 222) is highly critical about its function: "Under Stalin, the Ferghana Valley had the misfortune of becoming the Soviet model for an irrigated agricultural zone in the East. It was here that planned delivery of water in Central Asia was first applied and tested, and that cotton cultivation reached the most absurd proportions. Construction and maintenance programs focused on Ferghana as if it were another republic, separate from the rest of Uzbekistan. Throughout the Stalin era, the Soviet media commonly spoke of 'transferring the Ferghana experience' in irrigation to other areas of Central Asia. This would be done after World War II, with disastrous results".



**Fig. 9.6** Enclaves and exclaves in the borderlands of Tajikistan, Kyrgyzstan and Uzbekistan after independence (Source: modified after Kreutzmann 2013a, p. 18)

Moscow Institute of Political Geography conducted a survey in 1992 and recorded 180 border and territorial disputes among new neighbours (Halbach 1992, p. 5). A few cases illustrate the range of conditions and demands in Central Asia: irredentist movements in Turkmenistan expect Uzbekistan to “return” the territory of the Khanates of Khiva and Khorezm. The long-standing demand of Tajik nationalists has been reiterated that Samarkand and Bukhara as the centres of Tajik culture must be “returned”. The divide of Fergana into three sections is questioned, and the present-day economic and commercial centre of Southern Kyrgyzstan – Osh Oblast’ – is claimed by Uzbekistan. A multitude of legal documents about boundary decisions taken in the 1920s concerning territorial issues in Central Asia are archived in Tashkent. The Uzbekistan government blocks access to researchers from neighbouring countries wanting to consult the archival material.

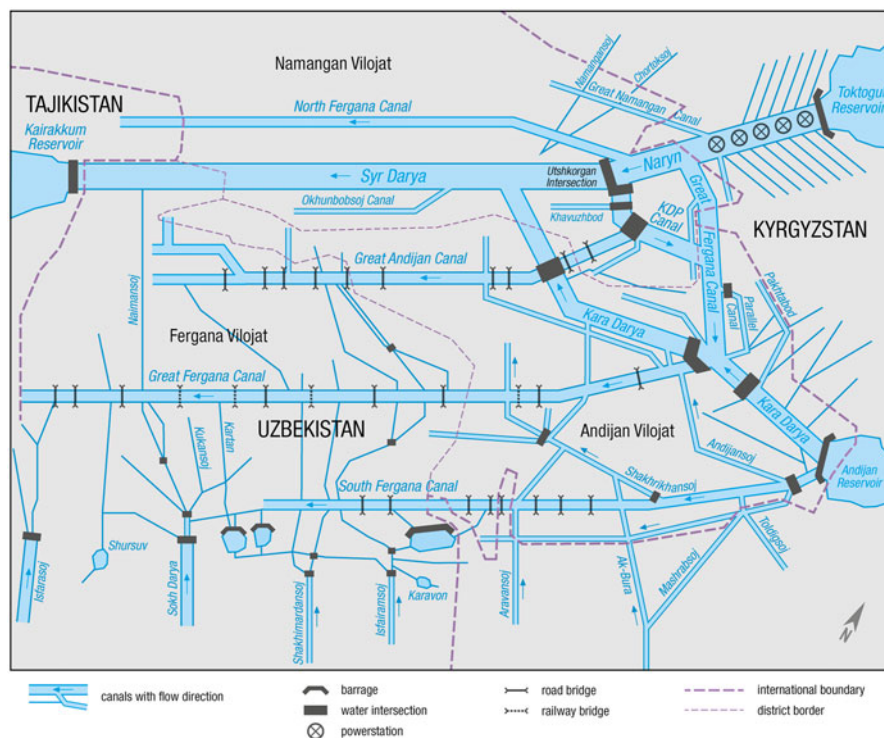
The Fergana and Alai Valleys alone contain seven enclaves and exclaves through which major traffic routes lead and which are valuable resource-rich areas (Fig. 9.6). Regularly, the freedom of travel is affected, especially when diplomatic relations worsen. The inhabitants of these enclaves have become pawns in bilateral negotiations. Some of the border closures have been justified in the aftermath of attacks from Afghanistan-trained rebels, which plundered Tajik and Kyrgyz villages on their way to the Fergana Valley in 1999 and 2000. Territorial rescaling has been one of the major challenges for post-Soviet societies far beyond the unsolved issues of commanding a compact state territory, mutually accepted international boundaries and respective sovereignty.<sup>5</sup>

<sup>5</sup>The Central Asian republics are facing challenges that are well known from other irrigation networks that had to be divided such as the Indus waters between India and Pakistan in the process of decolonisation (Kreutzmann 2011).

