

Lessons from the Aral Sea disaster and rational solutions for future generations

Azizkulov Akram Abdurakhmonovich

Samarkand Institute of Economics and Service, Uzbekistan

a.azizkulov@mail.ru



Article History:

Received on 1 November 2025

1st Revision on 26 November 2025

Accepted on 30 November 2025

Abstract

Purpose: This study aims to analyze the historical trajectory of the Aral Sea disaster and examine its ecological, social, and economic consequences. The research highlights how the drying up of the Aral Sea has affected environmental security, public health, and the livelihoods of surrounding communities.

Research methodology: The article employs a qualitative historical-analytical approach, using secondary data from scientific publications, government reports, and international organizations. Comparative analysis is applied to evaluate environmental, socio-economic, and policy dimensions, while a conceptual framework of sustainable development guides the assessment of possible solutions.

Results: Findings reveal that the degradation of the Aral Sea has caused severe ecological imbalance, including biodiversity loss, desertification, and water scarcity. Socially, local populations face deteriorating health conditions due to dust storms and polluted water, while economically, agriculture and fisheries have collapsed, leading to unemployment and migration. At the same time, international cooperation and the application of innovative technologies are identified as potential drivers of regional recovery.

Conclusions: The Aral Sea disaster represents one of the most significant ecological crises of the twentieth century, with lasting impacts on future generations. Restoration requires integrated strategies combining cross-border collaboration, environmental innovation, and sustainable resource management.

Limitations: The study is limited by reliance on secondary data and the absence of primary field research, which may restrict contextual depth and recent local perspectives.

Contribution: This article offers insights and recommendations, stressing sustainable strategies to restore the Aral Sea and ensure environmental security.

Keywords: *Aral Sea, Ecological Crisis, Environmental Security, International Cooperation, Sustainable Development*

How to Cite: Abdurakhmonovich, A. A. (2025). Lessons from the Aral Sea disaster and rational solutions for future generations. *Journal of Multidisciplinary Academic and Practice Studies*, 3(4), 355-367.

1. Introduction

The XXI century began with global environmental problems in the public life of the peoples of Central Asia. Between the two deserts of Central Asia, the Kyzylkum and the Karakum, there is a rare gift of nature, the Aral Sea (Saiko, 1998; Wang et al., 2020). The sea is located in the territory of Uzbekistan and Kazakhstan, two Central Asian countries, and is geographically close to the Caspian Sea. For thousands of years, this sea has had a positive impact on the natural conditions, climate, and fauna of the region. However, anthropogenic activities have had a catastrophic impact on this sea (Anchita et al., 2021; Plotnikov, Aladin, Zhakova, Mossin, & Høeg, 2023; White, 2013).

The Aral Sea, once the fourth-largest inland body of water in the world, played a vital role in shaping the livelihoods, traditions, and economic development of Central Asia. Historically, it has served as a crucial ecosystem that regulates the regional climate, supports rich biodiversity, and provides sustenance for fishing communities. Its fertile deltas have nurtured agricultural prosperity and sustained pastoralist societies across centuries. The sea also holds deep cultural and symbolic meaning, representing abundance and resilience in an otherwise arid landscape. However, in the latter half of the twentieth century, unsustainable human activities transformed this once-thriving ecosystem into one of the most dramatic examples of environmental degradation in human history (Alieva, Usmonova, Shadmanov, & Aktamov, 2023).

The tragedy of the Aral Sea is primarily linked to Soviet-era irrigation policies that diverted the Amu Darya and Syr Darya rivers, the two main tributaries feeding the sea, for large-scale cotton cultivation and agricultural expansion. What was initially hailed as a bold modernization project to increase economic productivity soon revealed to have devastating ecological consequences. As water inflow diminished drastically, the sea began to shrink at an alarming rate. By the 1980s, entire fishing towns were left stranded miles away from the retreating shoreline, while once-thriving fisheries collapsed, destroying the economic base of the local communities (Jin, Wei, Yang, & Lin, 2017).

The shrinking of the Aral Sea has produced multidimensional consequences that extend beyond ecological loss. The exposure of the seabed, laden with salt and toxic chemicals from agricultural runoff, has led to frequent dust storms that spread pollutants over vast distances. These toxic storms have degraded agricultural lands, reduced crop yields, and threatened food security in the surrounding regions. Public health has also been severely compromised in this regard. Respiratory diseases, cancer, and infant mortality rates in the Aral Sea region have risen dramatically as people inhaled contaminated dust and consumed polluted water. The demographic composition of the region began to shift as migration increased, with many families leaving in search of safer environments and better economic opportunities (Amirgaliyev et al., 2023; Chen, Gao, & Lei, 2022).

On a geopolitical level, the Aral Sea crisis highlights the complexities of transboundary water management in Central Asia. As the sea straddles Uzbekistan and Kazakhstan and its tributaries originate in Kyrgyzstan and Tajikistan, disputes over water allocation have often strained regional cooperation. In the post-Soviet era, newly independent Central Asian states inherited both ecological disasters and governance challenges in managing shared water resources. Balancing agricultural demands, energy production, and environmental restoration has proven to be one of the most pressing issues for regional stability and sustainable development (Prniyazova, Turaeva, Turgunov, & Jarihani, 2025; Sorg et al., 2014).

From a global perspective, the Aral Sea has become a symbol of the unintended consequences of short-term development policies prioritizing economic gains over environmental sustainability (Metriyana & Zaim, 2024). The lessons drawn from this tragedy resonate far beyond Central Asia, offering a cautionary tale for countries pursuing aggressive industrial and agricultural projects without considering their long-term ecological impacts. International organizations, including the United Nations and the World Bank, have recognized the urgency of addressing the crisis and supported various initiatives aimed at mitigating its consequences (Perdana, Riyadi, & Yuliari, 2025; Sarker et al., 2025). Projects such as the Kok-Aral Dam in Kazakhstan have demonstrated that the partial restoration of the sea is possible when political will and technical innovation are combined. However, the overall picture remains one of loss, with the southern part of the sea in Uzbekistan largely beyond recovery (Muchingami, Basera, Mashoko, & Bhasopo, 2025; Wang et al., 2020).

