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WATER-RELATED ENVIRONMENTAL ISSUES IN CENTRAL ASIA

Gadaev A.¹, Niyazov I.¹, Juraev A.¹, Alibekova N.²

¹Samarkand State Architectural and Civil Engineering Institute,

²Jizzakh Polytechnic Institute, Uzbekistan

This article addresses the need for a sustainable water resource management in the Central Asian region with a hot, dry and continental climate. This research and its results meet sustainable development's goals and also specifically the potential to solve or softening consequences of the Aral Sea ecological disaster. The urgency of this concern is felt most deeply in areas lacking potable water, most notably the larger Aral Sea region. During the long summer (from May until October) water consumption increases sharply and water sources cannot meet the demand. Intensive water use and sharply increasing of the water demand misbalances water flow in the main rivers as Syr Darya and Amu Darya which feed the Aral Sea. The primary challenge facing water supply and sustainability specialists in Central Asia and specifically in Uzbekistan is to balance competing water supply demand and water sources preservation in the region. Among these demands is the urgency of halting further depletion of water in the Aral Sea, and, ideally, to augment the water in that basin. But there is also the need to develop high quality water delivery systems for human and industrial use. And, of course, there is the question of what water can be left for the agricultural sector of the dry and hot temperature region to irrigate its crops or just sustainable water resources management. This study will address water-related issues in the Central Asian Republics with special emphasis on the Republic of Tajikistan. The authors analyse a current situation and describe the factors that contribute to these issues and will provide recommendations for alleviating the

Aral Sea disaster. Authors offer to solve this problem with wider team from different fields.

Introduction

Central Asia is a specific region with a dry and hot climate and consisting of Republics of Uzbekistan, Kazakhstan, Turkmenistan, Tajikistan, Kyrgyzstan. These nations all gained their independence from the former Soviet Union in 1991. Unfortunately, with their independence they also inherited many environmental issues. By far the most pervasive issue is the shrinking of the Aral Sea. The Aral Sea began to shrink in the 1970's during the Soviet Era. At this time, little attention was paid to environmental issues; political issues and hopes of increasing agricultural and industrial yield prevailed. Unfortunately, this lack of attention to the Aral Sea persisted through the independence of Central Asian countries in 1991. In the early 90's, these new states were preoccupied with political and structural reformations and the Aral Sea disaster worsened. It was not until 1993 that attention was finally paid to the Aral Sea, and efforts are currently in motion to salvage what remains of the once bountiful sea.

Research. Material and Methods

It is estimated that the surface area of the Aral Sea is now just 25 % of what it was during the Soviet Era. The Aral Sea has the capacity for 60,000 sq km of surface water, its original surface area in 1960. Sixty cubic km per year would be needed to maintain the original surface area, but today 1000 cubic km to refill the sea to its original volume. There are a large number of contributing factors to the shrinking of the Aral Sea. Water pollution in the Amu Darya and Syr Darya rivers, increases in the agricultural industry, political conflict, and a boost in the population of Central Asia, are among some of these reasons. The water resources exist, however they are not making their way to the Aral Sea. One hundred and fifteen cubic km of water is available in the Aral Sea Basin, however the waterflow to the Aral Sea was less than one cubic km in 2002. The following table shows how waterflow to the Aral Sea has changed over time.

Yet it has been 24 years since the first efforts were made to save the Aral Sea and still conditions are not improving. A variety of factors are responsible for this, namely the failure of cooperative water management and full participation of all Central Asian countries. Ignoring this issue has produced disastrous results, and it is estimated that the Aral Sea can completely dry out by the year 2025.

Table 1 – Available water resources in cubic km

	Water available in the basin	Natural water losses	Water use	Inflow to the Aral Sea
1930	115	36	25	54
1960	115	13	48	54
1990	115	7	103	5

Today, more than 50 million people live in Aral Sea disaster zone, and about 150 million people inhabit the surrounding area. It will take the cooperation of many nations to restore the Aral Sea, however this is endeavor may not be easy to overcome. Each of the Central Asian and surrounding countries has its own unique conditions which affect its international cooperation. Factors including population, government, industries, culture, geography, health, and transboundary issues all influence water-related issues.

This article addresses water-related issues in the Central Asian Republics with the focus to the Republic of Tajikistan, describe the factors that contribute to these issues, and provide recommendations for alleviating the Aral Sea disaster. Because Tajikistan is the main upstream country with an important geographical location where a water formation for an Aral Sea basin consists 60,583 cubic kilometers per year (52,0 %) for all Central Asian region (table 2).

