CONFLICT OF INTERESTS BETWEEN HYRDOPOWER ENGINEERING AND IRRIGATION IN CENTRAL ASIA: CAUSES AND SOLUTIONS

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Introduction

All the main rivers in Central Asia (CA) are transborder and are used by the region's countries in several spheres of the economy at the same time, mainly in irrigation and hydropower engineering. The first is traditional and has existed for several millennia, while the sec-

ond is at the development stage; the first hydropower plants in CA were not built until the middle of last century.

The structure of the water industry existing in CA (both in irrigation and in hydropower engineering) was created during the Soviet era, in conditions of an extensively developing economy. As we know, this economic development path led to serious environmental problems, the most devastating of which was the Aral Sea disaster.

After five independent sovereign states formed in CA in 1991, the situation in the water industry became even more aggravated. The conflict of interests between irrigation, which was well-developed mainly in the countries on the lower reaches of the rivers (Kazakhstan, Turkmenistan, and Uzbekistan), and hydropower engineering, which primarily concerned the countries located at the heads of the rivers (Kyrgyzstan and Tajikistan), acquired interstate significance. Both of these spheres require different water regulation regimes. Hydropower engineering is interested in accumulating water in the summer and using it in the winter (at the peak of the energy shortage), while irrigation, vice versa, requires water to be accumulated in the winter and used in the summer, during the vegetation period.

History of the Conflict Development

The conflict of interests between hydropower engineering and irrigation developed gradually and was slow to appear against the background of the fundamental political reforms that were carried out in the region's countries after 1991. Part of the problem was the slow flux of change in management of the hydropower industry. In addition, the CA Unified Energy System, managed from a single dispatch center, and the Interstate Coordinating Water Industry Commission with its Scientific Information Center, set up early in the 1990s, were still functioning under the conditions established in Soviet times.

At the beginning of the 1990s, all the countries of the region signed the Alma-Ata Agreement and the Nukus Declaration, which enforced the existing situation.

The Alma-Ata Agreement of 1992 declared equal rights of all the CA countries to the use of water resources:

"Recognizing the communality and unity of the region's water resources, the Parties shall have equal rights to their use and bear equal responsibility for ensuring their rational consumption and protection."[1]

This provision was enforced more specifically in the Nukus Declaration of 1995:

"We agree that the Central Asian countries shall recognize previously signed and current agreements, treaties, and other acts that regulate the relations among them regarding water resources in the Aral basin and unconditionally adhere to them."[2]

But gradually, particularly as market relations developed among the region's countries, the shortcomings of this approach became evident. It remained basically administrative, although it could be called relatively reformed. The countries on the upper reaches, Kyrgyzstan and Tajikistan, in the territory of which all the region's main water resources form, began claiming property rights to these

[1] *Agreement among the Republic of Kazakhstan, the Republic of Kyrgyzstan, the Republic of Uzbekistan, the Republic of Tajikistan, and Turkmenistan on Cooperation in Joint Management and Protection of Interstate Water Resources,* Alma-Ata, 18 February, 1992.

[2] *Nukus Declaration of the Central Asian States and International Organizations on Problems of the Sustainable Development of the Aral Sea Basin,* Nukus, 20 September, 1995.

resources at the regional level. This prompted Kyrgyzstan to adopt the Law on Interstate Use of Water Bodies, Water Resources, and Water Facilities of the Kyrgyz Republic in 2001, which set forth:

"When implementing state policy on the use of water resources of the rivers originating in the Kyrgyz Republic and flowing beyond its borders, and participating in any interstate negotiations on water issues, the Kyrgyz Republic acts on the basis of the following principles and provisions:

— *recognition of the right of the state to ownership of the water bodies, water resources, and water facilities within its state borders;*

— *recognition of water as a natural resource and economic commodity which has its own economic value in all competing forms of water use;*

— *user pays principle in interstate water relations."*

An active debate about making the countries located on the lower reaches pay for water use also began in Tajikistan. However, this did not resolve the problem, it only increased the tension.

To some extent a compromise solution was found in 1998. The four countries located in the Syr Darya River Basin, where relations were most tense, signed an agreement[3] which set forth the general principles of interrelations between hydropower engineering and irrigation based on compensation for drainage regulation services:

"Electric energy additionally generated by the Naryn-Syr Darya chain of hydropower plants relating to water drainage in the irrigation regime and perennial drainage regulation in the Toktogul and Kairakkum reservoirs that is over and above the needs of the Kyrgyz Republic and the Republic of Tajikistan shall be delivered in equal parts to the Republic of Kazakhstan and Uzbekistan.

"It shall be compensated for by the delivery of the equivalent amount of energy resources (coal, gas, black oil, electric energy), as well as other products (work, services), to the Kyrgyz Republic and the Republic of Tajikistan, or in monetary form, as agreed upon, in order to create the necessary annual and perennial water supplies in the reservoirs for irrigation needs."

