SEEING BEYOND CATASTROPHE: RETHINKING DEVELOPMENT AND ENVIRONMENTAL TRANSFORMATION IN THE ARAL SEA REGION OF UZBEKISTAN

by

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A DISSERTATION

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DISSERTATION ABSTRACT

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Title: Seeing Beyond Catastrophe: Rethinking Development and Environmental Transformation in the Aral Sea Region of Uzbekistan

The Aral "catastrophe" has resulted from ongoing diversion of water flowing into the Aral Sea for irrigation, largely cotton, primarily from the 1960s until present. The shrinking of the sea has resulted in loss of livelihoods, local climate change, health impacts, and the creation of the world's newest desert. This dissertation sees beyond catastrophe to de-exceptionalize the Aral Sea and tell nuanced stories of the human and more-than-human (e.g. trees, fish, insects) residents of the region. It highlights the life, value and beauty of the Aral Sea region while showing how the region has been devalued.

Using feminist mixed-methods that treat all data as situated knowledges and embodied (rather than disembodied) visions, this work interweaves the partial perspectives of ethnographic data from nine months of fieldwork, geophysical, and remote sensing data while attending to the politics of these data's creation. This dissertation contributes to scholarly conversations on the co-production of development and expertise, political ecologies of the state, and feminist methods for human-environment interactions.

Using ethnographic data, I first unpack the 2021 designation by the UN General Assembly – initiated at the behest of the Uzbek state – of the Aral Sea region as a "Zone of Ecological Innovations and Technologies." I problematize the ideology of innovation that lies

behind the “Zone” arguing instead for an ethos of repair.

Next, I probe state-sponsored and crowed-funded plantation-style afforestation that is framed as mitigation of the consequences, particularly toxic dust, of the dried Aral Seabed. Data come from a visual classification of the seabed using Google Earth Pro and participant observation. I argue afforestation should be understood as a performance of environmental stewardship and mobilization of trees as infrastructure rather than ecosystem restoration.

Finally, interweaving remote sensing, geophysical and ethnographic data, I illustrate how flows of water into the Amu Daryo delta have decreased and how surface water in the delta is increasingly variable over time and discontinuous across space. I conclude that the greatest risk for residents is not toxic dust, but ongoing violence of water allocation policies that continue to remake the landscape and affect residents’ ways of life, livelihoods and nutrition.

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To the woman I met at the bench at 56.19, -4.67 who started me on this journey

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LIST OF ABBREVIATIONS

ASBP	Aral Sea Basin Program
DCA	Development and Cooperation Agency [pseudonym]
FAO	Food and Agriculture Organization
GSW	Global Surface Water
ICSD	Interstate Commission on Sustainable Development
ICWC	Interstate Commission for Water Coordination
IFAS	International Fund for Saving the Aral Sea
ILO	International Labor Organization
IPD	International Partners in Development [pseudonym]
IWRM	Integrated Water Resources Management
MPHSTF	Multi-partner Human Security Trust Fund
NASA	National Aeronautics and Space Administration
UN	United Nations
USD	US Dollar
USSR	Union of Soviet Socialist Republics
UZS	Uzbek So’m

LIST OF UZBEK, KARAKALPAK AND RUSSIAN WORDS

Word	Meaning
Berdaq Baǵí	Berdakh Garden
buhanka	loaf style bread
collector	drainage canal
daryo	river
hashar	system of obligations such as canal maintenance tied to benefits
Jumurtaw	Jumur Mountains
kolkhoz	collective farm
ko'l	lake
Mo'ynoq, Mo'ynaq	Muynak (town)
non	round flat loaf of bread
o'blast	district
Oliy Majlis	Council of Ministers of Uzbekistan, equivalent to parliament
Orol Dengizi	Aral Sea (literally Island Sea)
Orolbo'yi	around the Aral Sea
plov	dish of rice and meat, sometimes with spices
Priaral'ye [Приаралье]	Russian/Soviet name for the Aral Sea region
Qarataw	Black mountains, Karakalpak brand of vodka
Qoraqalpog'iston	Karakalpakstan
selector	meeting in which the president or another high-up official presents an idea and then instructs everyone below him/herself to implement these ideas
tugai	riparian forest

videoselector	selector done through a video conference

LIST OF SPECIES[1]

Animals

Latin name	Local name	English name
Carassius	*Karas*	Crucian carp
Chrysopa perla	*Oltinko'z*	Green lacewing
Ctenopharyngodon idella	*Beliy amur*	Grass carp
Cyprinus carpio	*Sazan*	Eurasian carp
Helicoverpa armigera	*Ko'sak Qurti*	Cotton bollworm
Passer ammodendri		Saxaul sparrow
Species of *Trichogramma*		Trichogramma

Plants

Latin name	Local name	English name
Apocynum venetum L.; *Apocynum pictum* Schrenk		Kendyr
Cistanche deserticola		Cistanche
Elaeagnus angustifolia	*Jiyda*	Russian Olive
Halostachys belangeriana	*Qorabaraq*	
Haloxylon aphyllum	*Saksovul*	Saxaul
Salsola paletzkiana	*Cherkez*	
Species of *Atriplex*	*Atripleks (lebeda)*	
species of *Calligonum*	*Juzgun/qandim*	
Tamarix leptostachys	*Tamariks*	Tamarisk
Vigna radiata	*Mosh loviya*	Mung beans
Ziziphus jujuba	*Irgchtek*	Jujube

[1] Some species do not have an English name. If a species is missing a local name it is either because the Latin name was used by locals, or I only spoke about the species with my participants in English.

INTRODUCTION

> "I have just flown over the Aral Sea by helicopter with Prime Minister [Shavkat] Mirziyoyev of Uzbekistan. It is clearly one of the worst environmental disaster of the world. I was so shocked. It really left with me a profound impression, one of sadness that such a mighty sea has disappeared" (Ban Ki-moon, UN Secretary General, April 4, 2010).

> "This [the Aral Sea] is probably the biggest ecological catastrophe of our time. And it demonstrates that men can destroy the planet. The Aral Sea's progressive disappearance was not because of climate change, it was mismanagement by humankind of water resources. But it also shows that if in relation to climate change, we are not able to act forcefully to tame this phenomenon, we might see this kind of tragedy multiply around the world" (António Guterres, UN Secretary General, June 10, 2017).

Why the Aral Sea region?

The Aral Sea is one of the most dramatic examples of an environmental catastrophe, as demonstrated by the quotes from two UN Secretary Generals (one past, one current) above. The Aral Sea region lingers as a warning for the dangers of state socialism, cotton monoculture, environmental exploitation, and climate change among others. It is the topic of magazine articles, travel websites, blogs, and documentaries (for an example of each see Gordillo 2023; Zinna 2020; Bates Kassatly 2021; Gottschau et al. 2006) and features in many Introduction to Environmental Studies classes. Yet despite the pervasive use of the Aral Sea as a warning, there have rarely been analyses of the region in the anglophone literature that complicate these simple stories (for exceptions see Peterson 2019; Obertreis 2017). As one scholar of environmental remote sensing who listened to my practice job talk told me, I thought I knew about the Aral Sea, and now I realize I know nothing.

One goal of this dissertation is thus to see beyond catastrophe to tell different and more nuanced stories about the Aral Sea region.

> *As Arslan drives, he tells me that he loves horses, that he has been riding since he was five years old. We arrive at a sandy area with ridges on both sides, one ridge paralleling the collector [drainage canal]. There are some native shrubs in the area, but it is largely open. We park over the bridge across the collector and when we walk past we see that there are goats underneath the bridge. Arslan tells me that I can stay*

in the car, but I decline. We are here so that Arslan can join a game called ilıq (Figure 1)*. This game is being sponsored by a local family to celebrate their son's circumcision. After putting me in the care of an older man, Arslan goes to find the horse he has been lent for the day. There are two teams, all on horseback, and the goal is to capture a goat that has been stuffed with salt and get it to a designated place – something like capture the flag. As the horses thunder back they leave a cloud of dust behind them. Prizes are awarded for the different rounds. They start at 100,00 UZS [about 10USD] and go up to a cow. Over the thunder of horse hoofs the head of the family, dressed in a ceremonial robe and hat, comes over to meet me and in deeply accented Karakalpak he thanks me for joining their celebration and tells me that there is not enough water here.*

Figure 1: Ilıq

This story highlights two things for me. First, how despite the environmental transformation of the Aral Sea region, residents continue to celebrate, play games, and keep traditions passed from generation to generation in this place. Second, that despite this continuity, the environment is never out of mind, but always present in the lives of residents.

When I first stood at the former edge of the Aral Sea on 110-degree day in the summer of 2019, I unexpectedly started crying. Cried for a place I had never known, that I would never know. Yet despite the loss in the region – of the sea and of livelihoods – as the story above shows, the Aral Sea region remains a place of value to its residents, a place where their ancestors lived and are buried, a place where they invest their time and their hopes, and a place of beauty. This side of the region takes an outsider longer to see, and requires slowing down, listening more, and looking harder. In this sense, this work speaks to that of Anna Tsing (2015), as I seek to show life, value and beauty in post-socialist, post-Soviet ruins.

A second goal of this dissertation is to de-exceptionalize the Aral Sea and to show how the Aral Sea is one example, like the Great Green Walls of China and the Sahel (Turner et al. 2023), of how the state and multilateral organizations are grappling with complicated environmental challenges that exceed the bounds of the nation state where health, security, livelihoods and citizenship intertwine. Kalinovsky argues that development in Soviet Central Asia was "not only comparable to the efforts of postcolonial nation states but that they were linked—ideas circulated between the USSR, the Third World, and the 'capitalist West'—and found their local adaptations" (2018, 247). Understanding development in the Aral Sea region thus contributes to a broader understanding of the history and present of development.

Finally, investigating human-environment interactions in the Aral Sea region can also contribute to calls in critical physical geography to attend to 'crappy landscapes', landscapes degraded and devalued by humans (Urban 2020) like the Aral Sea region. Attention to 'crappy landscapes' allows for investigation of how humans have become an integral part of earth's biophysical systems in the Anthropocene (Biermann, Kelley, and Lave 2021), while also understanding how these landscapes come to be seen as valueless.

Research questions

My dissertation deploys novel data sources and geographical methods rarely used in combination to reveal the value of the Aral Sea region of Uzbekistan (encompassing both the Aral Sea and Amu Daryo delta) (Figure 2) to the humans, animals and plants that call this region home, and to compare the ways that residents, development organizations, and the government imagine the future of the region. My dissertation answers four primary questions:

1) How is the Uzbek State mobilizing the Aral "catastrophe" to reinvent and reposition the country and access international development aid?

2) How do development actors negotiate global imperatives for landscape restoration and economic development given the socio-ecological and political challenges of the Aral Sea region?
3) How successful is afforestation of the dried seabed in terms of both plant survival and enhancing the state's image as an environmental steward? How are planting programs implemented and represented?
4) What are the consequences of water allocation policies for the landscape and the human and more-than-human (i.e. animal, plant) residents of the Aral Sea region?

The Aral Sea region

Water levels of the Aral Sea (Figure 2) were stable from 1911 when monitoring began until 1960 (Wheeler 2021), although the Aral Sea has varied dramatically across geological time (Boroffka et al. 2006) (see Appendix for a timeline of the political history of this region). In all, since the 1960s, more than 45,000 km^2 of seabed has been exposed as the Aral Sea has shrunk and divided into two separate water bodies. Fishing was an important industry (Wheeler 2021) and the town of Muynak was Uzbekistan's port, and a center for fishing and canning. However, cotton production was Uzbekistan's primary role in the Soviet Union (Teichmann 2007; Peterson 2019; Obertreis 2017), and this role was supported by irrigation water diverted from the Syr Daryo and Amu Daryo rivers upstream of the Aral Sea. The Soviet goal was "to bridle the Syrdarya and Amudarya rivers, to control them and to make their water serve the cause of socialism" (First Party Secretary of Uzbekistan 1939, quoted in Zonn 1999, 159).

In addition to material goals, Central Asia's water served political goals. As Lenin stated, "irrigation ... changes the country; it leads to its rebirth, buries the past and enforces the transition to socialism" (quoted in Teichmann 2007, 503). Water was diverted to such an extent that in some years water from these rivers did not reach the Aral Sea at all (P. Micklin 2007). Discursively, the catastrophe is often framed as Soviet ignorance or ecocide. However, Soviet scholars were aware of the challenges this large-scale irrigation was causing. Research on the

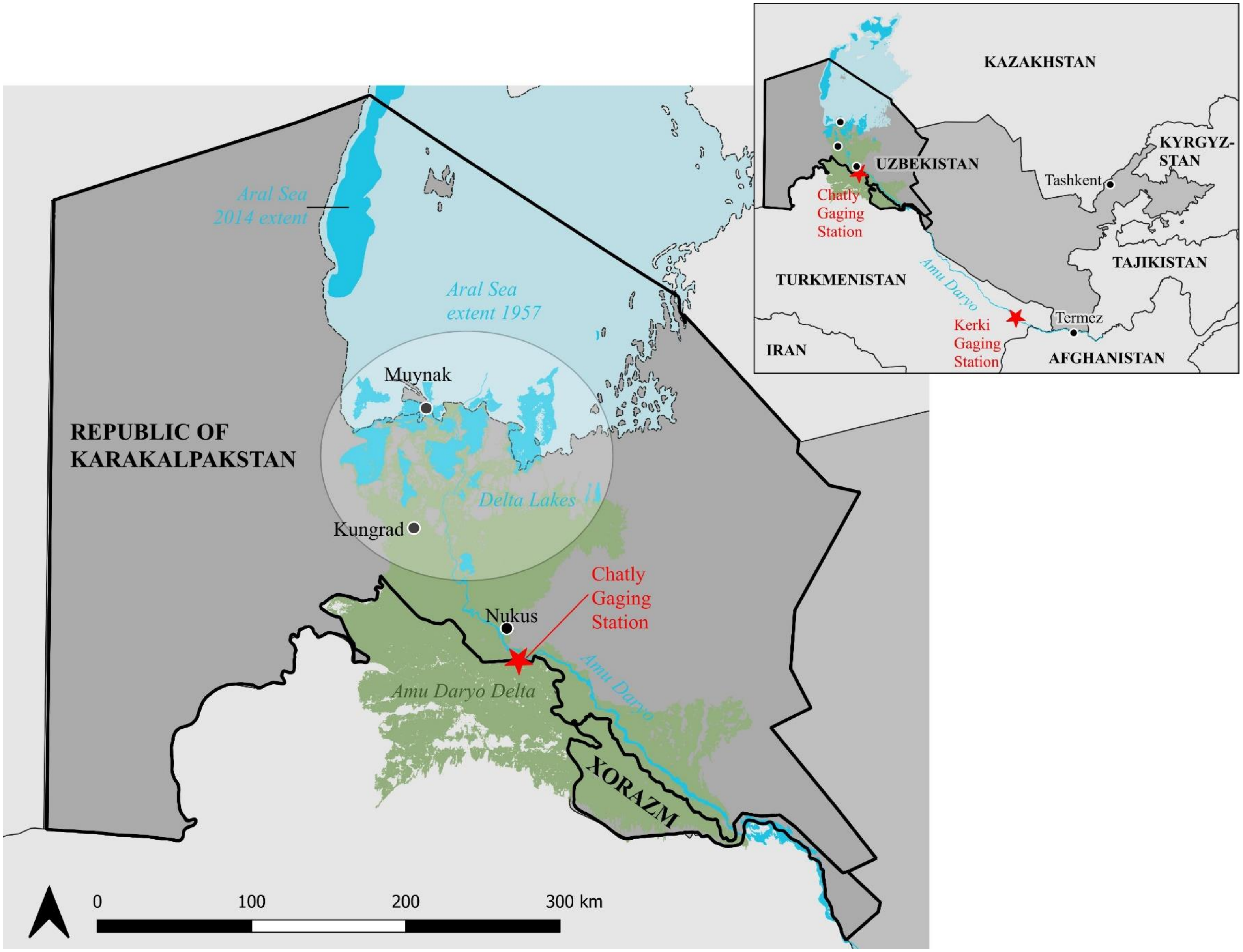

Figure 2: Reference map of the Aral Sea region of Uzbekistan

environmental consequences of these diversions began in the Soviet period (Asarin 1974; Kuznetsov 1977) as scholars drew attention to the changing water balance and the need for increasing water use efficiency (Kes et al. 1982).

