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# COTTON, CARBON, AND DATA: TRACING THE LINEAGE OF ENVIRONMENTAL INJUSTICE IN THE ARAL SEA

**Laziza Abdullaeva**

*Student, Franklin & Marshall College*

**James Strick**

*PhD, Professor, Program Chair of Science, Technology and Society, Franklin  
& Marshall College*

*e-mail: [james.strick@fandm.edu](mailto:james.strick@fandm.edu)*

## Introduction

The Aralkum Desert is not merely a geological fact or a feature on modern maps but a crime scene. Where the world's fourth-largest lake once regulated the climate of Central Asia, there is now a vast, toxic salt flat, generating dust storms that poison the lungs of the local Karakalpak and Khorezm population with pesticides and heavy metals. Standard narratives frame this collapse as a case of Soviet "mismanagement," reducing it to a technical error in which planners supposedly miscalculated the water budget.<sup>1</sup> However, describing the Aral Sea crisis as "mismanagement" is itself a form of erasure. This paper argues that the destruction of the Aral Sea was, and remains, a structural act of environmental injustice, a deliberate choice to sacrifice a specific ecosystem and its people for the sake of external accumulation.

The injustice did not begin with a lack of knowledge or an inability to live in an arid environment. Archaeological evidence shows that for millennia, the inhabitants of the Khorezm oasis practiced flexible “agropastoral” systems that integrated farming with the natural volatility of the river delta.<sup>2</sup> Collapse occurred only when this local resilience was displaced by the rigid industrial logic of the Soviet command economy, which treated the landscape not as a lived home but as a machine for producing cotton. This transformation produced a system of deep dependency, stripping local communities of their capacity to adapt to environmental change and binding them instead to centralized directives that prioritized production targets over human health.

Crucially, this analysis demonstrates that this “colonial algorithm” did not end with the dissolution of the Soviet Union. While the primary commodity has changed, the underlying ethic of extraction has endured. The Soviet fixation on cotton (“white gold”) has given way to a dual contemporary extraction: carbon,

<sup>1</sup> I. Rudenko and J. P. A. Lamers, [The Aral Sea: An Ecological Disaster] (Cornell University, 2010), p. 3.

<sup>2</sup> Elizabeth Baker Brite, [Irrigation in the Khorezm oasis, past and present: a political ecology perspective] (Journal of Political Ecology, 2016), p. 4.

through natural gas drilling on the exposed seabed, and data, through the systematic harvesting of knowledge by international institutions. Just as Soviet planners extracted value from the region while marginalizing local culture and autonomy, modern development regimes convert the Aral Sea disaster into reports, metrics, and scientific capital, even as the sea itself remains dry, a condition that directly enables continued fossil fuel extraction. By tracing this lineage from the cotton monocultures of the 1960s to the gas fields and development reports of the 2020s, this paper demonstrates that the Aral Sea is not deteriorating through neglect; it is being actively maintained in a state of crisis to serve the interests of distant centers of power.

### **Theoretical Framework: Adaptation, Domination, Extraction**

To understand the Aral Sea crisis not merely as a technical failure but as a structural injustice, this paper employs a tripartite framework. It contrasts the indigenous "Traditional Nature Management" (Ballieva) with the colonial "Ideologies of Domination" (Brite/DeMeo) and critiques the modern aftermath through the lens of "Data Colonialism" (Couldry & Mejias).

Before Soviet intervention, the relationship between the Karakalpak people and the Aral Sea was defined by adaptation rather than domination. Ballieva describes this as a state of "quasi-equilibrium," in which irrigated agriculture, cattle breeding, and fishing formed an ethnogeographically adapted system responsive to the volatility of the Amu Darya delta. This indigenous management maintained a functional balance between nature, economy, and population until the late nineteenth century. The injustice began with the erasure of this locally adaptive rationality.<sup>3</sup>

The destruction of this equilibrium was driven by a specific psychological and political orientation: the "Patrist" or "armored" psychology, which views nature as an enemy to be conquered. It is documented that Soviet planners viewed the Aral landscape as "backward" and in need of "reconstruction" to enforce a transition to socialism. This ideology necessitated the dismantling of the Karakalpak "triad" economy. By centralizing water control and imposing a cotton monoculture, the state replaced the flexible, local *mirab* (water master) system with rigid industrial engineering. This was an act of procedural injustice: the local population was stripped of their decision-making power, and villagers "no longer even knew from where their water came from".<sup>4</sup>

