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Energy Policy 35 (2007) 3815–3825

ENERGY POLICY

www.elsevier.com/locate/enpol

Reliving the past in a changed environment: Hydropower ambitions, opportunities and constraints in Tajikistan

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Received 17 November 2006; accepted 29 January 2007
Available online 13 March 2007

Abstract

In Central Asia, various arguments, ranging from a unifying purpose to political control to conflict potential, have been made about the relationship between downstream water utilisation and the upstream water control infrastructure. This paper analyses the construction and utilisation of the Nurek dam in Tajikistan during and after the break-up of the Soviet Union. The political and socio-economic changes that ensued after independence influenced the utilisation of the water control infrastructure. The new economic reorientation of Tajikistan demanded by the break-up caused concerns to downstream riparian states. The conflict potential is based not on water resource allocation, but on the utilisation of water for energy production, its control and transmission infrastructure. Even though there is conflict potential, the situation could be turned into a win–win situation for all the riparian states.

Keywords: Water control; Hydropower; Tajikistan

1. Introduction

It is common for tensions to arise between upstream and downstream users of large dams (e.g. the Attatürk Dam on the Euphrates river, the Pa Mong Dam on the Mekong river) in relation to the use of water resources. Nowadays, most of the discussion is based on who (population) and what (environment, cultural monuments, traditions) is affected by a dam's construction. In discussions on water management, the focus is on the basin level, and on integrated approaches. In the political discussions on the construction of large dams, these dams are mainly presented as zero-sum games, in which the upstream country has the benefits and the downstream country becomes in some way subservient. Once the dam is constructed, it often becomes a ''black box'' that appears to be independent of wider political and economic changes. After the break-up of the Soviet Union attention was first focused on the water-sharing agreements and only later did the attention shift to large dams as water control infrastructure in Central Asia.

Smith (1995, p. 351), looking at water-sharing arrangements, argues that ''nowhere in the world is the potential for conflict over the resources as strong as in Central Asia''. In addition to the issue of water resource allocation, the matter of water control infrastructure, i.e. the dams and reservoirs in upstream Kyrgyzstan and Tajikistan, has become a point of contention. O'Hara (2000) interprets the building of dams and reservoirs upstream in Central Asia as a political strategy. She reasons that under the Soviet Union the location had two advantages for Moscow and furthered its strategy of ''divide and rule''. First, ''disputes over water reinforced the national distinctiveness of the Republics, thus limiting the potential for regional cooperation which would threaten Soviet control. Second, as competition for water increased the Republics were forced to ask Moscow to intervene, a role it was more than willing to undertake'' (O'Hara, 2000, p.430). Hence, for O'Hara the main winner is neither downstream nor upstream, but Moscow as the political controlling system. Lange

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doi:10.1016/j.enpol.2007.01.024

(2001, p. 1), however, explains the dams in the Syr Darya basin in a non-political manner, stating, "the water management infrastructure was designed for a unified purpose and placed where it made sense". Hence, Lange sees the construction of dams upstream as a way to have full water control for downstream irrigated agriculture. According to this view, only downstream countries benefit. Similarly, Wegerich (2004) shows for the Syr Darya basin that the old, integrated management system with its issue linkage approach between water, energy and food benefited all the riparian states and offered a win–win solution. It is questionable whether any of these general arguments made for upstream water control infrastructure in Central Asia, or for the Syr Darya basin in particular, can be applied to the Amu Darya and the Nurek dam in upstream Tajikistan. Therefore, this paper critically analyses these perceptions about water control infrastructure with reference to the Nurek dam.

Currently, Tajikistan is planning to increase hydropower production by changing the Nurek dam's mode of operation and by recommencing the construction of the Rogun dam upstream of Nurek. Although Uzbekistan is opposing the plan on the grounds that the construction of the dam is a threat to its agricultural production (ICG, 2002, Spoor and Krutov, 2003), it is questionable whether a dam at Rogun could be correctly perceived as a threat to downstream interests. This paper analyses the anticipated changes to the Nurek dam's mode of operation and the Rogun construction plans in the changing socio-economic and political context.

The paper continues with a short framework section on provision infrastructure and water control. This is followed by a short introduction to the hydrological background of the Vakhsh River and the Nurek reservoir. The fourth section analyses the influence of the Nurek dam on agricultural production downstream, and the fifth section focuses on energy production and utilisation. The next section looks into the different plans proposed by Tajikistan to expand its hydropower production and energy export possibilities. The paper concludes that the construction of an additional dam could offer a basket of benefits for all the riparian states along the river's course and even beyond the basin.

2. Provision structures and water control

Trans-boundary rivers can be classified as common pool resources (CPRs), that is, resources that are utilised by two or more users. Ostrom et al. (1994) distinguish between two types of CPR problems: appropriation and provision. The appropriation problem of a CPR relates to the subtractability of the benefits consumed by one member from those available to others. Provision problems relate to the operation and maintenance (O&M) of the resource delivery system. In this sense, a dam during the initial period of filling the dead storage creates an appropriation problem, but during its lifetime continuous siltation reduces the initial appropriation problem annually. Whereas the dead storage creates an appropriation problem, the live storage creates a provision problem in terms of the operating system and maintenance of the dam. All in all, it appears that the provision problem is the most dominant.

In addition to the technical question, control is another important factor in relation to provision structures. Mollinga (2003, p.35) reasons that "water control refers to managerial control of the water distribution process, and other organisational processes"; in terms of a dam, the definition could be expanded to include hydropower, and its distribution network. The socio-economic and political conditions shape what happens in the basin, and the water control practices within the basin have implications for the evolution of these conditions.

Not every upstream resource utilisation subtracts benefits from the downstream users. In the case of water for upstream hydroelectric power production and for downstream-irrigated agriculture, a win–win or a zero-sum solution is possible. A win–win solution occurs when water is released in the period when both sectors can utilise the water at the same time. However, releases in a time period in which the water is not needed for irrigation implies benefits for the energy sector and no benefits for the irrigation sector. Hence, subtractability of benefits is dependent on other factors, such as method of utilisation and time.