The Aral "catastrophe" was first shown on Soviet television in 1988, which led to the formation of an expedition, named Aral-88, to report on the situation (Wheeler 2016). The leader of the expedition, Grigori Reznichenko, recorded a diary of the two-month journey, in which he reflects on the challenges of the Aral Sea region and his interactions with scientists and bureaucrats in the region, providing a window into this expedition. Wheeler (2016) argues that while Aral-88 provided a critique for the Aral Sea region and the Soviet system more broadly, it also provided hope that these critiques might be met with serious change and improvement. However, with the breakup of the Soviet Union in 1991, Uzbekistan and the other newly independent Central Asian republics "fell from the heights of membership in a great power to the lowly status of developing countries" (Atlani-Duault 2008, 2) and hope for the Sea, at least within the scope of the Soviet Union, was extinguished. Writing the afterward for the publication of his diary in December 1991, Reznichenko writes both provocatively and pessimistically "let's pause now and ponder: for what do we produce so many million tons of cotton each year?...The obvious conclusion is that the Aral Sea has simply been strangled" (Reznichenko 1992, 91).

The imposition of international borders on the region also disrupted the previous management regime where the mountainous countries of Kyrgyzstan and Tajikistan, source of the Syr Daryo and Amu Daryo, would forgo summer hydropower so that the downstream countries of Turkmenistan, Uzbekistan and Kazakhstan could irrigate crops – primarily cotton – in exchange for fossil fuels from the downstream countries (Obertreis 2017; Weinthal 2001).

Transboundary water management continues to remain an issue in the region, and is the subject of several ongoing development initiatives.

As a symbol of the failures of the Soviet model, the Aral Sea has become an "object of development" (Mitchell 1995) for international organizations including the World Bank, European Union, and USAID in the post-Soviet era. The International Fund for Saving the Aral Sea (IFAS) was established in 1993 to coordinate the actions of the now independent states on saving the sea. Kyrgyzstan however suspended its involvement in 2016. The presidency of the executive committee of IFAS rotates between the Central Asian republics on a three-year basis, with the current president as Tajikistan. IFAS also encompasses the Interstate Commission for Water Coordination (ICWC) and the Interstate Commission on Sustainable Development (ICSD) that are key producers and keepers of knowledge about water and the environment more broadly in the region. IFAS also oversees the Aral Sea Basin programs (ASBP) which seek to coordinate development in the region. There have been three completed programs: ASBP-1: 1994-1999; ASBP-2; 2003-2010; and ASBP-3; 2011-2015. ASBP-4 was approved in 2018 and is scheduled to run from 2021-2030.

According to my participants, there has been a shift in Uzbekistan away from IFAS as the primary organization for coordinating development in the Aral Sea region to UN agencies. This shift came after the UN Secretary General's visit to the Aral Sea in 2010. The first UN program in the Aral Sea region of Uzbekistan ran from 2012-2016, with a second program from 2016 to 2019. One of the primary goals of the second program according project documentation was to establish, in collaboration with the Government of Uzbekistan, the Multi-Partner Human Security Trust Fund for the Aral Sea Region (MPHSTF), a funding mechanism which would pool donor funding for projects implemented by two or more UN agencies. The Uzbek state has claimed the MPHSTF as one example of the state's successes in the Aral Sea region. Since its launch on November 27, 2018, the MPHSTF has overtaken IFAS as the main coordinating body for development in the region. This turn toward the UN has helped the Uzbek state reach a broader audience for its development work in the Aral Sea region as I show in Chapter 1.

Positionality and methods

In this section I reflect on how this dissertation is both a very personal story of trying to do social science research in Central Asia, but also a story that is likely familiar to others who are "outsiders" and working in the region. I seek to analyze my own positionality as I answer the most common question I got during my fieldwork which was why are you, the first American social science researcher in the region since at least 2005, here? I then describe my project and the barriers I encountered, followed by the ways that I adapted my project to integrate environmental and remote sensing data, and what I see as the value of my approach for feminist methodologies and imagining alternative environmental futures. In this sub-section, I provide a more critical reflection on my methods. Details of data collection and analysis are included in each chapter.

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It is 2011. I am in my first year of a dual master's program at the University of Michigan having just returned from three years living in Istanbul, Turkey. The student services advisor has suggested that since I know Turkish, I might consider learning Uzbek as my next language. I know nothing about Uzbekistan. As I do my first Google search, I am confronted by satellite images and photos of ships stranded in the sand of the disappearing Aral Sea. I want to learn more, and although I study Uzbek for five semesters, I never have an opportunity to use it until my PhD.

Images I found when starting my PhD in 2017 were no different than those in 2011: satellite images of the seabed and photos of rusted ships. In online materials, the Aral "catastrophe" was explained as exceptional, encapsulating everything that was wrong with the Soviet system where growing cotton or "white gold" had created an empty, dead wasteland. I found biomedical studies showing the devastating consequences of the Aral "catastrophe" on health. Environmental exposures have been shown through water (Small 2003; Bosch et al. 2007), food (Muntean et al. 2003), and toxin laced dust (O'Hara et al. 2000; Wiggs et al. 2003). Health impacts have included respiratory issues (Kunii et al. 2003), thyroid (Mazhitova et al. 2007) and kidney problems (Kaneko 2003; Kaneko et al. 2007), accumulations of toxins in the blood of pregnant women and newborns and in breast milk (Ataniyazova et al. 2007; Hooper et al. 1997; 1998), fertility challenges (Balmagambetova et al. 2017; 2015), prevalence of diarrheal diseases (Henderson et al. 1998), multi-drug resistant tuberculosis (Cox et al. 2007; 2004), and anemia (Hashizume et al. 2004; 2003; Giebel, Suleymanova, and Evans 1998).

But this work included nothing of the stories of residents themselves and their embodied experiences of health and environmental transformation. As a human-environment geographer, I wanted to know more – how did locals adapt to and understand the current situation? I obtained funding, and eventually after much pushing, an academic visa and research permission from the Ministry of Foreign Affairs of Uzbekistan for nine months of fieldwork during the COVID-19 pandemic (Letter No20/6711). Ethical approval for this project came from the University of Oregon Office of Research Compliance Services (Protocol Number: 05222019.029) and the US Department of Education. My goal: to see beyond catastrophe and "re-people" the region through embodied experiences of residents I planned to collect through environmental oral histories. I was warned by the US Embassy, who had facilitated my visa and research permission, before leaving for Uzbekistan that it might not be possible to do any interviews with locals – that there were state actors that might not allow this to happen.

I also sought to understand current state and development activities in the region, particularly large-scale afforestation efforts of the Aral Seabed through participant observation internships with two different development organizations. I was also able to do 22 key stakeholder interviews with development organization staff and to assemble a database of documents (legislation, presidential speeches, and development organization reports).

My positionality during my fieldwork, particularly participant observation, was complicated. People would assume I was Russian and the first time they met me they invariably spoke to me in Russian. When I responded in Uzbek with a Turkish accent (I do not know Russian), they were quite surprised, asking if I was Turkish. Responding that I was American led to looks of confusion. I was the first American social science researcher to be hosted at Karakalpak State University, and one of the first foreign social science researchers to work in the Aral Sea region of Uzbekistan since 2005. Being a foreign woman and according to Karakalpak culture a perpetual guest, provided me a liminal status, allowing me to attend events that were often all men, or closed to locals or other students or scholars. At the same time, my status as researcher and a foreigner closed some doors.

Despite the warning I had received that interviews with locals might not be possible, when I arrived the head of the international office at Karakalpak State University assured me that it would take a few letters and a month and everything would be sorted out. To make a long story short, I pushed and I pushed for these letters for months – my requests often met with the phrase "*xudo xohlasa bo'ladi*" ["God willing it will happen"] or similar. After six months in the field, I wrote this to my committee regarding the permission process:

> At every turn I have run into a barrier, and when I try to go around it a new barrier appears. Since I have now had this experience in two different parts of Uzbekistan [Karakalpakstan and Xorazm], I believe that this is a more systemic effort of the state to deny me access to locals and their stories. Also, I think that no one here wants to be responsible for anything I might publish or do that could anger someone above them in the hierarchy. Finally, it seems to me that there is a significant risk to my participants if I do interviews and the government is not fully on board. So at this point I need to make plans for my fieldwork under the assumption I cannot do these interviews [Email, 10/13/2021].

In a last-ditch effort, the US ambassador, who came to visit Nukus, the capital of Karakalpakstan, and had heard that my research was encountering difficulties, very kindly used his connections to speak to the deputy chair of the Council of Ministers of the Republic of Karakalpakstan. I was then called in to have a meeting with the deputy chairman who said that he would do what he could, and I was told again that a letter of permission would be forthcoming. It was only on the day that I left Nukus to return to the US that I was finally told that the Council of Ministers had declined to write a letter of permission. So nearly nine months after arriving, more than six months after requesting permission to do oral history interviews, I finally – although indirectly – got an answer: No.

As I wrote to update my committee, I also began to seriously consider alternative methodologies. In the end, experiences in my participant observation led me to bring in data from two other areas of geography: remote sensing and biophysical geography. These new data sources have also forced me to consider and take seriously the more-than-human world of the Aral Sea region – the plants, salt, water, etc. – in addition to the human world.

Nearly all of the focus of satellite images in the region is on the decreasing water of the sea itself, with almost nothing on the decreasing forest cover and changing land uses in the Amu Daryo delta. For my first six months in Uzbekistan, I ranted to myself and to others about the use of satellite imagery writ large and how it erased lived experiences of people from the landscape.

I promised myself not to use these images in my own work. However, working and traveling in the Aral Sea region has forced me to rethink the stories that satellite imagery can tell.

Two trips in particular really changed the ways I thought about remote sensing imagery. The first trip was to the Lower Amudaryo Biosphere reserve. The director of the National Park explained that the riparian forest, *Tugai*, is dying because the water level in the river has been consistently very low and there has been no annual flooding to bring more water in. This was reinforced later at a meeting where I heard that an estimated 90% of the riparian forest of the Delta has died – although the spatial distribution and drivers are not well documented. This means that both 90% of the volume of the Aral Sea has been lost, and 90% of the forest of the Delta has been lost. Reflecting on this, I thought that analyzing forest change was something that would be relatively straightforward to do with remote sensing. While creating a time series of forest change using imagery from two different satellite sensors is not, in fact, straightforward as I would discover, and will form part of a future project rather than my dissertation, the realization that I could use remote sensing to explore the delta landscape would have major impacts on my research approach.

One of the major mitigation approaches to the Aral "catastrophe" is large-scale afforestation with the native tree *saxaul* in order to stabilize the sands of the dried seabed, which I explore in Chapter 2. Wanting to see what this looked like, the second influential trip was to a 2002 afforestation site, where saxaul trees grew in long straight lines that had clearly been planted. The pictures I took were automatically geotagged by my phone.

It was only after I returned home and accidentally pulled up the heat map of the photos that I realized that I could clearly see where the afforestation stopped and started. I found further evidence of afforestation on the seabed through Google Earth Pro, which made me realize that these very high-resolution satellite data could tell us about the impact that humans are having at the small scale on the landscape. This dissertation uses remote sensing imagery to look at changing surface water in the Amu Daryo delta. Bringing water into my analysis through remote sensing and the view from the satellite comes with limits though, which include technical aspects such as data resolution and quality, the geopolitical origins of remote sensing, and the fact that this is the view from space, rather than the ground.

Second, one of my participant observation internships included co-coordination of a "business potential" assessment of one of the districts of Karakalpakstan. In addition to interview data with small and medium enterprises, this included collecting geophysical data on soil chemistry. These geophysical data are rarely available to foreigners. I was fortunate that my strong connection with this organization and their commitment to open data has meant that I have access to these data as well as having witnessed some of their collection. These data allow me to extend my analysis to the soils of the Amu Daryo delta. My work probes how state water policy influences soil chemistry and surface water availability and how these in turn affect lived experiences of residents. Here too there are limitations, including the one-off sampling and the ways in which soil science and hydrology are western enlightenment modes of knowing the world.

Beyond using new sources of data, this bureaucratic wall has also forced me to think more creatively about how I can still use an ethnographic approach – and what it means to use feminist methods and to consider situated knowledges and partial perspectives (Haraway 1988; Nightingale 2003). The colleagues I became friends with and who began to trust me through my participant observation and at the university would open up to me during lunch breaks and car rides about their history, their family's history, and their opinions of Karakalpakstan. I did ask a lot of questions, but these sharings were not the direct result of my questions. Rather, the questions that I asked and the work that I did for these organizations came from my perspective that the Aral Sea is still a place of life, value and beauty. I think it was being honest about my fascination and wonder at the region that led people to share incredible stories with me. While I would have gotten different information from my oral history, I am quite sure there were things I would have missed without the time to build trust and a working relationship.

Another piece was from the "ground truthing" trips that I took around the region. These were with 1-3 other foreigners (who all spoke Russian), often a local driver, and sometimes a Kyrgyz street dog now living in Nukus. Since it was clear that there was concern by the state about me interviewing locals, I purposely did not take these ground truthing trips with local friends and colleagues so as to not put them at any kind of risk. I also went on fieldtrips with both of organizations during my participant observation with a mix of locals and foreigners. In addition to the primary goal of ground truthing through taking GPS-tagged photos and notes for my remote sensing analysis, these also become opportunities for unexpected informal conversations. For example, during the afforestation site visit described above, I got to talk with two members of the State Committee on Forestry, probably gaining more insights than I would have in my long-requested formal meeting with the committee.

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How is this of broader relevance? I see my original data collection plans as creating a nice square dataset – each piece neatly stacking on the others so that I could dig down in any section and excavate my findings. Instead, I find myself trying to weave a complex carpet, pulling in lunch conversations, car conversations, meeting notes, remote sensing imagery, soil chemistry, and more.

My goal is not just to confirm ethnographic data with remote sensing and/or physical data (or vice versa) but to put them in conversation. This approach can also help to imagine alternative environmental futures. Landsat views of the entire Aral Sea (cutting out the delta) and photos of empty boats lead us to think of the region as a wasteland. But on the other hand, ethnographic data alone is not sufficient to imagine alternative environmental futures – just and inclusive ways in which the human and more-than-human world can thrive together. The Aral Sea region shows us the power that humans have had on the environment through a desire for control and order. The region also shows us that control and order is always incomplete, and humans, animals, and plants can be unruly. A just and inclusive future cannot only consider the human perspective. By weaving in – to the best of our ability – the more-than-human world – soils, tree growth, water flows – we can begin to get a human-environment perspective that will enable this kind of future. A future where saxaul, humans, and the Amu Daryo river itself can all flourish.

Contributions to the literature

Here I provide an overview of this dissertation's contribution to the literature in three areas. Each chapter also includes the more specific contribution of that analysis.

Feminist methods for human-environment interactions

This dissertation upends simplistic and exceptionalist narratives of the Aral "catastrophe" as tragic mistake of Soviet planners by re-politicizing the Aral Sea and calling attention to questions of power. While questions of power are core to feminist theory, feminist political ecology (Rocheleau, Thomas-Slayter, and Wangari 1996; Elmhirst 2011) has historically tried to make political ecology more "feminist" by focusing on experiences and/or stories of women. Rather than try to make feminist political ecology more feminist by narrowing my focus to women, my work pushes the boundaries of feminist political ecology by integrating feminist theory into my methods. By treating all data as situated knowledges and embodied (rather than disembodied) visions (Haraway 1988), I am able to interweave the partial perspectives of geophysical, remote sensing and ethnographic data while attending to the politics of their creation (Nightingale 2003; Rocheleau 1995).

Throughout my PhD I have returned to Andrea Nightingale's paper *A Feminist in the Forest* as an example of how to take a feminist mixed-methods approach to human-environment interactions. As my dissertation expanded from an ethnographic study to a mixed-methods project including ethnographic, remote sensing and geophysical data, I once again returned to her work. I discovered what most people who have done this work probably already know: it is hard to operationalize the conceptual work that dominates this area and to figure out how to mix methods and treat each type of data as partial and situated. I was able to meet with Andrea Nightingale at the 2023 AAG meeting in Denver to get her advice on mixing methods. What was most helpful was her advice to think not just about the epistemological challenges of mixing methods, but the ontological challenges. The process of bringing the puzzle pieces together has required reckoning with both their different epistemologies and ontologies – and the frictions and powers within and between each type of knowledge.

One of the primary contributions of this dissertation to feminist mixed-methods is that I devise and implement feminist mixed-methods and provide two different empirical examples of my attempts to weave together different types of data. Chapter 2 brings together remote sensing and ethnographic data, while Chapter 3 brings together remote sensing, geophysical and ethnographic data. In addition, my work extends Nightingale's by thinking through how each of my datasets is partial in two ways: they are a partial perspective as Nightingale highlights citing

Haraway, and they are partial in the sense that it is incomplete. The limitations of doing research in the Aral Sea region, as I described above, meant that my methods were opportunistic by necessity, taking advantage of whatever openings were present. Rather than seeing my doubly partial data as a limitation, however, I weave these threads together to probe trees, water, salt, gardens and fish in the Aral Sea region.

