

Consequences of the Aral Sea Ecological Disaster

Mahmood Alraisi

University Of World Economy and Diplomacy, Tashkent, Uzbekistan

ABSTRACT

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Correspondent Author:
Mahmood Alraisi
E-mail: mmalraisi@live.com

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The Aral Sea basin is situated at the northern part of the Republic of Karakalpakstan (an autonomous republic within Uzbekistan) and decants into the Syr Darya River. The southern part is located in the Republic of Uzbekistan territories and decants into the Amu Darya River. The two rivers irrigate most of the territories of Central Asian countries (Uzbekistan, Kazakhstan, Karkyistan, Tajikistan and Turkmenistan) beside the northern parts of Afghanistan. The Aral Sea has faced acute environmental, economic and humanitarian crises for many decades due to an agrarian reform project during Soviet Union era. The gradual drying of the Aral Sea led to an environmental disaster affecting millions living in the Aral Sea basin area and its surroundings, particularly in Uzbekistan and Kazakhstan. This research addresses the Aral Sea ecological disaster's consequences and socio-economic situation, in addition to the Aral Sea disaster impact on population and environment. The aim of this research paper is to create awareness of the ecological disaster of the Aral Sea basin, finding solutions from the international community, cooperation among the Central Asian Countries regarding the issue, and water security in the region.

النتائج والعواقب البيئية لكارثة بحر الاورال

محمود محمد الرئيسي

جامعة الاقتصاد العالمي والدبلوماسية ، طشقند ، أوزبكستان

المُستخلص

منطقة حوض بحر الاورال يقع جزءها الشمالي داخل أراضي جمهورية كازاخستان وتصب فيه نهر سرداريا ويقع جزءه الجنوبي داخل اراضي جمهورية أوزبكستان وتصب فيه مياه نهر أموداريا. ويعبر النهران أراضي معظم دول آسيا الوسطى (أوزبكستان، كازاخستان، طاجيكستان، فيرغيزستان وتركمانستان) بالإضافة الى أجزاء شمالية من أفغانستان. بسبب الازمة البيئية والاقتصادية والانسانية قيام الاتحاد السوفيتي السابق في ستينيات القرن الماضي بتنفيذ مشروع استصلاح أراضي نهر الجوع في كازاخستان، الامر الذي أدى لاستجرار كميات من المياه الاراضي المستصلحة واستجرار المياه ادى الى عدم وصولها الى بحر الاورال بشكل كبير وبالتالي تعرض لجفاف تدريجي منذ أكثر من نصف قرن . ادى ذلك الى كارثة بيئية واقتصادية وسكانية حادة يعاني منها ملايين السكان في منطقة حوض بحر الاورال والمناطق المتاخمة لها حتى اليوم وخاصة في أوزبكستان وكازاخستان. ومستوى البحث: للوقوف على واقع وأفاق مشكلة منطقة حوض بحر الاورال البيئية والاقتصادية وطرق التصدي لها واستعراض وتناول مشاكل منطقة حوض بحر الاورال.

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الكلمات الدالة

حوض بحر آرال ، أوزبكستان ، آسيا الوسطى ، البيئة ، الكوارث البيئية ، البيئة

Introduction

The Aral Sea disaster is considered one of the world's worst environmental disasters in recent history as the situation is exacerbating year by year.¹² The drying up of the Aral Sea directly affected the natural and environmental systems in Central Asia as well as the surrounding areas in addition to its social and demographic implications, the adverse impact on the genetic and biological settings, and human health. In fact, the damage done is virtually irreparable and cannot be brought back to normal without robust support from abroad and solid assurance to the countries of the region that they will not be left alone to face such global disaster.

The breakup of the Soviet Union left the emerging republics of Central Asia without a water management strategy. The water resources problems date back to the middle of the twentieth century due to the Soviet Union's policies toward glorification of agricultural productions, and enhancing electrical power production in Central Asia. The Soviet policy-makers decided that the irrigated area of the Aral Sea basin should be expanded and devoted mainly to cotton production. Hence, there are reports about success of this policy toward increased agricultural production, and electrical energy production enhancement. However, the reports do not mention anything in regards to the ecological consequences of this aspect.³

Contemporary Ecological and Socio-Economic Situation in Aral Sea Basin

The Aral Sea is an example of the effects of water abstraction for irrigation purposes to grow cotton from the water fed from Amudarya and Syrdarya, when many Soviet ecologists, hydrologists and engineers were worried and critical about the plans to set up in the Aral Sea basin. In the last century, the evidence on environmental consequences became clear, but no attention was given to these concerns, and very little was done to prevent the ecological disaster in Central Asia until the fall of the Soviet Union.

After the dissolution of the Soviet Union, the former Central Asian Republics inherited several problems: in the forefront, deficiency in water resources and energy production, salinity increase and drought of Aral Sea, and decertification of large amount of areas in the region, as well as an ecological disaster.

The ecological changes from the climate to the landscape in the Aral Sea basin are the effects of man-made decisions. The responsibility of the environmental disaster – that the area now faces – and the water usage and distribution in Central Asia are some of the most challenging issues. Moreover, after the countries in the region gained their independence, they inherited salinization and water contamination, which in turn became a catalyst for political instability and conflict within the region.

Environmental scientists and historians describe what happened in the Aral Sea as “the worst ecological disaster ever,” and garnered great global interest and concern, particularly to the states in the region. Due to the shrinkage and reduction of its volume, it led to numerous environmental and socio-economic consequences in the Central Asian region and its population.

No doubt, the water reduction in the Aral Sea basin is considered one of the most dramatic consequences of a natural area destroyed by human activities. We can focus on the environmental disaster in the basin area, thinking of solutions that led to such detraction of the environment, and how new organizations and institutions should be introduced in order to join in finding real and effective solutions from the international community toward this issue.

The Aral Sea basin problem needs more attention from the international community, to reconsider strategies for socio-economic development, sustain the environment and offer hope and solutions to the people of the region. After the collapse of the Soviet Union, the Aral Sea became an international problem from the geopolitics perspective, and needs interstate cooperation within the countries in Central Asia. Moreover, the scale and the nature of the problems in the Aral Sea region require adequate cooperation, and the countries in the

region need ways of strengthening regional and international coordination.

After gaining independence, following the collapse of the Soviet Union in 1991, the five Republics in Central Asia (Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan) agreed to form a supranational body to manage water use, resulting in the Interstate Coordination Water Commission (ICWC) in Almaty, and was stated in the February 1992 agreement between the parties concerned. The ICWA operation was to set “quotas” for the five countries in Central Asia, and the BVOs (river basin organization) duty was to control the follow of the Syrdarya and Amudarya- which was formed during the Soviet era.⁴The agreement intended in cooperation of the management, utilization and protection of the water resources in interstate sources; several organizations have also been formed in order to take the water issues in relation to the Aral Sea disaster.