If the Nurek reservoir was constructed to increase interdependencies between the Central Asian countries, then one could assume that the dam was constructed either to support agricultural production downstream or to supply hydropower to neighbouring states with high electricity demand.

3. Hydrological background information

The Amu Darya is the largest river in Central Asia. It is formed by the confluence of its main headwater tributaries, the Vakhsh and Pyanj Rivers. The total length of the Amu Darya from the head of the Pyanj River to the Aral Sea is about 2540 km, whereas the length from the river confluence is 1415 km (Froebrich and Kayumov, 2004). The catchment area (Fig. 1) of the Amu Darya basin comprises 309,000 km^2 and is shared by Afghanistan and four Central Asia Republics: Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

The Vakhsh river, also known as Kyzyl-Suu in Kyrgyzstan and as the Surkhob in north-central Tajikistan, originates in the alpine regions of the Pamir Alai in the south-east of Kyrgyzstan, where parts of the Abramov glacier and the Fedchenko glacier contribute to the runoff generation.[1] The Vakhsh River flows from north-central

[1]The Pyanj originates at the glacier in the Vakjdjir Pass and forms the border between Afghanistan and Tajikistan. The tributaries of the Pyanj are located in Afghanistan and Tajikistan. The major tributaries from Afghanistan are the Wakhan, Pamir, Badkhshan and Kokcha. The major

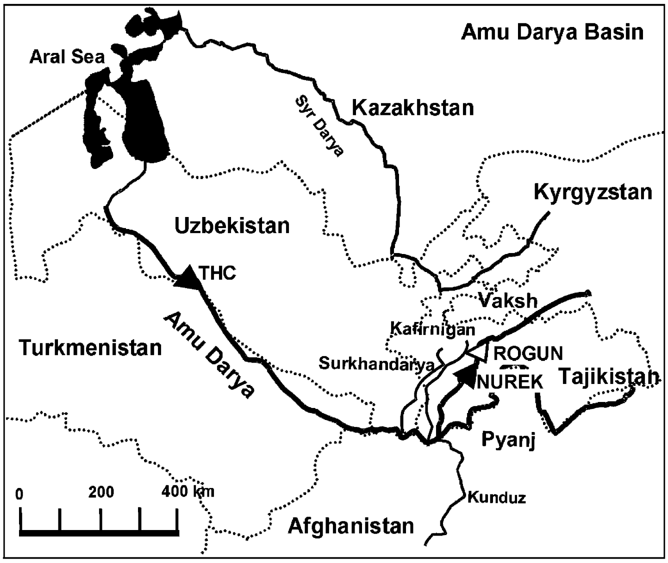

Fig. 1. The Amu Darya Basin with its main tributaries and the Dams of Rogun, Nurek and Tuyamuyun Hydroengineering Complex (THC).

Kyrgyzstan to the south-west of Tajikistan. Until its confluence with the Pyanj, the Vakhsh has a length of 524 km, and a catchment area in Tajikistan of 31.2 thousand km^2. The largest tributaries of the Vakhsh are the Miksu and the Obihingou (UN, 2004).

The average annual runoff of the Vakhsh River at the site of the Nurek dam is equal to 20 km^3, there is a 10 per cent probability of a 23 km^3 runoff, and a 90 per cent probability that runoff will not exceed 16.6 km^3.[2] Giese et al. (2004) report an annual mean discharge of 20.0 km^3/a for the Vakhsh and a mean discharge of 34.3 km^3/a for the Pyanj. The Vakhsh contributes only 25 per cent to the total mean discharge of the Amu Darya (79.3 km^3/a).

The Vakhsh is dominated by the Nurek reservoir, which is located about 75 km east of Dushanbe. The Nurek is a large earthfill dam 300 m high. Its reservoir, with a design capacity of 10.5 km^3, is the largest reservoir in Tajikistan. It is over 70 km long, with a surface area of over 98 km^2 and a maximum depth of 220 m (Sherman and Rafikov, 1992). The reservoir bottom has a design level of around 680/690 m above sea level (a.s.l.), and the normal pool level (NPL) elevation is 910 m a.s.l. The operation of the Nurek reservoir is characterised by water level variations between the maximum operating level of 910 m a.s.l and minimum operating level of 857 m a.s.l. Within this range, the active

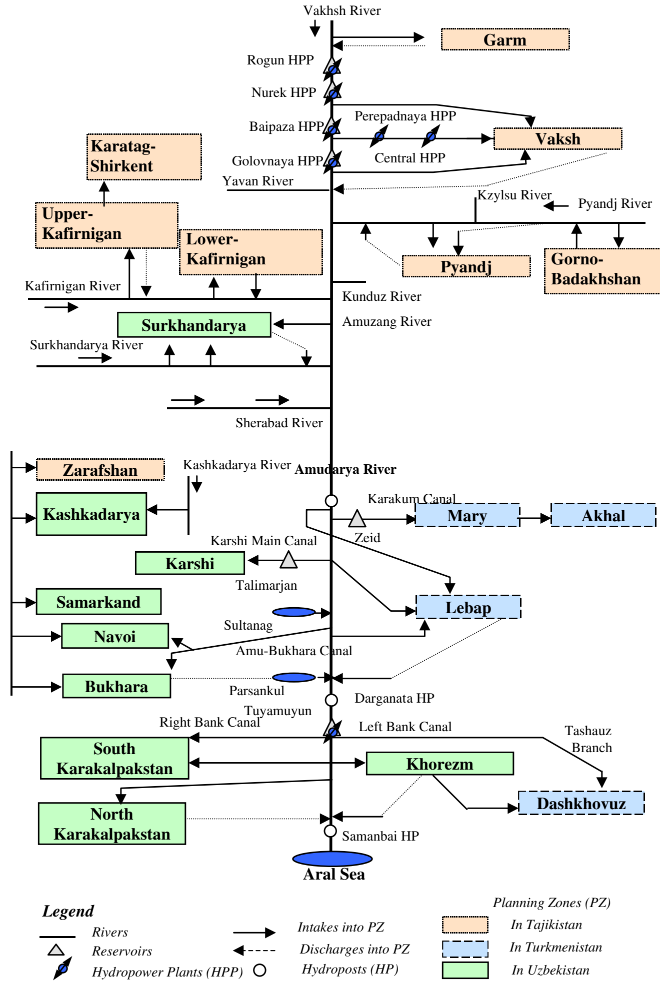

Fig. 2. Control structures and tributaries in the Amu Darya Basin. *Source*: PA Consortium Group and PA Consulting (2002).

regulation storage of the conservation pool is 4.5 km^3, providing seasonal stream flow regulation of the Vakhsh River (Sherman and Rafikov, 1992), while in total the inactive/dead storage between the water levels of 680 and 857 m a.s.l. amounts to 4.0 km^3, according to the design capacity. The hydropower capacity is 3000 MW and the long-term average annual hydropower production is 11.2 TWh (Fig. 2).