Development and expertise: drylands and temporality

This dissertation contributes to conversations on the co-production of development, knowledge and expertise, which has been built on the work of Ferguson (1994), Mitchell (2002), Goldman (2005) and Li (2007), among other scholars. Specifically, my work contributes to conversations about development and expertise in dryland or arid lands, which have been historically seen as wastelands that needed to be fixed, while in other areas development goals related to the environment were either conservation or management of resources. Diana Davis shows how despite greater understandings of the ecology of the drylands in recent years, development policy continues to be based on "desertification dogma and old, outdated Anglo-European ecological ideas" (D. K. Davis 2016, 19) in order to fix these areas and make them civilized through activities such as through tree planting (D. K. Davis and Robbins 2018) and irrigation expansion. Despite their colonial and neocolonial histories, Turner and colleagues (2021) caution against sweeping critiques of afforestation programs, insisting instead on a more nuanced view of how these programs affect residents. Work by geographers and environmental historians have showed how historical and current development policies of planting trees to create "green walls" or shelterbelts reinforces state power of territory, including in the Sahel and across China in the present (Turner et al. 2023) and the Stalin Plan for the Transformation of Nature in the past (Brain 2010; Denis J. B. Shaw 2015).

With a shift in development policy globally to ecosystem restoration, reflected most clearly in the launch of the UN Decade for Ecosystem Restoration in 2021, development and international finance organizations are turning their focus to ecosystem restoration, including in drylands. This is further supported by Sustainable Development Goal 15, "Life on Land" and specifically Target 15.3: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world" (UN 2017), which formalized land degradation neutrality. One of the major questions for ecosystem restoration is what to restore to. Setting the baseline for restoration is a deeply political decision (Alagona et al. 2012). If the baseline is set at 33% forest, which is the perceived rate of forest for a civilized country based in colonial notions (D. K. Davis and Robbins 2018), restoration will continue as a neocolonial endeavor to fix drylands through afforestation. There is, on the other hand, an opportunity to take up work by drylands ecologists on arid lands as resilient complex non-equilibrium systems (Vetter 2005), and to conduct restoration based on these ideas. My work contributes to these questions of development and restoration through a case with no clear baseline, since the Aral Sea will not be restored to its 1960 level. In Chapter 2, I show how legacies of colonial forestry continue to shape baselines in practice and colonial fears of desertification shape afforestation projects and funding by international organizations, even as some development organization staff in the Aral Sea region question these plantation-style monocultural approaches.

Scholars have also highlighted the need to bring history back into development (Lewis 2009; Bayly et al. 2011), and how part of the power of development is in the way it imagines the past (Kothari 2011). This imagined past of development has strong parallels to use of baselines for ecosystem restoration, and as ecosystem restoration becomes a new focus in development, interrogating ideas of the past and the ways that they are always political and read through the present becomes increasingly important. My work sits in this nexus, breaking down clean boundaries between past and present through the use of remote sensing data that spans the Soviet – post-Soviet divide. I show how, in this case, the inability to return to the "baseline" when the Aral Sea was full in 1960 has opened possibilities for the region and made it strategic for the Uzbek state. Development in the Aral Sea region tacks – sometimes uncomfortably – between ideas of the past when there was water and ways of development for the future that do not require water.

My work shows how development's "perpetual present" (Lewis 2009) is taken up through a focus on innovation that appears in endeavors such as the declaration of the Aral Sea region as a "Zone of Ecological Innovations and Technologies", while at the same time this presentist focus is deeply tied to imaginaries of both past and future. In doing so, this research builds on conversations around environment, catastrophe and development from a number of recent special issues/sections including: The Temporality of Disaster (Prentice 2023), Political Ecologies of Time and Temporality in Resource Extraction (Fent and Kojola 2020), Time, Temporality and Environmental Change (Edensor, Head, and Kothari 2019a), and Temporality as a Lens for NGO Studies (Davidov and Nelson 2016). In some ways, temporality is one of the defining characteristics of the Aral as "catastrophe", and I explore in Chapter 3 how slow and fast/spectacular violence are relational (Christian and Dowler 2019). Kindervater highlights that "the concept of catastrophe also necessarily carries within it an intrinsic temporality; or more precisely, several temporalities at once" (2017, 99). These temporalities include the past (pre-catastrophe), catastrophe and imaginations of futures and possibilities (Kindervater 2017).

Political ecologies of the state

Political ecologists have recently turned to consider "political ecologies of the state" (Meehan and Molden 2015; Harris 2017), responding to critiques that political ecology has not explicitly engaged with the state (Robbins 2003b). A key question in the political ecologies of the state is on the nature of the state. While many analyses have considered the state as a fixed entity, a line of scholarship has built on Mitchell's (1991) argument that the state is not ontologically distinct from society, but continuously co-produced as effect. Harris (2012) considers the role of socionature in the production of the state as effect, and focusing on the importance of scale, argues that, "we need to consider large-scale landscape and waterscape productions not as incidental but as potentially central to the function or definition of states" (2012, 37). Nightingale (2018) extends this further to look at state-society-nature-citizen boundary-making processes, highlighting how projects like forest management and dam building also define who and what is or is not part of the state.

In the Central Asian context, Reeves (2014) takes up Mitchell's approach in her work on borders in the Ferghana valley. She critiques previous work by political scientists including Starr (2011), Radnitz (2012), and Jones Luong (2004a) that has identified a "strong weak state" in Central Asia – strong in the sense that these states are authoritarian, but weak in their ability to provide for their populations – because of these scholars' assumed separation of state and society. She argues that by viewing the state as effect "we see the perplexing 'strong weak state' as a problem of detachment: emerging in a situation in which there are 'too many actors competing to perform as state'" (Reeves 2014, 13).

I think with Reeves' comment "to perform as state" in conversation with Webber's (2013) work on Kiribati. Webber details how state actors have to perform vulnerability in order to secure international finance. Key to this performance are statistics, photos, maps and other visuals which are taken up and circulate beyond their original presentation or publication. While the literature on the state as an effect focuses on actions taken by the state which continue to draw the boundary with society (and nature and citizens), I want to draw attention to the way that state actors perform their work and responsibilities (and what is not their responsibility), and how these performances often have the effect of bringing different material realities into being than the work that state actors were performing.

During my fieldwork, a development consultant for a multilateral came to Nukus and wanted to meet with me during his short visit. He was a whirlwind of action early on a Saturday morning toward the end of my fieldwork. As I recorded in my fieldnotes, “he's a very, very fast talker. And just questions, bang, bang, bang, bang”. He wanted to get my thoughts on why there is increasing attention to the Aral Sea region. During the conversation he told me

> *that he was really interested in knowing who was planning this and where these ideas were coming out of, because he said that they have this long-term PR campaign for the country that is obviously well planned. And he said it is happening in all the ministries and there have been no missteps, they seem to know exactly what to do, and how to play their cards to redo the image of Uzbekistan* (Fieldnotes 12/4/2021)

I had already started to think about performativity during my fieldwork, the ways that I was asked to perform as a foreigner, the ways that trees were planted in celebration and then allowed to die, the ways that new buildings were created, and then left largely empty. This conversation with the development consultant though made me think about performance as core to the re-creation of the Uzbek state, rather than simply a part of my fieldwork process and experience.

For example, in Chapter 2, I describe the large-scale state-sponsored (and largely state-implemented) afforestation of the dried Aral Seabed. While the actual work of this program is ostensibly to create one material reality – a new forest – the performance of afforestation, through conference presentations, photos and videos of planting, and news articles sharing statistics of hectares planted, serves to reperform the global image of Uzbekistan as an environmental steward and materially brings in new international finance to the country. The performance of afforestation therefore recreates the state as an effect, and distinct from society/nature/citizens but in different ways from the work of afforestation itself. In other words, it is essential to look to both the work of state actors, and also the way that this work is performed and narrated.

Overview of the dissertation

In Chapter 1, I show how the Aral "catastrophe" is intertwined with the devaluation of the Aral Sea region. I highlight how the Zone of Ecological Innovations and Technologies as a "solution" to the Aral "catastrophe" fits within existing power structures and policies at the intersection of global pressures for landscape restoration and the Uzbek state's goal of becoming a global environmental leader and innovator. The fact that there is no return to "baseline" for the Aral Sea has led to an "ideology of innovation" which prioritizes technological fixes and an ethos of new is better. This chapter provides examples of state-led development and international development initiatives in the Zone which take up and reinforce this ideology including large-scale rebuilding, crop rotation and beneficial insects in agriculture, hydrogels in afforestation, and the World Bank-sponsored Global Disruptive Tech Challenge. I argue that this ideology of innovation operates by erasing history, depoliticizing the Aral "catastrophe", entrenching and exacerbating unequal power relations, and obscuring local knowledge and agency. I suggest for the Aral Sea region it is necessary to politicize both catastrophe and the ideology of innovation and instead is to start from the premise that the Aral Sea region is still a place of value and that it is both possible and necessary to repair the landscapes and social and physical infrastructures of the region.

In Chapter 2, I unpack “successful” state-sponsored and crowed-funded afforestation of the dried Aral Seabed in terms of planting extent, tree survival, and the state’s image as an environmental steward. I quantify afforestation activities to suggest that large-scale state-sponsored afforestation is less extensive with fewer surviving plants than claimed in circulating statistics. I argue that afforestation is less about plant life than it is a performance by the Uzbek state, both of the promise of trees for local residents and of environmental stewardship to a global audience. This work shows what the pursuit of restoration can become in the plantationocene, where the plantation is the structuring logic of production and monoculture the planned outcome. I suggest instead that co-creating the future of the Aral Sea region requires that development actors instead take a “polyculture” approach that incorporates multiple scales, species and types of cultivation.

Finally, in Chapter 3, I bring together ethnographic, geophysical and remote sensing data through feminist mixed-methods to investigate interconnections between humans, water, salt, fish and gardens in the Amu Daryo delta. I illustrate how water in the delta is decreasing over time, how it is increasingly variable over time and discontinuous across space, and the way that these changes are experienced and some of their consequences. I argue that dust from the Aral Seabed is not the greatest challenge of the Aral “catastrophe” for residents. Rather, it is the ongoing and slow violence of water and agricultural policies in the delta that continue to remake the landscape and affect resident ways of life, livelihoods and nutrition. I show how a narrow focus on the territory of the former Aral Seabed, and the selective use of snapshots within the long history of the drying of the Aral Sea obfuscates continuities in Soviet and post-Soviet water and agricultural policies and priorities and creates that Aral “catastrophe” in specific ways.

CHAPTER 1: TOWARD REPAIR IN THE "ZONE OF ECOLOGICAL INNOVATIONS AND TECHNOLOGIES

> "It is clearly one of the worst environmental disasters of the world... It really left with me a profound impression, one of sadness that such a mighty sea has disappeared" (Ban Ki-moon, UN Secretary General, remarks after visiting the Aral Sea, 2010).
>
> "After all, who is winning in this rapidly developing world? Only a state that relies on a new thought, a new idea, an innovation. Innovation means the future. If we begin today to build our great future, we must do this primarily on the basis of innovative ideas, an innovative approach" (Mirziyoyev 2018).

Introduction

Entering the district capital of Bozataw, the road surface abruptly improves thanks to repaving for a recent presidential visit. We stop at the entrance to town at the *Berdaq Baǵí* (Berdakh Garden), a small quiet garden with trees, bare of leaves on this late November day and a statue of Berdakh, a famous Karakalpak poet of the nineteenth century and the "father of Karakalpak literature" (Hanks 2000). On either side of the gates to the garden sit recently added signs and robot statues (Figure 3). The signs say "I am an innovator" and "I am an inventor". Bozataw is located in the Republic of Karakalpakstan, an autonomous republic that makes up western Uzbekistan which is best known for the Aral "catastrophe". The "catastrophe" has resulted from ongoing and long-term diversion of water flowing from the mountains of Central Asia through the Syr Daryo and Amu Daryo, the two major rivers of Central Asia, into the Aral Sea. The diverted water has been used for irrigation, primarily for cotton. More than 45,000 km^2 of seabed has been exposed since 1960 as the Aral Sea has shrunk and divided into two separate water bodies. This dramatic transformation has resulted in loss of livelihoods (Wheeler 2021), local climate change (Sharma et al. 2018), health impacts including anemia and cancer (Turdimambetov 2016), and the creation of the world's newest desert (Breckle et al. 2012),

Figure 3: Robot statues and signs that say “I am an inventor” (top) and “I am an innovator” (bottom) at the entrance to Bozataw

among other impacts. Innovation has been portrayed by the Uzbek state as the main vehicle in the transformation from catastrophe to possibility in the region, both domestically and internationally.

In May 2018, the Aral Sea region of Uzbekistan, which I define as the Republic of Karakalpakstan, and Xorazm *O'blast*[2] (Figure 2), came to a halt as it was hit by the spectacular violence of a three-day salt and sandstorm (W. Wang et al. 2022). The storm has, at least partly, galvanized policy action and investment in the region and has become a pivot point on which to reframe the Aral Sea region, a symbol of catastrophe for the Uzbek state since independence in

[2] The Uzbek state also includes the Navoiy and Bukhara *O'blasts* in their definition of the Aral Sea region. I base my definition both geographically to include the extent of the Amu Daryo delta and the full extent of the Aral Seabed and historically, to match the Soviet definition of the *Priaral'ye* [Приаралье]

1991, to a symbol of possibility. Shavkat Mirziyoyev, current president of Uzbekistan, first announced the idea of transforming the Aral Sea into a "Zone of Ecological Innovations and Technologies" at the Heads of States-founders International Fund for Saving the Aral Sea Summit on August 24, 2018, just months after the storm. On May 18, 2021, the UN General Assembly unanimously approved a resolution declaring the Aral Sea region a "Zone of Ecological Innovations and Technologies". Eighteen days after the declaration of the Aral Sea region as the Zone, on World Environment Day, June 5, the UN launched the Decade for Ecosystem Restoration. While the construction of the Ko'k Aral dam has led to partial restoration of the North Aral Sea in Kazakhstan, there is general consensus that it is not possible to restore the Aral Sea to the 1960 level (i.e. before the sea started shrinking (Wheeler 2021)). The Aral Sea in Uzbekistan is portrayed as a lost cause. The Western Basin of the South Aral Sea continues to shrink and will either reach an equilibrium level with the groundwater or dry up altogether.

In this paper I show how the Aral Sea region as place and a home for its human and more-than-human residents is subject to historic and ongoing devaluation even as the Aral "catastrophe" has become increasingly valuable to the Uzbek state to mobilize global aid money. I highlight how the Zone of Ecological Innovations and Technologies as a "solution" to the Aral "catastrophe" is embedded in existing power structures and policies at the intersection of global pressures for landscape restoration and the Uzbek state's goal of becoming a global environmental leader and innovator. "Innovation" as an ideological trope is a core part of the "new" Uzbekistan. The fact that there is no return to "baseline" for the Aral Sea has led to an "ideology of innovation" (Canfield 2022) which prioritizes technological fixes and an ethos of new is better. This paper provides examples of state-led development and international development initiatives in the Zone which take up and reinforce this ideology including large-scale rebuilding, crop rotation and beneficial insects in agriculture, hydrogels in afforestation, and the World Bank-sponsored Global Disruptive Tech Challenge. I argue that this ideology of innovation operates by erasing history, depoliticizing the Aral "catastrophe", entrenching and exacerbating unequal power relations, and obscuring local knowledge and agency. Vázquez-Arroyo has emphasized the need to politicize catastrophe, which means "asking the questions of to *what* end is a catastrophe invoked, *who* is deploying it, and in the name of *whom*" (2013, 758). I suggest for the Aral Sea region it is necessary to politicize both catastrophe and the ideology of innovation. What is needed instead is to start from the premise that the Aral Sea region is still a place of value and that it is both possible and necessary to repair the landscapes and social and physical infrastructures of the region. I contrast repair not with the *act* of innovation since, as Russell and Vinsel (2018) argue, this is a false dichotomy, but with the ideology of innovation. Creativity, improvisation – and acts of innovation – will be required for repair (Russell and Vinsel 2018; Jackson 2014).

The ideology of innovation

In this paper, I probe how the ideology of innovation has become the vehicle for ongoing depoliticization of the Aral "catastrophe." Russell and Vinsel (2019) distinguish between the act of innovation and "innovation-speak". Innovation-speak is a discourse of fear and an ideology which creates innovation as a panacea or magic bullet to solve all the world's problems, often through technology (Russell and Vinsel 2019; Canfield 2022). Irani highlights how a focus on innovation in development "occluded the possibility of solidarity building, oppositional politics, or even politics that destroy value" (2019, 217). In this way, the ideology of innovation "renders technical" (Li 2007) and therefore depoliticizes the problems it purports to solve through innovation.