The importance of studying the Aral Sea disaster in the twenty-first century lies not only in documenting the scale of ecological damage but also in analyzing its broader socio-economic implications. The collapse of traditional livelihoods has forced communities to adapt to new realities, often under conditions of extreme hardship. Social resilience, community adaptation strategies, and government interventions have become central themes in understanding how people cope with environmental crises.

Simultaneously, disasters provide a testing ground for innovative approaches to sustainable water management, ecological restoration, and cross-border cooperation (Pan et al., 2022; Sukrana, Jui, & Khan, 2025).

Moreover, the Aral Sea tragedy highlights the intricate links between environmental degradation and human security (Heydari, Torabi, & Jahromi, 2023). The crisis has not only threatened the physical health of populations but has also eroded social stability, economic viability, and cultural continuity. The erosion of trust in state institutions, combined with worsening living conditions, has sometimes fueled discontent and social unrest in the affected areas. Addressing the Aral Sea disaster, therefore, requires more than technical solutions; it demands comprehensive policies that integrate ecological, economic, social, and political dimensions (Wijesundara, Khatibi, Azam, & Tham, 2025).

In addition, the cultural and psychological impacts of the Aral Sea disaster cannot be underestimated. For generations, the sea has shaped the identity and worldview of local populations. Its disappearance has left a profound sense of loss, not only of livelihoods but also of heritage and belonging in the community. Artists, writers, and scholars have documented this transformation, turning the Aral Sea into a powerful metaphor for human neglect and nature's fragility. Preserving these cultural narratives is essential for ensuring that the lessons of the past inform the choices of future generations (Kulsarieva, Sultanova, & Shaigozova, 2018).

Sustainable development strategies aimed at mitigating the consequences of the Aral Sea disaster must include several key components (Naa, Umar, & Ngutra, 2024). First, rational water management policies that prioritize efficiency and equity are needed. Reducing water-intensive agricultural practices, introducing modern irrigation technologies, and promoting crop diversification are essential steps (Alikhanova & Bull, 2023; Berndtsson & Tussupova, 2020). Second, environmental restoration must be supported through afforestation, soil rehabilitation, and the creation of protected areas to safeguard biodiversity. Third, the health crisis requires urgent attention, including improved healthcare infrastructure, access to clean water and targeted public health interventions. Fourth, community-based development programs should empower local populations by providing education, vocational training, and alternative livelihood opportunities. Finally, international cooperation is indispensable. Given the transboundary nature of the crisis, only collaborative approaches can ensure the sustainable management of shared resources and the gradual restoration of ecological balance (Kumar, Khamzina, Knoefel, Lamers, & Tischbein, 2021; Rustamova, Primov, Karimov, Khaitov, & Karimov, 2023).

The Aral Sea disaster also offers an opportunity to reimagine Central Asia's role in global environmental governance. By positioning itself as a laboratory for ecological restoration and sustainable development, the region can attract international investment, scientific collaboration and policy innovation (Tiimub et al., 2023). This shift would not only benefit local populations but also contribute to the global knowledge pool on addressing large-scale environmental challenges. As climate change accelerates and water scarcity becomes a critical issue worldwide, lessons from the Aral Sea will become increasingly relevant for policymakers, scientists, and communities across the globe.

In conclusion, the Aral Sea disaster represents one of the most dramatic examples of human-induced environmental change. Its consequences—ecological, social, economic, and cultural—continue to unfold, shaping the lives of millions in Central Asia and beyond. However, tragedies also carry the seeds of renewal, offering opportunities for learning, innovation, and cooperation. By studying the history and implications of the Aral Sea crisis, societies can better prepare for the environmental challenges of the twenty-first century, ensuring that such catastrophes are not repeated elsewhere. The introduction of this article, therefore, situates the Aral Sea within broader debates about sustainability, resilience, and human-environment relations, laying the foundation for a comprehensive analysis of its past, present, and future.

2. Literature Review

2.1. Historical Context of the Aral Sea

The literature on the Aral Sea emphasizes that before the mid-twentieth century, it was one of the largest inland seas in the world, ranking fourth after the Caspian Sea, Lake Superior, and Lake Victoria. Covering an area of approximately 68,000 km² with an average depth of 16 m, the Aral Sea functioned as the core of a vibrant ecosystem supporting biodiversity and fishing communities in the region (A. Azizkulov, 1999). However, since the Soviet era, large-scale irrigation policies that diverted the Amu Darya and Syr Darya rivers for cotton monoculture have drastically reduced inflows. Unsustainable water resource management has been identified as the main factor behind the Aral Sea's dramatic shrinkage. The historical context of this transformation reveals a deliberate prioritization of economic output over the ecological balance. Soviet planners envisioned Central Asia as a cotton powerhouse, branding it "white gold" To achieve this, immense irrigation networks were constructed, diverting billions of cubic meters of water annually from the Aral Sea's main tributaries. Initially, these projects were celebrated as symbols of progress and industrial achievement. However, scholars argue that the absence of comprehensive environmental assessments and the neglect of long-term sustainability sowed the seeds of ecological collapse. Water withdrawal far exceeded natural replenishment, leading to an accelerating reduction in sea volume by the 1960s and the 1970s.