4. The Nurek dam and agricultural production downstream

Dyker (1970) suggests that Tajikistan's hydroelectric potential had already been recognised as far back as the 1930s, and that this led to the construction of smaller dams. In 1953, Soviet leader Nikita Khrushchev initiated the "virgin-land" policy, which was intended to increase agricultural productivity. As part of the virgin-land project, Khrushchev promoted the idea of expanding the irrigated areas in Central Asia (Rumer, 1989). In 1959, the Nurek dam was proposed and construction started in 1961. Although this would suggest that the dam was explicitly built to support agricultural production, Dyker (1970)

(*footnote continued*)
tributaries from Tajikistan are Gunt, Bartang, Vanch and Kyzylsu. After the confluence of the Vakhsh and Pyanj, the Amu Darya receives water from the Kunduz (from Afghanistan), the Kafirnigan (from Tajikistan), the Sherabad and Surkhandarya (from Uzbekistan) rivers. The Afghan rivers Khulm, Balkh, Sar-e-Pul and Sherintang are mostly consumed locally and reach the Amu Darya only rarely (Ahmad and Wasiq 2004).

[2]The coefficient of variation of the annual runoff is $C_v = 0.13$. Up to 80 per cent of the runoff passes between April and September with $C_v = 0.14$ (Sherman and Rafikov, 1992).

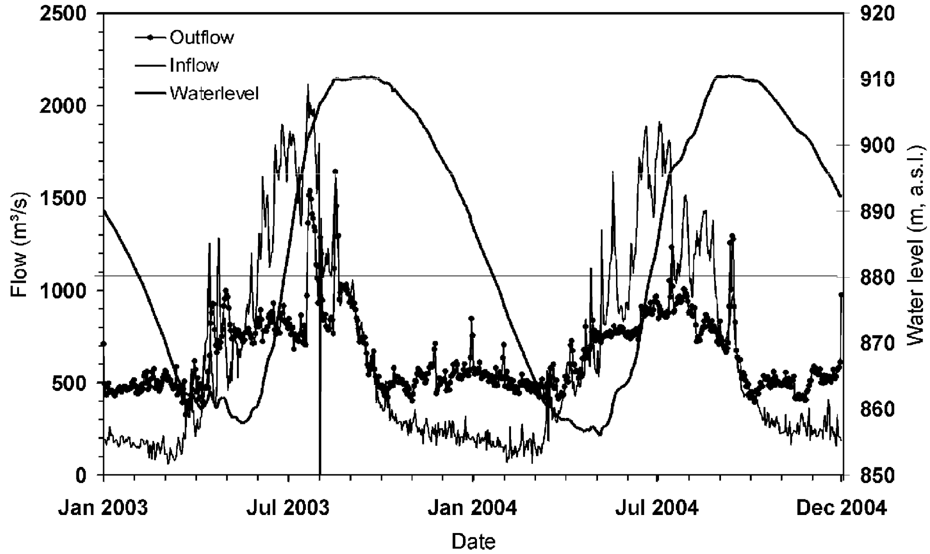

Fig. 3. Daily water level variations, inflow and outflow for Nurek Reservoir for 2003 and 2004.

mentions irrigation only in a footnote.[3] His failure to mention water control for the support of agricultural production could be interpreted either as him not being aware of this aspect or as this purpose not being an issue for the Nurek dam at the time of construction.

Nurek's current mode of operation demonstrates its dual role of water control to support downstream-irrigated agriculture and to produce energy. Fig. 3 shows daily values for water levels, inflow and outflow in 2003 and 2004. The minimum inflow, $57\,m^3/s$ in 2003 and $64\,m^3/s$ in 2004, occurs during February, with a rapid increase of inflow beginning in March. There is a characteristic sequence of flood events leading to a continuous increase of the average flow. The water level variation is characterised by a continuous decrease during the winter and spring months until the minimum level is reached in May (17 May 2003: 858 m; 6 May 2004: 856 m). Directly after the minimum level is reached, refilling of the reservoir commences and the maximum water level of 910.5 m is reached in autumn (19 August 2003 and 11 September 2004). Subsequently, there is a continuous decrease until May of the following year. This indicates that the Nurek dam is currently mainly utilised to regulate the flow of the Vakhsh River for irrigated agriculture, in downstream Turkmenistan and Uzbekistan.

If one compares the impact of the Nurek reservoir releases with the downstream inflow into the Tuyamuyun dam[4] then it becomes evident that the impact of Nurek is minimal. Fig. 4 compares the daily outflow of the Nurek reservoir with the inflow to the Tuyamuyun Hydroengineering Complex (THC) at the reference station Darganata (80 km upstream of THC).[5] During the summer flood (between April and August) the releases from the Nurek reservoir are in the order of magnitude of 20 per cent of the total discharge at Darganata station, for average water years such as 2003 and 2004. From August, the contribution of the Nurek releases to the discharges at Darganata increases to more than 50 per cent. Nurek's releases for hydropower purposes represent proportionally more than 60 per cent of the discharge at the Darganata station, which is downstream in the Amu Darya, between September and April. Hence, in terms of irrigation, the water from the Nurek reservoir seems to be utilised mainly for the last seasonal irrigation and the off-season leaching period of the downstream riparian states.