One of the main bodies established in 1993 was the International Fund for Saving the Aral Sea (IFAS), and over the previous years it has implemented two programs, worth more than USD 2 billion in aid to the countries of the Aral Sea basin, supported by the international donor community.⁵ Its main objective is to finance joint practical actions favorable projects and programs to save Aral Sea and mitigate the environmental health of the whole region.

Hence, the international community must double its efforts to encourage the logical and equitable use of the common water resources plus the viable construction of hydroelectric power plants across the rivers shared by the countries of the region. The conflicts and disputes in Central Asia are due to the trans-boundary nature of the water sources, taking in mind the importance of water to the regional economy. In addition, the international political boundaries did not make the issue any easier between the upstream and downstream states in the region. Therefore, the above issues should influence the international community while working toward new and effective strategies for waterpower relations in the Aral Sea basin.

A complex set of socioeconomic, demographic, ecological-climatic problems with far-reaching

global consequences have arisen in the Aral Sea region. At no point in time has modern history seen the disappearance of a large inland lake over a span of a decade, like the demise of the Aral Sea which resulted in catastrophic consequences for over a million people living in the areas of the Aral Sea basin. This resulted in ecological-climatic, socioeconomic and demographic problems that rose in the region at a global level. The Aral Sea crisis is one of the consequences of insensible policies of water consumption.

The rapid shrinkage of the Aral Sea over the last fifty years, has caused catastrophic ecological and socioeconomic consequences for the region and its population which is covering now about 10 per of its original surface, and less than 10 per of its former volume, while supporting more than 60 million people.⁶In addition, one of the main ecological impacts of the Aral Sea disaster is desiccation, caused by the dramatic drop of the level of water supplying the sea, and the salinity increase of seawater, and the water level decline increased from 10 ppt in 1960 to 92 ppt in 2004.⁷ The desiccation of the Aral Sea is also associated with the change in the sea-surface temperature, increasing in summers and decreasing in winters with seasonal climate change, cooling and warming of the sea.⁸ The climate change also affects the region’s water and energy security, leading to political tension between the countries in the region.

The former Secretary General of the United Nations, Ban Ki-moon, has expressed his concern to the ecological crisis in the Aral Sea as “one of the most wide-scale anthropogenic catastrophes and that which has inflicted a considerable damage to the millions of people and environment”,⁹ and during a previous visit of the Secretary General to the Aral Sea region in April 2010, described the situation as “one of the worst environmental disasters in the world”¹⁰. Therefore, the Aral Sea crisis poses a direct threat to the health, gene pool and the future of the Central Asian region’s population, bearing in mind the mismanagement and the thoughtless waste of natural resources during the Soviet Union era, lying behind the drying out of the Aral Sea. When the environmental crisis

keeps deteriorating, the problem needs greater attention from the international community.

Due to the adverse effects of the diminishing Aral Sea waters, experts in various fields have come out with various proposals to reduce the negative effects on the environment. Among these proposals is to create a string of buffer zones to prevent the spread of dust and saline materials carried by the wind, desertification and the restoration of the fishing wealth in the delta of Amu Darya River to its previous levels of production. In this regard, from 2001, the Executive Committee of the International Fund for the Safeguarding of the Aral Sea (EC IFAS) has started to finance joint actions and programs saving the Aral Sea and environmental recovery of the Aral Sea basin, stabilize the environment of the Aral Sea basin and improving the management of land and water resources in the region. Uzbek Water Resources Scientific Investigation and Design Survey Institute has prepared technical and economic studies for the establishment of water-immersed areas along the shores of the Aral Sea adjacent to the delta of Amu Darya River and the studies were recently endorsed by Uzbekistan Government. The project includes several urgent measures to implement in stages, including the establishment of water control structures, increasing the capacity of the dams constructed at the tributaries of the Amu Darya River, and rehabilitate and redesign the infrastructure of the lakes existing in Muynak¹¹ to revive the whole areas delta of the Amu Darya River. Considering the limited finances, water resources, and the need to implant immensely urgent projects within a limited timeframe, the plan was implemented on stages to avoid the devastating effects of water scarcity and deficit, which occurred in 2000 and 2001.

The first phase of the project included newly constructed, rebuilt, and rehabilitated waterworks along the shores of the Aral Sea basin at Amu darya delta in 2001; at the same time preparation for the second phase of the project was launched and implementation started in 2005 while massive construction activities were undertaken at the delta of Amudarya River. However, priority should be given to efforts to quell desertification and the

spread of toxic dust, which may inflict devastating damage on the agricultural land. To address this problem, a green belt of drought and salt-resistant shrubs should be planted along the delta of Amudarya River in the Gulf of Gulaterbas. Several initiatives were launched to plant a green belt running along the delta of the Aral Sea, reaching up to the areas where the sea-water receded, by cultivating different kinds of plants resistant to drought and salts. These are seen as effective measures to address the environmental crisis in the Aral Sea basin.

The Aral Sea, whose basin is shared by five Central Asian countries, once supported a vibrant economy, with many people relying on fishing and agriculture for their livelihoods. However, massive diversion of water for cotton cultivation from the two main rivers flowing into the Aral Sea in the 1960s shrank the sea, resulting in thousands of lost jobs, severe degradation of the surrounding environment, and ill health among local people, when they played an important role in the development of the regional economy, being sources of employment.

The Aral Sea was formerly one of the four largest lakes in the world, but after the reduction of the amount of water follow from its original sources (Amudarya and Syrdarya) for irrigation purposes, it resulted in splitting the sea into several bodies with high level of salt on the eastern and western sides. The Aral Sea has gradually retreated into one of the eight largest lakes in the world after the level of its water fell by 26 meters; the water surface shrank by more than 7 times, from 65,000 to 9,000 square kilometers; the water reservoir moved away from the shore by 100-120 kilometers. The mineralization of the water increased from 10g/l to 120g/l (gram/liter), and in the eastern part- to 280g/l, about 5 million hectares of desert area was formed at the bottom of the former Aral Sea¹². The total surface area of water of the South Aral Sea (SAS), declined by 50 percent from 67,500 km sq. in 1960 to 9,452 in 2009, and rebounded to more than 10,000 km sq. in 2013, according to NASA satellite images, while the North Aral Sea

(NAS) surface area remained steady with some slight changes in the Syrdarya delta. The water level reduction in the SAS led to an increase of its salinity to more than 100 grams/liter. 13

Evidently, over the last fifty years, the Aral Sea basin has gone through many changes from population increase, to doubled irrigated areas and decline in water runoff to the sea from 55 km³ /year to 10.6 km³/year.¹⁴ This has led to the deterioration of agricultural production in the southern areas of the Aral Sea falling within the territory of Uzbekistan for the following reasons:

- Evaporation of the sea water, highly salted soil and decline of the land used for agriculture from 550,000 to 20,000 hectares;
- Drying up of about 50 lakes in the delta of Amuarya River.