Table 2 – Water resources (surface) formation in the Aral Sea basin (km³/year)

Basin Countries	Rivers		Aral Sea	
	Syr Darya	Amu Darya	km ³ /year	%
Kazakhstan	2,426	-	2,426	2,1
Kyrgyzstan	27,605	1,604	29,209	25,1
Tajikistan	1,005	59,578	60,583	52,0
Turkmenistan	-	1,549	1,549	1,2
Uzbekistan	6,167	5,056	11,223	9,6
Afghanistan, Iran	-	11,593	11,593	10,0
Total	37,203	79,280	116,483	100

Results and discussion

Approximately 2,590 sq km of Tajikistan is covered with water in various forms. The country has approximately 25,000 rivers and 1,300 lakes, has nine operating reservoirs, and about 8 % of the country is covered by glaciers. Glaciers provide 25-50 % of the yearly flow; this number is on the rise due to increase in annual temperature and decrease in population size. The country's main watersheds are Syrdarya River in northern Tajikistan, Zeravshan River in central Tajikistan, Pyanj and Amu Darya Rivers in southwestern Tajikistan and the Pamirs, and the basin of saltwater lakes in the Eastern Pamirs. The major water streams in Tajikistan are the Pyanj, Amu Darya, Vakhsh, Syrdarya, Zeravshan, Kafinigan, Bartang, and other rivers. The Pyanj, is made up of 5 other major rivers including the Kafirnigan, Vahksh, and Kyzylsu. Pyanj means hand or palm in Tajik, and the river is named so because it is the base of the Amu Darya River, much like where the wrist is attached to the hand. Flow consumption of AmuDarya and SyrDarya, two of the major rivers, are 15.2 % and 7 %, respectively.

Tajikistan's lakes have a total combined surface area of 705 sq km and a total capacity of about 50 cubic km. They are divided into three categories: tectonic, erosive, and glacial. Over 80 % of the lakes are smaller than 1 sq km in area, and 78 % are located in the mountains at an altitude higher than 3,500 m above sea level. Large lakes have a total combined area of more than 680 sq.km. Karakul is the largest lake in the country with an area of 380 sq km. It is a non-outlet, saltwater lake located in the Eastern Pamirs at an elevation of 3,914 m above sea level. Scientists believe the lake was formed in crater from a large meteorite. The deepest freshwater lake is Sarez Lake located in the Western Pamirs at 3,239 m above sea level. It has an area of 86.5 sq km, a length of 60 km, a volume of 17 cubic km, and reaches a depth of 490 m. The lake was formed during an earthquake in 1911 in the steep-sloped canyon of the Bartang River. A landslide sealed off the Murghob river valley, thus creating the lake. The natural dam created by the mountain rocks is called the Usoi and is over 550 m high, making it the tallest natural or man-made dam in the world. Because of the unstable geographical conditions of the area, however, environmental officials worry about the lake's stability as a dam should there ever be another earthquake.

Water Budget

Tajikistan produces 66.3 cubic km of water internally per year. Sixty three point three cubic km is from surface water, 6 cubic km is

from groundwater, and there is an overlap of 3 cubic km. Because it is located upstream, Tajikistan contributes a large amount of water to the Aral Sea Basin compared to other countries. The chart below indicates the percentage that each Central Asian country contributes to the Aral Sea.

Water use in Tajikistan is primarily agricultural; 84 % of use is for agriculture, 8.5 % is for domestic use (drinking water), 4.5 % is for industrial use, and the remaining 3% is for additional uses. Agriculture dominates water use in Tajikistan because agricultural exports are the country's best chance at reducing rural poverty. Mountains are physical barrier and challenge for distributing water to the population. Forty eight percent of crops are dependent on pumps to irrigate the land; this is quite an expensive endeavor. Pumps lift water to higher elevations which requires a lot of electricity and is expensive for farmers. Since 1991, 1/6 arable land no longer receives water due to this issue. Much of Tajikistan's water is also used to produce hydroelectric power. In fact, 98 % of Tajikistan's electricity came from hydropower in 1997. Tajikistan has a gross theoretical hydropower potential of 527,000 GWh per year, the most by far of any Central Asian country; Kyrgyzstan has the next highest potential at only 162,500 GWh. Tajikistan also has the greatest dam capacity in Central Asia at 28,970 cubic meters. Hydropower is sustainable resource; however it creates issues of water consumption and soil damage. A large amount of the waterflow to the Aral Sea is retained in dams used to produce hydroelectric power. Also, hydroelectric power causes the water table to rise, which can lead to soil salinity as well as other problems. Because of these issues, it has been proposed that other forms of renewable energy, such as solar power, be utilized.

Save Aral Sea Foundation

The significance of the Aral Sea's depletion was first acknowledged in 1993; 18 years after the sea began shrinking in 1975 Central Asian countries realized they must work together in order to combat the disaster. In 1993, the first meeting of the Save Aral Sea Foundation took place in Kyzyl-Orda, Kazakhstan. On March 26, an agreement was made that the Heads of State of the independent Central Asian states would work together to come up with a comprehensive water management plan. The Aral Sea Basin Program was approved by the Heads of State in January 1994 and was designed to be administered by the new regional institutions. The mission of the program is to address issues of water quantity as well as quality. It was determined by the Heads of State that Save Aral must prepare a gen-

eral strategy of practical water distribution, use, and protection as mandated by state governments. Also, each state must regulate and limit water pollution, water consumption, and industrial use of water. Finally, it is suggested that each country donate at least 1 % of its annual budget to the Save Aral Sea Foundation.