A recent World Bank (2005) report states that, during the last 25 yr, roughly 50 m of the 300 m have been lost due to silt and that Nurek will be able to operate even without silt removal for at least another 30 yr. An earlier World Bank report (2003, p. 9) had argued that "the Nurek reservoir's capacity has been reduced by 67 per cent over the past 26 yr". A more recent survey of the reservoir bathymetry shows that the storage capacity has been reduced from 10.5 to $8.7\,km^3$ (17.1 per cent). Therefore, it is questionable whether the Wold Bank estimate of the lifespan of the reservoir can be accepted unreservedly.[6] In

[3]According to Dyker (1970), the costs of Nurek should be charged to irrigation; however, it is not clear which irrigation he means—that in downstream regions, in south Tajikistan, or only in the 70,000 ha which are in the direct proximity of the dam.

[4]The Tuyamuyun dam is located in Turkmenistan and provides water to Turkmenistan and Uzbekistan. In a bilateral agreement (April 1996), Uzbekistan agreed to pay annually to Turkmenistan land rent for the water storage area of Tuyamuyun and to cover in addition all the operation and maintenance costs.

[5]It describes the potential and not the effective impact and proportion of the Nurek releases on the seasonal discharge of the Amu Darya and on the lower Amu Darya region. The comparison of Nurek releases and the discharge at Darganata station ignores the contribution of other main tributaries (e.g. Pyanj) and withdrawals (e.g. Karakum canal) on the total Amu Darya discharge.

[6]The Vakhsh river is characterised by frequent land slides and avalanches. In addition, the very steep mean slope of the Vakhsh results in a very high transport capacity. The intensive use of fuel wood during

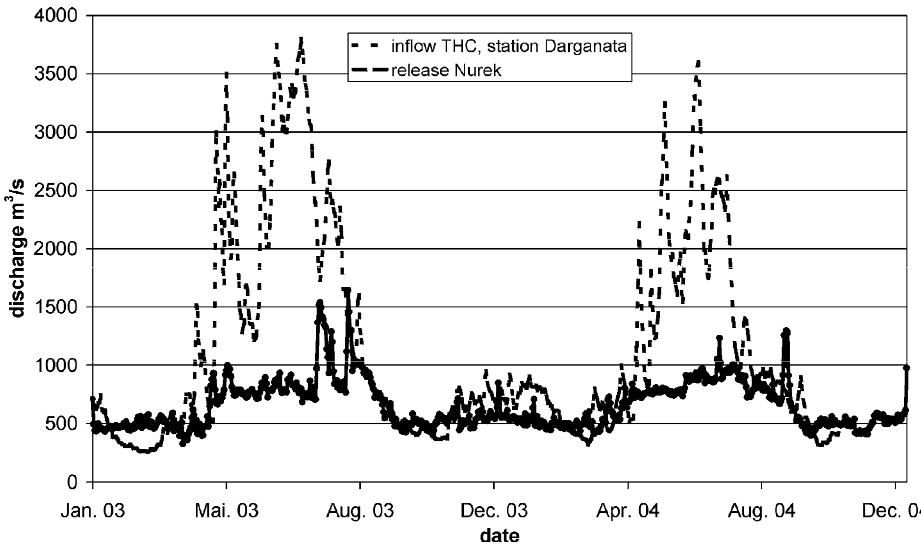

Fig. 4. Water releases of Nurek reservoir and the impact on the water inflow to the THC reservoir system downstream, 2003–04.

any case, Nurek will slowly lose its capacity to store the water from the summer floods, and also its importance for season water utilisation in the downstream regions.

The presented data suggest that neither O'Hara's (2000) original argument of "divide and rule" nor Lange's (2001) argument of "unifying purpose" can be applied to the Nurek reservoir. Because of the large dead storage of the dam, it cannot be utilised to control the flow of the Vakhsh, and, therefore, the interdependence between upstream control and downstream utilisation is definitively less than commonly argued. The situation would have been different if the anticipated construction of the Rogun reservoir had been completed under the Soviet regime.

5. Hydropower production, changing electricity demand and cost recovery

Dyker (1970) argued that the Nurek dam was intended to be a hydroenergy system. At the time of construction, it was anticipated that the bulk of the energy generated would be utilised in Tashkent/Uzbekistan. Dyker (1970) reasoned that the high costs of constructing a transmission line were not fully considered. This changed the planned utilisation. Only a single transmission line was constructed, and the bulk of the hydropower generated was supposed to be utilised in south Tajikistan itself. For this purpose, an aluminium plant and a chemical combine were established. According to Dyker (1970), this decision was not economically rational, given the high costs of transport and the limited amount of raw material deposits in Tajikistan itself. Overall, Dyker argued that an economic rationale did not dictate the building of the Nurek dam, but that "Nurek could perhaps be seen as a 'bribe' to the Tajiks, as a move in foreign policy, or simply as a result of the good blat of the Tajik leaders" (p. 505). However, a recent UN report (NHDR, 2003) contradicts this statement. In the report it is argued that "Tajikistan's hydropower structures once had an income of $150 million, returning a $90 million profit to Moscow after operating and maintenance costs of $60 million" (p. 46). Furthermore, a recent World Bank (2005) report argues that aluminium production is economically viable, because of the low labour costs in Tajikistan.

Since independence in 1991, the profits generated through hydropower have been falling, and for the last 10 yr there has been a funding gap of US$20 million annually (NHDR, 2003).[7] How can the shift in income generation be explained? A World Bank (2004) report argues that there was a sharp decline in electricity consumption by the aluminium plant. Tajikistan produced 450,000 metric tons of aluminium in 1991; after independence, the production declined to a low of 196,300 ton in 1998. Consequently, during the last decade, the aluminium plant's share of electricity consumption fell from 68 to 39 per cent, and the share of the residential areas rose from 8 to 34 per cent. The high electricity prices charged to the local industries subsidised the low electricity prices charged to the residential and the agricultural sector. In 2003, the cost recovery electricity price at the domestic retail level was 2.1 cents per kWh, this included 0.3 cents per kWh generation cost at Nurek and estimated transmission and distribution costs. "However, the average domestic retail price of electricity in Tajikistan in 2003 was just 0.5 cents or

(*footnote continued*)
the civil war decreased the forest areas and volumes and led to mountain slope deforestation. Consequently, there is now an increased risk of mudflows and soil erosion (Makhmadaliev et al., 2003). It is unlikely that the need for fuel wood utilization will change, because of the high level of poverty.