The crisis has led to catastrophic consequences for plants, animals, the ecosystem and nature, north of the Amudarya delta, where 20 species of the fish population have perished, only 4 species survived and in 2012 all species vanished.¹⁵ Due to the declining fish population, commercial fishing was halted. Thousands of fishermen and labors lost their main source of income and were affected badly, after industrial fishing in Muynak, Karakalpakstan – an autonomous Republic within Uzbekistan – has come to a halt. Muynak was once a bustling fishing community at the Aral Sea coast but today it is dozen of kilometers from the rapidly receding shoreline of the Aral Sea. The seawater became heavily salty and polluted with fertilizer and pesticides. The dust blowing from the exposed lake-bed, contaminated with agricultural chemicals, became a public health hazard and a threat to the environment, flora, fauna, and the health gene pool of population in the Aral Sea region.

Therefore, one of the main reasons for the drying up of the Aral Sea, as explained, was the massive use of the water of its feeding rivers in irrigation. This followed the expansion of agricultural land, especially cotton production within the Aral Sea basin from 1960, when cotton cultivation rose from 1.9 million hectares to 3.1 million hectares,

and cotton production increased from 4.3 million tons to 8.7 million tons.¹⁶

The Aral Sea has completely lost its role as an ecological balance, after playing a moderating role. Summer has become hotter with severe drop in the level of rainfall and winter has become chillier due to the winds blowing from the Siberian plains. The 3 million hectares of seabed have become a source of saline materials, residue of pesticides and other chemicals used in agriculture. Moreover, some of the sea area was used during the Soviet era for chemical and biological tests ground that lead to 70 million tons of waste materials spread by the wind to neighboring agricultural lands.¹⁷ The researchers who developed a climate, land-ice and rainfall- run model in 2012 for the Syrdarya, indicated that climate change affects the river's run-off regime (snow will melt earlier, and less water will be available for summer irrigation, due to downstream tributaries that do not have enough storage facilities.)¹⁸

The negative health consequences and its dangerous impact to the environment and population adds to the catastrophe. One of the Aral Sea islands, Vozrozhdeniye Island, was used as testing ground for the Soviet biological weapons program.¹⁹ Vozrozhdeniye Island is located in the middle of the Aral Sea, and part of a large peninsula extending from the south was a secret place for testing the Soviet Union biological warfare program operated from 1954 to 1992,²⁰ and others go back to 1930 until the fall of the Soviet Union. When hundred to tons of anthrax were transferred to this island, the island was used for biological warfare experiments and a dumping ground for unwanted anthrax, adding another man-made health disaster to the habitants of the Aral Sea region²¹. The impact on public health was shocking, infant mortality rates in the region today are high, exceeding 100 infant deaths per 100,000 live births in several areas²². These tragic figures were mainly attributable to the pollution of water and agricultural products, increased levels of lead and zinc in blood, the spread of kidney immune deficiency, liver illnesses and cancer, thyroid gland

diseases, rheumatoid, concentration of salt in human body and anemia which affects primarily a large number of women.

However, the Executive Committee of the International Fund for Saving the Aral Sea (IFAS), founded in 1993 by the five countries in the region, continued its efforts in including all stakeholders in the neighboring countries to improve the environmental conditions and revive the area in collaboration with the donors and the funding institutions around the globe. The IFAS is looking for more cooperation from all concerned parties to implement the urgent and crucially needed initiatives²³, and has undertaken massive activities to mitigate the effects of the environmental crisis in the areas southern of the Aral Sea basin.

Evidently, the scarcity of irrigation and drinking water in Central Asia is exacerbating day by day. For instance, only 40% of the Uzbekistan population have access to safe drinking water as opposed to the population of autonomous Karakalpakstan and the population of Khorezm, Bukhara and Navoiy regions of Uzbekistan that do not. Uzbekistan uses a big portion of the water released by upstream states (Kyrgyzstan and Tajikistan) in spring and summer for irrigation, especially for cotton, but water wastage is high, and the irrigation system needs moderation, 50 to 80 per cent of water used for agricultural irrigation is lost according to researchers, and only 25 to 35 percent is used efficiently²⁴. This is so in spite of the fact that five countries of the region share two large trans-boundary rivers with advanced power generating systems, irrigation and drainage networks, and qualified human resources. They still lack legal and economic frameworks to govern and regulate their relationships in matters of distribution, consumption and use of their shared water resources.

Due to the absence of a meticulous regional water strategy in Central Asia, the possibility for an effective water management in the area is almost non-existent. However, it is naive to believe any of the countries of the region are qualified enough to address such problems by their own. In fact, they need collective actions in order to deal with the existing water problems,

including salinization and contamination. Experts suggest that the crisis of the Aral Sea is attributable to random economic activities and lack of consultation among the countries of the region when it comes to the management of water resources. Uzbekistan, Kyrgyzstan and Tajikistan share 3,681 kilometer of borders, of which 961 kilometer are not delimited, mainly in the Fergana Valley. Therefore, water aggravation is not only a management and infrastructure problem, but also of issues of demarcation and delimitation of borders. Some recent border incidents in the region put pressure on water and land resources.

From 1960 onward, a sizeable portion of the water of Amudarya and Syrdarya rivers was used to irrigate agricultural land and during the period 1965-1990, the agricultural land in the Aral Sea basin was expanded by around 35% with a concomitant increase in water consumption to more than double. All this was done to reduce the cost of cotton and cereal production yet the Aral Sea has lost more than 70% of its water and its water body has declined gradually to almost a third of its normal size. This has triggered many environmental crisis including climate change in the region, the disruption of the ecological system, the loss of economic importance of the Aral Sea and the exit of the Amu Darya and Syrdarya Rivers from the agricultural cycle due to the lack of sufficient water for irrigation. The increase of cotton production starting from the 1960s was a turning point to the Aral Sea basin catastrophe, showing the end of its stability. The above policy to increase cotton production continued within the Aral Sea region until the fall of the Soviet Union, the sea shrank by 67 per cent, and the water salinity tripled²⁵.

Other damages in the Aral Sea region include:

- Partial alteration in the climatic conditions in the area: increased heat, saline- laden storms and other pollutants;
- Disruption of the ecological system; diminished biodiversity; loss of economic vitality.