In the post-Soviet era, the injustice has evolved into Data Colonialism, a concept defined as the appropriation of human life and social reality as "raw material" for value extraction.<sup>5</sup> In the Aral Sea context, this manifests as an epistemic extraction. The region has become a "laboratory" for international institutions. In this context, local suffering is converted into data for technical

<sup>3</sup> Ruza Ballieva, [Karakalpak Ethnos and Traditional Nature Management] (Lesson Press, 2022), p. 18-22

<sup>4</sup> Elizabeth Baker Brite, [Irrigation in the Khorezm oasis, past and present: a political ecology perspective] (Journal of Political Ecology, 2016), p. 9, 15.

<sup>5</sup> Nick Couldry and Ulises A. Mejias, [The Costs of Connection: How Data Is Colonizing Human Life] (Stanford University Press, 2019), p. 10.

reports, while the material benefits of this knowledge largely accrue to external institutions rather than returning to the community in the form of restoration.

### **Cotton: Foundations of Injustice**

The destruction of the Aral Sea was driven by a massive reconfiguration of the region's hydrology, initiated in the mid-20th century to satisfy the Soviet Union's demand for cotton.

Until the 1960s, the Aral Sea maintained a relatively stable surface area of approximately 68,000 km<sup>2</sup> and a volume of 1,056 km<sup>3</sup>. This stability depended on a fragile equilibrium between evaporation and inflow from two major rivers, the Amu Darya, which supplied roughly 77 km<sup>3</sup> of water annually, and the Syr Darya, which contributed approximately 34 km<sup>3</sup> per year.<sup>6</sup>

Beginning in the early 1960s, Soviet central planners initiated a dramatic expansion of the regional irrigation network to support cotton and rice production. Large dams were constructed in the upper reaches of both rivers, while an extensive system of unlined canals was dug to divert water deep into the desert. By the 1980s, the total irrigated area within the basin had expanded to 7.9 million hectares, consuming more than 95 km<sup>3</sup> of water annually. As a result, between 80 and 95 percent of the rivers' flow was redirected for agricultural use, preventing it from ever reaching the sea.<sup>7</sup>

This infrastructure was "ideologically motivated," designed to "convert the spirit of the people" and enforce a transition to socialism by replacing the region's natural hydrological cycles with a centrally planned production machine.<sup>8</sup>

The reduced inflow caused an immediate and precipitous decline in the sea's volume. By 1990, the sea had shrunk to 39,734 km<sup>2</sup>, nearly half its original size, and separated into two distinct water bodies: the "Small Aral" in the north (Kazakhstan) and the "Large Aral" in the south (Uzbekistan). This physical retraction triggered a chemical crisis. As the water volume decreased, the salt concentration increased dramatically from a brackish 10.3 g/kg in 1960 to over 140 g/kg in the western Large Aral by the 2000s.<sup>9</sup>

The native ecosystem could not survive this hypersalinization. The original fauna comprised 20 species of fish, including the commercially valuable Aral Sea sturgeon and Aral trout. By the late 1990s, almost all native fish species had disappeared from the Large Aral, rendering commercial fisheries extinct. Furthermore, the receding water exposed vast stretches of the seabed, creating a new terrain known as the Aralkum Desert. This new desert became a source of salt and dust, with 1.5–2 cm of soil blown away annually by winds.<sup>10</sup>

The ecological collapse of the Aral Sea produced immediate and severe consequences for the approximately five million people living in its vicinity. The newly exposed seabed, saturated with salts and agricultural pesticides such as DDT

<sup>6</sup> I. Rudenko and J. P. A. Lamers, [The Aral Sea: An Ecological Disaster] (Cornell University, 2010), p. 2.

<sup>7</sup> I. Rudenko and J. P. A. Lamers, [The Aral Sea: An Ecological Disaster] (Cornell University, 2010), p. 3.

<sup>8</sup> Elizabeth Baker Brite, [Irrigation in the Khorezm oasis, past and present: a political ecology perspective] (Journal of Political Ecology, 2016), p. 9.