[7]The funding gap resulted in an underinvestment in maintenance. Consequently, there is "increasing leakage in dams, failing turbines and transformers, reduced staffing and monitoring—all threatening efficiency, reliability and security" (NHDR, 2003, p.47). Currently, "Tajikistan's hydroplants are estimated to lose as much as 30–40 per cent of their power output" (p. 47).

Table 1
Irrigated land by pump lift heights in Tajikistan

Lifting height (m)	Pumped irrigation (ha)	Pumped irrigation (%)
0–100	247,450	70.7
100–150	50,750	14.5
150–200	44,800	12.8
200–250	4550	1.3
250–300	2450	0.7
Total	350,000	100

Source: NHDR, 2003, p. 36.

24 per cent of the cost recovery price'' (World Bank, 2005, p.42). In addition to the low prices charged to the domestic sector, the losses in the electricity distribution system to the domestic sector and billing inefficiencies are high.[8] Furthermore, the NHDR (2003) argues that the senior managerial and technical staff, who were mainly of Russian origin, have gradually left, that the lack of available funds has prevented the recruitment of skilled personnel and has made ''the system more susceptible to bribery and corruption'' (p. 26). It, therefore, appears to be unlikely that measures can be implemented relatively quickly to gain profitability through the domestic sector in Tajikistan. In addition, the supply shortages which ''are acute in winter (October to March)'' make it unlikely that customers would be willing to pay for a service that is not fully operational (World Bank, 2004, p. 8).

Similarly, it is questionable whether energy charges to the agricultural sector could be increased. A World Bank (2004) report argues that currently the agricultural sector is using 21 per cent of produced hydropower. In Tajikistan, agriculture is largely dependent on irrigation with high pump lift infrastructure (see Table 1).

According to Bucknall et al. (2001), the overall irrigated land area with negative gross margins (if real energy costs are charged) is 52 per cent in Tajikistan, affecting 250,000 people. Hence, an increase in energy prices for the agricultural sector would increase poverty.

The northwest of Tajikistan is dependent on electricity from Uzbekistan because of the set-up of the transmission grid (see Fig. 5). Hence, while in 1990 prior to independence, Tajikstan exported 2668 GWh to its Central Asian neighbours, it imported at the same time 3927 GWh (see Table 2). In 2002, the electricity trade turned even further to the disadvantage of Tajikistan: it exported 266 GWh and imported 1058 GWh (World Bank, 2004).

According to the World Bank (2004), the poor domestic economic situation and the forecast of falling national electricity demand from 16,348 GWh in 2003 to 11,267 GWh in 2010 led Tajikistan to focus on energy markets abroad.

Who could be potential buyers for Tajikistan's electricity? It was originally anticipated that electricity could be exported to Uzbekistan, but since independence Uzbekistan has followed a policy of energy self-sufficiency and, therefore, has not opened up its energy sector to imports from Tajikistan. Although a World Bank (2004) report shows that Tajikistan does not export electricity to Kazakhstan, a USAID report (2004) states that Tajikistan and Kyrgyzstan sell power to south Kazakhstan.[9] ''Tajikistan has been able to negotiate a deal to sell surplus energy to Russia, or rather to southern Kazakhstan in a swap for energy delivered to Russia from generators in northern Kazakhstan'' (USAID, 2004, p.36). In addition, the NHDR (2003) argues that the cheap and secure source of energy from Tajikistan would free up the region's hydrocarbon resources for export. The report points out, ''some states, notably Kazakhstan, have made it government policy to generate as little of their own energy as possible, aiming to import from cheaper sources elsewhere in the region, and therefore preserving their hydrocarbons for export'' (NHDR, 2003, p.50).

However, the contract between Tajikistan and Russia could not be fulfilled. Reasons for the failure could include the congestion in the transmission grid, financial tariffs imposed by the Uzbeks for transmission or an argument made from the Uzbek side that ''the Kyrgyz captured the market in Kazakhstan and there was no room for the Tajiks, perhaps on the Grid as well as within the market'' (USAID, 2004, p. 36). The congestion had already been identified as a problem and was supposed to have been solved through an Asian Development Bank project; however, Uzbekistan did not agree to allow provisions that ''would allow Tajikistan to more readily export its surplus hydropower through Uzbekistan'' (USAID, 2004, p. 32). Hence, the current transmission grid does not allow Tajikistan to promote its export inside or even outside the Central Asian region.

Since the 1998 low of aluminium production, it appears that the former main user of hydropower has recovered. Aluminium production had reached 269,200 tons in 2000

[8]The World Bank (2004) report points out that there were 22 per cent losses in the electricity distribution system in 2001. The report argues that the loss on the way to the aluminum smelter is only one per cent, the remainder is ''half attributed to technical losses in the transmission and distribution system and the rest is attributed to non-technical losses arising from theft, defective metering, use of norms based billing for consumers without meters, non-billing or inadequate billing'' (p. 10). The report continues that ''billing inefficiencies are so high that only about 70 per cent of the consumption gets billed. Collections are at around 70 per cent of the amounts billed. Only 40 per cent of the collections are in cash, the rest being in barter and offsets'' (p. 10).

[9]Kyrgyzstan's energy sales are related to water-energy swaps, based on the March 17, 1998 Framework Agreement between Kazakhstan, Kyrgyzstan and Uzbekistan on the operation of the Toktogul dam in an irrigation rather than a hydropower mode. During the winter, Kyrgyzstan itself has electricity shortages and imports fuels from downstream countries. ''The supply of these fuels in exchange for summer electricity exports remains uncertain'' (USAID, 2004, p.5). Furthermore, the electricity is subsidised to the local consumers, and consequently importing fuels at market prices, implies that the electricity supplied during the winter runs at a loss.