It can be noted that the principle set forth in the agreement with respect to the Syr Darya Basin is of a framework nature. It does not describe the economic mechanism of interrelations between hydropower engineering and irrigation and does not define such basic concepts as "*the electric energy additionally generated over and above the needs of the Kyrgyz Republic and the Republic of Tajikistan," "equivalent amount of energy resources," "necessary annual and perennial water supplies in the reservoirs for irrigation needs."* But this should have been clarified, particularly for calculating the amount of energy resources and the cost of compensation. Despite the fact that Kyrgyzstan and Tajikistan bear mutual responsibility, the agreement does not mention distribution of the functions of the reservoirs in terms of drainage regulation.

As a result, from the very beginning, the provisions of the Agreement (on the Syr Darya River) were frequently violated and finally, in 2008-2009, due to lack of agreement regarding compensation, the Toktogul reservoir was almost completely drained, which immediately led to a serious water shortage in the region during the vegetation period. The consequences of this critical situation are still being felt today.

Renewed construction of the Rogun hydropower plant in Tajikistan and the Kambarata chain of hydropower plants in Kyrgyzstan aggravated relations between the countries on the upper and lower reaches even more.

The Rogun hydropower plant on the Vakhsh River with a capacity of 3,600 MW has a reservoir of 13.3 cu km in volume; in 2008, full-scale construction work began there financed from the repub-

[3] See: *Agreement among the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, the Government of the Republic of Tajikistan, and the Government of the Republic of Uzbekistan on the Use of the Hydropower Resources of the Syr Darya River Basin*, Bishkek, 17 March, 1998.

lic's budget. In 2009, approximately $80 million was allotted for this purpose, and in 2010 there are plans to spend another $150 million. In addition, in January 2010, shares of the Rogun hydropower plant began being sold to the country's population, and during the first three months, $180 million was collected.

The Kambarata chain of hydropower plants consists of two plants (1 and 2) with a capacity of 360 and 1,900 MW, respectively (the volume of the reservoir at hydropower plant-1 alone amounts to 5 cu km).

Construction of all these hydropower plants began during Soviet times. At present, a dam has been built at Kambarata HPP-2, and a technical and economic feasibility report is being drawn up at Kambarata HPP-1 of a project in which French companies are participating.

Uzbekistan is extremely worried about and has raised serious objections to such large hydropower plants being built in Kyrgyzstan and Tajikistan. It set forth its official position regarding the Rogun hydropower plant in a letter from Prime Minister Shavkat Mirzieyev in February 2010:

"It is our deep conviction that the possible consequences of building such a grandiose facility as the Rogun hydropower plant should be given an objective and qualified evaluation, paying particular attention to:

— the damage this project may inflict on the fragile environmental balance in the region due to the consequences of the Aral disaster;

— the influence this project may have on the change in the amount of drainage and its regime with respect to the Amu Darya, since the survival of millions of people in this region with its severe continental desert climate depends directly on the availability of drinking and irrigation water, particularly at times of systematically repetitive low water;

— the degree this project is protected from man-triggered threats, primarily the threat of major earthquakes, since the Rogun hydropower plant is to be built in a high seismic zone on a tectonic fault where earthquakes of up to 10 points on the Richter scale have repeatedly occurred. It is difficult to imagine the scale of the humanitarian disaster that would be induced, entailing the deaths of hundreds of thousands of people, if the dam broke.

"But the government of the Republic of Tajikistan has totally ignored our repeated appeals regarding this issue and is continuing at an accelerated rate to carry out construction of this facility without taking account of the possible consequences and of the proper project and technical support."[4]

As of today, all the countries of the Aral Sea Basin, Russia, the U.S., and many international organizations have become involved in the water conflict, which is shown by the events below:

- At a meeting with his Uzbek colleague in March 2010, President of Kazakhstan Nursultan Nazarbaev supported Tashkent's position, which objected to construction of the Rogun hydropower plant in Tajikistan and the Kambarata HPP-1 in Kyrgyzstan without first carrying out an international expert's evaluation of these projects. According to him, Kazakhstan and Uzbekistan, countries on the lower reaches of the Syr Darya and Amu Darya rivers, require security guarantees.
- President of Turkmenistan Gurbanguly Berdymukhammedov said in October 2009 during a meeting with journalists in Ashghabad that Tajikistan, in the territory of which the main sources of drinking water for the CA post-Soviet countries originate, is experiencing an acute short-

[4] "Pemier-rech. Pravda Vostoka opublikovala otkrytoe obrashchenie Mirzieyeva k Akilovu," 3 February, 2010, available at [http://www.avesta.tj/index.php?newsid=3749].

age of electric energy and sees the solution of this problem in building new hydropower plants. This, in turn, could decrease the drainage volume and lead to an acute shortage of water in the countries located on the lower reaches of the transborder rivers. So Turkmenistan is calling on Uzbekistan, Kazakhstan, and Kyrgyzstan to pay Tajikistan a joint monetary compensation for resolving energy problems in exchange for retaining the current volumes of water drainage of the transborder rivers.