The massive and sustained use of water resources has deprived the region from economic

development in addition to scarcity of safe drinking water. The availability of fresh water has always been a tremendous challenge in Central Asia. Naturally enough, the pressure on water resources in general and freshwater resources, in particular, will exacerbate. Mass exodus of the population from the area has followed and the issue of water and economic security in Central

Asia became top on the agenda of international relations and its resolution will ensure better life for the current and future generations.

To prevent further environmental degradation, security threats, and more importantly water wars, it is imperative to accurately set the main agendas for scientific and applied researches and the measures followed in sharing water resources between the countries of the region. In fact, countries in the region are required to adopt balanced decisions within a framework of international cooperation to resolve the following issues:

- The optimum and efficient use of trans-boundary water resources;
- Reduce the pollution of surface and underground water bodies located in the borders of the countries of the region;
- Increase the storage capacities of dams and natural water buffers and other vital installations in the Aral Sea basin;
- Establish regional structures to prevent the occurrence of major water disasters;
- Adopt common measures between countries of the region to resolve the problem of water scarcity in the region.

Experts consider the unilateral efforts undertaken by each state are not effective enough to address the situation since the protection and maintenance of water infrastructure and the prevention of further deterioration in the quality of water resources shall be of little value unless the efforts are coordinated between the states at the regional level.

It is worthwhile to underline the international efforts to improve drinking water networks in Karakalpakstan Republic and other regions in Uzbekistan. USD 20 million was allocated for

this purpose and the Asian Development Bank has already provided USD 11 million to cover the cost. This is in addition to the participation of South Korean company “Chindong Enercom” and the Turkish company “ALKE” in the activities to improve the network.²⁶

The Asian Development Bank is coordinating the implementation of the activities of the UN Global Environment Fund. This program is particularly useful for Uzbekistan because 50% of its lands are used for agriculture and it requires international efforts to improve its productivity, and protect its farming lands from salinity, desertification and erosion. This program is expected to address the problem of biodiversity, management of grazing land, forests, and re-balance the ecosystem in the Aral region.

Until 2008, Uzbekistan has earmarked more than USD 4 million for the joint finance of two vital projects to achieve the stability of the ecosystem in Karakalpakstan and Kyzyl-Kum Desert and irrigation of agricultural land in the area.²⁷ Mr. Embitov, member of Uzbekistan Academy of Science, underlined the vitality of the project to restore the Aral Sea, as announced by the Heads of States of Central Asia during their summit in Astana (Kazakhstan) in 1993. He quantified the benefits of this project and its abilities to revive agriculture and fishing industry in Karakalpakstan in addition to addressing many environmental and social problems. An artificial lake covering an area of more than 100,000 hectares was established and its fishery produce is expected to be around 600 tons annually. Embitov also pointed out the efforts to restore the fishery resources, through artificial hatcheries after the lake lost 85 per cent of its fish population due to drought.²⁸

Replenishment of water levels in the North Aral Sea (NAS) in the last decade resulted in stabilization of water levels, when the fishing out in late 2005 reached from 2,650 to 3,000 tons of fish. ²⁹ Also with the help of the World Bank as the phase 1 project, the total fish biomass has risen rapidly since the project’s completion in 2011, from 3500 tons to 18,000 tons.³⁰ According to the expectations of experts, restoration of the Aral

Sea will boost the production of the fish harvest to 10,000 tons annually but this will require that Aral Sea shall be fed with 1,200 cubic meters of water annually. To address this problem, an agreement should be concluded between the three countries that Amu Darya River flows across their territories (Tajikistan, Turkmenistan and Uzbekistan).³¹

There are some speculations to bring back to life a previous project through which Central Asia could be supplied with portion of the waters of the rivers flowing through the Siberian plains. The project was first envisaged in 1868 and it surfaced again in the 1960s, but its actual elaboration started in 1986. Other ideas included the proposals submitted by Uzbekistan leadership in the 1970s and 1980s, to supply Uzbekistan with water from outside its borders in order to compensate the depleted water of the Aral Sea and to avoid the then impending environmental woes.

There were suggestions to divert a portion of the waters of Siberian Rivers (Irtys, Ob) through 2550 km canal that runs across Syrdarya River to feed the Aral Sea. However, Moscow rejected this proposal in December 1983, claiming that it will inflict enormous damage on the environment in the northern portion of the former Soviet Union plus its substantial financial cost.³² But in August 1986, the Soviet government postponed diversion of Siberian rivers project, and never considered it again.

It was planned that the project will supply the Aral Sea with 27,000 cubic meters of water or 7% of the waters of Ob River, which flows in northern Arctic Ocean. Experts believe that this negligible amount of water, if diverted from the rich Siberian River, will not result in adverse effects to USSR - neither economically nor environmentally. If the project was implemented, the Aral Sea would have received fresh and pure water from the Ob River. This could have improved the quality of its water and possibly mitigate the environmental challenges currently faced by Central Asia due to the insufficiency of water resources leading to the gradual disappearance of the Aral Sea.

It was expected that the canal would transport 1000 cubic meters of water from Siberia to Central Asia and there was a possibility to divert it to the

industrial area south of the Aral Sea and Kurgansk region in Russia, in addition to 4,000 cubic meters of water to the dry region in north Kazakhstan to irrigate the cereal crops. If the Siberian River Diversion project had been implemented, it could have resolved some of the major economic and social problems in the central part of Russia, west Siberia, vast areas in northern Russia, the industrial area south of the Aral Sea and large areas in Central Asia, and it would have increased in irrigated lands and agricultural production in the Aral Sea basin. Experts suggested that such a project could have served as an economic bridge linking Central Asia to Russia, bringing stability to the entire region and trigger massive economic cooperation between the nations of the region.

The Siberian river project is also expected to achieve industrial development for the Central Asia countries in addition to the possibility to construct power generation projects, sea transportation and railway transportation along the canal, creating solid and multiuse infrastructure. The International Conference held in Tashkent in 2002 under the theme "The Problems of the Aral Sea and the Surrounding Areas – towards International Cooperation" discussed the possibility of reviving the construction of the Siberian River Diversion Project. The conference was organized by ECOSAN Foundation³³ and the Russian-based organization, Rosszarubejcenter³⁴, in Uzbekistan. The conference served as a forum for environmental protection and it was attended by water scientists and specialists from the Russian Federation, Uzbekistan and representatives from the ministries and institutions concerned with management of natural resources, diplomatic corps, clerics, international and local NGOs and the mass media. The conference stressed the importance of reviving the Siberian canal project with due consideration to the current realities in order to attract governmental resources, foreign investors and capitals from the businessmen with a view to establish a joint venture to achieve the project.

