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Rogun or Sarez? Energy Choices and Regional Risks

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Abstract

The article analyses material on exploiting the flow of trans-border rivers in Central Asia, the risks connected with the formation of natural lakes and the creation of artificial reservoirs in mountainous regions. Options for averting the possible failure of natural dams and barriers forming natural reservoirs on mountain rivers are assessed and the possibilities for using the water of natural mountain lakes to meet power engineering needs are evaluated.

Keywords: Central Asia, Hydropower, Rogun Dam, Sarez Lake, Transboundary Rivers, Water Security, Energy Policy, Environmental Risks, Dam Safety, Aral Sea

1. Introduction

Central Asia faces a difficult energy and water dilemma. The construction of large dams promises electricity, but it also creates serious environmental and geopolitical risks. This issue has become more urgent due to Tajikistan's plans to resume construction of the Rogun Hydropower Station on the Vaksh River. The main arguments for building the Rogun Hydro Power Station are as follows: Tajikistan lacks substantial energy resources and suffers from constant electricity shortages; its biggest power generation facility, the Vaksh River chain of hydroelectric power plants which it inherited from the Soviet Union, cannot meet all its requirements. Tajikistan is considering options for boosting its energy supply and the Rogun Hydropower Station project is one of them. However, the construction of the Rogun Hydropower Complex and its reservoir, with a capacity that was planned before the collapse of the Soviet Union, may lead to major disputes in Central Asia over the use of the waters of the trans-border rivers by Tajikistan's neighbours – Uzbekistan, Turkmenistan and Kazakhstan. The Rogun Reservoir will accumulate a substantial amount of the water which should enter the lower reaches of the Amu Darya River which flows through Turkmenistan and Uzbekistan and drains into the Aral Sea. The volume of water in the lower reaches of the Amu Darya may fall sharply, the Aral Sea crisis may worsen and water shortages may become more acute in the downstream countries in the Aral Sea basin due to the accumulation of water in the reservoir during the growing season and its release in winter. Any violation of building safety regulations and of operating the Rogun Hydropower Station Dam will bring further ecological and social risks both for Tajikistan and for the neighbouring states.

2. Rogun Risks

The Rogun Hydropower Station has a planned height of 335 metres, the capacity of the reservoir at full will be 13.8 billion cubic metres of water, and the station's planned generating capacity is 3,600 MW. By its design parameters, the Rogun Dam may be considered to be the highest artificial dam in the world. The dam of the Nurek Hydropower Station, which also stands on the Vaksh River in Tajikistan, is the world's tallest existing hydropower station dam at 310 metres high, with a reservoir capacity of 10.5 billion cubic metres.

Figure 1: Nurek Hydropower Station Dam on the Vaksh River, similar to the proposed Rogun Hydropower Station.

The base of the Rogun Hydropower Station lies on a tectonic fault and on substantial salt seams and experts think that this poses the main risk in its construction and operation [1]. They also think that the high level of seismicity of the area where the station is being built exacerbates these risks. Moreover, the experience of operating high-head hydropower plants shows that their dams and hydropower equipment should be more robust than those of mid- and low-head hydroelectric plants [2]. Some aspects of the technological processes at such plants have not been studied thoroughly and are not always monitored fully by service personnel. The accident at the Nurek Hydropower Station (dam height 310 metres) in 1983, which is typical of high-head hydro power plants, illustrates this. It was averted only because staff managed to close promptly the turbine water-gate. However, a similar accident in 2009 at the Sayano-Shushenskaya Hydropower Station in Russia (dam height 240 metres), which was not fitted with such a turbine gate, had disastrous consequences, with fatalities, substantial damage to the plant's equipment and considerable local environment damage. Emergency measures had to be taken to lower the reservoir's water table. The construction of major dams leads to irreversible environmental changes and is therefore marked by substantial ecological damage. The direct effects on the environment due to the construction of such dams include, among other things, accelerated erosion and damage caused by major earthworks. The greatest damage is caused by the substantial flooding of the lands under the reservoir and changing the flow of the river and the water temperature in the dam's tail waters. The siltation of reservoirs leads to the accumulation in them of mineral and organic deposits, natural fertilizers enriching the soil, which means that the soil in the lower reaches of the river is consequently less fertile. China has already encountered this problem with the commissioning of the big dams built recently on the River Yangtze. All these factors have a direct effect on the whole ecosystem – the soil, plants, animals, pristine nature, the climate, and most importantly, on the people living in the region and downstream from the dam. Upsetting the ecological balance will have far-reaching consequences.