- In February 2008, the Presidents of Russia and Uzbekistan signed a joint statement in which *"the Parties agreed that there is a need to take into account the interests of all the states located on the transborder water courses of the Central Asian region when implementing construction projects at their hydropower structures."*
- In January 2009, the new Russian president, Dmitry Medvedev, confirmed this position by saying that when building such hydropower plants as Rogun, it was necessary *"to keep in mind the interests of all neighboring states,"* and that without the consent of neighboring republics such power plants should not be built.
- First Vice-Premier of the Russian Government Igor Shuvalov was even more specific in the statement he made after his meeting with Tajik President Emomali Rahmon at the beginning of March 2010: *"We understand that a difficult situation is developing in the region; there are different approaches to the development of hydro resources. We are willing to participate in developing the energy industry as a whole in CA and are proceeding from the fact that the interests of the various states that have existed for centuries in this region should be kept in balance. Russia should not do anything to upset the balance in these relations."*[5]
- In February 2010, during his visit to Tajikistan, U.S. Assistant Secretary of State for South and Central Asian Affairs Robert O. Blake stated the position of his country on construction of the Rogun hydropower plant: *"We realize the importance of energy safety for Tajikistan and we support the efforts of the Tajik government to give their citizens, enterprises and organizations access to adequate and reliable energy sources. We urge Tajikistan to consider the opinions of its neighbors concerning the construction of hydroelectric projects such as Rogun."*[6]

In this difficult situation, keeping in mind the importance of the problem, the World Bank assumed the role of mediator in drawing up a technical and economic feasibility report of the Rogun hydropower plant project. In so doing, it is keeping in mind both Tajikistan's interest and the concern of Uzbekistan and other neighboring countries.

A letter from Philippe Le Houerou, Vice-President of World Bank for Europe and Central Asia, sent on 22 March, 2010 to the Uzbekistan government, noted: *"We appreciate your acknowledgement of our efforts on developing transparent processes with participation of all interested sides, which will guarantee objectiveness and independence of the assessment of Rogun hydropower station project (HSP).*

"The feasibility report, as well as environmental and social examination, will be directed at carrying out careful assessment of technical conditions, as well as the environmental and social risks and advantages of the proposed project. The research will be carried out in line with all the special protection mechanisms and instructions of the World Bank.

[5] "Pervy vitse-premier Rossii I. Shuvalov: 'Rossia gotova uchastvovat v razvitii energeticheskogo kompleksa v Tsentral'noi Azii v tselom,'" *Fergana.ru*, 3 March, 2010, available at [http://www.ferghana.ru/news.php?id=14139&mode=snews].

[6] [http://www.asiacentral.es/uploads/tajikistan_mar10.pdf].

"Mutual understanding has been reached with the Tajik authorities, and they have pledged to ensure that any future construction work beyond the framework of rehabilitation work will be based on the results of above-mentioned assessment."[7]

The question of carrying out a similar assessment is also examined with respect to the Kambarata HPP-1 in Kyrgyzstan.

So the conflict between hydropower engineering and irrigation in CA is becoming increasingly intense and acquiring the traits of a crisis situation. It is being examined at the highest world level, but neither diplomats nor high-ranking international mediators have been able to resolve it.

According to the estimates of World Bank Regional Director for Central Asia Moto Konishi, carrying out an expert's examination of only one hydropower plant like Rogun will take a long time. It will take the bank three months to complete the corresponding procedures and preparations, after which it will take another 12-18 months to carry out the examination itself. Then consultations and talks will be required among the basin's countries.

It is worth noting that precisely this last stage will be of decisive importance, and so only the region's countries themselves are capable of resolving this conflict. International mediators can only ask them to keep each other's interests in mind and promote mutual understanding in every possible way, which is confirmed by the documents cited above. This was also mentioned in a statement by U.N. Secretary-General Ban Ki-moon during his visit to Central Asia in April 2010, in which he said that Central Asia's natural resources must be used *"for common prosperity. Whether it is oil and natural gas or water, this method should be used fairly and harmoniously, it is in the interest of neighboring countries. This is a collective responsibility, both of the leaders of Central Asia and the international community." "We need to sit down and resolve these issues in a harmonious way, to benefit all,"* he went on to emphasize.[8]

The Essence and Nature of the Conflict

So only the CA countries themselves can resolve the problem of common use of hydropower resources. This requires a specific analysis of the causes of the conflict and the possible solutions to it.