Following independence, Fergana's water management system faced similar challenges. The irrigation network was implemented at a time when no boundaries affected the decision-making of concerned engineers and politicians. The meshed system of canals and reservoirs had emerged from a genetic expansion of irrigation from Tsarist to Soviet times (Fig. 9.7). Previously, abundant quantities of water were available; post-Soviet management had to cope with the challenges of importing water from neighbours and sharing the network across borders.

The legacy of past decisions and constructions is an in-built factor of the Fergana system that is represented in the structural pattern of the existing meshed system, the incorporation of new additions to the system by sharing the available water and the organisation seasonal shifts in a decentralised balancing of flow characteristics. Kai Wegerich et al. (2012) have analysed the hydrological constraints and its consequences:

In the past, a management regime was implemented that fitted the state objective (expansion of the state order on cotton production) regardless of sources, distances, inter-linkages, and



**Fig. 9.7** The present state of Uzbekistan's irrigation network in the three bordering provinces (Viloyat Andijan, Fergana and Namangan) with Kyrgyzstan's share in the East and Tajikistan's share in the West of the Fergana Valley. All major reservoirs are located outside of Uzbekistan's direct control and influence (Source: own design based on management plans displayed in various offices of Uzbekistan's irrigation authorities in the Fergana Valley in 2014)

costs. Obviously, the past objectives are reflected in the current design of the system; consequently, it may not be possible to implement new objectives regarding water management and governance at the sub-catchment and irrigation system levels without adjusting and modifying the original design. (Wegerich et al. 2012, pp. 562–563)

In their opinion any institutional and/or technical restructuring requires a thorough analysis of the complexities of the existing meshed system in order to identify the spatial and organisational units where reforms could be implemented (Wegerich et al. 2012, p. 563). The authors conclude that only a far-reaching reconstruction and adaptation of the water management system would be feasible for smooth future operations. Beyond hydrological considerations, the question of the water source occurs. The Fergana Valley taps most of its irrigation water from the Syrdarya via Toktogul Reservoir and the Kara Darya via the Andijan Reservoir, both of which are located in Kyrgyzstan. Since the Kyrgyz government has adopted its authority over the management of their water resources, the dispute about the allocation of river water is regularly revived when it comes to compensation measures and contribution to the actual costs for providing network maintenance and supply of water. A water treaty was approved by the four Central Asian neighbours in Almaty in 1992 which allocated fixed shares of the Syrdarya water: Kyrgyzstan 1 %, Tajikistan 9.2 %, Kazakhstan 38.1 % and Uzbekistan 51.7 % (Bichsel and Mukhabbatov 2011, pp. 261–263). The water key will need to be renegotiated as Kyrgyzstan is in the process of expanding its energy-producing sector and its irrigated agriculture. The recent signing of the Central Asia South Asia Electricity Transmission and Trade Project (CASA-1000)<sup>6</sup> project treaty and its financing by the World Bank for the transmission of hydroelectricity from Kyrgyzstan's "surplus" production to Afghanistan and Pakistan via Tajikistan affects the weak equilibrium between Uzbekistan and Kyrgyzstan and changes the latter's bargaining power. Consequently, the political dimension of negotiating exchange of water for monetary funds or energy will gain momentum in the future. Ecological constraints such as growing water logging and salinisation, as well as disputes in times of scarce seasonal supply, have aggravated the situation between competitors along the Syrdarya (UNEP et al. 2005, p. 24; Bichsel and Mukhabbatov 2011, p. 264). It appears that the quality of water and land in terms of salt content and contaminations is significantly deteriorating, although the quantity of available irrigation water is estimated and projected not to dwindle.