As the shoreline receded, entire communities that had depended on fishing for generations faced economic and cultural displacement. By the 1980s, ports such as Moynaq, once bustling with fisheries and canneries, were left stranded dozens of kilometers from the shrinking sea. What was once a fertile region has turned into an expanding salt desert, signaling not only the ecological cost but also the socio-economic vulnerability created by unbalanced resource exploitation. Historians note that warnings from scientists regarding the risks of over-diversion were largely ignored by authorities, who continued to pursue cotton output targets at any cost. This legacy of unsustainable development is now considered one of the starkest examples of environmental mismanagement of the twentieth century, offering lessons on the dangers of subordinating ecological systems to short-term economic agendas (Konjala & Wulansari, 2024).

2.2. Ecological Consequences

Numerous studies have highlighted the severe ecological impacts of the Aral Sea disaster. Environmental (A. A. Azizkulov, 2007) degradation is marked by a rise in water salinity to more than 70 grams per liter, which destroyed natural habitats and wiped out 24 endemic fish species (A. A. Azizkulov, 2015). The Amu Darya and Syr Darya deltas, once home to diverse migratory bird species, have also suffered extensive ecological collapse. As a result, thousands of hectares of land turned into a salt desert, now known as the "Aralkum Desert." Recent literature highlights that this desertification process contributes to the release of 100 million tons of salt and dust into the atmosphere annually, spreading as far as the Arctic, Scandinavia, and even Japan (A. A. Azizkulov, 2007). The consequences of these ecological transformations extend far beyond their immediate regions. The loss of biodiversity has dismantled intricate food webs, destabilizing ecosystems that have thrived for centuries. The collapse of fish populations eliminated not only a major source of protein for local communities but also disrupted aquatic vegetation cycles and predator-prey relationships in the deltas. The disappearance of wetlands in the lower Amu Darya and Syr Darya has been particularly devastating, as these areas once provided critical habitats for waterfowl and other migratory species traveling along Eurasian flyways. Conservationists argue that the disappearance of such biodiversity hotspots represents an irreplaceable loss to the global ecological heritage (Turayevich, 2024).

Moreover, the transformation of the seabed into the Aralkum Desert has intensified the regional climate volatility. The absence of a stabilizing water body has altered the local humidity and wind patterns, exacerbating the frequency of dust storms. These storms not only spread toxic salts and agrochemical residues but also accelerate soil erosion in nearby agricultural lands, creating a feedback loop that further undermines the environmental resilience. Studies have documented that airborne particles from dried seabeds contain pesticide residues, such as DDT, which linger in ecosystems and bioaccumulate across trophic levels. This contamination poses long-term threats to flora and fauna and to human populations exposed to contaminated air, soil, and water. The transboundary dispersal of salt and dust also highlights the global dimensions of the Aral Sea tragedy. Deposits found in distant regions, such as the Arctic and Japan, confirm that the crisis is not confined to Central Asia but constitutes a planetary-

scale environmental issue. In this sense, scholars frame the Aral Sea disaster as a stark reminder that local environmental mismanagement can trigger global ecological repercussions, demanding coordinated international responses and stricter environmental governance frameworks (Chen, Gao, & Lei, 2025).

2.3. Socio-Economic Impacts

Beyond its ecological impacts, the literature underscores the profound socio-economic collapse caused by the shrinking of the Aral Sea. The once-thriving fishing industry, which produced tens of thousands of tons of fish annually, completely collapsed, leaving communities in Moynaq and Aralsk jobless. Once-vibrant port cities have since turned into a “cemetery of ships,” symbolizing the tragedy (A. A. Azizkulov, 2007). Agriculture has also been severely affected by soil salinization and fertility loss. Many families were forced to migrate, abandoning their ancestral lands due to economic and health crises. Economic studies confirm that the social costs of forced migration, unemployment, and cultural identity loss are massive and intergenerational in nature. The collapse of fisheries devastated not only household incomes but also regional trade networks that relied on the export of processed fish products. Entire canneries and related industries shut down, stripping thousands of workers of their livelihoods almost overnight. This industrial decline created ripple effects throughout local economies, as ancillary sectors such as transportation, markets, and services also experienced contraction. Scholars have pointed out that this loss of economic diversity has left affected communities dependent on subsistence farming and seasonal labor, both of which have become increasingly unsustainable due to soil degradation and water scarcity.

Migration has emerged as both an adaptive strategy and a source of social dislocation. Families who left the region often faced precarious conditions in urban centers, struggling to integrate into new labor markets while also maintaining cultural ties. Those who stayed behind experienced declining living standards, limited access to services, and a growing dependence on state assistance. Anthropological studies highlight how the erosion of traditional livelihoods has also led to a weakening of cultural identity, as fishing practices, community rituals, and intergenerational knowledge tied to the sea have been gradually lost. The long-term socio-economic costs are particularly evident in the context of intergenerational poverty. Children from displaced families often lack access to quality education and healthcare, perpetuating cycles of disadvantage. Moreover, the strain on social cohesion has been significant: migration has disrupted kinship networks, created demographic imbalances, and generated tensions between local populations and newcomers in receiving regions. These patterns illustrate how environmental degradation can produce cascading socio-economic vulnerabilities that persist long after the initial ecological shocks.

2.4. Public Health Crisis

The public health consequences of the Aral Sea disaster are a central focus of the literature. Epidemiological studies have revealed a significant increase in cancer, chronic respiratory diseases, tuberculosis, and thyroid disorders among populations living near the former sea. Dust from the dried seabed, laden with pesticides and agricultural chemicals, has been identified as the main factor (A. A. Azizkulov, 2007). The data show that oncological diseases increased from 0.24% in 2000 to 0.26% in 2014, while urolithiasis doubled during the same period. Infant mortality rates are also considerably higher than the national average in these areas. Thus, this tragedy is not only an environmental disaster but also a public health emergency. Scholars have highlighted that toxic dust storms carry residues of sodium sulfate, magnesium, chlorine, and agricultural pesticides such as DDT, which infiltrate food chains and accumulate in human tissues. Long-term exposure is associated with chronic kidney and liver diseases, reproductive health problems, and weakened immune systems. Women and children are disproportionately affected, with maternal health complications and developmental disorders among infants reported at higher rates than in other parts of Central Asia. The degradation of water quality due to salinization and contamination by agrochemicals further compounds these health risks. Many communities depend on unsafe drinking water, contributing to outbreaks of diarrheal diseases, hepatitis, and other water-borne infections.