The pressing question is, how will the mega oil investment projects, currently ongoing in the Aral Sea region, affect the efforts to restore the Aral Sea water to its previous levels and to reduce the environmental damages in the area?

Particularly, because the government committee for environmental protection in Karakalpakstan has exerted tremendous efforts to restore ecological stability in the Aral Sea basin and protect the flora and fauna during the last decade. In order to improve the land conditions, increase productivity and for fishing activities to continue to supply the industrial lakes in Muynak with fresh and clean water, and in order to reduce the airborne saline, a vast green belt of 5,000 hectares has already been planted in the area. Special project funded by the World Bank was implemented to maintain and improve the irrigation system in Uzbekistan. The project includes the activities of the Chinese company Sinohydro that won the international bid. After the project is fully completed, water discharge in Amudarya River will be improved, and it will flow directly into the Aral Sea basin through Jandar. There will be a possibility to improve the irrigation of about 100,000 hectares of agricultural land in addition to the improvement of ecological and climatic conditions in the area.³⁵

In August 2011, the Chinese company Sinohydro completed the rehabilitation of the sewage system in Karakalpakstan Republic with a cost of USD 48 million according to the contract signed in 2006.³⁶ The World Bank and the Executive Committee of the International Fund for Saving the Aral Sea signed on September 2014 a memorandum of understanding, aimed at improving water management, and the social, economic and environmental situation in the Central Asian region.³⁷

Aral Sea Disaster Impact on Population

The intensive irrigation and using herbicides and pesticides in agricultural process and cotton monoculture in the last century destroyed the balance between people and nature, economy and ecology, especially after the fall of the Soviet Union with the socio-economic difficulties moving to market economy.

It is a fact that the gradual diminishing of the Aral Sea has resulted in an unprecedented environmental, economic and demographic disaster suffered by millions of the local populations of the Aral region and the surrounding areas. The outcome of this critical situation is on human health, associated impacts on the local population, and the ecological

balance in the region. Recent studies show that the Aral Sea lost a third of its original size, due to heavy irrigation of cotton, from the Syrdarya and Amudarya rivers, which had direct effect on local population dependent on fishing and agriculture. It was an important source of income to the local people, for the Aral Sea basin supports more than 60 million people. Intensive sea desiccation and coastal area desertification have led to deterioration of the population's health. Moreover, the decrease in the volume and the size of the Aral Sea has resulted in collapse of its fishing industry, shortage of pure drinking water, soil salinization, and an increase in the dust storms from the new Aral-kum desert. Over the last fifty years many changes occurred in the Aral Sea basin. There has been increase in the population of 14.1 million in 1960, to 60.4 million in 2012, with total irrigated lands from 4.5 million hectares to 8 million hectares³⁸. Adding to that, another 20 million by 2040 will be living in the area, butting huge demands on water and infrastructure.

The collapse of the fishing industry in the Aral Sea region in the eighties of the last century cost tens of thousands of people their jobs. An increase of agriculture around the Sea basin lead to an increase use of fertilizers and pesticides, which caused contaminated seabed sediment and rising ground water levels, causing more soil salinization, effecting drinking, and leading to irreversible environmental deterioration methods.³⁹ The diversion of the Amudarya and Syrdarya water resulted in disappearance of smaller lakes and deltas, such as Tugai Forests and reed beds.

The Aral Sea played an important role in the development of the regional economy; it was a source of employment and sustainable social infrastructure; more than 80 per cent of its inhabitants lived on fishing, where the annual caught of fish was from 30,000 to 35,000 tons of fish. Beside the Amudarya and Syrdarya, fertile lands provided employment for more than 100,000 people in cultivating agriculture crops and livestock rearing.⁴⁰

The Aral-kum desert with high level of salinity

covers more than 5.5 million hectares of its surface area, now covering almost the entire Aral Sea region, which was once home to the rich flora and fauna. The negative environmental impact of the Aral Sea on population's gene pool, health and quality of life affected the whole Central Asia region. Polluted water, the dust, and salt from the bottom of the dried sea have resulted in spreading diseases in the Aral Sea region such as gallstones and anemia, kidney diseases, respiratory organs and others. Infant mortality rate in the Aral Sea region is dangerously high – 120 per 100 thousand and 100 infant per 1000 die due to contamination of water, farm products and the high concentrations of lead and zinc in the systems of the local people, animals and birds. This figure places the Aral Sea among the world's highest rates of infant mortality.

The incidences of many diseases are increasing including anemia; kidney and liver diseases, typhoid, arthritis and cancer. High concentration of salts accounts for 80% of deaths in women, with those suffering from anemia becoming more vulnerable. The dioxin levels in pregnant women and in their milk in Karakalpakstan are five times higher than in Europe.⁴² These are some of the signs of devastating impacts of the Aral Sea disaster on the inhabitants' health.

Regarding the health disaster in Republic of Karakalpakstan from the Aral Sea basin problem, there are indications that the deaths percentage in the last century exceeded 21% per each thousand people, the rate of which is 1.7 times greater than Republic of Uzbekistan. This is due to water and plants pollution, increase in zinc and lead percentages in blood, the spread of kidney, liver, cancer, thyroid and rheumatoid diseases, the precipitation of salts inside the body, and anemia's, which reached 154.2 per each hundred thousand in 2009. The closer the region is to the Aral Sea, the greater are the diseases and deaths.⁴³ People living in Khorezm region of Uzbekistan, downstream of the Amudarya, south-east of Karakalpakstan, Dashkhanovuz region, Turkmenistan, and Kyzyl-Orda regions of Kazakhstan, who are within the Aral Sea basin area, have also suffered greatly in this ecological disaster.

Therefore, we believe that the scarcity of irrigation

and safe drinking water is exacerbating day by day, beside losing its fishing industry, livestock rearing, resulted in losing tens of thousands of their sources of income. Hence, concerted international efforts are needed to address this problem and provide good employment opportunities for the population of the region to set the rising exodus given the fact the Karakalpakstan Republic is endowed with abundant natural resources, but in need of genuine and profitable investments to develop its economy which is an integral part of Uzbekistan economy. It is the responsibility of the international community to bring to light to this catastrophe, which affected millions of people in the Aral region, minimized the grazing land, reduced agricultural productivities and caused the loss of more than 100,000 employment opportunities.