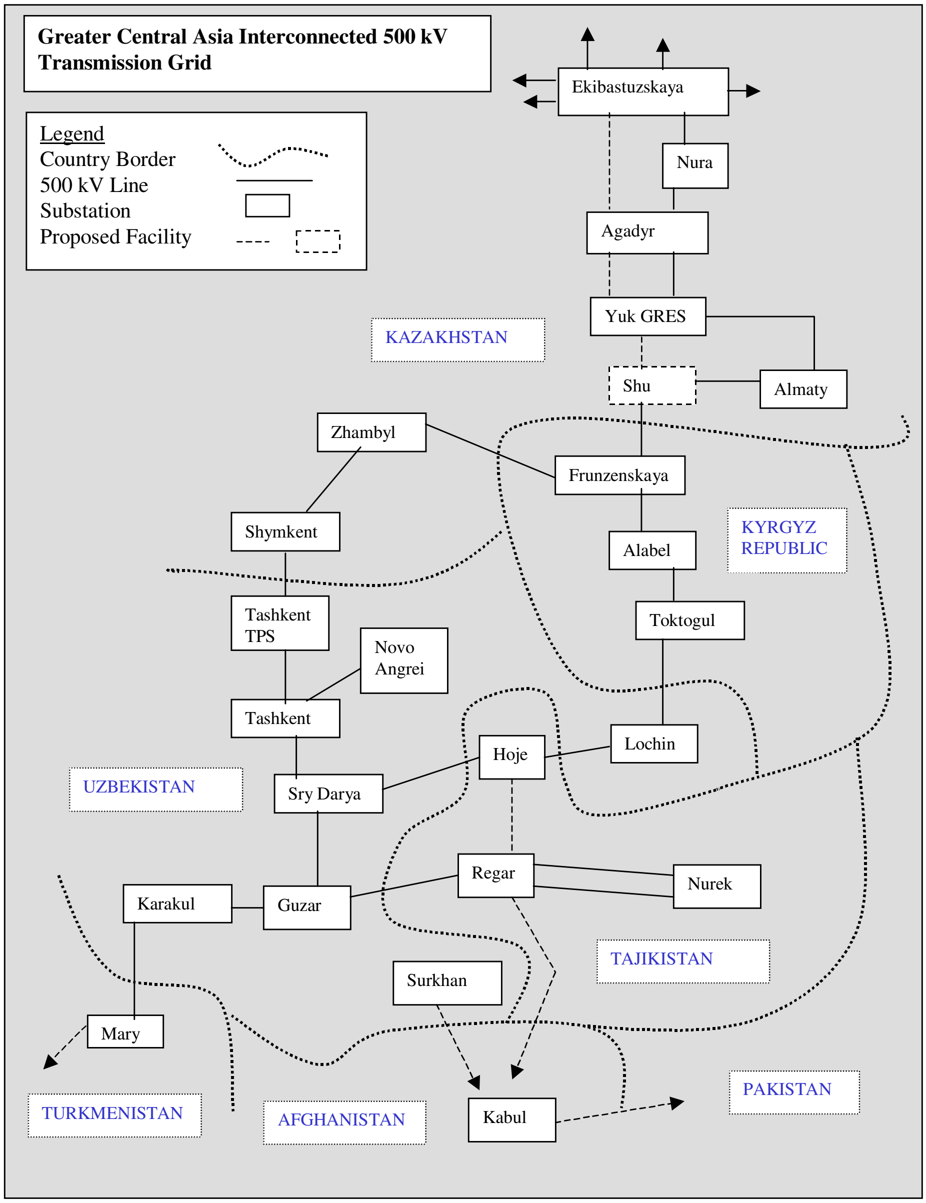

Fig. 5. Transmission grid in Central Asia. *Source*: USAID report, 2004.

and had further increased to 319,360 tons by 2003 (Levine and Wallace, 2004). In 2005, production had risen to 375,000 tons, earning the republic around US$560 m in exports. Therefore, it might have already altered the World Bank's negative forecast of falling domestic energy consumption by the year 2010. Utilising the concept of "virtual water"[10] (Allan, 2003), Bouwer (2000, p. 226) explains that "water-short countries can save water by importing most of their food and electric power from other countries with more water". Going one step further, one could argue that the export of aluminium was a kind of "virtual water" or "virtual energy" export. The World Bank (2005) argues along a similar line. However, like the electricity transmission grid, the railroad tracks cross Uzbekistan. The World Bank (2005) report states that there is a tariff dispute between Tajikistan and Uzbekistan. According to the report, the dispute was triggered by Tajik Rail, which increased its transit tariffs for Uzbek shipments to Ferghana; Uzbek Rail retaliated by increasing the transit tariffs for Tajik shipments. Although both railroad companies benefit from the increased tariffs, TADAZ, the Tajik aluminium plant, has to pay US$8 million annually (World Bank, 2005).

[10]Water embedded in food. The approach argues that water-stressed regions can ensure water and food security by actively seeking a strategy that reduces domestic agricultural production for basic foodstuffs by increased reliance on the global food trade system.

Table 2
Shifts in electricity trade in Central Asia power system (CAPS) 1990–2000

Exports	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan	Outside CAPS	Total Exports
Electricity trade in 1990 (GWh)							
Imports							
Kazakhstan		277	0	0	310	0	587
Kyrgyz Republic	697		0	0	2383	0	3080
Tajikistan	0	324		0	2344	0	2668
Turkmenistan	0	0	0		6066	0	6066
Uzbekistan	8139	0	3927	945		0	13012
outside CAPS	0	0	0	0	0		0
Total imports	8836	601	3927	945	11103.2	0	
Electricity trade in 2000 (GWh)							
Imports							
Kazakhstan		0	0	0	0	0	0
Kyrgyz Republic	1253		154	0	1926	0	3333
Tajikistan	0	126		0	244	0	370
Turkmenistan	35	0	819		68	0	921
Uzbekistan	0	195	729	32		0	956
outside CAPS	2224	0	0	0	0		2224
Total imports	3512	320	1702	32	2237	0	

Source: World Bank, 2004, p. 13

6. Increasing the hydropower output and extending the transmission grid

To make up for the electricity shortages during the winter period, Tajikistan is expected to change the Nurek dam's mode of operation. As argued, Nurek's summer releases do not contribute significantly to the total flow, and, therefore, it is questionable whether a small change in the mode of operation will have a significant influence on downstream agriculture.[11] Until now, Uzbekistan has not perceived the potential changes to the Nurek releases as a threat, assuming that a modification of the releases will only have a minor impact. Although the impact might be small, it is questionable whether even a small change would be appropriate given the political tensions in the region.