An agreement was made between Tajikistan, Uzbekistan, and Turkmenistan about sharing the Amu Darya; however Afghanistan refuses to comply because it will bring them a water shortage. Tajikistan has also made an effort to reduce agricultural water use. In 2003, the Water User's Association imposed a tax on farmers for water use. Because poor farmers cannot afford to pay this tax directly, the government takes out a certain amount of their taxes for this purpose. Because this tax is not something farmers are forced to be salient of, it has done little to decrease agricultural water waste, but it is a step in the right direction

Future Plans

The Save Aral Sea Foundation has constructed a list of possible plans to ameliorate the current situation. Suggestions are listed in order of how plausible the organization believes these plans are in succeeding. The first plan is to divert additional water resources from the north into the Aral Sea basin. The diverted rivers would come from Russia; a likely candidate is the Irtysh River which flows from China through Kyrgyzstan to Russia. This plan is seen as the most plausible because it is sustainable and promises to be a long term solution. Situation is changing but still to look for the additional sources are urgent and it can make a real ecological improvement in the region. It could be Siberian rivers, Caspian Sea or Volga river and negotiation is the a challenge for today. The second plan is to start using new modern irrigation technologies. These would be more sustainable and would save much water wasted during agriculture production in Central Asia. Examples of modern technologies include: termination or water resource misuse and mismanagement, drip irrigation technologies, and modern pumps and piping. Problems with this system are that it is expensive and would require significant funding from individual countries; replacing out of date irrigation systems is a large, time-consuming endeavor; and a need for specials and new training for current laborers. A third option is to reuse treated waste water. This would involve using water drained from showers and drinking sources for secondary purposes such as plumbing. The problem with this plan is that treatment plants are only located in big cities, so it would be difficult for rural areas to participate. The

fourth plan is not very optimistic; some say the Aral sea is beyond repair and should be left alone. This plan is not much of a solution, and does nothing to prevent the environmental consequences related to the shrinking of the Aral Sea. Some advocates of this plan hope that, if left alone, the sea will eventually one day naturally replenish itself. The fifth option is to take water from the Caspian Sea and relocate it to the Aral Sea Basin. The water table of the Caspian Sea is rising, and this is a problem for surrounding countries. These countries are strong advocates for this plan because lowering the water table would give them better access to oil under the sea. However the problem with this plan is that it only provides a short term solution; if the same issues of poor water quality and management continue, eventually the donated water will become polluted and diminished too. Also, a minimum of 12 pumping stations would be required to pump water from the Caspian to Aral sea due to differences in elevation, which would be a very costly ordeal. The sixth plan would be to use more applied technologies for water supply and irrigation. This plan could be effective at conserving water but would require extensive new training for laborers who have been using the same methods for generations.

Conclusion

It is clear that the Aral Sea and surrounding inhabitants are in grave danger, and something must be done about this environmental crisis. It will take the cooperation of all Central Asia countries to mitigate this disaster, and Tajikistan is no exception. From Tajikistan's perspective, some potential future plans look more promising than others. Using modern irrigation technologies seems to be the best option, despite the cost of replacing old equipment and installing pumps to bring water up the mountains. This plan will have the best long term effects, and the sooner action is taken, the less expensive and time consuming the process will be. This option would not only help replenish the Aral sea, but would also provide plentiful and safe drinking water to rural Tajikistan inhabitants. It would also update inefficient agricultural irrigation systems which would ultimately produce a greater yield and boost economic production, which is especially important in Tajikistan.

It is clear that some of these solutions would just not be practical in Tajikistan or elsewhere. Reusing treated waste water is a good idea in theory, but would be nearly impossible to practice in Tajikistan due to the geography. This would only be possible in cities, and with nearly 75 % of the population living in the mountains, the mon-

ey and effort this project would require would be better used carrying out a different plan. Also, ignoring the Aral Sea disaster altogether is definitely not an option. There are too many health and environmental issues directly related to the Aral Sea, and deny the Aral Sea crisis will only make these matters worse.

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ИСПОЛЬЗОВАНИЕ РЕГИОНАЛЬНЫХ ДОПУСТИМЫХ КОНЦЕНТРАЦИЙ КАК СПОСОБ РЕШЕНИЯ ПРОБЛЕМЫ ЭКОЛОГИЧЕСКОГО НОРМИРОВАНИЯ

Денисова В.Е., Ковалев Р.А.

Тульский государственный университет

В статье рассматриваются проблемы экологического нормирования на основании предельных допустимых концентраций, рассмотрено несовершенство существующей системы нормирования и предложен вариант использования региональных допустимых концентраций.

Экологическое нормирование является одной из ключевых проблем в формировании экологической безопасности России. Важным аспектом экологического нормирования является система предельно допустимых концентраций вредных веществ в воде. Несмотря на то, что состояние качества вод в водных объектах, по данным Государственных докладов о состоянии окру-