First we need to keep in mind that hydropower engineering and irrigation are not mutually exclusive; both of these branches are vitally important for the CA countries. But in so doing it is important to note the significant differences that exist between these sectors of the economy.

Irrigated farming, as mentioned above, is a traditional method of economic management in the CA countries, which are almost all located in an arid climatic zone. Irrigation has existed in the regions for several millennia, but it became particularly developed during the second half of the last century. The area of irrigated land in the region between 1960 and 2000 increased from 4,510 to 7,990 thousand hectares, while the use of water resources rose from 60.6 to 105-120,7 cu km (see Table 1). This figure is equal to the amount of available water resources in the region, the average perennial volume of which is equal to 116.5 cu km.[9]

[7] "World Bank to Conduct Examination of Rogun Project," 26 March, 2010, available at [http://www.uzdaily.com/articles-id-9412.htm].

[8] "Ban Outlines UN Role in Resolving Central Asian Tensions over Water Resources," 6 April, 2010, available at [http://www.un.org/apps/news/story.asp?NewsID=34291&Cr=central+asia&Cr1=].

[9] See: *Strengthening Cooperation for Rational and Efficient Use of Water and Energy Resources in Central Asia. Special Programme for the Economies of Central Asia Project Working Group on Energy and Water Resources*. ECE/ESCAP, 2004.

Table 1

Dynamics of Water Resource Use in the Aral Sea Basin (*cu km*)

Country	1960		1970		1980		1990		1999	
	Total	Irrigation	Total	Irrigation	Total	Irrigation	Total	Irrigation	Total	Irrigation
Kazakhstan	9.75	9.50	12.85	12.28	14.20	12.83	11.32	10.14	8.24	7.96
Kyrgyzstan	2.21	2.12	2.98	2.85	4.08	3.90	5.16	4.91	3.29	3.10
Tajikistan	9.80	8.69	10.44	11.17	10.75	11.82	9.26	10.24	12.52	10.15
Turkmenistan	8.07	7.95	17.27	17.09	23.00	22.74	23.34	22.96	18.08	16.79
Uzbekistan	30.78	27.90	48.06	43.45	64.91	55.51	63.61	58.16	62.83	56.66
Total	60.61	56.15	94.56	86.84	120.69	106.79	116.27	106.40	104.96	94.66

So all the water resources needed today for further extensive development of irrigation in CA have been fully exhausted. This situation developed during formation of the water economy system at the end of the last century. At that time, a project was being developed for transferring drainage from Siberian rivers to the region, which was later recognized as environmentally detrimental.

Nor can we place any hope on introducing new technology into irrigated farming; its beneficial effect in conditions of high harvest yield goes without saying, but it cannot solve the water shortage problem. There are essentially no internal water reserves for irrigation in the Aral Sea Basin today.

It is often said that water for irrigation in CA is being used very inefficiently and a transfer to new state-of-the-art irrigation technology (for example, Israeli) could reduce the amount required several-fold. Such opinions are populist and based on superficial knowledge of the problem.

The real situation in irrigated farming in CA and Israel is shown in Table 2.[10]

At first glance, the amount of water required for irrigation in CA indeed amounts to 12,877 cu m/ha, whereas in Israel, it is 5,590 cu m/ha, that is 2.3-fold less. But taking account of natural precipitation (which is much higher in Israel), the picture significantly changes: in Israel, water use amounts to 10,390 cu m/ha, while in CA, it is 14,690 cu m/ha. The difference between them in the latter case is only 4,300 cu m, which amounts to 29.3% of water use in CA.

The last estimate shows that water saving in CA, even compared with a world irrigation leader such as Israel, are relatively low and do not exceed 30%. In actual fact, they are even lower, since we should keep in mind that evapotranspiration in the vegetation period in Israel is less than in CA.

As Table 3 on p. 60 shows, in Israel, evapotranspiration is equal on average to 1,029.9 mm or 10,299 cu m/ ha, while in CA, it is 11,453 cu m/ha, that is, 1,154 cu m/ha more.

Keeping this in mind, the actual difference in water use between Israel and the CA countries amounts to 3,146 cu m/ha (4,300-1,154), which is only 21.4% of the actual water application rate for the region.

[10] See: *Osnovnye polozheniia vodnoi strategii basseina Aralskogo moria*, Interstate Council on Problems of the Aral Sea, International Bank for Reconstruction and Development, Alma-Ata, Bishkek, Dushanbe, Ashghabad, Tashkent, 1996.