The Rogun Hydropower Station will only start producing electricity within a few years, even if everything goes well and if the project is launched sooner rather than later. The station will consume energy in these first years prior to its commissioning rather than produce it. Some calculations say that it will take about 30 years to recoup the investment in full. And while the Rogun Reservoir is filling up with water, all the other power stations of the Vaksh chain of Hydropower Plants downstream of the Rogun Hydropower Complex will produce less energy because the water accumulating in the upper reservoir will be excluded from the energy production of the downstream power plants. The energy production of the entire chain of dams of the Vaksh Hydropower Plant, which accounts for 90 per cent of Tajikistan's entire energy capacity, will fall by 20-25 per cent in the first five to seven years of the Rogun Hydropower Station's operation. The entire region is facing common problems concerning the use of water, energy problems and the need to reduce ecological and social risks arising from natural and anthropological influences on the environment. A unified strategy for the rational use of natural resources is called for. In light of the above, several alternatives may be worthy of consideration. In addition to numerous artificial and natural lakes on the territory of Tajikistan, including the abovementioned Nurek Reservoir, there is another body of water in Tajikistan like the planned Rogun reservoir – Sarez Lake.

3. Sarez Dangers

Sarez Lake was formed high in the Pamir Mountains in Tajikistan in 1911 following a powerful earthquake which caused a mighty landslide. Over 2 billion cubic metres of rock formed a barricade on the Murghab River, creating a 600-metre high dam, called the Usoi Dam. Sarez Lake is still filling up with water and is rising by over 0.2 metres annually. Lying at 3,000 metres above sea level, it is now over 70 km long, about 500 metres deep at its deepest point and contains over 17 billion cubic metres of fresh water. This

natural dam, the Usoi Dam, lies at a height almost double that of the Rogun Hydropower Station and the capacity of Sarez Lake is one and a half times greater than that of the proposed Rogun Reservoir.

Figure 2: Sarez Lake, 3,000 Metres Above Sea Level, 17 Bn Cu.M.Of Fresh Water

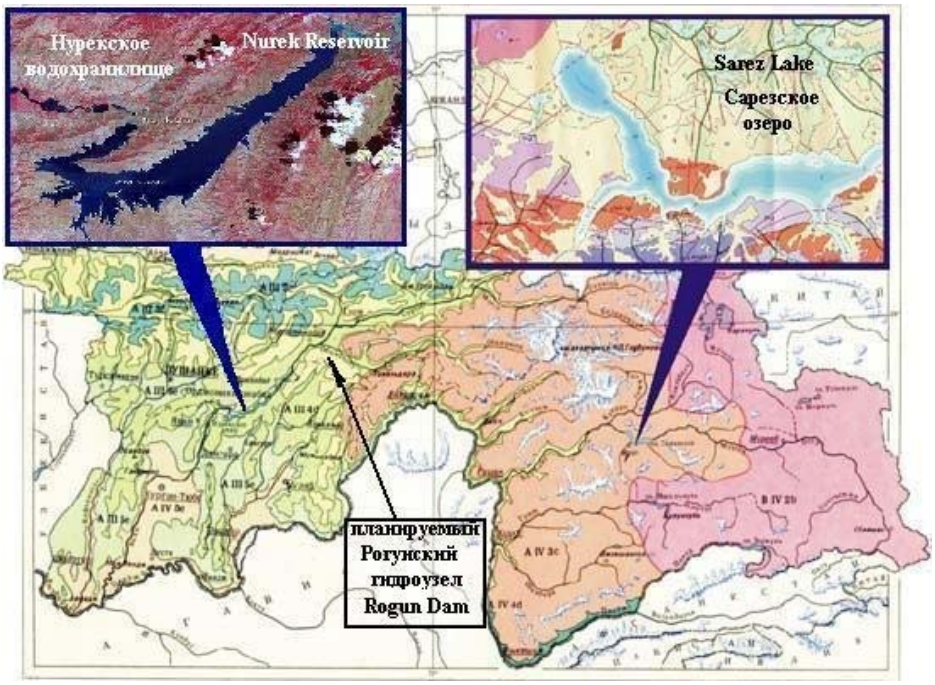

Figure 3: Satellite Photo, Maps Show Sarez Lake, Nurek Reservoir, Rogun Hydropower Complex In Tajikistan

The problem with Sarez Lake is that it lies in an area of high seismic activity. Experts think it is likely that in a future major earthquake, a landslide may develop on the right shore of the lake. They think at least 0.5 billion cubic metre of rock might slide into the lake and create a huge wave capable of washing over the crest of the Usoi Dam and destroying it. The resulting mudslide may cause catastrophic flooding of the rivers in the basin downstream and, according to some predictions, may reach the Aral Sea several thousand kilometres away. Should the Usoi Dam fail, over six million inhabitants of several states lying in the valleys of the rivers Bartang, Pyandzh and Amu Darya and in the Aral Sea area will be in an ecological disaster zone. Cities such as Termez and Nukus in Uzbekistan, Turkmenabad (previously Chardzhou) in Turkmenistan, as well as a large number of populated areas in the valley of the River Pyandzh in Tajikistan and Afghanistan may also be hit. The state of the Usoi Dam is monitored constantly and

there are provisions for promptly warning the population in the danger zone of a dam failure. No concrete technical measures are being taken yet to reduce the risk of water spilling over it probably because of the huge scale of such projects, insufficient financing and the remoteness of this lake. However, these measures are essential. One option may be to exploit this natural lake to produce energy as a partial alternative to the Rogun Hydropower Complex [3,4]. Sarez Hydropower Station options have been mooted since the late 1960s but none of them have been developed due mostly to the huge amount of work involved and because there was not at that time a real burning need to do so. With the collapse of the USSR in the 1990s and the ensuing lack of resources for implementing such a project, other issues superseded them.