Karakalpakstan, an autonomous Republic within Uzbekistan, is believed to be most affected in the region from the Aral Sea disaster. It is located at the delta of Amudarya River, with an area of 165,300 square kilometers. The Soviet Encyclopedia indicates that in about 1811 the Khanate of Khiva forced the nomadic Kara kalpak people to flee their turfs downstream Syrdarya River to their current locations. In 1873, the Kara kalpak people annexed the right bank of the Amudarya River to Tsarist Russia. In December 1917 the Kara kalpak people were brought under the Russian influence and in April 1918, they annexed the right bank of Amudarya River to the autonomous Turkmenistan Republic in USSR. Following the end of the civil war in February 1920, which was flared up due to the takeover of the Russian Bolsheviks of the Russian Empire, the Karakalpak – who lived in the left bank of the Amudarya River – were under the dominance of Soviet Socialist Khorezm Republic.

Starting from 2006, Uzbekistan has announced about the utilization of international loans to improve the drinking water distribution network in the Republic of Karakalpakstan, and Jizakh, Tashkent, Khorezm, Bukhara, Samarqand, Syrdaria and Qashqadaria regions. The total amount of loans is 20 million USD, 11 million of which were presented by the Asian Development Bank. The southern Korean company "Shindong Enircom" is participating along with the Turkish

company “Alke” in the improvement of drinking water.⁴⁴Hence, we see that the Republic of Karakalpakstan is rich in natural resources, but the Aral Sea disaster and scarcity of financial resources are limiting its development, to achieve suitable living conditions to its residents.

The economic and social characteristic of the Aral Sea is that Republic of Karakalpakstan and Khorezm and Bukhara’s states constitute 47.4% of total area of Republic of Uzbekistan, 21.4% total population; 21.6% of man-force resources are living in that area, including 7.2% industrial products, 8.6% consumables products, 18.8% agricultural products, 11.2% other services which include 3.1% of total national exports.⁴⁵

During the reception of chairman of directorates of “Gazprom” company by the President on Uzbekistan in 20/1/2006, there was a discussion about expansion of works performed by the Russian company in Uzbekistan in fuel and energy field, which are key aspects to develop the existing economical and commercial relationships between Uzbekistan and Russia. The collaboration between the governmental Uzbekistan Company “Uzbekneftgas” and the limited contributing Russian company “Gazprom” has started in 2002 by implementing a partnership agreement between them, to invest the gas wells in Uzbekistan and improve the infrastructure of transportation and exportation of gas from Central Asia through the Uzbekistan lands to abroad.

Hence, “Uzbekneftgas”, the Uzbekistan governmental company, has executed with “Zarubegneftgas” an agreement on 4th April, 2004 for fifteen years to share the output before commencing in investment of Shahbakhta region wells. According to that agreement the Russian side has invested 15 million USD for this purpose, starting from 2007. In 2012 Gazprom International has completed the multistage geological exploration program for the investment blocks of the Ustyurt Region. The total volume of investment in the exploration projects in Uzbekistan is estimated at 400 USD.⁴⁶ “Gazprom” is one of the largest companies in the world extracting 20% of the gas in the world and 94% of the gas in Russia; it includes tens of companies and facilities working

in extraction and manufacture of Oil and Gas, production of equipment, building materials and public consumption goods.

Expansion of common cooperation is beneficial for both parties as the company is interested in increasing the gas quantities exported from Uzbekistan, privatization of Uzbekistan country properties and in buying a share in the gas wells and facilities in Uzbekistan.⁴⁷Moreover, there are more than 50 million USD in investment projects with foreign investment share in construction of Ustyurt Gas Chemical Complex.⁴⁸

On 8th September, 2005, Uzbekistan government had signed an agreement with a number of foreign international investors in Tashkent, in order to share production and conduct geological survey and invest in the wells discovered in Oglivodorod in the Uzbek side of the Aral Sea. According of Uzbekistan experts, the Aral Sea region has not been sufficiently studied yet; the agreement includes 12.5 thousand square kilometers, and it is expected to find many sites preserving natural fortune including oil and gas. The excavation will be conducted in two phases. During the first phase, which lasts for three years, drilling will be carried out through short programs in the earth layers in an area including 2300 kilometer, and through it two exploring wells will be drilled with limited financial resources of 99.8 million USD.⁴⁹The project management will perform oil and gas production operations, while marketing will be carried out by a company conducted by the participant in this agreement as an entity of the Republic of Uzbekistan. Completion of all arrangements for exploring earth layers and utilization of necessary equipment were achieved after the scientific works to study earth lands which started from 2007, at the end of works, the economic study of the project and second phase plan and taxation will be approved along with other commercial standards to invest new oil and gas wells. The agreement period is 35 years; the output will be shared as follows: 50% Uzbekistan and 10% for each party in the international investors group (this includes: Uzbekneftegaz, Lukoil Overseas holding, Petronas Cargill Overseas, Chinese CNPC International, Korea National Oil Corporation).⁵⁰

It was announced within the results of investment program analysis for the years 2006 and 2007, that the Uzbekistan Government had given guarantees for 47 loans of 365.4 million during 2006, also about the decrease in investment projects with foreign loans insured by the country and increase of direct foreign loans and investments. Moreover, the investment indicators for 2007 indicate that 36 projects have received loans of 325.6 million dollars, and by decrease in number of projects, the direct investments and loans will decrease in value up to 20% to reach 692.7 million. This demonstrates large strategic investors are being involved in Uzbekistan economy.

We thus conclude that despite the internal environmental disaster the Aral Sea region is suffering, and the seriousness of applied practical steps to revive the Aral Sea and restore its water resources, which were lost during last years, foreign companies are interested in investment projects in Republic of Karakalpakstan in association with the aforementioned companies. The Socio-Economic Development Program of Karakalpakstan for 2014-2016 has 569 projects worth 18.7 billion Sum have been implemented since the beginning of 2014. More than 1,160 jobs have been provided, special part has been assigned to the service sector and services for the domestic market and rural areas, and there is further rational use of the desiccated Aral Sea, as well as on public health.⁵¹

Aral Sea Disaster Impact on Environment

As previously mentioned, the Aral Sea basin region is located in the northern part of the Republic of Kazakhstan, on which the Syrdaria River water flows, and its southern part is inside Uzbekistan lands where the Amudarya River flows. These are the two rivers that pass and irrigate most of Central Asian countries' lands (Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan, along with some northern parts of Afghanistan). All the above states suffer (with different degrees) from severe environmental and economical and humanitarian crisis, caused by the Soviet Union's policies which was executed in the sixties of the 20th century. The project for cultivation of Hunger Steppe in Kazakhstan, and expansion in cotton

cultivation in Uzbekistan, drew huge quantities of water to irrigate the reclaimed agricultural lands. This has prevented water from reaching the Aral Sea, and consequently, receded gradually ever since. The Soviet Union's unbalanced growth strategy in Central Asia of large water diversions, also of poor irrigation construction technology, was wasteful of water. The changes in the area and volume of the Aral Sea had a serious impact on the environment, livelihoods and the economies of local populations in Central Asia.