## 9.5 Persistence and Change Within Uzbekistan's Water Management

Given these major challenges, it is surprising how many elements of a powerful reluctance to change can be observed in the Fergana Valley. The institutional set-up has maintained its overall control over all operations despite opening up to world

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<sup>6</sup> See for details and maps [www.casa-1000.org](http://www.casa-1000.org).

market conditions for the export of cotton and its processed products and in spite of a quest for privatisation in land holdings. The farmer seems to be the least involved actor in making any decisions about cultivation patterns, timing of water allocation and selection of agricultural inputs. Water user associations have given a new name to the old control mechanism. The water management system in Fergana seems to be the least in line with the changed conditions and with the changing conditions of a growing population and expanding demands of the up-and-coming generation. The latest report by the International Crisis Group (ICG) (2011) on “water pressures in Central Asia” states that “[t]he concerns Crisis Group identified in 2002 – inadequate infrastructure, poor water management and outdated irrigation methods – remain unaddressed, while the security environment is bleaker”. The ICG recommends to the governments sharing the Fergana Valley: “Commit to resolving border demarcation problems without using water or energy as a coercive factor; facilitate cross-border cooperation between police forces and form a tripartite intra-regional council to oversee day-to-day management of water and land resources parallel to high-level border delimitation negotiations”.<sup>7</sup> The hydraulic constraints that were imposed on Kyrgyzstan, Tajikistan and Uzbekistan after independence remain to be the result of path-dependent developments from Tsarist and Soviet legacies. Rescaling could become a necessity if no consensus among neighbours can be accomplished that serves the purpose. Rescaling is a major challenge in changing the rules of the game within respective countries. It seems that practical measures to address the challenges of rescaling the water management system require a transformative spirit from both inside and outside of the Fergana Valley.

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## References

- Benyaminovich ZM, Tersitskii DK (1975) Irrigation in Uzbekistan II. Fan Publishing House, Tashkent (in Russian)
- Bichsel C (ed) (2009) Conflict transformation in Central Asia. Irrigation disputes in the Ferghana Valley. Routledge, Abingdon
- Bichsel C, Mukhabbatov K (2011) Land, water, ecology. In: Starr FS, Beshimov B, Bobokulov II, Shozimov P (eds) Ferghana valley. The heart of Central Asia. M. E. Sharpe, Armonk/London, pp 253–277
- Brenner N (1999) Beyond state-centrism? Space, territoriality, and geographical scale in globalization studies. *Theory Soc* 28:39–78. doi:10.1023/A:1006996806674
- Cariou A (2004) Le jardin saccagé. Anciennes oasis et nouvelles campagnes d'Ouzbékistan. *Ann Geogr* 113:51–73

<sup>7</sup> See the detailed Europe and Central Asia Report No. 233, released on 9 September 2014 at [http://www.crisisgroup.org/en/regions/asia/central-asia/233-water-pressure-in-central-asia.aspx?utm\\_source=central-asia-report&utm\\_medium=1&utm\\_campaign=mremail](http://www.crisisgroup.org/en/regions/asia/central-asia/233-water-pressure-in-central-asia.aspx?utm_source=central-asia-report&utm_medium=1&utm_campaign=mremail) (=http://tinyurl.com/ocbbkln) and accessed on 12 September 2014.