Figure 4: Likely Zone Of Inundation If Wave Breaks Over Usoi Dam

4. Solutions

If the Sarez project were to be implemented instead of the Rogun Hydropower Station, water which has accumulated in the Pamir Mountains over the past century could be used instead of the water which would have to accumulate in the new Rogun Reservoir and thereby not reach the downstream water basin. The Rogun Reservoir would take about five to six years to fill whereas, according to rough estimates, reducing the level of Sarez Lake by 70-100 metres would allow up to 6-8 billion cubic metres of water to be released into the Aral Sea basin.

The risk of the Usoi Dam failing with catastrophic regional consequences could be mitigated by partially lowering the water level of Sarez Lake and consequently substantially lessening the water load on the dam. Disaster could be averted completely by a gradual reinforcement of the Usoi Dam. Lowering the water table in Sarez Lake would also lessen the danger of water pouring over the dam from a landslide-induced wave. The construction of the Rogun Dam may intensify existing regional problems while leaving the risks associated with Sarez Lake unresolved.

The volume of water not used in the reservoir could be reduced by building several small dams rather than one large one. The reservoir's capacity, including the so-called "dead volume", that is, the volume of water which never drains from the reservoir, is not proportional to the height of the dam but is equal to the reduction in the height of the dam squared. For example, if the height of the dam is reduced threefold, the reservoir's "dead volume" of water increases nine-fold. Thus, building three smaller dams on the Vaksh River instead of one big one, with the same overall fall in flow height and therefore the same total capacity of the hydropower station, would reduce the "dead volume" of water threefold. In this option, the overall surface area of the reservoirs would be three times less so the potential zone of inundation would be reduced and the amount of water lost through evaporation would also be reduced proportionally.

The Sarez Lake project could provide enough energy for its own uses now with a small initial outlay. A small initial power station could be used to provide electricity for developing the infrastructure and further increasing the plant's capacity. According to preliminary estimates, full exploitation of the energy of 8 billion tonnes of water flowing down 400-500 metres (the approximate fall in height of the Sarez hydropower plant) could generate at least 7-9 billion kWh of electricity.

Another option for the Sarez Lake Hydropower Station is to build a so-called diversion hydropower plant far from the dam with water being carried to the turbines in pipes 10-15 km long, rather than building a power station beside the dam, which is more common. The advantages of the former are that a more suitable location can be chosen to build the station, the fall in the water height is greater

and consequently so is the capacity of the hydropower station and the volume of energy produced. If we take Sarez Lake's fall in height to be around 1000 metres, with the height of the Usoi Dam as 500 metres and the height of the diversion through pipes as 500 metres, the station's capacity along the waters of the Murghab River will be 600-700 MW (the average annual flow of the Murghab River is about 70 cubic metres a second). In other words, the capacity of this plant would be comparable with that of the Sangtudinskaya Hydropower Station built on the Vaksh River in 2009. A reduction of even 100 metres in the level of the water accumulated in Sarez Lake could allow the station to produce 20 billion kWh of electricity, or more than the 15 billion kWh which the entire electricity grid of Tajikistan produces annually now. A simple calculation shows that by draining this amount of water out of the lake and using the energy it produces, energy generation in Tajikistan would rise by 25-30 per cent over 4-5 years. Once the level of Sarez Lake has gone down by 100 metres, the hydropower station could operate on the watercourse alone, with a capacity similar to that of the Sangtudinskaya Hydropower Station and generate 3-4 billion kWh of energy.

Tajikistan's energy shortage can be partially resolved through the use of decentralised alternative energy sources, including solar power, alternative small hydropower and wind energy. Central Asia's climate and abundant water resources make it possible to use solar batteries, solar heaters, collectors, heat accumulators and to develop the technology of small dam-free power stations and wind energy installations in the region.

5. Conclusions

The above options may minimise the negative impacts of the Rogun Hydropower Station's construction, reduce the associated ecological and social risks, resolve energy shortage issues and preserve water resources for the region as a whole. Instead of concentrating resources in a single megaproject, the region could benefit from a combination of risk-reduction measures at Sarez Lake, smaller hydropower facilities, and decentralized renewable energy sources [5].

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