Table 2

Specific Water Use Indices of the CA Countries and Israel (*cu m*)

Indices	Israel	On average throughout the Aral Basin	Including				
			Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Specific amount of water per capita of the population per year in all branches of the economy	345	2,875	4,199	1,128	2,490	5,605	2,540
Specific amount of water per hectare of irrigated land per year	5,590	12,877	12,354	11,150	15,860	13,355	12,478
The same taking into account natural precipitation	10,390	14,690	14,130	17,680	18,055	15,028	14,900

But in actual fact even this figure is artificially high.

- First, because the main irrigated land in CA is located in Uzbekistan and Turkmenistan, where evapotranspiration is a little higher than on average throughout the region.
- Second, in CA, there is constant salinization of irrigated land[11] and so additional water resources are needed for flushing it.
- And, finally, third, the surplus water supplied to the fields is partially drained into rivers and canals, from where it is again taken for use.

Keeping in mind all these factors, it can be concluded that the water resources actually used for agricultural production in CA are greater than in Israel (by 10-15% at the most).

But this is not the only thing. When identifying the physical and environmental causes of water loss in irrigated farming in CA, another important factor should be kept in mind. During energy resource use, mineral fuel, for example, the savings potential implies the ratio of the loss coefficient to the efficiency coefficient. For example, if the efficiency coefficient of heat generation is 60%, losses and, consequently, energy-saving resources will be equal to 40%.

If irrigated farming is approached using the same standards, beneficial water use can only be considered that part which crops used to form their mass.

Then, for example, if a certain crop has a harvest yield of 40 hwt/ha, even without taking into account hard mass, the maximum amount of water used for the crop will only be 4 cu m/ha. But in

[11] See: Royal Haskoning, GEF Agency of the IFAS, Aral Sea Basin Program, *Water and Environmental Management Project*, Regional Report No. 2: "National and Regional Water and Salt Management Plans," 2002.

Table 3

Evapotranspiration in CA and Israel during Vegetation

	Israel			Turkmenistan		Uzbekistan	Tajikistan	Afghanistan
	Latitude: 32° 00' 00" Longitude: 35°10' 00"	Latitude: 32° 30' 00" Longitude: 35° 00' 00"	Latitude: 32° 30' 00" Longitude: 35° 10' 00"	Latitude: 36° 30' 00" Longitude: 58° 30' 00"	Latitude: 39° 10' 00" Longitude: 63° 30' 00"	Latitude: 40° 30' 00" Longitude: 68° 45' 00"	Latitude: 37° 30' 00" Longitude: 68° 40' 00"	Latitude: 37° 11' 00" Longitude: 68° 54' 00"
April	**4.44**	**4.36**	**4.36**	**3.60**	**4.78**	**4.09**	**3.69**	**3.54**
May	**5.74**	**5.47**	**5.47**	**5.20**	**7.03**	**5.86**	**5.41**	**5.3**
June	**6.64**	**6.33**	**6.33**	**7.09**	**8.89**	**7.81**	**7.33**	**7.69**
July	**6.65**	**6.46**	**6.46**	**7.73**	**9.12**	**8.05**	**7.67**	**8.09**
August	**5.99**	**5.94**	**5.94**	**6.78**	**7.90**	**6.94**	**6.81**	**7.12**
September	**4.96**	**4.88**	**4.88**	**5.08**	**5.48**	**5.01**	**5.09**	**5.36**
Average	**5.74**	**5.57**	**5.57**	**5.91**	**7.20**	**6.29**	**6.00**	**6.18**
Σ for vegetation	**1,049.8**	**1,019.9**	**1,019.9**	**1,082.1**	**1,317.6**	**1,151.7**	**1,098.0**	**1,131.6**
Average for the countries			***1,029.9***		***1,199.9***	***1,151.7***	***1,098.0***	***1,131.6***
Average for the region			***1,029.9***					***1,145.3***

Sources: Data from: *IWMI Water& Climate Atlas,* available at [www.iwmi.org].

both Israel and CA, the total use of water in the irrigated zone is more than 10,000 cu m/ha, that is, the efficiency coefficient of water use amounts to only 0.04%; the other 99.6% is losses or "water-saving resources." And they are related primarily to evapotranspiration and filtration.

This gives rise to an important question about the quality of these losses. Whereas in power engineering, these losses are irretrievably removed from circulation and, moreover, instead of being beneficial begin to inflict real damage on the environment by polluting the air, water, and soil, in irrigated farming, the unused water is simply incorporated into the hydrologic cycle, ensuring the sustainable existence of the environment. Evidently, if by some miracle, it would be possible to

achieve an efficiency coefficient of water use of 100% throughout Central Asia's vast irrigated zone, this would lead to a natural disaster of such proportions that death of the Aral Sea would seem a mere trifle.

So we can state that the irrigation technology used en masse in CA today blends sufficiently well with nature and is in environmental harmony with it. Of course, we are talking about the optimal version of this technology.