This "ideology of innovation" is promoted by philanthrocapitalism and has been increasingly been adopted by states, including recent pushes for a "Green New Deal" through a Green Keynesian approach (Goldstein and Tyfield 2018). The Uzbek state's current focus on creating a green economy through innovation reflects the ideology of innovation, as well as the entrepreneurial state. Goldstein and Tyfield define the entrepreneurial state as one that "empowers clean, productive, entrepreneurial innovators (who are still capitalists), enabling this new group of industrial (now high-technological) actors by entrusting them with the unique powers of the state" (2018). The entrepreneurial state sets policy in close collaboration with venture capital and the needs of the market become the focus for innovation, while the needs of human and more-than-human residents are de-prioritized.

Innovation has become a buzzword in development, what Scott-Smith (2016) describes as 'neophilia' or a love of the new. Often funding for projects requires that organizations demonstrate the novel or innovative aspects of their work. Innovation has an inherent temporality – for something to be innovative it must be new. There is also an implicit linear notion of progress embedded in innovation (Scott-Smith 2016) – that innovation is inherently better than what came before. However, as anthropologist David Lewis (2009) describes with development's "perpetual present", innovation often requires a parallel process of forgetting (Koch 2019). I suggest this means that local knowledge and practice can be appropriated by development organizations or the state without attribution. In addition, innovation is seen as a one-time act. But without maintenance and repair, previous innovations become ruins as a new cycle of innovation sweeps in. Finally, a focus on innovation in development privileges the universal over local knowledge and embodied experience (Pfotenhauer et al. 2022). As Barton and colleagues (2022) highlight, the ideology of innovation carries an assertion that Western science, rather than local ways of knowing, is essential.

After detailing my methods, I next show how the Uzbek state is working to move the Aral Sea region from a zone of "catastrophe" to a "Zone of Ecological Innovations and Technologies." I then provide examples demonstrating how the ideology of innovation is embedded in both state-led and international development, and how the Uzbek state leverages this development work internationally. Finally, I suggest repair as alternative to the ideology of innovation. My goal in suggesting repair is not to romanticize repair work and absolve the state of responsibility, but to keep in productive tension the creativity, voice, and hard work of the residents of the Aral Sea region with the responsibility of the state to its citizens.

Methods

In order investigate how the Uzbek state leverages the Aral "catastrophe" and new Zone to reposition the country and access development funding, and how development organizations operate under and take up the state's ideology of innovation, I rely on nine months of ethnographic fieldwork with organizations working in the Aral Sea region of Uzbekistan, centered on Nukus, the capital of Karakalpakstan. The process of data collection was iterative. As I identified new themes or participants, I sought to bring them into my research. My data includes 17 interviews conducted in Tashkent, Karakalpakstan, and Xorazm between April and December 2021 and five remote interviews conducted in January and February 2022 after my return to the US (Table 1). Formal interviews were recorded and transcribed while more informal interviews were documented with extensive field notes but not recorded. Interviewees – both formal and informal – provided verbal consent prior to participating.

Table 1: Participants

Interview number	Participant	Organization	Organization type	Recorded?	In-person/remote
1	P1	RT1	Bilateral development agency	yes	remote
2	P2	RT2	Local organization	yes	in-person
3	P3	RT3	Regional development organization	yes	in-person
4	P4	RT2	Local organization	yes	in-person
5	P5	RT1	Bilateral development agency	yes	in-person
6	P6	RT4	NGO	yes	in-person
7	P7	RT5	Local organization	yes	in-person
8	P8	RT6	Multilateral organization	yes	in-person
9	P10	RT4	NGO	yes	in-person
10	P11	RT7	Multilateral organization	no	in-person
11	P12	RT9	Multilateral organization	no	in-person
	P13	RT9	Multilateral organization	no	in-person
12	P14	RT10	Multilateral organization	no	in-person
	P19	RT10	Multilateral organization	no	in-person
13	P15	RT12	NGO	no	in-person
14	P16	RT15	Bilateral development agency	yes	in-person
15	P17	RT15	Bilateral development agency	yes	in-person
16	P18	RT12	NGO	no	in-person
17	P19	RT15	Bilateral development agency	yes	remote
18	P20	RT13	Multilateral organization	no	remote
19	P21	RT13	Multilateral organization	yes	remote
20	P23	RT13	Multilateral organization	yes	remote
	P24	RT13	Multilateral organization	yes	remote
21	P25	RT13	Multilateral organization	no	remote
	P26	RT13	Multilateral organization	no	remote
22	P27	PR14	Local organization	no	in-person

I conducted formal participant observation with two different development organizations here given pseudonyms: International Partners in Development (IPD), a multilateral, and Development and Cooperation Agency (DCA), a bilateral. I spent three months as an intern at each organization. I participated in the daily activities of the organizations and documented my observations through daily field notes (total 130 days of notes). In addition, I traveled extensively in Karakalpakstan and Xorazm and recorded informal daily interactions with local residents and the environment in my field notes. Finally, I amassed a collection of documents including UN resolutions and speeches, legislation, speeches of the President of Uzbekistan, and development organization documents, some of which are available online, and some of which were made available through the network that I generated.

My analysis process started during data collection by including reflective and/or analytical memos at the end of my fieldnotes. After completing fieldwork, all of my data were assembled in MAXQDA for further analysis. I derived initial concept codes (Saldaña 2016) from conversations with my participants and re-reading my memos. I used an iterative coding process to apply my initial concept codes (e.g. "state as steward", "possibility") and identify and develop additional concepts that emerged from re-engagement with my data through the coding process (e.g. "devaluation", "temporality"). I also used a holistic coding approach (Saldaña 2016) to mark information about specific development projects (e.g. "beneficial insects"), landscape types (e.g. "*tugai*" [riparian forest]), and species of interest ("e.g. "Artemia" [brine shrimp]).

From "Catastrophe" to "Zone of Ecological Innovations and Technologies"

The Aral "catastrophe" is unlike most catastrophes in that it continues to unfold. Similar to Nixon's (2011) distinction between slow and spectacular violence, the Aral Sea could be considered a slow catastrophe. Discursively, the start of the Aral "catastrophe" is dated to the Soviet period – usually the 1960s, but sometimes the 1950s. However, as demonstrated by Maya Peterson (2019), the roots of the Aral "catastrophe" actually date back to the Tsarist period. As Central Asia was colonized by the Russian Empire in the nineteenth century, irrigated cotton cultivation expanded. This was spurred by the American Civil War, when cotton supplies from the US South were unavailable and the Russian Empire turned to its own southern colonies to grow cotton.

In addition to the shrinking of the Aral Sea, the slow violence of reduced water flows to the region has affected the lives and well-being of human and more-than-human-residents. I suggest that the devaluation of the Aral Sea region by the Soviet and later Uzbek state as a place and home to these residents has been both cause and consequence of this slow violence. As diversion of water from the Syr Daryo and Amu Daryo to irrigate cotton ramped up in the 1950s and 1960s, Soviet scientists published work articulating the consequences of this diversion for the region (Asarin 1974; Kuznetsov 1977). The devaluation of the Aral Sea and the Aral Sea region by the Soviet state to achieve economic goals was thus a prerequisite for the slow violence of reduced water flows. As the Aral Sea has shrunk and the consequences of this water and agricultural policy on the environment have become apparent, the region itself has become increasingly devalued by the state, seen as a catastrophic wasteland. Slow violence and devaluation are thus part of a negative feedback loop. I argue that it is the ongoing devaluation of the Aral Sea region as a place through slow violence that has enabled it to become an "object of development" (Mitchell 2002) in need of intervention. As an "object of development", an abstract version of the place itself, the Aral Sea region has become increasingly valuable to the Uzbek state as a way to access international development aid and bolster its environmental credentials. The Zone then becomes the solution to the Aral "catastrophe". It is the ongoing devaluation of the Aral Sea region as a place and the home of its human and more-than-human residents that sustains value for the Uzbek state.

Just as Petryna (2013) argues that Chernobyl has been integral to Ukrainian nationhood, the Aral Sea has shaped Uzbekistan and its relationship with the world. Like Chernobyl, the Aral Sea was one of the rallying calls of a nascent environmental movement in the Soviet Union. The Aral "catastrophe" was first shown on Soviet television in 1988, which led to the formation of an expedition to report on the situation (Wheeler 2016). The Aral-88 factfinding mission to the Aral Sea region in 1988 was optimistic that social and economic change could restore the Aral Sea (Wheeler 2016).

However, with the dissolution of the Soviet Union in 1991, the rivers feeding the Aral Sea, the Syr Daryo and Amu Daryo, became transboundary rivers, and the Aral Sea was divided between Uzbekistan and Kazakhstan. Cotton continued to drive the Uzbek economy, and water policy and management remained largely unchanged from the Soviet period. The Karakalpak Autonomous Soviet Socialist Republic became part of the Republic of Uzbekistan, although it formally retained its autonomous status with its own constitution, flag, and council of ministers.

> *We are driving to Xorazm and Arslan says, oh, you see that rock back there? You know that's a monument to when the president said at independence that in 20 years they would give the Karakalpaks a referendum on whether they wanted to stay part of Uzbekistan. Later that afternoon on our way back to Nukus Arslan asks if we want to stop at the monument. Of course I say yes. We pull over to the side of the road and get out. The marker doesn't actually say anything about the referendum and Arslan clarifies that this is where Karimov [Uzbekistan's first president] gave the speech where he promised the referendum in 1992. At the end, when the Soviet Union fell, there were lots of discussions about independence and which republics would be independent. When he heard about these ideas and Karakalpakstan came up, Karimov immediately came to Karakalpakstan and gave the speech.*

Twenty years after Karimov's speech would have been 2012, but the referendum never happened. Despite this lack of full territorial independence, a degree of autonomy remains important to residents as evidenced by the protests that broke out in Karakalpakstan in the summer of 2022 when the Uzbek state proposed constitutional reforms. These reforms, which would have allowed Mirziyoyev to extend his tenure by another two terms in office, also included removal of the provision for the Republic of Karakalpakstan to secede from Uzbekistan, and downgraded Karakalpakstan's status to province or *o'blast* within Uzbekistan. The protests were the largest seen in Uzbekistan since the Andijan events in 2005, and by the account of the protesters were peaceful and included a broad range of residents. The state's violent response to these protests left at least 18 dead and 243 injured, although my conversations with people in Nukus suggest these numbers were much higher. The changes to the constitution specific to Karakalpakstan were quickly walked back, a month-long state of emergency was imposed, and Mirziyoyev immediately made a visit to Karakalpakstan to try to calm the situation (Murtazashvili 2022).

Today the Republic of Karakalpakstan is a multi-ethnic and multi-lingual place. Most people speak at least three languages, Karakalpak, Uzbek, and Russian, and many also speak Kazakh and Turkmen. Particularly in the downstream areas of the delta, residents speak Karakalpak as their primary language even if they are not ethnically Karakalpak.

The Aral Sea region was largely neglected by the Uzbek state in the years after independence. However, international development organizations and other NGOs were prominent in the Aral Sea region in the 1990s and early 2000s, to extent that locals would comment that if each expert brought a bucket of water the Aral Sea would be full. However, with the geopolitical realignment of Uzbekistan away from the US and toward Russia and China in 2005[3] (Khalid 2007), most of these organizations were forced to leave and the country's relationship with the US and EU remained tense until the death of Uzbekistan's first president, Islam Karimov, in 2016 (Sullivan 2019; Bossuyt 2010).

In 2016, Shavkat Mirziyoyev became the second president of Uzbekistan and embarked on a process of rapid reform and opening of the country. For example, a 2019 article in *Forbes* called Uzbekistan "the hidden gem in China's new silk road", asserting that under Mirziyoyev's

[3] This realignment was due to the Andijan uprising, where the Uzbek state was accused by the US and other "Western" countries of firing on an unarmed crowd rather than insurgents. The total death toll reported by the government was 187, while other sources report it to be as high as 700. For a more complete account of the Andijan uprising see the conclusion of Khalid 2007.

leadership "in just over two years, Uzbekistan has transitioned from an economic and social pariah to a free market economy" (Preiss 2019). Also in 2019, Uzbekistan was awarded "country of the year" by *The Economist* (2019) and Lonely Planet (2019) declared the Central Asian Silk Road the top region to visit in 2020. The Aral Sea region has become one of the top priorities for Mirziyoyev.

Mirziyoyev has been focused on innovation during his tenure as president. In November 2017, he created the Ministry of Innovative Development. He elaborated on the rationale for this in his January 1, 2018 speech to the *Oliy Majlis* (Council of Ministers):

> Today we are moving to the path of innovative development aimed at radical improvement of all spheres of life of the state and society. And this is natural. After all, who is winning in this rapidly developing world? Only a state that relies on a new thought, a new idea, an innovation. Innovation means the future. If we begin today to build our great future, we must do this primarily on the basis of innovative ideas, an innovative approach. That is why we organized the Ministry of Innovative Development and put before it specific tasks. We hope that this ministry will perform the role of a kind of locomotive in the implementation of the most important projects, not only in the economic sphere, but also in the life of our entire society (Mirziyoyev 2018).

Mirziyoyev created the International Innovation Center for the Aral Sea Basin under the President of Uzbekistan in October 2018, further emphasizing the role of innovation in the Uzbek state's response to the Aral "catastrophe".

It was the Ministry of Innovative Development that began the work to develop the concept for the Zone. The permanent representative summarized the Uzbek state's goals for the resolution when introducing it for approval from the UN General Assembly: "from Uzbekistan's perspective, the draft resolution should help combine joint efforts to create the conditions for attracting foreign investment in the development and implementation of various projects based on environmentally sound and innovative energy- and water-saving technologies" (UN General

Assembly 2021, 9). Attracting development funding is thus an explicit purpose of this resolution, as is implementation of technological solutions to the Aral "catastrophe".

According to my participants, the UN resolution for the Zone was left vague in order to get buy-in from the other countries of the Aral Sea basin. The intention was that the resolution would then be implemented by each state as they saw fit. While the resolution had the initial sponsorship of 11 countries (including Uzbekistan) and final sponsorship of 59 countries, the Aral Sea basin country of Kyrgyzstan did not sponsor the resolution. While Kyrgyzstan did in the end approve the resolution, the country's permanent representative spoke after the resolution's unanimous approval to reiterate their objection to the Intentional Fund to Save the Aral Sea (IFAS), the regional coordination body for the basin. This objection by Kyrgyzstan is one example of why the language of the resolution needed to be left vague if it was to be approved.

After approval by the UN General Assembly, national legislation in the form of a 2021 Presidential Decree (No 5202) and 2022 *Oliy Majlis* Resolution (No 41) have created the legal backing and detail required to realize the Zone in Uzbekistan. The stated goals in *Oliy Majlis* Resolution 41 are institutional, technological, financial, and legal innovations that "define approaches to the transition to a 'green' and circular economy and sustainable development in the Aral Sea region." Presidential Decree 5202 sets out 71 tasks to be achieved in the first three years of the Zone. Of the 57 tasks that list monetary values for implementation, sixty-four percent of the funding to accomplish these tasks is slated to come from entrepreneurial capital – 51% from domestic entrepreneurs who are assumed to usually need the support of loans from commercial banks (13 tasks) and 13% from foreign investors (2 tasks). The Uzbek state has assigned itself 25 tasks representing 2% of the total funding, and another eight tasks to fund in combination with entrepreneurs, international development funders and local budgets which represent 6% of the funding. The rest of the funding is to be provided by international development funders (23%) and state enterprises (3%).

State-led development in the "Zone"

In Uzbekistan, decisions about development and economic activities often occur through a meeting called a "Selector", where the president presents an idea and then instructs everyone below himself to implement these activities. Implementation activities can change suddenly without warning and put immense personal pressure on those that are designated for realizing these goals. This also means that ministries are focused on the latest tasks that they have been assigned, rather than creating integrated workplans. For example, when I was conducting my participant observation, a selector – actually a videoselector – was held on viticulture. Several days later, the organization I was working with received a request from their political partner – can you please figure out how to incorporate viticulture into your project? On the surface the selector seems contrary to the ideology of innovation. However, the selector is intertwined with innovation in two ways. First, both selectors and the ideology of innovation can impose one-off interventions and short-term thinking. Implementing the new mandate from the selector can push aside or divert the ongoing labor of maintenance and repair. Second, the centralized planning process to achieve innovation which is realized through a selector can be understood as "state entrepreneurialism," a concept developed by scholars on urban China, where state power is not replaced by but rather reinforced by the use of market instruments (Wu 2018). In the Chinese context, state entrepreneurialism has limited links to innovation, while in Uzbekistan the ideology of innovation is core to state use of market instruments. More broadly, this seeming contradiction between the top-down selector and the Uzbek state's ideology of innovation shows how post-socialist states selectively borrow new approaches to bolster state power, without fully dismantling institutions of their socialist past (Kinossian 2022). While the Uzbek state's policy around innovation for a "green transition" has many similarities to what Goldstein and Tyfield (2018) describe as a Keynesian Green New Deal mobilized by an entrepreneurial state, whether these policies will result in a move away from centralized top-down planning or be a selective borrowing of some aspects of the entrepreneurial state remains to be seen.