Medical research also indicates that psychosocial dimensions of health should not be overlooked. Communities living in the Aral Sea region experience high levels of stress, anxiety, and depression stemming from economic insecurity, forced migration, and the loss of cultural identity tied to the sea. Public health systems in Uzbekistan and Kazakhstan have struggled to cope with these multifaceted challenges as medical infrastructure remains underfunded and ill-equipped to address complex ecological health crises. International organizations, including the WHO and UNICEF, have attempted to intervene through targeted health programs, vaccination campaigns, and infrastructure projects aimed at improving water and sanitation. However, the scale of the problem continues to outpace the available resources. Scholars argue that a holistic approach is needed—integrating environmental restoration, healthcare investment, and community resilience programs—to address the cumulative health impacts of the Aral Sea disaster on the population. In this sense, the tragedy serves as a critical case study of how environmental degradation directly undermines human health and human development.

2.5. Climate Change and Regional Security

The literature highlights the connection between regional climate change and the Aral Sea disaster. The sea's shrinkage caused extreme temperature fluctuations: winters became 1.5–2°C colder and summers 2–4°C hotter than before (A. A. Azizkulov, 2007). These climatic changes have worsened agricultural conditions, shortened growing seasons, and deepened food insecurity. Furthermore, transboundary water management has become a regional security concern. Central Asian countries, such as Uzbekistan, Kazakhstan, Turkmenistan, Kyrgyzstan, and Tajikistan, often clash over the use of the Amu Darya and Syr Darya rivers. Environmental security literature stresses that the Aral Sea's degradation has complicated political relations in this region.

2.6. International Recognition and Cooperation

The Aral Sea tragedy is now recognized as one of the greatest environmental disasters of the twentieth century. Former UN Secretary-General Ban Ki-moon described it as “one of the worst environmental disasters on the planet” (A. A. Azizkulov, 2015). UNESCO has included related documents in the *Memory of the World* program. International efforts include the establishment of the United Nations Multi-Partner Human Security Trust Fund for the Aral Sea Region in 2018, as well as World Bank support for the rehabilitation of the Syr Darya Delta through the construction of the Kokaral Dam, which successfully restored part of the Small Aral Sea in Kazakhstan. The literature emphasizes that although the results remain limited, these projects demonstrate that partial restoration is possible through a combination of technology, policy, and international cooperation.

2.7. Rational Solutions Proposed in Literature

Scholars have proposed various solutions to mitigate the impact of the Aral Sea disaster. First, irrigation efficiency can be improved through the use of canal modernization and water-saving technologies. Second, agricultural diversification is required to reduce dependence on cotton as the dominant crop. Third, afforestation projects on dried seabeds using salt-tolerant plants such as saxaul have proven capable of reducing 90% of sand movement within 5–7 years (A. A. Azizkulov, 2015). Fourth, public health must be addressed through investments in medical infrastructure and clean water provision. Fifth, sustainable development policies should be regionally integrated with international support to ensure their effectiveness. The literature also notes more radical proposals, such as diverting water from the Caspian Sea, although many experts reject these due to the ecological risks they pose to other regions (Bekchanov, Ringler, Bhaduri, & Jeuland, 2016).

2.8. Theoretical Frameworks in Aral Sea Studies

Theoretical approaches to the Aral Sea often employ sustainable development and environmental security frameworks. The *tragedy of the commons* theory is also relevant, as it illustrates how shared resources (the Amu Darya and Syr Darya rivers) were overexploited without regard to their regenerative capacity. Political ecology perspectives highlight the role of state policies and the authoritarian Soviet regime in creating ecological crises. More recent literature emphasizes *resilience theory*, exploring how local communities develop adaptive strategies in response to dramatic environmental changes (Abdullaev & Rakhmatullaev, 2025; Ahn, Kamalov, & Juraev, 2024).

3. Research methodology

In this study, a comprehensive scientific research methodology was employed. First, through a historical-analytical approach, the causes of the Aral Sea's desiccation and the historical stages of ecological crisis processes were examined. Additionally, using sociological and statistical analysis methods, the socio-economic impact of environmental problems on the lifestyle of the Aral Sea region's population was analyzed. The primary objective of the methodology is to investigate the consequences of the ecological problem not only from a natural geographical perspective but also in relation to social, economic, and political factors and to establish a scientific foundation for developing rational solutions for future generations.