To increase its energy output, Tajikistan is planning to recommence the construction of the Rogun reservoir (3600 MW), 100 km northeast of the Tajik capital—a project that was started during the Soviet period but stopped with the Tajik civil war—and of the Sangtuda dam (670 MW) in the Vakhsh basin. The Uzbek government is highly critical of the Rogun dam (Spoor and Krutov, 2003), because it would "put it [Tajikistan] firmly in control of the river" (ICG, 2002, p. 23). However, neither Spoor and Krutov (2003) nor the ICG (2002) report distinguish between different stages of the Rogun construction. It is not clear whether Uzbekistan is opposed to the construction in general or to a particular stage of construction. The World Bank, and more recently the feasibility study of the construction company Lahmeyer International (Schmidt et al., 2006), distinguish between different stages of dam construction. In Stage I, Rogun is supposed to provide an annual energy output of 5.6 TWh, for this purpose the height should be 225 m, with a total reservoir volume of 2.78 km^3, live storage of 1.92 km^3 and installed capacity of 1000 MW. In Stage II, the dam height is supposed to be raised to 285 m (reservoir volume 6.78 km^3 and live storage 3.98 km^3) and in Stage III to 335 m (reservoir volume 13.3 km^3 and live storage 10.3 km^3) (Schmidt et al., 2006). It appears, therefore, that neither Stage I nor Stage II would put Tajikistan in full control of the Vakhsh basin; it is only in Stage III that this would occur. Consequently, only Stage III could be interpreted by Uzbekistan or Turkmenistan as a potential threat to their agricultural production.

The question still remains as to whether new constructions in the Vakhsh River are economically viable. A recent World Bank (2004) report compares the supply costs from generation options. The report distinguishes between nine different electricity-generating projects and only two different stages of the Rogun dam. According to this report, the Sangtuda dam and the Stage I of Rogun look very promising (Table 3, Fig. 6).

Tajikistan is also planning to extend its transmission grid to its north-western territory. In addition, together with Kyrgyzstan, Tajikistan is exploring the possibility of a north–south transmission line that would make Tajikistan independent of the transmission line through Uzbekistan. Putnam and Mukhamadiev (2005) identify China to the north and Afghanistan, Pakistan, Iran, and possibly India, to the south as potential buyers for Tajikistan's electricity. A World Bank (2004) report argues that the electricity trade with the markets outside will be initially limited, but

[11]Nevertheless, if one considers that water distribution between the administrative units (provinces and districts) within the downstream states is not always equitable, small changes in flow releases might have an impact on downstream agricultural users.

Table 3
Supply costs of generation options

No.	Country		Capacity (MW)	Economic cost/kWh (Cents)	Financial costs/kWh (Cents)	Rank
1	Uzbekistan	Talimardjan Thermal Power Project I	800	1.68	1.75	1
2		Talimardjan Thermal Power Project II	2400	2.76	2.92	5
3	The Kyrgyz Republic	Bishkek II Thermal Power Project	400	2.55	2.67	4
4		Kambarata Hydropower Project I	1900	7.17	8.54	9
5		Kambarata Hydropower Project II	360	3.72	3.95	7
6	Tajikistan	Sangtuda I Hydropower Project	670	1.97	2.44	2
7		Rogun Hydropower Project Phase I	1200	2.46	2.91	3
8		Rogun Hydropower Project Phase II	3600	2.83	3.24	6
9	Kazakhstan	New Ekibastuz Thermal Power Project	1000	4.54	5.05	8

Source: World Bank, 2004, p. x.

concludes, "as trade in electricity establishes a positive track record, the potential for expanded activity will increase" (World Bank, 2004, p. x). (Table 4)

Although the plans appear economically feasible, Parshin (2003) reasons that international financial institutions would not support new construction plans, unless Tajikistan's neighbours agree. Spoor and Krutov (2003, p. 612) argue "in view of the balance of power in the region, the latter [Uzbekistan] will never allow this to happen". Uzbekistan's failure to agree led Tajikistan to seek financial support for the infrastructure construction from Iran and Russia. According to Smith (2004), Russia's President Putin announced that his country would invest US$2 billion in Tajikistan. Some of this investment is earmarked for the completion of the hydroelectric projects in the Vakhsh valley. Schmidt et al. (2006, p. 407) report that "in October 2004, RUSAL [Russian Aluminium] and the Government of Tajikistan reached an agreement for Stage I construction completion of Rogun HEP". RUSAL will invest US$560 million for a share in the joint stock company, Rogun HEP. In addition, RUSAL was engaged in plans to increase aluminium production in Tajikistan. "RUSAL signed an agreement with the Government of Tajikistan in October 2004 that included construction of a new aluminium smelter with a 200,000-t/yr capacity and the installation of two new potlines (each with a 100,000-t/yr capacity) at the Tajik Aluminum Smelter" (Levine and Wallace, 2004, p. 7.13). Hence, although the direct electricity sales might be initially limited and, therefore, might be a risk, the production and export of aluminium (and therefore virtual energy) appears to be so profitable that it is already attracting investors to increase Tajikistan's hydroenergy production. However, as stated above, the bottleneck could be Uzbekistan, controlling and maybe charging tariffs on alumina imports and aluminium exports.

7. Conclusion

This paper has shown that the reasoning of O'Hara (2000) "divide and rule" and of Lange (2001) "unified purpose" cannot be applied to the Nurek dam, if one looks only at the basin level. It appears that Moscow took advantage of the Tajik hydropower potential to further industrial production in Tajikistan itself and for the greater benefit of the Soviet Union. However, if the Rogun dam had been completed (Stage III), then one would have to agree with Lange's (2001) statement. Hence, the current situation in the Amu Darya basin is very different from the situation in the Syr Darya basin, where Kyrgyzstan had a strong position, and could and still can use the mode of operation of its water infrastructure as a bargaining tool.