<sup>9</sup> Igor S. Plotnikov et al., [Past, Present and Future of the Aral Sea] (Zoological Studies, 2023), p. 30.

<sup>10</sup> Ruza Ballieva, [Karakalpak Ethnos and Traditional Nature Management] (Lesson Press, 2022), p. 18.

and lindane from decades of cotton cultivation, became the source of frequent toxic dust storms. These airborne pollutants spread across settlements, contaminating soil, water supplies, and human lungs.<sup>11</sup>

Public health indicators in the region deteriorated rapidly. Respiratory illnesses became widespread, particularly among children. In Turkmenistan alone, nearly 50 percent of reported childhood illnesses were linked to respiratory conditions. Maternal health also declined sharply, with anemia becoming prevalent among pregnant women. In Kazakhstan's Aral region, infant mortality rates rose by approximately 50 percent between 1985 and 2005, reaching between 60 and 110 deaths per 1,000 births. These figures far exceeded national averages in Uzbekistan and Russia during the same period.<sup>12</sup> Chronic diseases such as hepatitis, kidney failure, and esophageal cancer increased dramatically, largely due to the consumption of contaminated water and the long-term inhalation of toxic dust.

Economically, the collapse was total. The fishing industry, which once yielded 40,000 metric tons of fish annually, collapsed entirely, leading to the loss of 40,000 to 60,000 jobs in Kazakhstan alone. This disparity, where the "center" accumulated the wealth of the cotton harvest while the local population bore the biological burden of disease and poverty, illustrates the core distributive injustice of the Aral Sea crisis.<sup>13</sup>

### **Carbon: Profiting from non-restoration**

The dissolution of the Soviet Union did not liberate the Aral Sea. While the global community views the "Aralkum" desert as a tragedy to be mitigated, state and corporate actors increasingly view it as an asset to be developed. As the waters receded, they exposed a vast, desolated seabed that geologists identified as rich in hydrocarbons.

By the early 2000s, the "Aralkum" was no longer just a site of ecological collapse but a frontier for energy exploration. In 2005, an international consortium was established, including the Russian energy giant LUKOIL, the Uzbek oil and gas state company Uzbekneftegaz, and other foreign investors. This entity, formalized as the "Aral Sea Operating Company," was granted a Production Sharing Agreement (PSA) to explore the exposed seabed for oil and gas for a period of 35 years.<sup>14</sup>

Exploration efforts yielded immediate results. In 2010, the consortium announced the discovery of a major natural gas field in the "Western Aral" structure, with preliminary reserves estimated at 11 billion cubic meters. Further seismic prospecting identified "over 30 anomalies connected with oil and gas

<sup>11</sup> I. Rudenko and J. P. A. Lamers, [The Aral Sea: An Ecological Disaster] (Cornell University, 2010), p. 4.

<sup>12</sup> Igor S. Plotnikov et al., [Past, Present and Future of the Aral Sea] (Zoological Studies, 2023), p. 2-7, 24-28.

<sup>13</sup> Hudali Mukti et al., [Environmental Justice at the Environmental Regulation in Indonesia and Uzbekistan] (Journal of Human Rights, Culture and Legal System, 2023), p. 478.

<sup>14</sup> UzDaily, [LUKOIL increases its share in Aral agreement in Uzbekistan] (UzDaily.com, 2012)

<https://www.uzdaily.uz/en/uzbek-leader-approves-programme-on-exploration-of-aral-sea/#:~:text=In%20line%20with%20the%20document,initial%20stage%20of%20the%20project.>

[https://www.azernews.az/oil\\_and\\_gas/40415.html#:~:text=The%20start%20date%20of%20the,%2C%20analysis%2C%20and%20much%20more.](https://www.azernews.az/oil_and_gas/40415.html#:~:text=The%20start%20date%20of%20the,%2C%20analysis%2C%20and%20much%20more.)

reserves" within the Uzbek sector of the dried sea. Consequently, the disaster zone was effectively rezoned as an industrial block, where evaporation, previously viewed as economically unproductive, was replaced by large-scale fossil fuel extraction.