The gradual drought of the Aral Sea has led to severe environmental, economic and population crisis that millions of people are suffering from in the Aral basin region and the adjacent regions till this day. This issue was extensively raised on different aspects since the seventies of the last century but without achieving any effective actions that stop the sea drought and revive the region to the way it was. On the contrary, the problem became more severe after the breakdown of Soviet Union in the nineties of the last century, and each country in the region had its own irrigation projects and construction of dams and hydrometrical energy generation facilities without considering the needs of the adjacent countries.

The natural environment disaster is linked with the desiccating Aral Sea region, and the associated socio-economic negative foreign elements, show that natural environment costs of cotton production in this area were not viewed as important in the Soviet Union cost-benefit analysis of large scale cotton production. After the Soviet Union's decision to increase cotton production in the sixties of last century, cotton cultivation rose from 1960 – 1988, from 1.9 million hectares to 3.1 million hectares, and the production of raw cotton increased from 4.3 to

8.7 million ton.⁵² The negative impacts of Central Asia's cotton industry on the region's natural environment are most dramatic, at the outcome of shrinkage of the Aral Sea and the destruction of the ecosystems linked with the Sea and its inhabitants. The disappearance of the third of the original size of the Aral Sea was due to heavy irrigation of cotton and other agricultural products from the Amudarya and Syrdarya rivers, and it had

a direct effect on local population dependent on fishing, agriculture and on live stock.

The cotton monoculture in the region is considered the main reason for the dying of the Aral Sea; increased salinity of agricultural soils led to toxic pollution, when spraying the cotton fields with the persistent pesticides (DDT and lindane). Vozrozhdenye Island was one of the islands in the Aral Sea region most affected, and as mentioned earlier, it was used by the Soviet Union for chemical and biological weapons tests. Therefore, water pollution is another main environmental problem in the Aral Sea basin region. The drinking water deteriorated during the last fifty years, especially in Karakalpakstan region; about tens of thousands tons of toxic chemicals have contaminated the water in the last years and continue to pollute soil and water supplies.

With the efforts made by Uzbekistan to resolve the Aral Sea crisis, a round-table meeting was held in Jokargi Kenes (the local parliament) of Karakalpakstan on 7th August 2011 to discuss “the current situations and the future of issues suffered by Aral sea region and how to resolve them”, which was called upon by the Agriculture water and environment affairs Committee of the Senate of Oily Majlis (the Parliament) of Republic of Uzbekistan. The meeting has discussed the matters of getting over the environmental crisis in Aral Sea region and improvement of environmental conditions and preservation of environment in the region.⁵³ The Senate members participated in it along with local governmental authorities’ representatives, officials, experts from ministries and administrations, scientists and international organizations agents, and public media. During the meeting, the appearance of wide areas of white lands covered by salts and sands on the dried parts of Aral Sea was discussed. Aral-kum was transferred to a new desert with an area of 60,000 square kilometers of sandy, salty soil, which is contaminated with fertilizers and the leftovers from the agricultural lands which produce dust storms that move millions of tons of salts, dust and contaminated sands faraway to hundreds of kilometers. The salt-dust clouds can be up to 400 kilometers long and finer particles can travel up to

1,000 kilometers away.⁵⁴ The heavily populated areas of the Aral Sea in the Amudarya delta were most affected from these storms, because of its location downwind from the Aral-kum area. The dust storms have negative implications on rural and agricultural lands. Therefore, it led to depletion and drought of many small lakes in South Aral Sea basin that caused the disappearance of 90% of sea plants from lands extending on 800 thousand hectares. Additionally, the marine living organisms have also disappeared, and due to the drought and desertification the biological output decreased by ten times in the Aral Sea basin region.

In recent studies the salinity level in the Aral Sea increased by more than 13-25 times and exceeds average salinity of the world ocean by 7-11 times. A sand-salt desert area of 5.5 million hectares has been formed in the place of the sea, slowly taking over the Aral Sea region, and over 75 million metric tons of dust and toxic salts rises into the atmosphere annually from the desiccating sea.⁵⁵ From the outcome of the above, the people of the area were effected with several diseases from water contamination, and from the amount of salt and dust rise from the bottom of the sea. This led to the death of more than half of the gene pool of flora and fauna, and disappearance of 11 species of fish, 12 species of mammals, 26 species of birds and 11 species of plants.⁵⁶ Collectively, these have led to complete changes with disappearance of almost all forms of living organisms and plants in the Aral Sea region today. A number of difficult environmental, social, economic and population problems and threats are taking continental direction.

With the Aral Sea drought continuing, and accumulation of human disaster in the surrounding region, preservation of normal biological life in the Aral Sea basin and reduction of the fatal effects of the disaster on the environment became crucial. The most important on life millions of people living in the region today which is the interaction of international community responsibilities.

Since the start of aggravation of negative impacts of the Aral Sea drought, experts from different fields made many suggestions to limit the negative impact on the environment as a result of the Aral Sea drought on the surrounding region. Among

these suggestions was the idea of making a series of buffer zones to stop salts and dust movement, prevent desertification and restore the fish wealth in the Amudarya River apex.

Conclusion

Based on the above, there are many challenges facing the countries in the region to overcome the environmental disaster of the Aral Sea. Cooperative regional efforts along with the efforts from international organizations and entities which are specialized in environmental affairs, and international financial corporation, are needed, aiming to decrease the impact of the environmental disaster resulting from the Aral Sea drought.

In order to restore the Aral Sea to its previous shape and volume, cooperation and collaboration is needed to reduce the divesting effects of the Aral Sea crisis on the environment. Cooperative action in regional water management is deemed necessary for the region's future security, and for the future of the Aral Sea basin and its surroundings. The contemporary regional economic factors clearly impact both human health and political consideration within the region.

Witnessing the stabilization of "Little Aral" in the north of the Aral Sea, with return of life, its fish species and climatic conditions – with the help of international funds – raises hope for the southern part of the sea, which needs the required attention to overcome its ecological and socio-economic crisis.