- Dubovitskii V, Bababekov K (2011) The rise and fall of the Kokand Khanate. In: Starr FS, Beshimov B, Bobokulov II, Shozimov P (eds) *Ferghana valley. The heart of Central Asia*. M. E. Sharpe, Armonk, pp 29–68
- Fourniau V (2000) Some notes on the contribution of the study of irrigation to the history of Central Asia. In: Kreutzmann H (ed) *Sharing water. Irrigation and water management in the Hindukush-Karakoram-Himalaya*. Oxford University Press, Oxford/New York, pp 32–54
- Francfort H-P, Lecomte O (2002) Irrigation et société en Asie centrale des origines à l'époque achéménide. *Ann Hist Sci Soc* 57:626–663. doi:[10.3406/ahess.2002.280068](https://doi.org/10.3406/ahess.2002.280068)
- Halbach U (1992) Ethno-territoriale Konflikte in der GUS. Bundesinstitut für ostwissenschaftliche internationale Studien, Köln
- Hauner M (1992) What is Asia to us? Russia's heartland yesterday and today. Routledge, London
- International Crisis Group (2011) Water pressures in Central Asia. International Crisis Group, Brussels
- Joffe M (1995) Autocracy, capitalism and empire: the politics of irrigation. *Russ Rev* 54:365–388
- Kreutzmann H (2011) Scarcity within opulence: water management in the Karakoram Mountains revisited. *J Mt Sci* 8:525–534. doi:[10.1007/s11629-011-2213-5](https://doi.org/10.1007/s11629-011-2213-5)
- Kreutzmann H (2013a) The significance of geopolitical issues for internal development and intervention in mountainous areas of Crossroads Asia. [http://www.geo.fu-berlin.de/geog/fachrichtungen/anthrogeog/zelf/Medien/download/Kreutzmann\\_PDFs/HK\\_Crossroads\\_Asia\\_WP07\\_Jan2013.pdf](http://www.geo.fu-berlin.de/geog/fachrichtungen/anthrogeog/zelf/Medien/download/Kreutzmann_PDFs/HK_Crossroads_Asia_WP07_Jan2013.pdf). Accessed 4 Sept 2014
- Kreutzmann H (2013b) Boundary-making as a strategy for risk reduction in conflict-prone spaces. In: Müller-Mahn D (ed) *The spatial dimension of risk. How geography shapes the emergence of risks*. Routledge, Abington/New York, pp 154–171
- Middendorf AF (1882) *Ocherki Ferganskoi doliny*. Academy of Science Publishing, St. Petersburg (in Russian)
- Obertreis J (2007) Infrastrukturen im Sozialismus. Das Beispiel der Bewässerungssysteme im sowjetischen Zentralasien. *Saeculum* 58:151–182
- Perekhozhuk O, Bobojonov I, Glauben T (2013) Immer mehr, aber nicht genug. Über die wachsende Bedeutung von Weizen in Zentralasien. *Zentralasien-Analysen* 72:9–17
- Pierce RA (1960) *Russian Central Asia, 1867–1917: a study in colonial rule*. University of California Press, Berkeley
- Rickmers W (1907) *Impressions of the Duab (Russian Turkestan)*. Central Asian Society, London
- Savoskul OS, Smakhtin V (2013) Glacier systems and seasonal snow cover in six major Asian river basins: hydrological role under changing climate. International Water Management Institute (IWMI), Colombo
- Spoor M (2007) Cotton in Central Asia “curse” or “foundation for development”. In: Kandiyoti D (ed) *The cotton sector in Central Asia economic policy and development challenges*. The School of Oriental and African Studies, London, pp 54–74
- Thurman J (1999) *Modes of organization in Central Asian irrigation: the Ferghana Valley, 1876 to present*. Dissertation, Indiana University
- UNEP, UNDP, OSCE, NATO (2005) *Environment and security. Transforming risks into cooperation*. Central Asia: Ferghana/Osh/Khujand area. United Nations Environment Programme (UNEP), Geneva
- Wegerich K, Kazbekov J, Mukhamedova N, Musayev S (2012) Is it possible to shift to hydrological boundaries? The Ferghana Valley meshed system. *Int J Water Res Dev* 28:545–564. doi:[10.1080/07900627.2012.684316](https://doi.org/10.1080/07900627.2012.684316)

## *Map References*<sup>8</sup>

- Bulaevskii VF [Булаевский В.Ф.] (1925) Interethnic systems of Central Asia and form of their exploitation. In: Messenger of irrigation. No. 11. November 1925. Tashkent [Межнациональные системы Средней Азии и формы их эксплуатации. Вестник ирригации. № 11. Ноябрь. 1925 г. Ташкент]
- Glavnoe Upravlenie Zemleustroistva i Zemledeliya Otdel Zemel'nykh Uluchshenii (1914) Report of the hydro-module division for 1913. Moscow [Отчет гидромодульной части за 1913 год. Главное Управление Землеустройства и Земледелия Отдел Земельных Улучшений. Москва]
- Ponyatovsky SV [Понятовский С. В.] (1913) Experience of studying cotton cultivation in Turkestan and Trans-Caspian Province. V. F. Kirshbaum's printing house. St. Petersburg [Станислав Валентинович Понятовский (1913) Опыт изучения хлопководства в Туркестане и Закаспийской области. Типография В.Ф. Киршбаума, СПб]
- Zapiski Russkago Geograficheskago Obshchestva (1849) Map of the Khanate of Kokand prepared at the headquarters of the Separate/Special Siberian Corps on the basis of diverse checked and corrected materials, prepared in Omsk 1841. Scale: In one English inch 40 verst. St. Petersburg [Карта Коканского Ханства составлена при Штабе Отдельного Сибирского Корпуса из разных материалов вновь поверенных и исправленных, Омск 1841. Масштаб: В Англиском дюйме 40 верст. СПб]

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