The discovery of gas created a structural conflict of interest regarding the restoration of the sea. The physical presence of water is a logistical and financial barrier to extraction; drilling on dry land is significantly cheaper than offshore drilling. As Rudenko and Lamers explicitly note in their policy analysis: "Not refilling the sea will make the extraction of gas or oil for Uzbekistan less expensive and less labor- and technology-intensive than it would be on a refilled seabed."<sup>15</sup>

This economic logic fundamentally alters the political will for restoration. While official narratives often blame climate change or water scarcity for the failure to save the Large Aral, the reality is that the sea is now "more valuable dead than alive" to the extractive sector. The "take no action" approach to the South Aral Sea, often framed as a pragmatic acceptance of the inevitable, aligns with the financial interests of the gas industry, which benefits from the continued desiccation of the basin.

This shift to a gas-based economy reinforces the distributive injustice established during the cotton era. The benefits of this new wealth are highly concentrated. The Production Sharing Agreement stipulates that Uzbekistan retains 50% of the product, while the remaining share is distributed among foreign investors like LUKOIL and CNPC. Meanwhile, the local population, which previously depended on the sea for fishing and climate regulation, receives none of the direct profits but bears all the externalities.

The "Aralkum" serves as a textbook "sacrifice zone": the local atmosphere is polluted by salt and dust storms to facilitate the extraction of gas that fuels distant economies. Just as the Karakalpak people were once sacrificed for the Soviet cotton quota, they are now sacrificed for the global energy market, living in a toxic environment sustained by economic and regulatory choices rather than unintended consequences.

### **Data: Epistemic Injustice**

In the modern era, the Aral Sea has become a global laboratory for international financial institutions, development agencies, and researchers. The influx of "technical assistance" represents a form of epistemic injustice, a "Data Colonialism" that extracts knowledge capital from the region while failing to restore the environment for the people living there.

As theorized by Nick Couldry and Ulises Mejias, data colonialism refers to an extractive order that treats human life and social reality as "raw material" for processing.<sup>16</sup>

In the Aral Sea basin, this dynamic is visible in the proliferation of monitoring projects that treat the catastrophe as a scientific experiment. Since the 1990s, the region has been inundated with international missions aimed at

<sup>15</sup> I. Rudenko and J. P. A. Lamers, [The Aral Sea: An Ecological Disaster] (Cornell University, 2010), p. 10.

<sup>16</sup> Nick Couldry and Ulises A. Mejias, [The Costs of Connection: How Data Is Colonizing Human Life] (Stanford University Press, 2019), p. 10.

"assessing" the crisis—numerous donors and international organizations have implemented more than 20 large-scale projects worth about US \$500 million in the basin.<sup>17</sup> Yet, despite this massive investment in data collection and report generation, "the Aral Sea has not been restored" and the desalination of the Large Aral continues to accelerate. The disaster has generated vast amounts of knowledge for the Global North, in the form of hydrological models, salinity graphs, and biodiversity papers, but remarkably little water for the Karakalpak people.

The mechanism of this epistemic extraction is the "pilot project." The region suffers from a disconnect between the high volume of expert activity and the low volume of tangible results. Rudenko and Lamers describe this as a "classic case of too many stakeholders" with "diverse political agendas," where international efforts are often uncoordinated and arrive "too late" to address the root causes.

Local cynicism regarding this dynamic is profound. A common saying among the population in the disaster zone captures the essence of this epistemic injustice: "If everyone who came to study the Aral Sea had brought a bucket of water, the sea would be full by now." While consultants produce "Green Transition" reports that validate their own expertise, the physical reality on the ground, toxic dust and water scarcity, remains unchanged.

This modern data extraction echoes the "colonial science" of the Tsarist and Soviet eras. Historically, imperial scientists like Nikolai Borodin were commissioned to study the fisheries to determine if they could support Cossack colonization, often ignoring the "entrenched fishing habits" of the local populations.<sup>18</sup> Similarly, modern biological monitoring often focuses on adapting the ecosystem to the new, salinized reality rather than restoring the original balance.

For instance, scientific efforts have touted the introduction of the European flounder, a saltwater-tolerant alien species, as a "success" for fisheries in the salinized Small Aral. While this provides a temporary economic stopgap, it essentially accepts the destruction of the native freshwater ecosystem as a permanent fact. By managing the disaster rather than reversing it, "scientific management" becomes a tool for legitimizing the status quo. The "Aralkum" is accepted as a new reality to be monitored, mapped, and drilled, rather than a home to be healed.