4. Result and Discussion

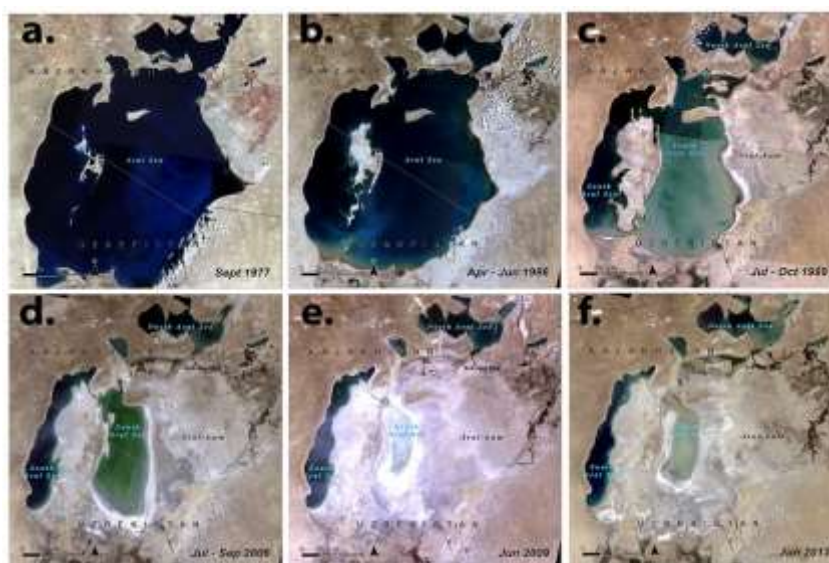
4.1 Analysis and results

As a result of improper development of the national economy, inability to see the future ecological situation, creation of excessive artificial lakes, disorderly use of water, and monopolization of cotton, the volume of water in the Syr Darya and Amu Darya rivers flowing into the Aral Sea decreased. The island's water area decreased from 64 thousand to 39 thousand km², becoming smaller and dropping to the 6th place among the largest lakes in the world. The water level in it decreased by 20.5-24 meters compared to 1960, and the amount of mineral salts in the water exceeded 70-72 grams per 1 litre of water" (Ergashev, Otaboyev, Sharipov, & Ergasliyev, 2009).

As a result of the unilateral, irrational activities of the authoritarian system of the former USSR, the Aral Sea began to dry up. This system has turned Central Asia into a raw material base. In the 80s of the last century, Uzbekistan was obliged to grow 6 million tons of cotton. Similarly, the Republics of Turkmenistan, Kazakhstan, and Tajikistan have received an obligation to grow large amounts of cotton. To grow such a large amount of cotton, hundreds of thousands of hectares of land must be developed. Consequently, many large channels were dug from the Amu Darya and Syr Darya rivers flowing into the Aral Sea. The waters of the Aral Sea were used unplanned and wastefully for the development of desert and steppe zones covering large areas of the region. As a result, insufficient water entered the Aral Sea, which led to its drying up. Consequently, thousands of hectares of salt deserts have appeared.

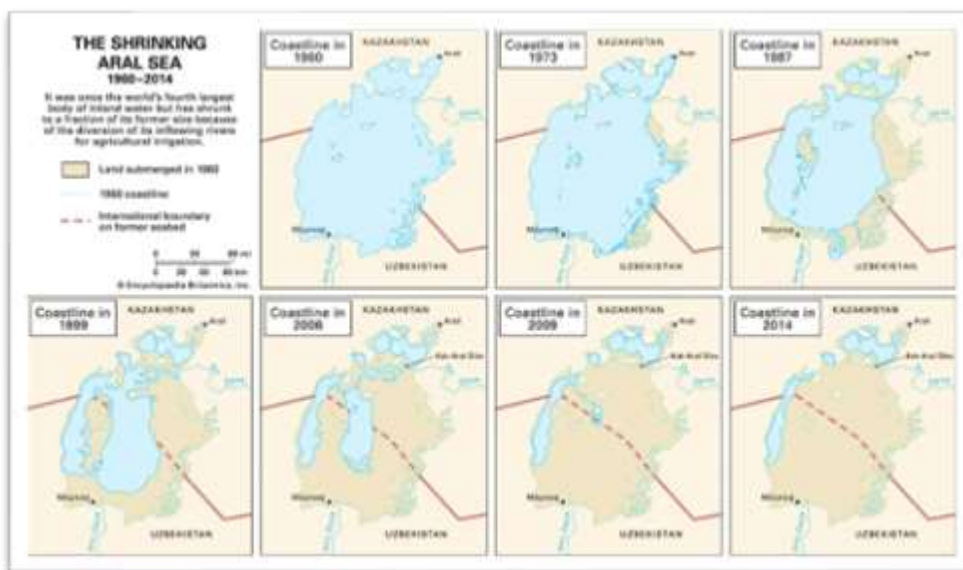
Currently, the Aral Sea is divided into three parts: a small and shallow northern part, a relatively large and shallow eastern part, and the deepest western part. "In subsequent years, the construction of the Kukaral dam and the restoration of the Syr Darya Delta led to stabilization of the level of the Small Aral Sea. The large area of the Eastern Aral Sea continues to become shallow and shrink. The fate of the Western Basin, which is considered the deepest, depends on the flow of groundwater. The researchers noted that there may be many freshwater springs on the west coast. According to some authors, the western

up to 2,100 to a certain auriferous, reaches a m. The water exceeds 100 (Ergashev et



area of the basin remains km², remains extent and in places depth of 37 salinity of its significantly g/l" al., 2009).

Picture 1



Picture 2.

Since the 90s of the 20th century, several projects have been proposed to prevent a catastrophic situation in the Aral Sea. One of them was the diversion of the southern tributaries of the Volga, Ob, and Irtysh into the Aral Sea. However, according to research by Russian scientists, this project will have a serious negative impact on the environmental situation in Western Siberia. If these scientists had made such a rational warning in the 60-70s and the last century and said in advance that the unreasonable use of the waters of the Amu Darya and Syr Darya would entail the drying up of the Aral Sea and an unfavorable environmental situation in the region, perhaps the Aral tragedy could have been prevented. However, the government needed cotton raw materials more than the environmental situation in the region did. "Currently, 700-750 kg of salts of sodium sulfate, chlorine, and magnesium account for every hectare of land around the island. The salinization of cultivated fields increases annually. The island environment has become a salt distribution area. The drying of the island also affects the climate. For example, the winter temperature in the foothills of the Amu Darya and Syr Darya rivers is 1.5-2 °C lower than the previous one, and 2-4 °C warmer in summer"(Ibragimova, 2012).