Mirziyoyev's first visit to the Aral Sea region was on November 11, 2018 to the town of Muynak, Uzbekistan's former port city. This visit occurred just months after the salt and sandstorm of 2018. A news article reporting on his visit was titled "A New Town Will Be Built in Muynak" and described how Mirziyoyev "gave instructions on organization of production of demanded products in the domestic market, using potential and natural resources of Muynak… [and] build[ing] 20 apartment buildings in Muynak in the next two years" (Press Service of the President of the Republic of Uzbekistan 2018). In effect, his visit was an extended selector. Muynak was for many reasons the logical place to start the physical transformation of the region. Instead of a fishing industry it now hosts the ship graveyard, final resting place for rusted fishing boats, and the place for tourists to witness the "catastrophe" firsthand. When I visited in summer 2019, the town was a hive of activity with the sounds of construction from dawn until dusk. The entire main street was under construction, with old buildings razed to the ground and signs in front of partially built new ones with drawings indicating future construction. Returning in 2021, I witnessed the new "modern" amenities in Muynak include a book café, IT center, sports stadium and clock tower. The old Soviet sign welcoming visitors to Muynak has been replaced with a much larger and glitterier sign (Figure 4). However, this makeover has not been popular among all residents. As one development actor noted, "people feel like that even the Karakalpak

Figure 4: Old Muynak sign (left) and new sign (right).

government has spent all this money in Muynak on stuff that is of no value or worth to the people that live there" (P10). While this development actor had noticed frustration with the Karakalpak state for the redevelopment of Muynak, it is likely that much more of the funding for the new Muynak has actually come from other sources including the Uzbek state, state enterprises, residents' own money, private business, commercial banks and international development funding[4]. Nor has the redevelopment been popular with tourists who want to see the "authentic" Muynak. The "new" Muynak embodies the ethos of "new is better" that is at the core of the ideology of innovation. The destruction of the "old" Muynak also literally erases history.

State development in the Aral Sea region also includes a number of extractive industries including natural gas production and gravel mining as well as factories and heavy industry. While this extractive and heavy industry seems on the surface contradictory to "ecological

[4] The budget breakdown for Presidential Decision 2731, the State Program for the Development of the Aral Sea Region 2017-2021, identifies less than 1% of the total budget for the program as coming from the local budgets of the Republic of Karalakpakstan and Xorazm O'blast. Although the rebulding of Muynak is not specifically outlined in this decision, this is the best data available on how state development of the Aral Sea region was being financed prior to the adoption of the Zone.

innovation", I argue that they both are underpinned by the devaluation of the Aral Sea region by framing it as an exceptional wasteland. This wasteland is both a place to exploit and a place to be redeemed through "innovative" development. Driving past some of these factories on the road from Xorazm to Nukus, a colleague tells me:

> *they are destroying our landscape and Karakalpakstan like that, they are bringing these factories but it is not actually bringing in any jobs. It is just destroying the landscape. The president has decided this is what Karakalpakstan should do, but it is our land and they are destroying it. The people who have these high paying jobs in the factories will be registered in Karakalpakstan but they are from Tashkent or somewhere else. But at the end all the money leaves.*

A few months later I was on the other side of the *Jumurtaw* (Jumur Mountains) and witnessed more of the environmental destruction my colleague had described. Gravel mining is dismantling these mountains.

Uzbekistan has an estimated reserve of natural gas of 2,239.3 billion cubic meters (International Energy Agency 2000). There are currently several natural gas fields producing in Karakalpakstan and natural gas production is likely to expand in the future. A joint geological exploration by RosGeo (Russia's state-owned geology company) and Uzbekistan has identified new fossil fuel reserves under the Aral Seabed (Tashkent Times 2022) and in 2023 RosGeo and Uzbekistan signed a contract to conduct a detailed survey to guide future exploitation of these reserves (UzDaily 2023).

There are two major chemical processing plants which sit on the Ustyurt Plateau on opposite sides of a now dried bay[5] of the Aral Sea. The Uz-Kor Gas Chemical Complex is collaboration between the state petrochemical company of Uzbekistan, Uzbekneftegaz, and a consortium of three Korean companies: Korea Gas Corporation (KOGAS), Lotte Chemical

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[5] This bay was full in the mid-1800s and appears on maps done during this time, but was dry by the 1960s.

Corporation, and GS E&R. The complex, completed in 2015, produces high density polyethylene and polypropylene. Gas to supply the complex comes from the nearby Surgil well field which has 269 wells (ROGTEC 2021). The nearby Kungrad Soda Factory is an enterprise of the joint stock company Uzkimyosanoat which produces soda ash. The main inputs – sodium chloride and limestone – both come from Karakalpakstan (UzDaily 2013).

The Uzbek state promotes this development domestically. Mirziyoyev has highlighted work in the Aral Sea region in three speeches to the national legislature. In his December 2020 speech, he suggested that successful afforestation and new infrastructure work was encouraging the population to achieve greater victories[6]. After the protests about proposed constitutional reforms rocked Karakalpakstan in July 2022, Mirziyoyev immediately flew to the region and in his speech emphasized the attention that his government has paid to the region:

> once backward Muynak has acquired a completely new appearance and turned into a modern, dynamically developing region. For the first time, the issue of its [the Aral Sea region's] development is defined as a priority of state policy. The Aral Sea area problem is regularly raised from high international tribunes. I firmly state that the positive changes in Karakalpakstan will continue to be carried out at an accelerated pace.

In this speech, state development in the region is used to build legitimacy of the Uzbek state by demonstrating care for the region. The high priority of the region in state policy becomes evidence of Karakalpakstan's belonging within the Uzbek state. Overall, state-led development in the Zone, both "improving" through the reconstruction of Muynak and extracting gas and gravel, consolidates authority of the Uzbek state.

[6] Original quote: "*Dengizning qurigan tubida yuz minglab gektar oʻrmon va butazorlar tashkil etilayotgani, Orolboʻyi hududlarida amalga oshirilayotgan ulkan qurilish va obodonchilik ishlari xalqimizni yuksak marralar sari ruhlantirmoqda*"

International development in the "Zone"

Development organizations, particularly those outside of the UN system, lament the lack of coordination and systematic government vision for the Aral Sea region. They appreciate the Zone as a vision or public relations move, but do not see that this is being implemented in any practical way on the ground. One development actor summarized the dominant view that I heard from my interviews in 2021 and early 2022, just after the UN resolution: "They [the Uzbek state] really did a good job on the whole Aral Sea region, how to frame it, how to sell it, how to position it in the world. How they want to do something about it, they show prominently that they want to do something about it, that they're willing to do something about it, that something will happen" (P17). Others highlighted that the designation would bring resources and partnerships to the region. Another (P1) noted that the declaration of this Zone is what brings John Kerry (US Special Envoy on Climate Change) and USAID administrator Samantha Power to the region and puts pressure on donors and development organizations to start investing in the region. A multilateral staff member highlighted that "The shift has not made a huge change in our day-to-day work on the Aral Sea. It just made a huge change in the way we work with Uzbekistan. They went from being a country that had almost no pipeline, no portfolio, [with] some [organization name] engagement, but very isolated, not quite Turkmenistan, but to one of our biggest clients in the region" (P23). This quote indicates how the Zone is achieving the Uzbek state's overall goal of increasing international development finance for the country – in this case areas outside the Zone. Finally, one actor suggested the Zone could even increase tourism and potentially shift the sector away from "dark tourism" – tourism to places associated with death and disaster like the Aral Sea (Sampson 2019) – arguing that "Because I think even as a tourist, if you say, oh, this region is now innovative, it's interesting to have a look" (P19). In this section I provide four examples of “innovations” that are being implemented by development organizations in the Aral Sea region (see Table 2 for summary). My point is not to argue that these projects are “innovative” (or not) but rather to show how they take up and reinforce the ideology of innovation by insisting that new is better while obscuring local knowledge and labor. Together these examples show how the label of innovation contributes to the process of rendering development technical and apolitical while working to erase the past.

Table 2: Summary of examples of international development under the ideology of innovation

Initiative	**Description**	**Entanglement with ideology of innovation**
Crop rotation with mung beans	Crop rotation of mung beans piloted by DCA, although crop rotation is already an established practice	Obscures local knowledge and practice
Trichogramma in cellulose capsules	Pilot by DCA putting three generations of trichogramma (a beneficial insect) in a spherical cellulose capsule which can be distributed over fields by drone so that the insects will hatch every few days and eat pest insects	Forgetting of past pilots, attempted technical solution to perpetuate the problematic system of monoculture cotton of the Aral Sea region which entrenches power imbalances
Zeba gel	Pilot by IPD using cornstarch-based product, Zeba gel, that absorbs up to 400 times its weight in water and releases it slowly in order to increase tree survival for Aral Seabed afforestation. It has shown to be effective, but is not put into practice.	Zeba gel is produced by one of the biggest multinational agrochemical companies in the world and imported. Project greenwashes the producer and depoliticizes the Aral “catastrophe”
Global Disruptive Tech Challenge	Competition held by World Bank and partners to identify innovative ways to solve the Aral “catastrophe”	Obscures local knowledge and practice; forgetting of past competition

Monoculture has negative impacts for both soil and human health (Faye and Braun 2022). One DCA project is “innovating” by piloting the incorporation of mung beans into a crop rotation with cotton and wheat, two commodity crops usually grown as monocultures. However, as a development actor told me, practices such as crop rotation are known to be effective in the region, and mung beans are already widely consumed in the Aral Sea region. Indeed, Soviet agronomists had advocated for “effective crop rotation” that incorporated existing agricultural practices in the 1980s (Obertreis 2017). The development actor explained that interventions such as crop rotation are piloted as innovative approaches "because the budget is not big enough and the timeframe is not long enough" (P17). He suggests that a longer timeframe is needed – with a correspondingly larger budget – in part because changing agriculture requires behavior change which is a slow process. His suggested alternative: "I think a lot of things like what we do now, crop diversification and winter peas. And so, this doesn't have to be piloted, you can roll it out… Do it for 10 years. Start slow. Talk to the people, win their trust and explain [to] them the situation, picture [for] them the future" (P17). This example highlights the strategic forgetting of an established agricultural practice. Because small budgets and short timescales do not allow for the scaleup of established practices, development organizations strategically forget (or overlook) existing knowledge and/or practices so that they can receive funding to pilot them as innovations. I suggest that more important than once again showing the technical value of legumes in a crop rotation is understanding why mung beans are not commonly used in cotton and wheat crop rotation. Behavior change is a simple answer based on a deficit model (Wynne 1991) of farmers that does not consider the larger structural barriers of Uzbekistan's agricultural system. Operating under an ideology of innovation, this initiative obscures existing knowledge and structural barriers for farmers, while promoting a technical solution.

A second example surrounds the use of beneficial insects for cotton pest management. Across Uzbekistan, most districts have at least one biolab which raise beneficial insects such as *oltinko'z* (green lacewings, Figure 5), a beneficial insect that eats many species of pest insects which eat many crops at all life stages: eggs, larvae, and/or adults. The DCA office in Tashkent was very eager to implement an "innovative" approach to the distribution of the beneficial insect Trichogramma, a parasitic wasp, through the biolabs. When I went with the local DCA staff to a biolab to explain the proposed project, the biolab head, with the use of her faded poster showing the lifecycle of the cotton bollworm (Figure 5) explained to me that unlike the *oltinko'z*, trichogramma only eat the eggs of one pest – the bollworm[7] – and that pest specifically attacks cotton. In other words, trichogramma fits in with the current cotton monoculture system. The long-term innovation was to put three generations of trichogramma eggs into a cellulose capsule (Figure 5) which could be closed using an expensive machine and then be distributed via drone. The local DCA office was asked to test these capsules in the Aral Sea region to see if it would be worth investing in the closing machine and the distribution drone.

However, none of the local biolabs was actually interested in testing the capsules because they did not see a market for trichogramma. The local DCA team and I also questioned the initiative – was supporting continued cotton monoculture in the region aligned with the goals of DCA's work in the region? After several visits to one biolab, the head brought out a stack of cards with holes to hang them up. She told us that these were from a previous DCA project to use trichogramma. The biolab had stopped using them because they ran out of the glue which would attach the eggs. There was no organizational memory of this intervention at DCA – the project had been literally forgotten – which allowed this new beneficial insects initiative to seem novel and innovative, rather than an incremental change to a technical solution that had not worked. The ideology of innovation and the cycles of forgetting and piloting it entails prevent funding of existing practices that are already adapted to the region, such as the use of *oltinko'z* rather than chemical pesticides, and importantly funding the labor of those local residents who implement them. Since DCA is a bilateral organization funded by the government of a "developed" country,

[7] Scientific literature indicates that species in the genus Trichogramma eat other species of Lepidoptera as well (Smith 1996). It is unclear which species of trichogramma is being used in this initiative, and whether it may eat the eggs of other pests.

Figure 5: Left: *oltinko'z* in a jar; Center: cellulose capsules; Right: poster showing lifecycles of the cotton bollworm

this example also highlights the global reach of the ideology of innovation in development (Canfield 2022). DCA is thus doubly embedded in the ideology of innovation: to obtain its funding and to implement its projects.

A third example comes from IPD project #trees4aral's work on afforestation of the Aral Seabed using the native plant saxaul (for more on this project see Chapter 2). In order to increase the survival rate of saxaul, the project tested Zeba gel, a cornstarch-based product that helps with water regulation by absorbing up to 400% of its weight in water and then releasing the water slowly to the roots of a plant. Zeba gel was provided for free for pilot testing on two hectares by its manufacturer, UPL. UPL is an Indian multinational company previously named United Phosphorus Limited. Although the company is one of the largest producers of agrochemicals in the world and its products are sold in more than 138 countries, UPL is branded by the project as simply a "green champion". The results of the testing indicated that Zeba gel increased saxaul survival rates in IPD's project, at least initially, from 30% to 87% using 35g of the product per seedling. This result is not surprising, since PepsiCo had already trialed the use of Zeba Gel on their potato farming in the Middle East showing 11-20% water savings per ton of potatoes grown (UPL 2019). However, the use of Zeba gel was not scaled up by IPD, and in later plantings the project began testing another hydrogel product, despite having one product that was known to work. Unlike the previous examples, Zeba gel was a new technology to the Aral Sea region, and in that sense innovative. However, operating under an ideology of innovation, the project contributed to greenwashing UPL, obscuring and entrenching existing power relations. In addition, by rendering the problem of saxaul survival on the dried Aral Seabed technical, the project contributed to the depoliticization of the Aral "catastrophe".

A final example comes from the Global Landscapes Forum's Global Disruptive Tech Challenge, held in 2021 and sponsored by the World Bank and the German-Kazakh University. The video trailer put out by the Global Disruptive Tech Challenge provides an overview of the challenge, as text appears line by line over footage of the dried Aral Seabed and calls on 'innovators' to propose 'disruptive solutions': "It is time to disrupt the tide and bring this region back to life. Global and local organizations are opening [graphic of all the logos] the floodgates to Central Asia and the Aral Sea for a new stream of disruptive innovation and technology" (Global Landscapes Forum 2021b). The language here of "opening the floodgates to Central Asia and the Aral Sea" suggests the privileged role of western knowledge in innovation and the insufficiency of actions already taken by local people. The ideology of innovation demands "solutions" that can be detached from embodied experiences and local knowledge and scaled up, transferred elsewhere, or both. Local knowledge and locally specific solutions do not count unless they are made legible to global organizations and western science (Anna L Tsing 2012; Pfotenhauer et al. 2022).

One hundred fifty-nine teams submitted proposals from 38 countries across four categories: agriculture and land management, sustainable forestry, socio-economic development and information and knowledge. Twenty-four proposals were shortlisted – six per theme. The shortlisted teams participated in a 'boot camp' prior to the final challenge. A staff member associated with the Global Disruptive Tech Challenge explained that

> the biggest challenge, I think it was really, we didn't [have an] equal level among the participants. But we really wanted that the local participants [would] have a really good level to compete with the rest of the world…And that's why we had this bootcamp before the challenge and really good trainers that spent more time with them…But the greatest success is that I think we really went global. And for me, it was the first time in 10 years in Central Asia that I saw many people who knew now about the situation and who wanted to participate, and to get engaged with us (P21).