References

Web Links:

Aral Sea disaster highlighted by UN Secretary-General Ban Ki-moon. (2010, April 05). Retrieved August 22, 2017, from <https://shipbright.wordpress.com/2010/04/05/aran-sea-disaster-highlighted-by-un-secretary-general-ban-ki-moon/>

Shrinking Aral Sea underscores need for urgent action on environment – Ban. (2010, April 04). Retrieved August 22, 2017, from <http://www.un.org/apps/news/story.asp?NewsID=34276#.WZwEDD4jHIV>

Pavlovskaya, L. P. (N.D.). FISHERY IN THE LOWER AMU-DARYA UNDER THE IMPACT OF IRRIGATED AGRICULTURE. Retrieved August 25, 2017, From [Http://Www.Fao.Org/Docrep/V9529e/V9529e04.Htm](http://Www.Fao.Org/Docrep/V9529e/V9529e04.Htm)

Uzbekistan has introduced a "second wind" in IFAS activity. (n.d.). Retrieved August 28, 2017, from <http://www.uzembegypt.com/e/newsletters/20160909/index.htm>

International Conference "Development of cooperation in the Aral Sea Basin to mitigate consequences of the environmental catastrophe". (2014, October 28-29). Retrieved August 22, 2017, from <http://www.icwc-aran.uz/aranconf2014-report.htm>

Interstate Commission for Water Coordination of Central Asia

UNEP Global Environmental Alert Service: Sand, rarer than one thinks. (n.d.). Retrieved August 22, 2017, from http://unepineurope.org/index.php?option=com_content&view=article&id=86%3Aunep-global-environmental-alert-service-sand-rarer-than-one-thinks&catid=15&Itemid=101

International Conference "Development of Cooperation in the Aral Sea Basin to Mitigate Consequences of the Environmental Catastrophe". (2014, March 11). Retrieved August 23, 2017, from <http://www.gwp.org/en/CACENA/News/International-Conference-Development-of-Cooperation-in-the-Aral-Sea-Basin-to-Mitigate-Consequences-of-the-Environmental-Catastrophe/>

International Conference Development of Cooperation in the Aral Sea Basin to Mitigate Consequences of Environmental Catastrophe. (2014). Retrieved August 23, 2017, from <http://Www.Aralconference.Uz/En/About/>

Azizov, D. (2014, September 09). Uzbekistan to hold international conference on Aral Sea. Retrieved August 23, 2017, from <https://en.trend.az/casia/uzbekistan/2309512.html>

World of Change: Shrinking Aral Sea: Feature Articles. (n.d.). Retrieved August 25, 2017, from https://earthobservatory.nasa.gov/Features/WorldOfChange/aral_sea.php

Semenov, O. E., 2012. Dust Storms and Sandstorms and Aerosol Long-Distance Transport, in: Breckle, S-W., Wucherer, W., Dimeyeva, L.A., Ogar, N.P. (Eds.), *Aralkum, a Man-Made Desert: The Desiccated Floor of the Aral Sea (Central Asia)*, Ecological Studies Volume 218. Springer-Verlag, Berlin Heidelberg, pp. 73, 82.

World Bank and International Fund for Saving the Aral Sea Will Cooperate on the Aral Sea Basin Management Program. (2014, September 8). Retrieved August 25, 2017, from <http://www.worldbank.org/en/news/press-release/2014/09/08/world-bank-and-international-fund-for-saving-the-aral-sea-will-cooperate-on-the-aral-sea-basin-management-program>

Regions: Republic of Karakalpakstan, Embassy of the Republic of Uzbekistan in Austria, 29 January, 2015.

For reclamation and increase//Tashkent; jahon news agency, 24/3/2006. Investment projects in the Aral Sea region, shoabdura khamnov, Rustom.

President of Uzbekistan receiving Alexi Miller, chairman of Gazprom Company. //Tashkent, Pravda vastoka newspaper (UZA), 20/01/2006.

Victor Nickolive: execution of in agreement to invest "Oglivodorod" sites in Aral basin. "Tashkent": "UZA" News agency, 30/8/2006.

<http://www.uzbekembassy.org/?9=node/644>. Pakistan. Electronic Uzreport, 9/8/2011. Improvement of drinking water network, Tashkent,

UZA News Agency, 24/03/2006. For reform and increase of productivity// Tashkent, Jahon News Agency, 22/11/2006.

Artigabyeve: Continuation of the works to improve the ecosystem in the Aral Sea region// Tashkent, UZA News Agency, 16/03/2007.

<http://forbes.kz/news2012/03/01newsid>

Reports:

Azizov, D. (n.d.). The Executive Committee of the International Fund for saving the Aral Sea (EC IFAS). Retrieved August 23, 2017, from https://www.unece.org/fileadmin/DAM/env/documents/2014/WAT/09Sept_8-9_Geneva/presentations/22_The_Executive_Committee_of_the_International_Fund_for_saving_the_Aral_Sea.pdf

The Executive Committee of the International Fund for saving the Aral Sea

Water problems in CentralAsia-conflict confrontation, Karina Fayzullina, Studies, aljazeera.net/reports/2013

International Crisis Group, water pressures in Central Asia, Europe and Central Asia report no.233, 11 September 2014.

Thorpe, A., & Al., E. (n.d.). Feasibility of stocking and culture-based fisheries in Central Asia (Publication No. 565). FAO. <http://www.fao.org/docrep/016/ba0037e/ba0037e.pdf>

International Conference "Development of cooperation in the Aral Sea Basin to mitigate consequences of the environmental catastrophe". (2014, October 28-29). Retrieved August 22, 2017, from <http://www.icwc-aral.uz/aralconf2014-report.htm>

Interstate Commission for Water Coordination of Central Asia

Water Pressures in Central Asia. (2016, December 06). Retrieved August 23, 2017, from <https://www.crisisgroup.org/europe-central-asia/central-asia/water-pressure-central-asia>

Projects & Operations. (n.d.). Retrieved August 23, 2017, from <http://projects.worldbank.org/P046045/syr-darya-control-northern-aral-sea-phase-project?lang=en>

Books:

Zavialov, P. (2005). *Physical Oceanography of the Dying Aral Sea*. Chichester, UK: Praxis Publishing, Ltd.

Ibrahimov, Namat-Allah, al Bukhari, Mohamed (2004). *Uzbekistan between the Past and Future Horizons*, p. 23-25. Unpublished manuscript.

Journals:

Promfret, R. (2002). State-Directed Diffusion of Technology: The Mechanization of Cotton Harvesting in Soviet Central Asia. *The Journal of Economic History* ,62(1), 170-188. Retrieved August 23, 2017, from www.cambridge.org.

White, K. D. (2012). Nature–society linkages in the Aral Sea region. *Journal of Eurasian Studies*,4(1), 18-33. doi:<https://doi.org/10.1016/j.euras.2012.10.003>

Wilson, P. W. (2002). The Aral Sea Environmental Health crisis. *Journal of Rural and Remote Environment Health* , 1(2), 2