As a result of the drying up of the Aral Sea, 5 million hectares of sandy salt desert appeared. For the negative reason for this tragic accident, the island is called the "Arolkum desert" because there is no need to call the island the sea. Due to a sharp increase in the mineralization of the water of the Aral Sea, all creatures in it disappeared, especially 24 species of fish. One of the most diverse ecosystems in the world, the Amu Darya and Syr Darya deltas, has been destroyed. The number of animal and plant species in the territory has significantly decreased. In subsequent years, negative changes in diseases such as thyroid gland and diabetes mellitus were observed among the population due to changes in ecology and climate due to the "Tragedy of the Aral Sea". The drying up of the Aral Sea has led to an increase in diseases among the population. Today, as a result of environmental changes caused by the "Aral tragedy," the incidence of urolithiasis in the region in 2000 was 0.8%, and in 2014, it was 1.6%,

which is an increase of 2.0 times. In particular, oncological diseases are common, including various forms of cancer, breast cancer, genital cancer, and similar serious diseases. In 2000, oncological diseases accounted for 0.24% of the population, and in 2014, they accounted for 0.26%. The tragedy of the Aral Sea has caused serious problems related to the health of the region's population. Therefore, UNESCO has included historical documents related to the Aral Sea in the "Memory of the World" register as a source for studying environmental tragedies (Asia & Pacific, 2016). Over the years, Moynaq on the Aral Sea used to be a port city with large production facilities and a large fish cannery, but now the dead shores of the sea have turned into a graveyard for ships.



Picture 3. The cemetery of ships in the Aral Sea

Today, the "Tragedy of the Aral Sea" has become a global environmental problem. More than 100 million tons of sand, dust, and salt fly from the dry bottom of the island over distances of hundreds and thousands of kilometers per year. Such migrated particles of salt and sand have been found in countries such as Norway, Japan, the Pamirs, Altai, the Tien Shan mountain ranges, and the Arctic (Asia & Pacific, 2016). The island problem is considered one of the largest catastrophes of the 21st century in terms of environmental and socio-economic consequences. Given that this problem is universal, Uzbekistan has taken the initiative to create a special United Nations commission on the island and hold an international conference on this issue under the leadership of the United Nations. In 1993, the First President of the Republic of Uzbekistan, Karimov (1994), spoke at the 48th session of the United Nations General Assembly and drew the attention of the world community to the tragedy of the Aral Sea.

He stressed that the problem of the Aral Sea is a global problem not only for Uzbekistan or Central Asia, but also for the whole world. In addition, on October 24, 1995, on the occasion of the fiftieth anniversary of the creation of the United Nations, at a special meeting of the General Assembly, it was emphasized that the environmental tragedy associated with the drying up of the Aral Sea, the biosphere covering the entire Earth, is a problem that has a devastating impact on the living conditions, health, and offspring of tens of millions of people, and it cannot be solved without the organizational activities

of international organizations, including the United Nations (Asia & Pacific, 2016). Former UN Secretary General Ban Ki-moon called the drying up of the Aral Sea "one of the worst environmental disasters on the planet" after his visit to Moynaq in 2011 (Asia & Pacific, 2016).

On November 27, 2018, the United Nations Multilateral Partnership for Human Security Trust Fund for the Aral Sea Region was established. This initiative was supported by the Secretary-General of the International Organization, Antonio Guterres. On June 5, 2018, the President of the World Water Council, Benedito Braga (France), who took part in the Tashkent International Conference on Island Problems, said, "We all understand that the island problem belongs not only to Uzbekistan or the Central Asian region." This recognition indicates that the tragedy of the Aral Sea is a global problem affecting regions both near and far.

Uzbekistan is taking practical measures to eliminate the environmental situation in the Aral Sea and reduce its tragic consequences. In particular, theoretical studies and practical work are being carried out in the Republic of Uzbekistan on problems related to the drying up of the Aral Sea, the negative consequences of the tragedy, and issues of improving the ecological condition of the Aral Sea. It is now planned to plant seeds and seedlings on the dry bottom of the Aral Sea to prevent salt storms. Currently, saxovullization work is continuing in the dry part of the Aral Sea. Today, 500 thousand hectares of saxaul have been planted along the Aral Sea. According to experts, saxaul is a plant that, if planted in seven rows, will be large enough to hold 90 percent of the sand in 5-7 years and is self-reproducing. In addition, the ecosystem in the area where the saxaul grows is an oasis. This will create opportunities to increase biodiversity in these regions. Experimental polygons have been created in the region, a gene pool of desert and ornamental plants resistant to salinity and drought has been formed, and 13 types of flora objects are being tested.



Picture. 4

5. Conclusion

5.1 Conclusion

The tragedy of the Aral Sea has shown us what irresponsible use of water and unreasonable treatment of nature, especially water resources, can lead to. Therefore, strengthening environmental education in the education system and the formation of a rational attitude of the younger generation toward nature is a requirement of the time. In summary, the results are as follows: First, it is technologically impossible to return the Aral Sea to its previous state. Second, to eliminate the negative consequences of the Aral Sea tragedy, it is necessary to improve the quality of irrigation channels in the region, prevent water loss, use alternative types of cotton that require less water, and, if possible, grow crops other than cotton. Third, extensive research on projects such as pumping water from the nearby Caspian Sea to the Aral Sea through a pipeline and diluting it with fresh water from local reservoirs is necessary. Fourth, it should be borne in mind that the construction of large hydroelectric power plants by countries in the lower reaches of the transboundary rivers of Central Asia poses a major threat to the ecology of the Aral Sea and the region.