The bootcamp was an acculturation in development startup culture including “technical, business and soft skills trainings, networking, etc.” (Global Landscapes Forum 2021a) provided by the World Bank and other implementing partners. The bootcamp was thus a way to provide what are seen as key skills for innovators based on Western science, skills that could allow for scalability. Notably, no trainings about learning the local context, local knowledge, etc. were included. It was Central Asian participants who were seen as deficient, despite their embodied experiences and accumulated knowledges of local landscapes. In the end, a winner was chosen in each category and five ‘rising stars’. Two of the winning teams were from Central Asia – one from Uzbekistan and one from Tajikistan. The other teams were from Greece and the Netherlands. The prize was 4,000USD and the opportunity to participate in a four-month mentoring program for the winning teams and 1,000USD for the ‘rising stars’.

This example also highlights again the erasure of history through the ideology of innovation, because it is not the first global competition to try to solve the Aral “catastrophe”. In 1990, the Government Commission on the Development of Measures for Restoring Ecological Equilibrium in the Aral Region and Monitoring its Implementation held a competition for the “formulation of a concept for preserving and restoring the Aral Sea, and normalizing the ecological, public health, medical-biological and socioeconomic situation in the Aral region” (Kotlyakov et al. 1992). Submission was open to anyone, including foreigners, making this a potentially global event. Twenty-six of the several hundred submissions were used by the Working Group created by the commission to develop a concept for restoration of the sea. Unfortunately, this proposal was shelved because of the dissolution of the Soviet Union.

Overall, these four examples show how international development organizations are entangled in the ideology of innovation – both by Uzbekistan and by their funders outside of

Uzbekistan. Their "innovative" initiatives contribute to depoliticizing the Aral "catastrophe" by rendering it as a series of technical problems to be solved. These initiatives also obscure local knowledge and practice, erase history, and contribute to greenwashing

Leveraging the "Zone" internationally

I argue that the state's engagement with the international community around the Aral Sea region as a Zone of Ecological Innovations and Technologies is a key part of transforming Uzbekistan's geopolitical status from closed authoritarian post-Soviet state to good partner and global environmental steward. In each of his three speeches to the UN General Assembly (2017, 2020, and 2021) Mirziyoyev has highlighted the work of the Uzbek state in the Aral Sea region. In his 2021 speech, after thanking the assembly for passing the resolution for the Zone, Mirziyoyev articulating Uzbekistan's plans to host two global environmental meetings: the sixth session of the high-level United Nations Environment Assembly in 2023 and a high-level international forum on green energy in Nukus, the capital of Karakalpakstan in 2022. Mirziyoyev (2021) made the connection between the Uzbek state's environmental activities and their global image explicit in his speech: "Uzbekistan is ready to develop mutually beneficial, long-term and multifaceted partnerships with every country and global organization in the world."

The Uzbek state also makes its claim as an environmental steward through major international events, for example co-hosting the first ever Central Asia Pavilion at the 2021 UN Climate Change Conference, COP26, and being a joint organizer of the 2021 Global Symposium on Salt-Affected Soils. In both of these settings, representatives of the Uzbek state sought to leverage its experience using innovation to mitigate the Aral "catastrophe" to bolster its environmental credentials and legitimacy as an environmental leader and steward. President Mirziyoyev himself spoke at the virtual 2021 P4G (Partnering for Green Growth and the Global

Goals 2030) Seoul Summit, identifying work on “overcoming the global consequences of the Aral Sea disaster” in the Zone as a major area in which the state is working to achieve green development goals and achieve green recovery to the COVID-19 pandemic before offering to hold an International Conference entitled “The Green Energy for Developing Countries” in Uzbekistan in 2022, one of the same conferences he also suggested in his 2021 UNGA speech. For the Uzbek state, being a champion of innovation that will solve the Aral “catastrophe” is a core part of its reimagining. However, the international green energy conference suggested by Mirziyoyev at the UNGA and P4G in 2021 was reportedly canceled by the United Nations after the 2022 protests in Karakalpakstan. This suggests that the state’s re-imaging campaign is not working exactly as planned, and that more attention needs to be paid to the needs and desires of residents of the Aral Sea region.

Toward a Zone of Repair

Residents of the Aral Sea region see their home as a place of value. As one staff member at a local organization told me, *people in Karakalpakstan don't want to leave, are really proud of their homeland, it's really important to them, and they're not going anywhere. I want to stay in Xorazm. Unless you paid me, I think $10,000 a year, I'm not leaving Xorazm*. I commented that foreigners don't really get that, and she responded that *even people in Tashkent* [the capital of Uzbekistan] *don't really understand why people would continue to want to stay in this place. They only see the ecological disaster, and they don't see beyond that* (P27). I argue that restoring the landscapes and social and physical infrastructures of the Aral Sea region requires starting from the Aral Sea region not as a place of catastrophe to be improved through the Zone, but as a place of intrinsic value that can and should be repaired.

Scholars over the past decade and a half have critiqued the lack of attention paid to maintenance and repair and begun the work of bringing this extensive labor to light. A key question centers on the work of repair. Much of the recent scholarship on the work of the repairer in the social sciences builds on an ethics of care and matters of care (Tronto 1993; Gilligan 1982). Repair as care work has been explored in waste work (Corwin and Gidwani 2021), climate geoengineering (McLaren 2018), climate mitigation and adaptation more generally (Carr 2022), mine remediation (Beckett and Keeling 2019), and engineering (Russell and Vinsel 2019) among other areas. An ethics of care approach is helpful because it brings an explicit focus on values into conversations about repair – what is being repaired, how, and for whom – since repairs do not necessarily benefit all (Barnes 2017). However, often this work on repair as a matter of care has romanticized maintenance and repair as it details the work done by vulnerable populations (Barnes 2017), and neglected the role of the state in creating the conditions that require repair. As Carr highlights, "care is also needed to ensure that resourcefulness and community autonomy do not replace the provision of necessary services and infrastructure by the state" (2022, 2).

Repair is also a key tenet in the practice of landscape restoration (also called ecosystem restoration) where ecological systems are seen as processes in need of repair rather than damaged static states (R. J. Hobbs and Harris 2001; Cairns and Heckman 1996; Gann et al. 2019). Repair in this case will also not return the sea to its 1960 level, so as Usher (2022) suggests, creating a new baseline for the repair of the Aral Sea region can be a generative act to imagine alternative futures. There is a growing body of work scrutinizing the political economy (Lave 2012) and political ecology (Thompson 2018) of ecosystem restoration as authors raise questions of "restoration for whom, by whom" (Elias, Joshi, and Meinzen-Dick 2021). These questions are essential in all restoration projects, and in this case particularly in the Republic of Karakalpakstan, due to its autonomous status within Uzbekistan and its multi-ethnic and multi-lingual population.

Some of activities I have described in this paper could be considered repair activities. The planting of mung beans (*Vigna radiata*) in a crop rotation I described previously can be an act of repair – over time it builds soil health. Moving away from cotton monoculture through cultivation of Kendyr (*Apocynum venetum* L. and *Apocynum pictum* Schrenk), a native plant and fiber crop (Thevs et al. 2022), can help repair ecosystem diversity. Implementing these activities through an ethos of repair will necessitate engagement with previous development efforts and their political and environmental histories. Large-scale cultivation of Kendyr was developed in Central Asia in the early Soviet period, with experiments with the fiber dating back to the tsarist period (New York Times 1930). Similarly, supporting and expanding already existing local repair activities, such as the use of beneficial insects rather than pesticides, will also be a cornerstone of repair. This must be led by local farmers and biolabs using insects that can support polyculture, rather than monoculture, agriculture.

Afforestation of saxaul[8] on the dried seabed has been one of the major approaches to mitigation of the Aral "catastrophe,"[9] with the goal of reducing dust erosion. If implemented with a long-term focus on the health and survival of trees, afforestation could become an act of repair for the historical saxaul forests of Central Asia. However, afforestation is currently done

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[8] There are actually two species of saxaul: black (*Haloxylon aphyllum*) and white (*Haloxylon persicum*). Black saxaul is a phreatophyte, meaning it relies on groundwater, whereas white saxaul relies on rainfall (Zhaglovskaya et al. 2017). Black saxaul is at the center of afforestation efforts, but because in my data I almost never saw people distinguish between the two species, I refer simply to saxaul.

[9] For more on the history of afforestation in the region and current afforestation efforts please see Chapter 2.

through a one-off plantation-style "innovation" approach with low tree survival rates. There is an estimated 120,584 km^2 of potential saxaul vegetation area in Uzbekistan currently (not including the dried Aral Seabed), of which 22,680 km^2 remained as of 2010 (Thevs, Wucherer, and Buras 2013). The saxaul has always been an important source of fuel because it emits nearly as much energy as coal. Particularly starting with Russian colonization in the mid-1800s, saxaul were cut down to build infrastructure such as railways, and burned in much larger quantities to fuel trains to the point that by 1900 the saxaul forests of the cold winter deserts of Central Asia were in danger (Keating 2022). Despite the rhetoric of innovation surrounding afforestation with saxaul, successful saxaul planting has as longer history in the region. After train tracks became buried in sand, Tsarist administrators started afforestation programs with saxaul to protect train tracks (Keating 2022). According to the memories of my participants, planting of saxaul around Nukus, the capital of Karakalpakstan, in order to mitigate dust storms was carried out with aerial seeding in the 1960s. Afforestation as a mitigation strategy on the dried seabed itself began at the end of the Soviet period in 1988. Development organizations were experimenting with the most effective ways to plant on the dried seabed in the early 2000s.

Repairing and maintaining social infrastructures is also critical. DCA supported a yurt making workshop, the last traditional yurtmakers of Karakalpakstan, as part of their work on ecotourism. While the local authorities wanted to replace one of the workshop buildings on the verge of collapse with a modern building, similar to the actions in Muynak, DCA was pushing them to repair the building instead, preserving the history of the workshop while at the same time ensuring a safe working environment for employees. In this sense disruption, as promoted by the Global Disruptive Tech Challenge can have a role in the ethos of repair. Disruption to support repair means questioning neophilic structures of power and repoliticizing the Aral Sea region.

Importantly, all of these acts of repair are partial and incomplete, none of them represent a one-size-fits-all or a magic bullet solution. Restoration in the Aral Sea region – of landscapes, social infrastructure, and physical infrastructure will require the ongoing transformative repair work of many: residents, development organizations, and the state, to name a few. It will require synergies between these partial repairs. They do not need to be coordinated and should not be implemented plantation style, but they do need to build off of each other. This requires leaving behind the ethos of new is better. The new Muynak will need continuous repair and maintenance, rather than leaving the new buildings for decades only to wipe the landscape clean and build something new – the next set of ruins. An ethos of repair starts from the value of a place, which includes the importance of local and embodied knowledges and the acts of repair generated by local residents.

Conclusion

In this paper I have shown how the "Zone of Ecological Innovations and Technologies" operates through and reinforces the Uzbek state's ideology of innovation. Both state-led and international development organization-led projects operate with and through this ideology of innovation. These projects erase history, depoliticize the Aral "catastrophe", entrench and exacerbate unequal power relations, and obscure local knowledge and agency. The Zone overall and these projects in particular become necessary through the slow but steady devaluation of the Aral Sea region which has occurred as the Aral Sea shrunk. This devaluation also justifies extractive industry and heavy industry in the Aral Sea region in the name of economic development. Both of these responses to devaluation – development and extraction – work to consolidate the Uzbek state's authority in the Aral Sea region through the ideology of innovation.

The Uzbek state leverages both state-led and international development organization-led projects internationally, promoting itself as a global environmental steward for tackling "one of the worst environmental disasters of the world" (Ki-moon 2010). I suggest that true stewardship would require starting from the premise of the enduring value of the Aral Sea region and that it is both possible and desirable to repair social and physical infrastructures, landscapes, and ecosystems of the region. This work highlights how some of the ongoing activities in the region could become reparative, if implemented outside of an ideology of innovation through adopting a repair mentality.

As Hobbs and Harris articulated more than 20 years ago: "If we change the focus of restoration from trying to recreate something from the past to trying to repair damage and creating systems *which fulfill sensible goals*, we will go a long way to solving many of the conundrums facing the science and practice of restoration ecology" (2001, 241 italics added). The question then becomes, what are "sensible goals", who should decide them, who finances restoration, who is restoration for, who should do it[10], and how should they be remunerated? Importantly, this shift away from an ideology of innovation should not move the burden of repair to the residents of the region who care deeply for this place – and who have already in many cases been doing the under recognized and underappreciated work of repair. Rather, repair in the Aral Sea region is something that must be an ongoing discussion and negotiation between all actors involved rather than something imposed by selector.

[10] See the special issue of *Ecological Restoration* (volume 39, issue 1-2) entitled "Restoration for Whom, by Whom?" for analysis within the field of restoration ecology on the questions of who is restoration for and who should do it.

CHAPTER 2: MAKING THE "SEA OF ISLANDS" A FOREST: LOGICS OF AFFORESTATION AND MONOCULTURE IN THE ARAL SEA REGION OF UZBEKISTAN

> "we do not flatter ourselves with the hope that a forest will grow at the bottom of the sea in the full sense of the word. But the creation of protective plantations is possible, and this is the only way to block the way for sand and dust storms. There are no alternative routes" (Khanazarov and Novitskiy 1990, 37).

> "Our country has set an ambitious task – to turn the dried-up floor of the Aral Sea into a garden and now almost one and half million hectares are covered with greenery" (Saida Mirziyoyeva [daughter of President Mirziyoyev], UN Water Conference, 2023).

Introduction

In January of 2019, more than 500 tractors from across Uzbekistan were sent to the dried Aral Seabed for what would be the first mass afforestation campaign since the independence of Uzbekistan in 1991. News footage shows the tractors moving together digging parallel black furrows in sharp contrast to the salt crusted dried seabed (Figure 6), interspersed with footage of

Figure 6: Afforestation in January 2019. Source: (O'zMTRK 2019)

the camp, enormous vats of food, officials looking at maps, and traditional dancing to celebrate the work (O'zMTRK 2019). One of my interviewees explains how this spectacular planting event came about:

> Our president, when he visited in 2018, he asked "Why you are so slow this saxaul plantation on the dried bottom? Why only during the last 15 years, only 300,000 [hectares]?", and I told you my work is 11,000 and 8,000 [hectares]. He ordered why we cannot scale up. Again, we explained to him, for example, I am working with Muynak forest enterprise. Muynak forest enterprise they have only 20 people, they have 3 tractors, they have 1 car, and a very small budget. So no capacity for big scale works. Similar, I have worked with Kungrad's forest authority, they have similar, they have 30 people, 2 tractors so we cannot work in big scales. He immediately found a solution. He invited Minister of Emergency and told him, "During two weeks you should create a special engineering battalion under the Ministry of Emergency, 400 persons from the Uzbek Army, to collect 400 young guys who can work on the tractors"…Then President organized a video conference with all provinces and he asked each province to allocate 50 tractors for three months…Video conference was 16th of December, [by the] 25th December in Muynak there were 570 tractors (P3).

This quote shows the power of the Uzbek state to transform the landscape of the Aral Sea region, and also the desire by the president to increase the speed and the scale of afforestation on the dried seabed. After this first mass mobilization, there have been four *Oliy Majlis* (Uzbek Council of Ministers) Resolutions in February 2019 (Resolution 132), December 2019 (Resolution 1031), November 2020 (Resolution 745) and January 2022 (Resolution 31) to further support the creation of "green coverings" (*yashil qoplamalar*) on the dried Aral Seabed.

The visual of this large-scale afforestation has strong parallels to large-scale Soviet and post-Soviet cotton monoculture, which was largely responsible for the desiccation of the Aral Sea (Spoor 1998) and the creation of the Aral "catastrophe." Between 1945 and 1988, Uzbekistan produced on average 65% of the cotton of the USSR (calculated based on data in Pomfret 2002). Globally, Uzbekistan remains a key producer of cotton. In 2020, Uzbekistan was the sixth largest producer of ginned cotton in the world, behind India, China, United States, Brazil, and Pakistan (FAO 2023). Cotton exports accounted for 11.6% of total foreign trade in

2021, equal to 1,926,261 USD (Figure 7) (Statistics Agency under the President of the Republic of Uzbekistan 2023).