## Discussion and Conclusion

The history of the Aral Sea is often narrated as a story of discontinuity, a sharp rupture between an "ancient harmony" and a uniquely Soviet disaster. This paper has shown that such a framing is misleading. A closer examination of the archaeological, political, and economic record reveals a profound continuity. From the cotton monocultures of the 1960s to the gas fields and development reports of

<sup>17</sup> I. Rudenko and J. P. A. Lamers, [The Aral Sea: An Ecological Disaster] (Cornell University, 2010), p. 1.

<sup>18</sup> Niccolò Pianciola, [Cossacks and Sturgeons: Fisheries, Colonization, and Science around the Aral Sea] (Journal of the Economic and Social History of the Orient, 2019), p. 660.

the 2020s, the region has been treated not as a human habitat to be sustained, but as a reservoir of resources to be stripped, processed, and exported.

A critical examination of the Soviet era reveals a disturbing paradox. The destruction of the Aral Sea did not happen because of a lack of scientific knowledge. As documented by Brite, the Soviet state funded the Tolstov Expedition, a decades-long archaeological project that pioneered the use of aerial photography to map ancient irrigation canals and study pre-industrial water management. Soviet planners were deeply interested in historical infrastructure and indigenous adaptation, seemingly willing to learn from earlier ways of dealing with water.

Yet the very system that produced this sophisticated knowledge simultaneously dismantled the ecological equilibrium it documented. Traditional practices were filtered through a Marxist-Leninist framework that viewed them as stages to be transcended rather than forms of wisdom to be preserved. Knowledge accumulation did not translate into restraint; instead, it facilitated more efficient domination.

In the post-Soviet era, the Colonial Algorithm was not dismantled but institutionalized through new legal and financial mechanisms. The most significant of these is the Production Sharing Agreement governing hydrocarbon extraction on the exposed seabed. The PSA granted to the Aral Sea Operating Company represents a powerful form of economic lock-in. Because refilling the sea would make extraction technologically complex and financially unviable, the continued desiccation of the Aral Sea becomes a contractual necessity. Under these terms, ecology and economy are placed in direct opposition: restoring the water would destroy the profitability of gas production, which has become a central source of state revenue. The Aralkum is thus stabilized, not accidentally but deliberately, as a dry industrial asset.

This economic lock-in is reinforced by a broader sovereignty deficit produced through three intersecting structures. First, state centralization persists in water governance. Despite post-Soviet reforms, control over irrigation and crop production remains centralized, displacing local water masters and rendering communities dependent on bureaucratic systems that prioritize export targets over ecological resilience. Second, International Financial Institution project logic fragments the crisis into short-term, technical interventions. Despite hundreds of millions of dollars in aid, restoration efforts remain uncoordinated and temporally limited, reproducing a system in which international experts retain authority while local knowledge is sidelined. Third, the legal designation of the seabed as an exploration block formally excludes the local population from land that once functioned as a commons, placing it under international commercial law rather than local stewardship.

These institutional arrangements produce a profound contradiction. The Aral Sea basin is simultaneously branded as an environmental catastrophe to attract international aid and managed as an industrial frontier to attract investment. “Green” interventions, such as planting saxaul trees to reduce dust storms, are

permitted only insofar as they do not interfere with fossil fuel extraction. Mitigation is allowed; restoration is structurally foreclosed.

Ultimately, the failure to save the Aral Sea is not a failure of technology, knowledge, or feasibility. It is a failure of stewardship embedded in institutional design. Ancient irrigation systems were sustainable precisely because they were locally managed, flexible, and responsive to ecological limits. Soviet and post-Soviet governance replaced this model with centralized, extractive systems that stripped communities of decision-making power.

Breaking the cycle requires more than technical mitigation or symbolic “green” projects. Environmental justice in the Aral Sea basin demands the restoration of local sovereignty, the return of authority to the communities who breathe the dust and drink the water. Until the Aral Sea is viewed as a home rather than a mine for cotton, gas, or data, the cycle of extraction and erasure will continue.

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