5.2 Suggestion

1. Strengthen Environmental Education

- Integrating environmental education into school curricula at all levels is necessary to build awareness among the younger generation. Programs should emphasize water conservation, sustainable agriculture, and ecological responsibility to foster long-term behavioral changes.
2. **Improve Irrigation Systems**
Modernizing and rehabilitating irrigation infrastructure in Central Asia to minimize water loss. This includes lining canals, adopting drip irrigation, and using digital monitoring technology to ensure efficient water distribution.
 3. **Promote Crop Diversification**
Encouraging the replacement of water-intensive cotton with alternative crops that require less irrigation. Governments should provide incentives and technical support to farmers adopting crop rotation and diverse agricultural systems.
 4. **Conduct Feasibility Studies on Water Transfer**
Support research on large-scale water transfer projects, such as pipelines from the Caspian Sea, with careful environmental impact assessments. Such projects should be considered only if they are proven to be sustainable and not detrimental to other ecosystems.
 5. **Regulate Hydroelectric Development**
Establish regional agreements to coordinate the construction and operation of hydroelectric plants on transboundary rivers. This cooperation should prioritize ecological balance and fair water-sharing mechanisms among the Central Asian states.
 6. **Promote International Cooperation**
Strengthen partnerships with international organizations, such as the United Nations, World Bank, and UNESCO, to mobilize funding, technical expertise, and policy support for environmental restoration and community resilience in the Aral Sea region.
 7. **Support Community-Based Adaptation**
Develop local programs that provide alternative livelihoods, such as eco-tourism, renewable energy projects, or sustainable fisheries in restored water bodies, to reduce dependency on vulnerable agricultural practices.

References

- Abdullaev, I., & Rakhmatullaev, S. (2025). Water Security in Central Asia: Towards Sustainable Development and Resilience (pp. 47-70).
- Ahn, Y.-J., Kamalov, B., & Juraev, Z. (2024). Revisiting the Aral Sea crisis: a geographical perspective. *International Journal of Environmental Studies*, 81(6), 2381-2398. doi:<https://doi.org/10.1080/00207233.2024.2422695>
- Alieva, D., Usmonova, G., Shadmanov, S., & Aktamov, S. (2023). Fishery culture, sustainable resources usage and transformations needed for local community development: the case of Aral Sea. *Frontiers in Marine Science*, Volume 10 - 2023. doi:<https://doi.org/10.3389/fmars.2023.1285618>
- Alikhanova, S., & Bull, J. W. (2023). Review of Nature-based Solutions in Dryland Ecosystems: the Aral Sea Case Study. *Environ Manage*, 72(3), 457-472. doi:<https://doi.org/10.1007/s00267-023-01822-z>
- Amirgaliyev, N., Opp, C., Askarova, M., Ismukhanova, L., Madibekov, A., & Zhadi, A. (2023). Long-Term Dynamics of Persistent Organic Pollutants in Water Bodies of the Aral Sea–Syrdarya Basin. *Applied Sciences*, 13(20), 11453. doi:<https://doi.org/10.3390/app132011453>
- Anchita, Zhupankhan, A., Khaibullina, Z., Kabiye, Y., Persson, K. M., & Tussupova, K. (2021). Health Impact of Drying Aral Sea: One Health and Socio-Economical Approach. *Water*, 13(22), 3196. doi:<https://doi.org/10.3390/w13223196>
- Asia, R. M. o. t. W. C. f., & Pacific, t. (2016). Memory of the World: documentary heritage in Asia and the Pacific.
- Azizkulov, A. (1999). Ilmiy ijod va amaliyot: Fan, tibbiyot va texnologiya. *Ijtimoiy-gumanitar fanlar*, 2, 7-8.
- Azizkulov, A. A. (2007). *Razionallik va noraionallik: kontseptual tahliliy yondashuvlar*.