The plan to recommence the construction of the Rogun dam is perceived as a potential threat to downstream interests. As argued above, neither Stage I nor Stage II could be perceived as threatening, because the live storage is still below 40 per cent of the mean annual flow, and the Vakhsh river contributes only 25 per cent of the total Amu Darya flow. Utilising the Nurek in combination with the Rogun dam could be a win–win solution for downstream and upstream countries. It would guarantee Tajikistan's energy requirements, enable the export of cheap hydropower and, therefore, enable downstream countries to export more of their carbon resources. At the same time, it would enable Tajikistan to continue to facilitate the agricultural production of downstream riparian states. Furthermore, Stage II of the Rogun dam could be seen as a safety measure for times of water scarcity or drought. During a period of drought, additional releases from Rogun could increase the available water for downstream urban and agricultural users. It appears that, with the additional dam, the benefits to all the riparian states could be increased. Going back to the provision problem of CPRs, one could argue that Tajikistan already provides and increases its service to the downstream countries by providing water at the time it is needed for agriculture. Therefore, one could pick up again on Dyker's (1970) contention that the agricultural sector in downstream riparian states could contribute to the costs of operation and maintenance of the dams. This is already happening between Turkmenistan and Uzbekistan in relation to the downstream Tuyamuyun reservoir.

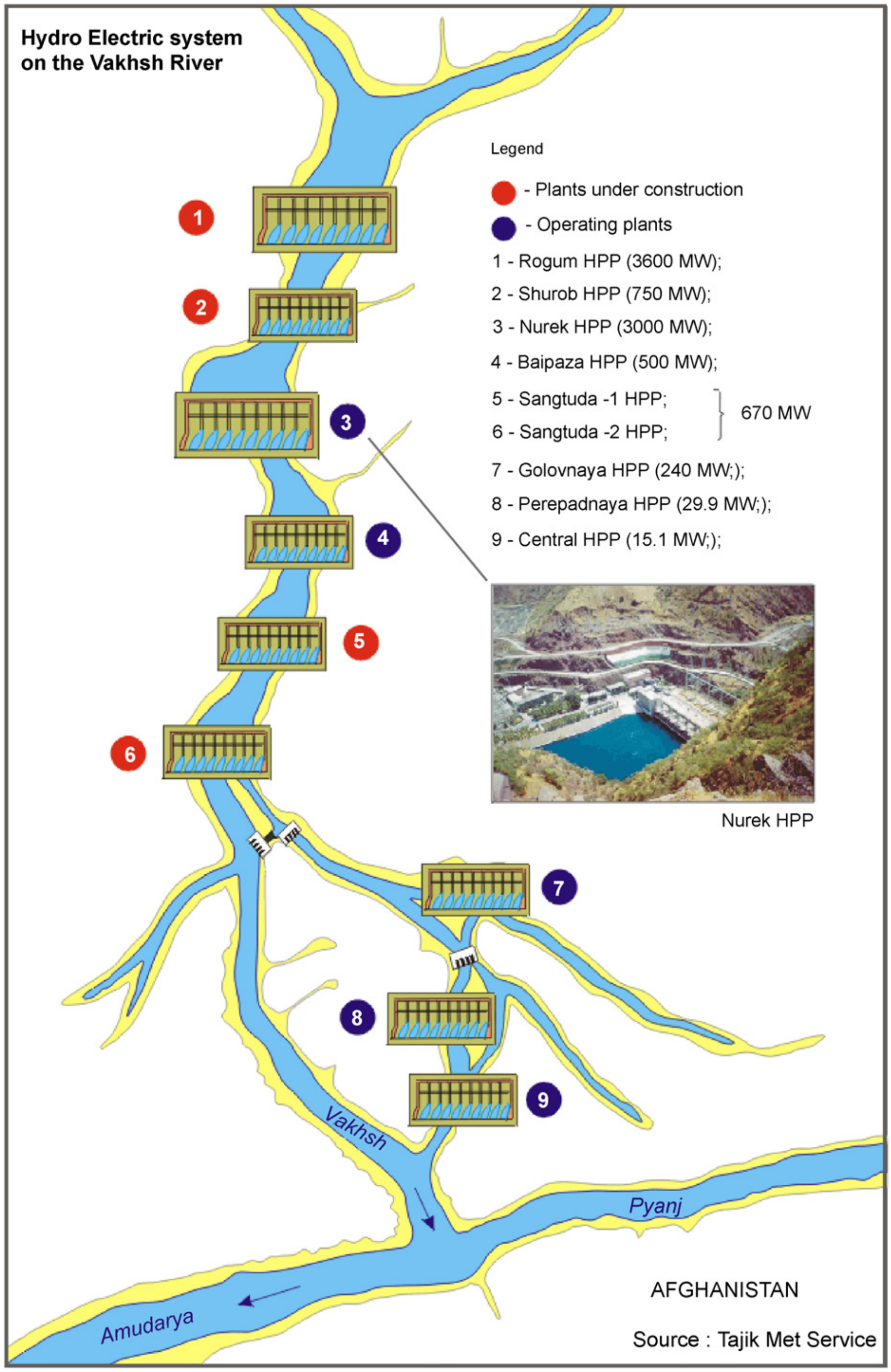

Fig. 6. Current and planned infrastructure in the Vakhsh Basin. *Source*: World Bank, 2004, p. 23.

Table 4
Marginal costs of generation in target markets vs. import costs (cents/kWh)

Target markets	Marginal generation cost in target markets	Supply options	Transmission cost	Total landed cost of imports
Afghanistan	3.7	Sangtuda I, Rogun I, Talimardjan I and II	0.51	2.26–3.43
Iran	3.6	Sangtuda I, Rogun I, Talimardjan I and II	0.54	2.29–3.46
Pakistan	5.6	Sangtuda I, Rogun I, Talimardjan I and II, Kambarata II	0.51	2.26–3.75
China	3.6	Sangtuda I, Talimardjan I	0.72	2.47–3.16
Russia	3	Sangtuda I, Talimardjan I	0.55	2.30–2.99

Source: World Bank, 2004, p. 36.

Overall, one could turn around Smith's (1995) argument on ''the potential for conflict over the resources'' in Central Asia, and argue for the potential for mutual benefits generated through water and water control structures.

Acknowledgement

The work presented in this paper was carried out during the initial part of the JAYHUN project (Hanover University), which is funded by the European Commission within the INCO program

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