Although the concept of the plantation is not typically used in the post-Soviet context, in this paper I show how cotton in Uzbekistan should be understood as plantation agriculture using Wolford's insight that "[t]oday the plantation lives on in the idealization of rationally ordered, large-scale, extractive landscapes across the rural–urban divide" (2021, 1623). Extending this idea of the plantation, I argue that saxaul monoculture is also a form of plantation, one where trees are not extracted from the landscape, but rather commodified in place on the landscape. In a sense, in the Aral Sea region, plantation monoculture of trees has come to be seen as the solution

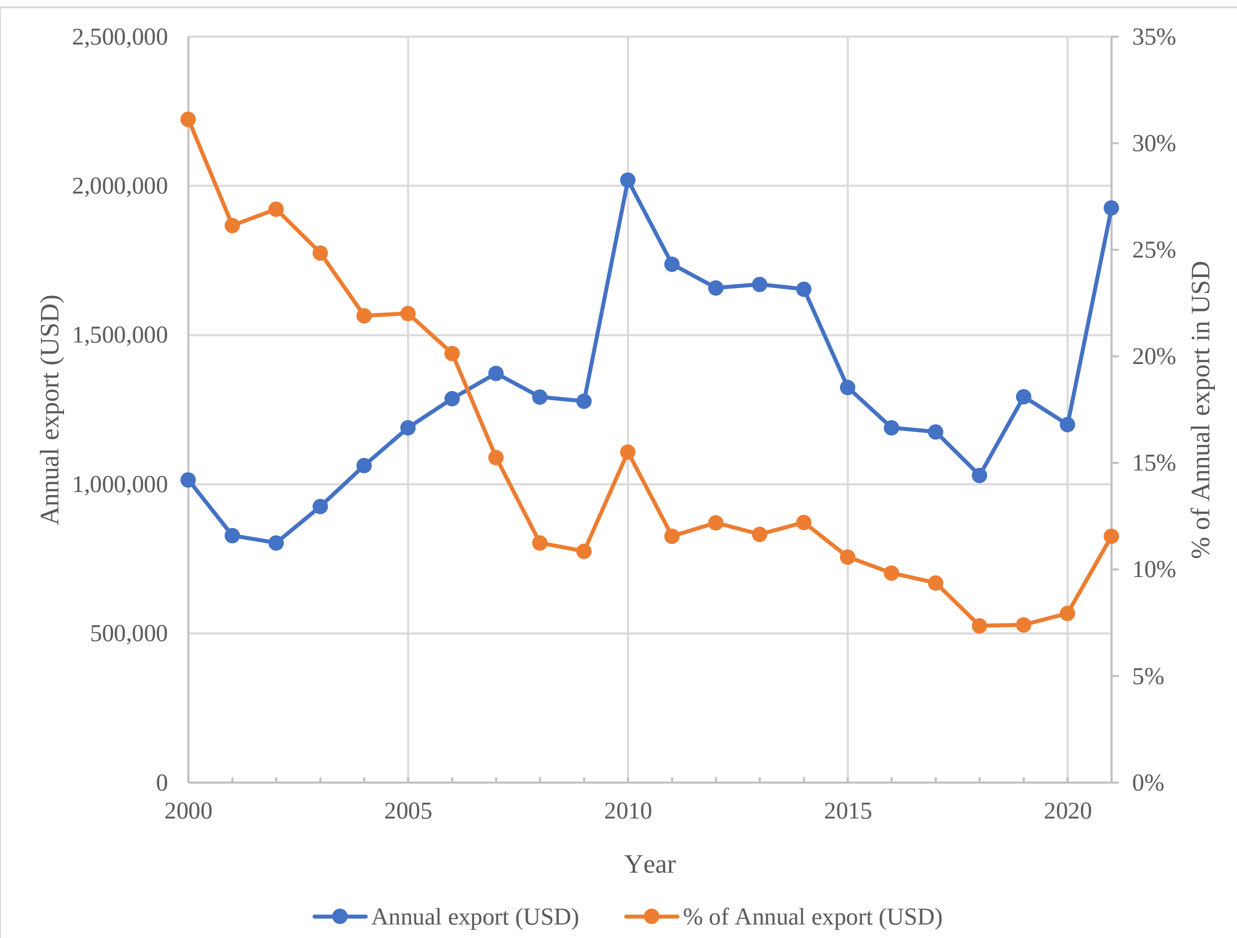

Figure 7: The value of cotton exports and cotton exports as a percentage of Uzbekistan's foreign trade. Data source: Statistics Agency under the President of the Republic of Uzbekistan

for the devastation caused by plantation monoculture of cotton. The promised value of the saxual plantations is their ability to stop the circulation of dust and salt from the dried Aral Seabed. Recent modeling on the impacts of salt and dust from the dried seabed on ecosystem services suggests that landscape restoration can prevent losses of "on-site" (timber, firewood and forage production, soil carbon) and "off-site" (crop production, potential climate regulation, disease and mortality costs) services valued at 44.2 million USD per year and generate additional ecosystem service benefits in these same categories of up to an additional 39 million USD per year (Akramkhanov et al. 2021). The modeling results suggest that the greatest benefits will occur once other vegetation, such as grasses, have grown in addition to saxaul. Although the conclusions of the modeling report are around restoration and rehabilitation, the focus of direct intervention is still saxaul plantations.

This paper unpacks "successful" state-sponsored and crowed-funded afforestation of the dried Aral Seabed in terms of planting extent, tree survival, and the state's image as an environmental steward. I quantify afforestation activities to suggest that large-scale state-sponsored afforestation is less extensive with fewer surviving plants than claimed in circulating statistics. I argue that afforestation is less about plant life than it is a performance by the Uzbek state, both of the promise of trees for local residents and of environmental stewardship to a global audience. This work shows what the pursuit of restoration can become in the plantationocene (Haraway et al. 2016; Wolford 2021), where the plantation is the structuring logic of production and monoculture the planned outcome. I suggest that co-creating the future of the Aral Sea region requires that development actors instead take a "polyculture" approach that incorporates multiple scales, species, and types of cultivation. In the next two sections I situate this work in two different sets of scholarly conversations. The first is about state desire for control of arid lands and the expertise that supports this goal. The second is the more-than-human world as infrastructure, and the performativity of this infrastructure.

Landscapes of anxiety, desire for control

Arid lands have long provoked state anxieties and the idea of "improvement" of deserts is an old one, dating back to at least 1627 (D. K. Davis 2016). Nomadic peoples, like those of Central Asia, were perceived as a threat to the state, resulting in forced sedentarization and in some cases huge loss of life (Cameron 2018; Pianciola 2020). The ruins of irrigation systems in these landscapes was read as justification that these lands were once "civilized" by autocratic governments, justification for colonization and imposing efforts to remake these lands (Wittfogel 1957). Davis argues that even though understanding of drylands ecology has improved, development policy is still "based on desertification dogma and old, outdated Anglo-European ecological ideas… the belief that pastoralists should be settled and herds reduced, that forests should be planted, and that agriculture and irrigation should be expanded continue" (2016, 19). In this section, I describe the two main approaches to dryland development policy in the Aral Sea region, first irrigation expansion and then afforestation, both of which are shaped by the logics of the plantation.

The key role of the plantation in worldmaking has been emphasized in the plantationocene, an alternative to the Anthropocene first articulated by Haraway, Tsing and colleagues (2016) in a published conversation in *Ethnos*. For Wolford, the concept of the Plantationocene is helpful because it identifies how "large-scale, export-oriented agriculture dependent on forced labor has played a dominant role in structuring modern life since the insertion of European power in the Americas, Asia, and Africa" (2021, 1622). Building on these scholars, Barua (2023) argues that the lens of the plantationocene reveals how colonial violence on the plantation does not disappear but continues to reassert itself. I find this temporal aspect of the plantationocene combined with Barua's focus on more-than-human agency particularly helpful in highlighting the ongoing role of the logics of the plantation of the Aral Sea region.

I argue that the plantation has been and remains a core way of structuring land in the Aral Sea basin. From the start of Russian colonization of Central Asia in the 1860s and particularly during the Soviet period, the main approach to "improving" deserts has been irrigation which has been primarily to grow cotton, or "white gold" (Peterson 2019; Obertreis 2017). The Soviet goal was "to bridle the Syrdarya and Amudarya rivers, to control them and to make their water serve the cause of socialism" (First Party Secretary of Uzbekistan 1939, quoted in Zonn 1999, 159). Starting with the process of collectivization, which began in 1929, cotton was grown on collective farms or *kolkhoz* according to cotton production plans[11]. *Kolkhoz* that did not fulfil cotton production plans were punished (Obertreis 2017). Cotton production in the USSR reached its peak in 1981 at 2.9 million tons of ginned cotton (FAO 2023), of which approximately 1.8 million tons was produced by Uzbekistan. Post-independence, collective farms were officially broken up, but large landholders remain, the collective farm remains physically imprinted on the landscape[12], and landowners have continuing obligations to provide certain things to the government. While cotton production in Uzbekistan has decreased since its peak, monoculture cotton remains an important part of Uzbekistan's economy, with 828,000 tons of ginned cotton produced in 2020 (FAO 2023). Even after independence, children, students and civil servants were forced to pick cotton during the harvest each year. It was only in 2021 that the International

[11] The process of collectivization in Uzbekistan inspired resistance and protest, and was an ongoing and incomplete effort by the state (Obertreis 2017).

[12] For example, the division of Chimbay district of Karakalpakstan for soil sampling by the state agrochemistry lab is still along the lines of the former collective farms.

Labour Organization (ILO) certified Uzbekistan to be free of forced labor for cotton picking (ILO 2022).

As the Aral Sea has shrunk, largely due to cotton monoculture, a new desert, the *Aralkum*[13] has formed on the dried seabed. Wolford (2021) suggests that part of the power of the plantation is that this kind of rational structuring of large-scale agriculture becomes a normative ideal. This is reflected in the recent approach to development policy for the Aralkum that seeks to control the desert through large-scale afforestation that incorporates the logics of the plantation through scientific forestry (Scott 1998). I next show how forests and arid lands are not opposites, but are "tightly bound up" (D. K. Davis 2016, 20), and how European environmental thinking about forests has left its literal mark on the worlds drylands (D. K. Davis and Robbins 2018), including those of the Aral Sea region.

One key intervention to allay state anxiety over arid lands and to increase their control over them has been afforestation. Elkin (2022) argues that the idea of "tree-planting good" undergirds these efforts, because planting is automatically framed as the good and moral thing to do. Examples of this scientific, plantation-style afforestation in arid lands to create forests legible to and controlled by the state abound: French afforestation in North Africa (D. K. Davis 2007), British afforestation in India, Russian "halfhearted" attempts in Central Asia (Keating 2022), the US shelterbelt program during the Great Depression (Zon 1935; Gardner 2009), the planned shelterbelts of the Great Stalin Plan for the Transformation of Nature (Brain 2011; 2010), the great green walls of China (Jiang 2016; Stein 2015) and the Sahel (Goffner, Sinare, and Gordon 2019), and Zionist efforts to turn the desert green in Israel/Palestine (Cohen 1993). Unlike other

[13] The *Orol Dengizi* (Aral Sea in Uzbek) literally translates as Island Sea. The new desert, the *Orolkum* in Uzbek, (often written as Aralkum in English) translates as Island Sand.

cases of afforestation in arid lands, the Aral Seabed is unique for studying the relationship between hoped-for forests-in-process and the state because the seabed itself does not currently have any permanent residents. There are a few seasonal or temporary residents including workers in natural gas extraction and foresters. While residents of the region and tourists make their way across the seabed for various reasons, the thorny question of state vs. resident control over resource governance and use does not arise on the Aral Seabed.

State anxieties about forests and arid lands are also tied together through lineages of expertise. Experts of German scientific forestry developed approaches to "tame" existing forests. These German trained experts trained French foresters that conducted large-scale afforestation in North Africa. Davis argues that many of the "standard prescriptions for restoring desert environments to their "proper," usually forested, state: controlling grazing and burning, destocking and sedentarization of nomads, and reforestation" originated from the French experience in Algeria, even "the idea for "green dams" (*barrages verts*)—planting thick bands of trees at the desert edge to try to prevent the spread of the desert" (2016, 100).

Russian foresters looked to both German and German-trained French foresters for ideas on how keep back the desiccating winds from Central Asia (Keating 2022). These Russian foresters trained Soviet and Central Asian foresters, such as Zinoviy Novitskiy, who developed approaches to hold down the sands of the drying Aral Sea at the Central Asian Forestry Research Institute (SredazNIILKh) in the 1980s. Novitskiy co-authored an article for the Russian forestry journal *Lesnoe Khoziaistvo* in 1990 advocating afforestation of the dried seabed as the solution to the Aral "catastrophe": "we do not flatter ourselves with the hope that a forest will grow at the bottom of the sea in the full sense of the word. But the creation of protective plantations is possible, and this is the only way to block the way for sand and dust storms. There are no alternative routes” (Khanazarov and Novitskiy 1990, 37). He asked why the institute’s foresters, with all of their experience experimenting and planting on the seabed, were not to be involved in proposals for the future of the seabed. The expertise of these same foresters is now highly valued, and they have been key advisors to the Uzbek state’s program of large-scale afforestation.

The lineage of expertise of Central Asian foresters like Navitsky has focused on monoculture forestry. Scott describes how German scientific forestry “illustrates the dangers of dismembering an exceptionally complex and poorly understood set of relations and processes [of a forest] in order to isolate a single element of instrumental value” (1998, 21). While in Scott’s example the goal is to maximize timber, the aboveground part of trees, it is the belowground value of the tree roots and their ability to stabilize soils that are the instrumental value for afforestation of the Aral Seabed. One tree, the saxaul[14], is at the center of the afforestation efforts (Figure 8A&B). Saxaul are salt-tolerant trees which can grow up to seven meters and are found across Central Asia. Saxaul used to cover large areas of the cold deserts of Central Asia, and have been described as “perhaps Turkestan’s quintessential plant” (Keating 2022, 14).

However, it is not just saxaul that live in the cold deserts of the Aral Sea region. Like most biomes, this is a complex system. Some species live closely with saxaul. Cistanche (*Cistanche deserticola*) is a parasitic plant that lives on the roots of the saxaul and is widely used in Chinese medicine. The saxaul sparrow (*Passer ammodendri*) lives in and around saxaul, feeding on its seeds. Other animals eat the saxaul, including the wild Bactrian camel and the

[14] There are actually two species of saxaul: black (*Haloxylon aphyllum*) and white (*Haloxylon persicum*). Black saxaul is a phreatophyte, meaning it relies on groundwater, whereas white saxaul relies on rainfall (Zhaglovskaya et al. 2017). Black saxaul is at the center of afforestation efforts, but because in my data I almost never saw people distinguish between the two species, I refer simply to saxaul.

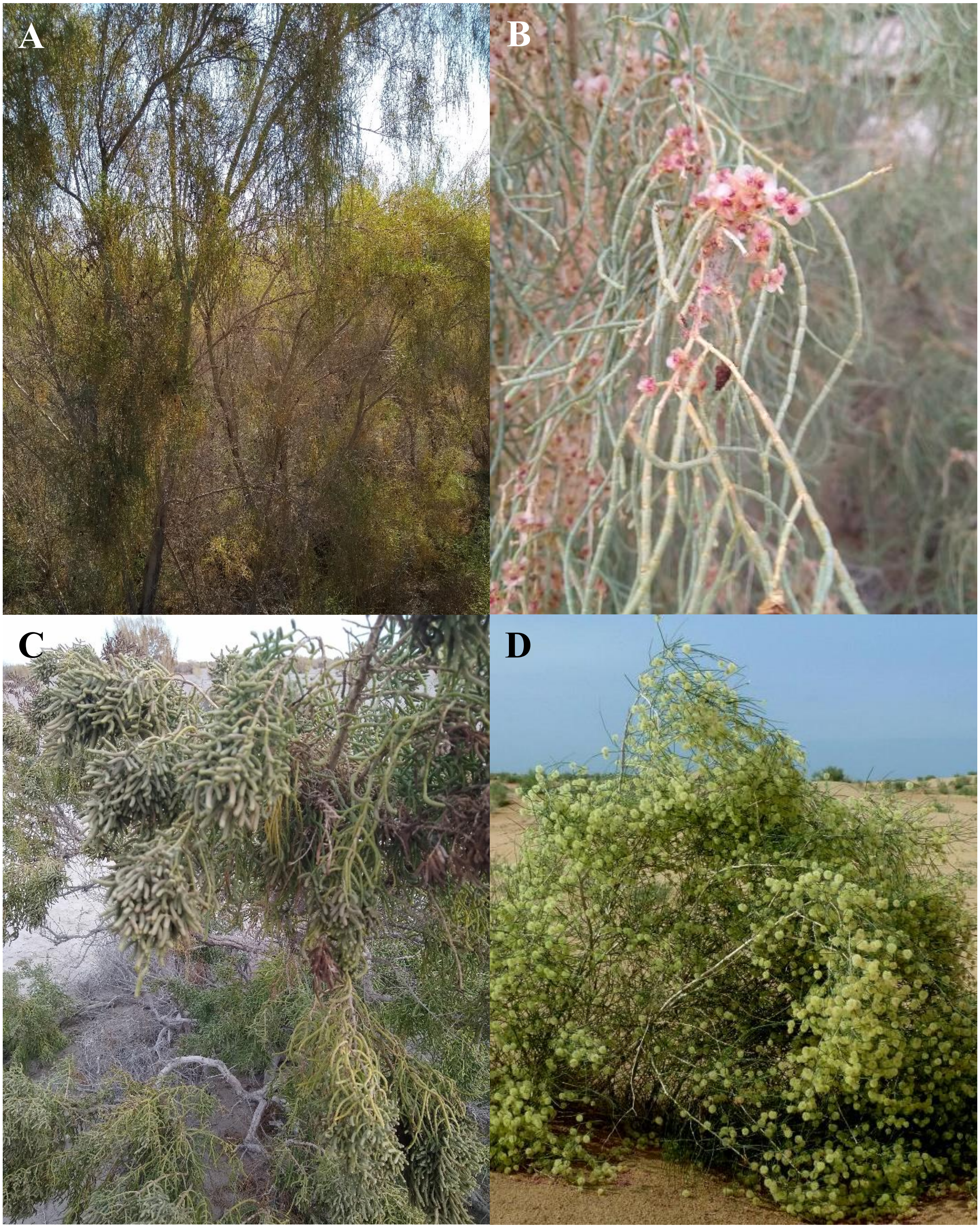

Figure 8: A: Saxaul; B: Close up of flowering saxaul; C: Qorabaraq; D: Juzgun or qandim [Source: A-C: K. Shields; D: H. Bendsen

ibex. Insects, too, eat saxaul (Mombaeva et al. 2017). Numerous other plants and animals thrive in the same areas as saxaul, including qorabaraq (*Halostachys belangeriana*), juzgun/qandim (*species of Calligonum*), and others[15]. In the plantation forest that is being created on the Aral Seabed, however, these species and other aspects of desert ecology become unimportant and therefore ignored.