Within the framework of the development strategies in effect today in CA and keeping in mind the continuously burgeoning population, it is impossible to overcome irrigation problems by decreasing the area of irrigated land, while constant criticism of its recent past can also be regarded as populism. There is no other way to explain why, after declaring the main cause of the existing water crisis in the region to be the overextensification of irrigated farming during Soviet times, the CA countries are not even trying to resolve the problem today in the simplest way, by reducing the irrigated zone. On the contrary, as Table 4 shows, almost all the CA countries, particularly those situated on the lower reaches, are envisaging a further increase in irrigated land in their national development strategies.[12]

Table 4

Development Dynamics of Irrigation in the Aral Sea Basin (*thou. ha*)

Year	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Total
1990	782	410	706	1,329	4,222	7,449
1995	786	416	719	1,736	4,298	7,955
2000	786	415	719	1,714	4,259	8,101
2010	806	434	1,064	2,240	4,355	8,899
2025	815	471	1,188	2,778	6,441	11,693

In contrast to irrigation, hydropower engineering, like power engineering as a whole, is a relatively new economic branch in the region. For example, in Tajikistan, these industries did not begin developing until the middle of last century (see Fig. 1).

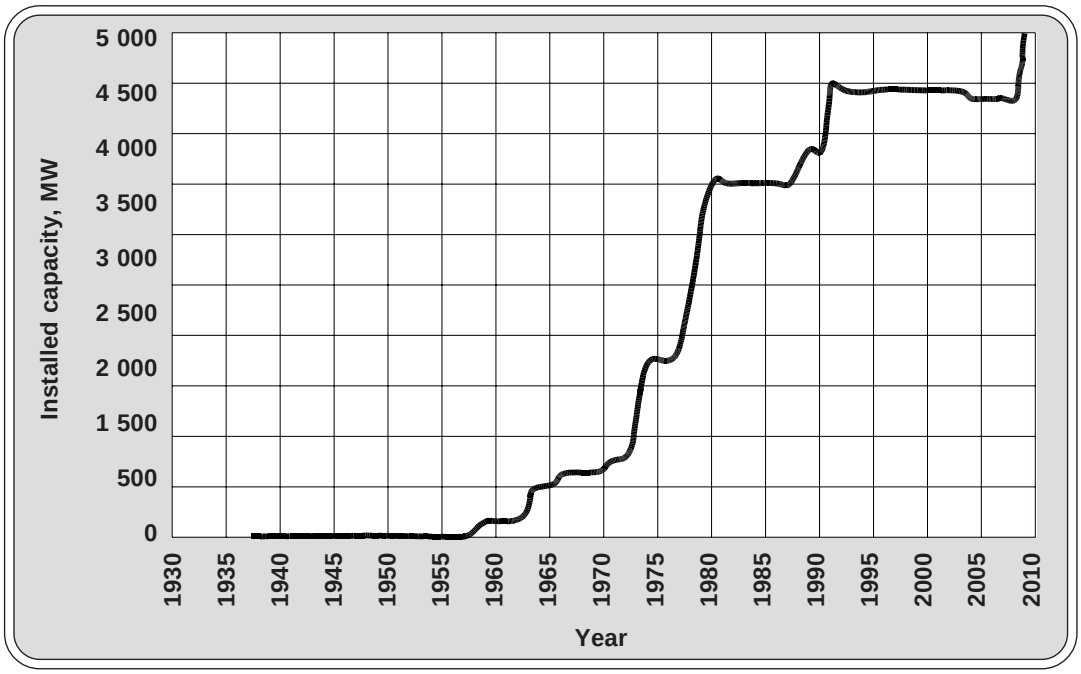
Power engineering has been developing in the same way in other countries of the region. Whereby, in contrast to irrigation, hydropower resources in Tajikistan and Kyrgyzstan have essentially not been developed yet. In Tajikistan, which has a total hydro resource capacity of 527 billion kWh[13] a year, only 15-17 billion kWh have been developed so far. In Kyrgyzstan, only 10-14 billion of the total 246 billion kWh[14] are being used.

It is worth noting in this context that hydropower engineering is much more profitable than irrigation. For example, the profit from one large hydropower plant, such as Nurek, alone, at the current electricity rates, is higher than the cost of the entire cotton harvest (the republic's main agricultural crop). The cotton industry itself in Tajikistan, which is raw material-oriented, is not only inefficient

[12] See: *Osnovnye polozheniia vodnoi strategii basseina Aralskogo moria*.
[13] See: *Gidroenergeticheskie resursy Tadzhikskoi SSR*, Nedra Publishers, Leningrad, 1965, p. 658.
[14] See: D.M. Mamatkanov, L.V. Bazhanova, V.V. Romanovskiy, *Vodnye resursy Kyrgyzstana na sovremennom etape*, Ilim Publishers, Bishkek, 2006.