- Azizkulov, A. A. (2015). Problemy formirovaniya informatsionnoi kultury molodyozhi v sovremennom obshchestve. *Innovatsii v tekhnologiyakh i obrazovanii*, 194-198.
- Bekchanov, M., Ringler, C., Bhaduri, A., & Jeuland, M. (2016). Optimizing irrigation efficiency improvements in the Aral Sea Basin. *Water Resources and Economics*, 13, 30-45. doi:<https://doi.org/10.1016/j.wre.2015.08.003>
- Berndtsson, R., & Tussupova, K. (2020). The Future of Water Management in Central Asia. *Water*, 12(8), 2241. doi:<https://doi.org/10.3390/w12082241>
- Chen, Z., Gao, X., & Lei, J. (2022). Dust emission and transport in the Aral Sea region. *Geoderma*, 428, 116177. doi:<https://doi.org/10.1016/j.geoderma.2022.116177>
- Chen, Z., Gao, X., & Lei, J. (2025). Monitoring of wind erosion in the southern Aral Sea using SBAS-InSAR technology. *International Soil and Water Conservation Research*, 13(3), 551-563. doi:<https://doi.org/10.1016/j.iswcr.2025.05.005>
- Ergashev, A., Otaboyev, S., Sharipov, R., & Ergasliyev, T. (2009). Suvning inson hayotidagi ekologik mohiyati. *T.: Fan*.
- Heydari, M., Torabi, H., & Jahromi, M. (2023). A mathematical model of routing problem for hazardous biomedical waste: A multi-objective particle swarm optimization solution approach. *Journal of Multidisciplinary Academic and Practice Studies*, 1(2), 129-142. doi:<https://doi.org/10.35912/jomaps.v1i2.1794>
- Ibragimova, R. A. (2012). *Orol tabiiy geografik okrugi*. Tashkent.
- Jin, Q., Wei, J., Yang, Z.-L., & Lin, P. (2017). Irrigation-Induced Environmental Changes around the Aral Sea: An Integrated View from Multiple Satellite Observations. *Remote Sensing*, 9(9), 900. doi:<https://doi.org/10.3390/rs9090900>
- Karimov, I. (1994). *Bizdan ozod va obod Vatan qolsin*: Ўzbekiston.
- Konjala, W. Q., & Wulansari, P. (2024). The influence of compensation and motivation on the performance of civil servants at The Population and Civil Registry Office of Bandung District. *Global Academy of Business Studies*, 1(2), 131-147. doi:<https://doi.org/10.35912/gabs.v1i2.3468>
- Kulsarieva, A. T., Sultanova, M. E., & Shaigozova, Z. N. (2018). Folklore And Identity: History, Memory And Myth Making In The Modern Visual Culture Of Kazakhstan. *SERIES OF SOCIAL AND HUMAN SCIENCES*, 5, 19-25. doi:<http://dx.doi.org/10.32014/2018.2224-5294.3>
- Kumar, N., Khamzina, A., Knoefel, P., Lamers, J., & Tischbein, B. (2021). Afforestation of Degraded Croplands as a Water-Saving Option in Irrigated Region of the Aral Sea Basin. *Water*, 13, 1433. doi:<http://dx.doi.org/10.3390/w13101433>
- Metriyana, A., & Zaim, I. A. (2024). Proposed green marketing strategy to collaborate with tourism awareness group (Pokdarwis): Case study at Sein Farm, Bandung. *Global Academy of Business Studies*, 1(1), 55-68. doi:<https://doi.org/10.35912/gabs.v1i1.3384>
- Muchingami, A., Basera, V., Mashoko, D., & Bhasopo, T. (2025). Sustainable tourism practices adopted by the hotel sector in Zimbabwe. Hotel managers perceptions. *Journal of Sustainable Tourism and Entrepreneurship*, 7(1), 35-45. doi:<https://doi.org/10.35912/joste.v7i1.2491>
- Naa, O., Umar, H. B., & Ngutra, R. N. (2024). Analysis of the effect of Supplementary Food Provision (PMT) budget distribution on improving child nutrition for stunting eradication in Mimika Regency. *Global Academy of Business Studies*, 1(3), 161-172. doi:<https://doi.org/10.35912/gabs.v1i3.3477>
- Pan, X., Wang, W., Liu, T., Akmalov, S., De Maeyer, P., & Van de Voorde, T. (2022). Integrated modeling to assess the impact of climate change on the groundwater and surface water in the South Aral Sea area. *Journal of Hydrology*, 614, 128641. doi:<https://doi.org/10.1016/j.jhydrol.2022.128641>
- Perdana, P., Riyadi, B., & Yuliari, G. (2025). Semarang's nature tourism: Sustaining growth through digital-based innovation and stakeholder collaboration. *Journal of Sustainable Tourism and Entrepreneurship*, 7(1), 95-106. doi:<https://doi.org/10.35912/joste.v7i1.2779>
- Plotnikov, I. S., Aladin, N. V., Zhakova, L. V., Mossin, J., & Høeg, J. T. (2023). Past, Present and Future of the Aral Sea -A Review of its Fauna and Flora before and during the Regression Crisis. *Zool Stud*, 62, e19. doi:<https://doi.org/10.6620/ZS.2023.62-19>

- Prniyazova, A., Turaeva, S., Turgunov, D., & Jarihani, B. (2025). Sustainable Transboundary Water Governance in Central Asia: Challenges, Conflicts, and Regional Cooperation. *Sustainability*, 17(11), 4968. doi:<https://doi.org/10.3390/su17114968>
- Rustamova, I., Primov, A., Karimov, A., Khaitov, B., & Karimov, A. (2023). Crop diversification in the Aral sea region: long-term situation analysis. *Sustainability*, 15(13), 10221. doi:<https://doi.org/10.3390/su151310221>
- Saiko, T. S. (1998). Geographical and socio-economic dimensions of the Aral Sea crisis and their impact on the potential for community action. *Journal of Arid Environments*, 39(2), 225-238. doi:<https://doi.org/10.1006/jare.1998.0406>
- Sarker, D. K., Shaha, S. R., Saha, D., Saha, M. K., Saha, S. M. K., & Sarker, B. K. (2025). Scenario of e-waste management: Navigating business prospects overcoming environmental challenges. *Journal of Sustainable Tourism and Entrepreneurship*, 6(3), 209-226. doi:<https://doi.org/10.35912/joste.v6i3.2674>
- Sorg, A., Mosello, B., Shalpykova, G., Allan, A., Hill Clarvis, M., & Stoffel, M. (2014). Coping with changing water resources: The case of the Syr Darya river basin in Central Asia. *Environmental Science & Policy*, 43, 68-77. doi:<https://doi.org/10.1016/j.envsci.2013.11.003>
- Sukrana, B., Jui, F. I., & Khan, N. H. M. (2025). Factors influencing job satisfaction among tourism and hospitality undergraduate students: A path to a sustainable tourism industry in Bangladesh. *Journal of Sustainable Tourism and Entrepreneurship*, 6(3), 245-262. doi:<https://doi.org/10.35912/joste.v6i3.2610>
- Tiimub, B. M., Christophé, N., Atepre, B. A., Tiimob, R. W., Tiimob, G. L., Tiimob, E. N., . . . Agyenta, J. J. (2023). Crop production potential of reclaimed mine sites for sustainable livelihoods. *Journal of Multidisciplinary Academic and Practice Studies*, 1(1), 1-13. doi:<https://doi.org/10.35912/jomaps.v1i1.1785>
- Turayevich, U. (2024). Qahramonovich HN Zamonaviy dunyoning axloqiy muammolari-zo ‘ravonlik falsafasi. *Ustozlar uchun*, 57(4), 422-425.
- Wang, X., Chen, Y., Li, Z., Fang, G., Wang, F., & Liu, H. (2020). The impact of climate change and human activities on the Aral Sea Basin over the past 50 years. *Atmospheric Research*, 245, 105125. doi:<https://doi.org/10.1016/j.atmosres.2020.105125>
- White, K. D. (2013). 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>
- Wijesundara, N., Khatibi, A., Azam, S. M. F., & Tham, J. (2025). Effect of motives on sustainability performance of tourist hotels: Mediating role of sustainability adoption. *Journal of Sustainable Tourism and Entrepreneurship*, 6(2), 125-140. doi:<https://doi.org/10.35912/joste.v6i2.2412>