Figure 1

Development of Power Engineering in Tajikistan



today, it is even unprofitable; its debts currently amount to more than $500 million (with an annual cotton production of 250,000 tons). So agriculture in the CA republics is, on the whole, only a way for the population to survive, while being a hindrance to the region's development.

Thus, the immanent crisis in irrigated farming and irrigation is the main cause of the problems currently existing in hydropower engineering in CA. And it will only continue to intensify in the future due to the sharp increase in the size of the region's population. Therefore, further orientation toward the use of water resources primarily for irrigated farming is leading Central Asia into an impasse.

The situation involving the development of hydropower engineering and irrigation can be described in the terms used to describe the stages of scientific-technical progress, technology levels.

The cyclical nature of economic development was first researched by Kondratiev, who showed that from the end of the 18th century to the 1920s, three long full cycles occurred lasting an average of 55 years each. The baton was taken up by Austrian economist Shumpeter.

Sergey Glaziev, in turn, who also developed this idea, said that economic cycles were caused by a change in technology level (the total amount of technology characteristic of a certain level of production development). A certain technology level is replaced by another after the first has fully exhausted its capability for development. At present in world technical and economic development, scientists single out five technology levels.

Intensive development of irrigation and building canals and irrigation networks belong to the first technology level (1770-1830), the nucleus of which was the textile industry.

Development of power engineering was the nucleus of the third technology level (1880-1930).

At present, the fifth level is unfolding, the basis of which is the electronic industry, computer technology, software, information services, nano technology, and so on (from 1980-1990 to 2030-2040).

It should be noted that the CA countries, although with some delay, belong to the third technology level. But irrigated farming and irrigation are still at the first level. So the conflict of interests between irrigation and power engineering is becoming a serious hindrance to the future economic development of the region's farm-oriented countries.

Solutions to the Crisis

The CA countries can only make up for lost time, move up to the fifth technology level, and so ensure their efficient economic development by further developing power engineering. In this context, hydropower engineering plays a very important role, whereby a decisive one for Tajikistan and Kyrgyzstan. Its development will make it possible not only to move to a higher technology level, but also significantly raise the financial efficiency of the national economies. The latter, in turn, can promote rational reduction of the irrigated zone of technical crops, cotton,[15] for example, which will lead to improvement of the situation in the Aral Sea Basin.

There may be objections that this approach will develop hydropower engineering mainly in the upstream countries, while reduction of irrigated areas in the downstream countries will only aggravate the conflict between them. This could indeed happen if the proposed strategy is carried out unilaterally. But in reality, the upstream countries (Tajikistan and Kyrgyzstan) are not capable of building even one large hydropower plant today using their own resources, while more than 80 large hydropower plants could be built in Tajikistan alone.[16]

So foreign investments are needed to develop the hydropower industry, and, in the current geopolitical conditions, cooperation among the countries of the Central Asian region itself will be the most effective and expedient. Common use will promote regionalization of the region's countries, while also solving national tasks. This will make it possible to establish close ties both among the economic entities and among the states.

It should be noted that in the Soviet Union too (one of the most ideologized countries of the world), the main unifying element was common use, albeit to some extent virtual, and of a general nature. The separation of ownership was what led to the upheavals that are still being experienced by all the CIS countries.

So in the future, orientation toward the joint development of power engineering, including hydropower engineering in the countries at the heads of the rivers, Tajikistan and Kyrgyzstan, is the best development strategy for the CA countries. But this prospect is rather long-term and will take decades to implement, while the conflict between hydropower engineering and irrigation is becoming all the more aggravated.

In order to resolve the problem of common use of hydropower resources right now, the strategy could be proposed for regulating relations among the countries of the transborder basins: the countries located in the drainage zone upstream (and the power plant owners) shall provide water regulation services for the countries downstream that use the water for irrigation. In this case, these services will entail a transfer from the national energy regime of reservoir operation in the upstream countries to an irrigation regime, whereby all the expenses and losses associated with this must be compensated for by the downstream countries.

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[15] The matter does concern only technical crops grown to obtain profit or for international exchange. It does not obviously entail reducing the production of farm produce, which ensures the countries' food safety.

[16] See: G. Petrov, «Tajikistan's Energy Projects: Past, Present, and Future,» *Central Asia and the Caucasus*, No. 5 (29), 2004.

It is precisely this approach that is envisaged in the 1998 Agreement among the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, the Government of the Republic of Tajikistan, and the Government of the Republic of Uzbekistan on Use of the Hydropower Resources of the Syr Darya River Basin.

The proposed strategy for regulating relations among the countries of the transborder basins can be regarded as a necessary supplement to this agreement in the form of a mechanism or technical and economic feasibility of the relations among the countries. Absence of such a mechanism is the main reason today for poor execution of this agreement and aggravation of the conflict between hydropower engineering and irrigation.

For a basin that has several hydropower plants, the mechanism is implemented as follows.

First, operating regimes that meet national interests are defined for all the existing hydropower plants. Calculations are carried out consistently, from the highest-lying to the lowest-lying hydropower plant in the chain. This is a well-known scheme in hydraulic engineering of independent drainage regulation by a chain of reservoirs. In so doing, the national regime for the highest-lying hydropower plant is calculated as though it were operating on its own, based only on the river's natural inflow, that is, as though there were no other countries or water users below this hydropower plant. After that, the regimes of the lower-lying hydropower plants are calculated not according to the river's natural inflow, but based on the releases from hydropower plants further up the river.

This calculation for the lowest-lying hydropower plant determines the amount of water that can be used by the downstream countries during the vegetation period. As experience shows, these amounts and the water supply schedule during vegetation are calculated based only on the national interests of the countries located upstream and do not satisfy the countries on the lower reaches. In order to meet the needs of the latter, drainage must be redistributed and the operating regime of the hydropower plants changed.

This redistribution of drainage should begin with the lowest-lying hydropower plant. If its regulating capabilities prove insufficient, the next hydropower plant is hooked up, and so on, right up to the highest-lying. This is also a well-known scheme of chain-compensated drainage regulation.

It becomes clear from the above that using the proposed strategy, the countries on the upper reaches will have to change the operating regimes of their reservoirs to the detriment of their national interests. What losses will the upstream countries bear in this event and how should the downstream countries compensate them for this?

As we know, the countries on the upper reaches (Tajikistan and Kyrgyzstan) are interested in the energy operating regime for their hydropower plants. Their losses can only be related to losses in electric power due to transfer of the hydropower plant operating regimes from energy to irrigation.

But electricity generation at hydropower plants depends primarily on the amount of water used, which is the same in any regime. The head of the hydropower plants can also be considered identical, both in the energy and the irrigation regimes, since the reservoirs are filled and drained in the same way, only at different times of the year.

So the countries on the upper reaches do not seem to be losing anything by providing drainage regulation services. But in actual fact, this is not so, since the upstream countries are in reality interested not so much in the total amount of electric power, as in its maximum generation in the winter, which is colder and when the greatest shortages are experienced, while also coinciding with the low-water season in the rivers. So when transferring from the energy regime to irrigation, the upstream countries in fact suffer losses, since they lose winter electricity, although they receive an equivalent surplus of it in the summer, during the vegetation period.

So again, if these countries were able to engage in equivalent export-import of this electric power (exchange of surplus summer for deficit winter electric power), there would be no losses. The problem is that the upstream countries cannot carry out this equivalent exchange themselves today.

There are several reasons for this: the shortage of winter electricity in the downstream countries themselves, electricity transit problems, difficulties with exporting electric power to countries of the Far Abroad, and so on.

Thus, it becomes clear what the water-consuming countries should do for the drainage-regulating countries: they should provide the upstream countries with the amount of winter electricity they lose, receiving in exchange the same amount during the summer.

Naturally, compensation could be made in other ways, not just return of the electricity itself; it could be made by delivering other energy resources—coal, gas, or petroleum products. Payment could also be made in monetary form. It is only important that the amounts of energy resources or funds make it possible for the country to generate the same amount of winter electricity it lost at its own power plants.

Thus, if the proposed scheme of drainage regulation is used in the interests both of irrigation and hydropower engineering, none of the participants will suffer from any losses. Uzbekistan and Kazakhstan will receive irrigation water in the full amount and in the regime they need, while Kyrgyzstan and Tajikistan will receive the energy they require (under optimal conditions). But the thermal power plants of Uzbekistan and Kazakhstan will have to operate in slightly changed conditions.

The difficulties in implementing the proposed scheme of compensational exchange are related to the technical possibilities of transferring electricity itself. Several recommendations can be offered regarding this.

First, in the past, Uzbekistan always delivered electric power to Tajikistan and Kyrgyzstan at the end of the winter, the highest-deficit season. This is the time when a tense situation also develops in the power industry of the supplier countries. But the electricity does not necessarily have to be returned at the end of the winter. For example, Tajikistan could receive this electricity much earlier, immediately after water begins to be drained from the Nurek reservoir in September, whereby the overall period of its return could be increased. In this case, Tajikistan would simply be accumulating this electric power in its Nurek reservoir.

Kyrgyzstan would not need to have any strict electricity return deadlines at all, since electric power can be conserved in the Toktogul reservoir at almost all times.

Such possibilities will increase even more after the Rogun and Kambarata hydropower plants are built.