Trees as infrastructure and performance

In this section, I outline how the more-than-human world, including trees, can be infrastructure. I then theorize the performativity of both the representation or "promise" (Anand, Gupta, and Appel 2018) and the construction of infrastructure. Larkin defines infrastructures as "matter that enable the movement of other matter. Their peculiar ontology lies in the facts that they are things and also the relation between things" (2013, 329). I use this definition but suggest that infrastructures such as walls can also disable the movement of other matter. While we usually think of infrastructure as comprised of pipes, concrete, rebar, etc. there is nothing that requires that infrastructure be non-living, and scholars have begun to theorize living infrastructure. Scholars have written about humans (Simone 2004), and more-than-humans (Barua 2021) including pigs (Gutgutia 2020), arthropods (Shani 2020), oysters (Wakefield and Braun 2019), giant tortoises and gecko gardens (Krieg 2020) as infrastructure.

In her analysis of gecko gardens, gardens constructed for human enjoyment and gecko habitat and mobility, Krieg highlights the differences between "*building* and *growing* of infrastructure" (2020). She leaves this as an open question but suggests differing temporalities

[15] For a more complete look at the flora and fauna of the Aral Sea region, see https://www.beyondcatastrophe.com/encyclopedia/

and complexities as a starting point. Krieg's differentiation between building and growing infrastructure echoes Elkin's (2022) contrast between the planting and growing of trees in afforestation projects. In both of these cases, the relationships between plant and human life are at the center. Rosengren (2022) warns how the "co-constitutive agential potential" is lost when trees like willows and other plant life is folded into anthropocentric plans for "green" infrastructure. In this paper, I suggest that trees are planted by the Uzbek state as "green" infrastructure, with the purpose of disabling the movement of sand, dust and salt and slowing the movement of air across the dried seabed, and without consideration of multispecies relationships.

Infrastructure itself can be performative, through what Larkin (2013) calls the poetic mode of infrastructure. In this mode, form and function are disconnected and the "state proffers these representations to its citizens and asks them to take those representations as social facts" (2013, 335). As one example, Todorov argues that under communism, "factories are not built to produce commodities. They produce the united-working-class-body…they are poems of communist ideology" (1995, 10). This performance of infrastructure is closely tied with what Appel, Anand, and Gupta call the 'promise of infrastructure' noting that "material infrastructures…have long promised modernity, development, progress, and freedom to people all over the world" (2018, 3). Larkin explains that the referent of this promise "is not to the here and now of things but to an uncertain future that infrastructure is to bring about and institutes a temporal deferral that refuses to deliver something in the present" (2018, 181). In her analysis of the temporality of large dam construction, Braun identifies this promise as leading to an 'affective economy of anticipation' (Y. Braun 2020). My research demonstrates how afforested seeds or seedlings are themselves performative as the Uzbek state offers the representation of afforestation to global, domestic, and local audiences as future mitigation of the Aral “catastrophe”. This emphasis on form remains in tension with the materiality of trees and the function they are intended to perform. Ultimately, the value of saxaul afforestation comes from soil stabilization. Getting these trees to actually function as infrastructure requires more care, investment, and time than the Uzbek state is willing to allocate.

In addition to infrastructure itself, state processes can also be performative. In her work on Kiribati, Webber (2013) shows how state actors perform climate vulnerability to secure climate adaptation finance. In the case of the Great Green Wall of the Sahel and the Three Norths Shelterbelt Program in China, Turner and colleagues (2023) highlight how “green wall rhetoric mobilizes support and empowers certain actors rather than describing actual dryland afforestation practices“. In this work I show how the Uzbek state performs environmental stewardship through afforestation activities. Though this performance the state further distances itself from its Soviet past and cotton monoculture.

Webber (2013) highlights how statistics and images are an important part of the performance of Kiribati state actors. As Elkin states, “Tree-planting campaigns assuage the moral and biotic difficulties posed by extant landscape conditions. As long as trees are being planted, trees can be counted” (2022, 2). This countability is central for the Uzbek state. These statistics or metrics are themselves performative, as they shape the world that they purport to only measure (Cusworth et al. 2023). My work highlights how statistics of hectares planted and images of green trees in the midst of the dry seabed are key to this state performance of stewardship even as they shape the Aral Seabed itself by constraining planting activities to the ones that will be counted.

Methods

I was initially very reluctant to use remote sensing data because it has so far been used primarily to advance the story of the Aral Sea as a catastrophic wasteland but working and traveling in the Aral Sea region has forced me to rethink the stories that satellite imagery can tell. Afforestation loomed large in my fieldwork and wanting to see what "successful" afforestation looked like in-person, I took a trip to a 2002 afforestation site where saxaul grew in long straight lines that had clearly been planted. I took pictures with my phone which were geotagged automatically. It was only after I returned home and accidentally pulled up the heat map of the photos that I realized that I could see the sharp rows of trees in the satellite imagery. I found further evidence of afforestation on the seabed through Google Earth Pro. During my fieldwork, I continued to read statistics of hectares planted, see images of successful afforestation projects, and be told that perhaps things were not exactly as successful as they seemed. My remote sensing analysis emerged from these fieldwork experiences and questions. In this paper, I leverage both this remote sensing analysis and my ethnographic work, which I next describe in more detail.

Visual classification

In order to systematically explore the extent and success of afforestation, two research assistants and I performed visual classification using Open Foris Collect Earth (Open Foris Initiative of the FAO, https://openforis.org/), an open-source software that allows for systematic visual classification of imagery from Google Earth Pro, using a two-by-two-kilometer grid with a 40N UTM projection. We classified the entire seabed with the categories of "evidence of afforestation", "no evidence of afforestation", and "unclear" between October 31, 2022, and February 12, 2023. Evidence of afforestation included patches of furrow lines and patches of trees growing in straight lines (Figure 9). If there was any evidence of afforestation within the square, the entire square was classified as "evidence of afforestation". We also documented the year(s) of the imagery, which ranged from 2004 to 2022. Some imagery did not have a documented date. If imagery within a square was from multiple dates, this was recorded. Both research assistants classified the entire seabed, and I reviewed any discrepancies between results from the two research assistants for both classification and date data, as well as squares both research assistants had designated "unclear" to create the final classification. Data were then mapped and unexpected squares (i.e. one square with no evidence of afforestation surrounded by squares with evidence of afforestation) were re-checked.

Ethnographic

Ethnographic data comes from a variety of sources. The first is daily fieldnotes from participant observation. I conducted participant observation with the Nukus offices of two development organizations, here given pseudonyms[16]: International Partners in Development (IPD), a multilateral and Development and Cooperation Agency (DCA), a bilateral. I was an unofficial intern at DCA for three months, an informal compromise because their internal policies require that all interns be paid, and my funding stipulated I could not receive any renumeration for my fieldwork. This informal status meant that I could not attend some higher-level government meetings, but also meant that I was outside the organizational hierarchy giving me flexibility beyond a defined internship. I was an official intern at IPD for three months which would not allow such an informal relationship and was able to waive their pay requirement since

[16] All names in this paper related to my ethnographic work are pseudonyms, including the organization names, crowdfunding campaign name, and names of people. For well-known political and scientific figures were not part of my ethnographic work, I use actual names.

I had another source of funding. My clearly delineated formal status meant that I had both more access to formal meetings and less access to events above my intern status. In addition, I conducted interviews with development stakeholders and amassed a collection of development project documents, government documents and legislation. Finally, during the visual classification process, my research assistants and I took notes about the process and interesting or unexpected observations of the dried seabed. These data were assembled and coded in MAXQDA.

At IPD, my main responsibility became leading a crowd-funded afforestation campaign, called #trees4aral which sought to raise 100,000 USD to plant 100,000 trees on 100 hectares. The campaign was initiated directly by IPD due to their inability to find an appropriate national partner or NGO. An initial team of three internationally educated Uzbekistanis[17] created the project which was turned over to the IPD office I was working with during my participant observation, and I was given the lead role. The campaign website, with hand drawn artwork, leads the reader through a simplified narrative of the history and consequences of the Aral "catastrophe" before informing them that their contribution can help create a greener and better tomorrow for the region. Donations are accepted internationally, through an established crowdfunding platform, and through a local bank. In addition to planting trees, one of the major goals was awareness raising. The project uses Instagram and Facebook to try to connect with potential supporters and has in-person events that include reaching out to corporate donors and working with local schools and universities. During my time I gave presentations at two local universities and a high school about the project. This was a particularly interesting assignment,

[17] I use the term Uzbekistani here to indicate that the person is from Uzbekistan. Unlike the term Uzbek, this does not connote any particular ethnic identity.

because I had been following the campaign since it was launched a year and a half earlier. I had planned to write about the campaign, and I was now making decisions about how the campaign would evolve even as I studied it. In effect, part of this work became a sort of autoethnography.

Afforestation: how much, when, and where?

This section probes how much afforestation there has been of the seabed, where this afforestation is, and when planting could have occurred. The view from Google Earth Pro reveals that the Aral Seabed is not static nor empty, but a complex mosaic. Introducing the visual classification to prospective research assistants, I asked them how they would deal with the tedious and boring work this could entail. I was surprised when my two research assistants later reported back how interesting and also beautiful they found the seabed to be. My contribution to the classification provoked new insights and questions about the dried seabed. Here I intertwine our qualitative and quantitative findings.

Plantation afforestation is instantly recognizable once you know what to look for (Figure 9). What is particularly striking about this imagery is the furrows from plantation monoculture that cover broad swaths of the land in parallel lines or afforestation lines. As clarified by one of my participants: "What is the purpose of this furrow? Because the main problem is that soil covered by salt layer, so you should open this salt layer and, in this furrow, by him, fresh sand. Not to the salt, we put this seed to fresh sand inside of furrow. There is more opportunities that this seed can survive in this fresh sand, but not in this salty soil" (P3).

But the Aral Seabed is full of lines, only a subset of which are evidence of afforestation. People have, quite literally, written names of other places on the seabed near afforestation areas (Figure 10). We hypothesize that workers from other parts of Uzbekistan wrote on the seabed with their tractors. Vehicle tracks crisscross the Aral Seabed. Some of the tracks are in

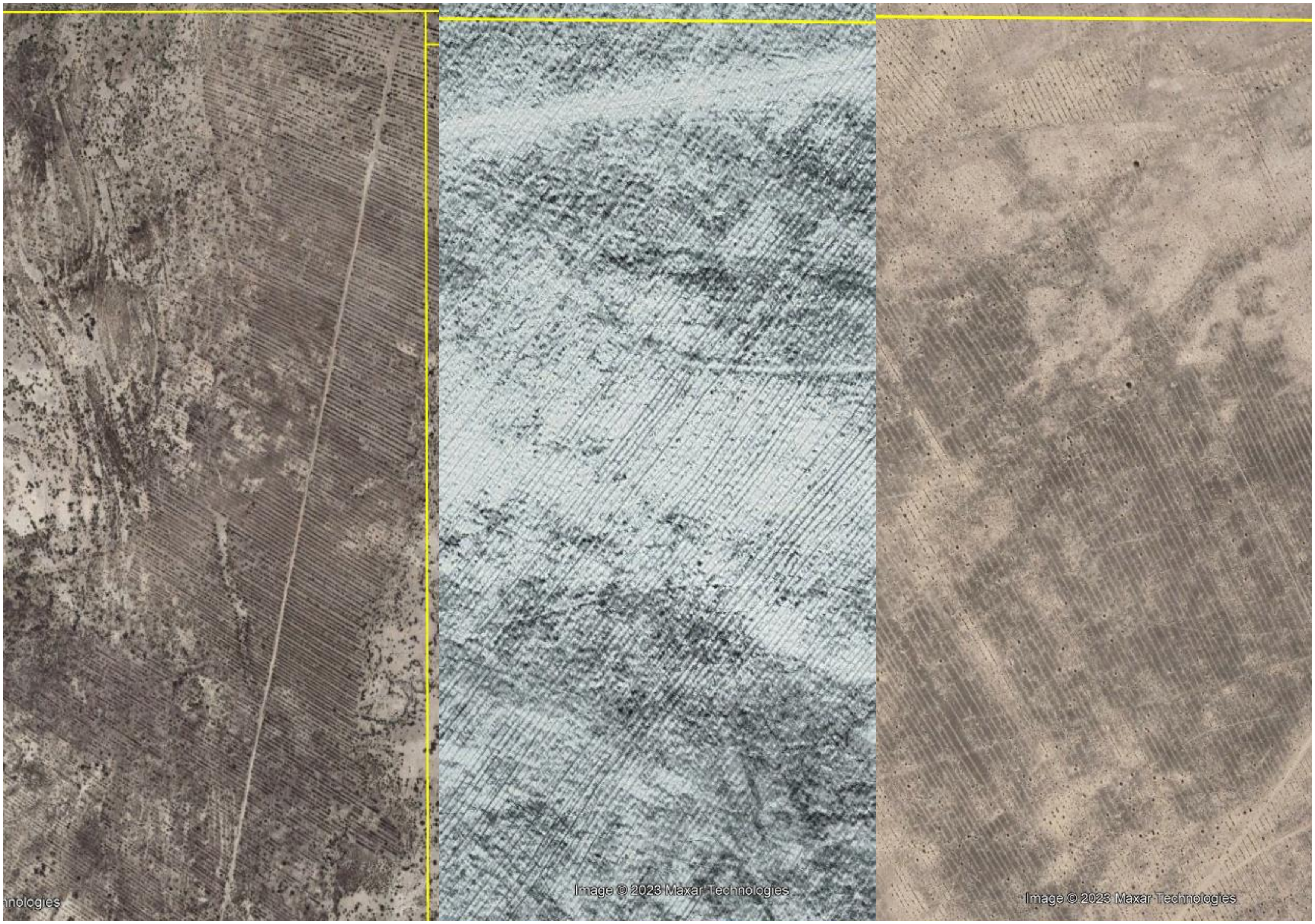

Figure 9: Afforestation lines on the Aral Seabed. Left shows project from 2002 with mature trees, while center and right snow furrows with no tree growth

predictable places – for example the route from Muynak to the edge of the current sea, the route of "dark tourism". The path for others is unclear – but vehicles are implicated by the set of parallel lines that correspond to car or truck wheels. There are often trees that grow in older, more well-established wheel ruts, likely because these collect the little rain that falls, which supports new life. When the ruts get too deep, drivers move to a parallel route, which opens up new future places for trees, while giving the trees in the older wheel ruts a chance to grow without being run over. My view from an SUV window reinforces how vehicles are connected to trees on the seabed. For areas that pre-date large-scale plantation-style afforestation, it is more difficult to decipher whether these lines, and the trees they may contain, are the result of afforestation, or human and more-than-human travels across the dried seabed.

In November 2021, I attended a one-day conference in Tashkent hosted by the Ministry of Innovative Development. One of the speakers was Zinoviy Navitsky, the forester who

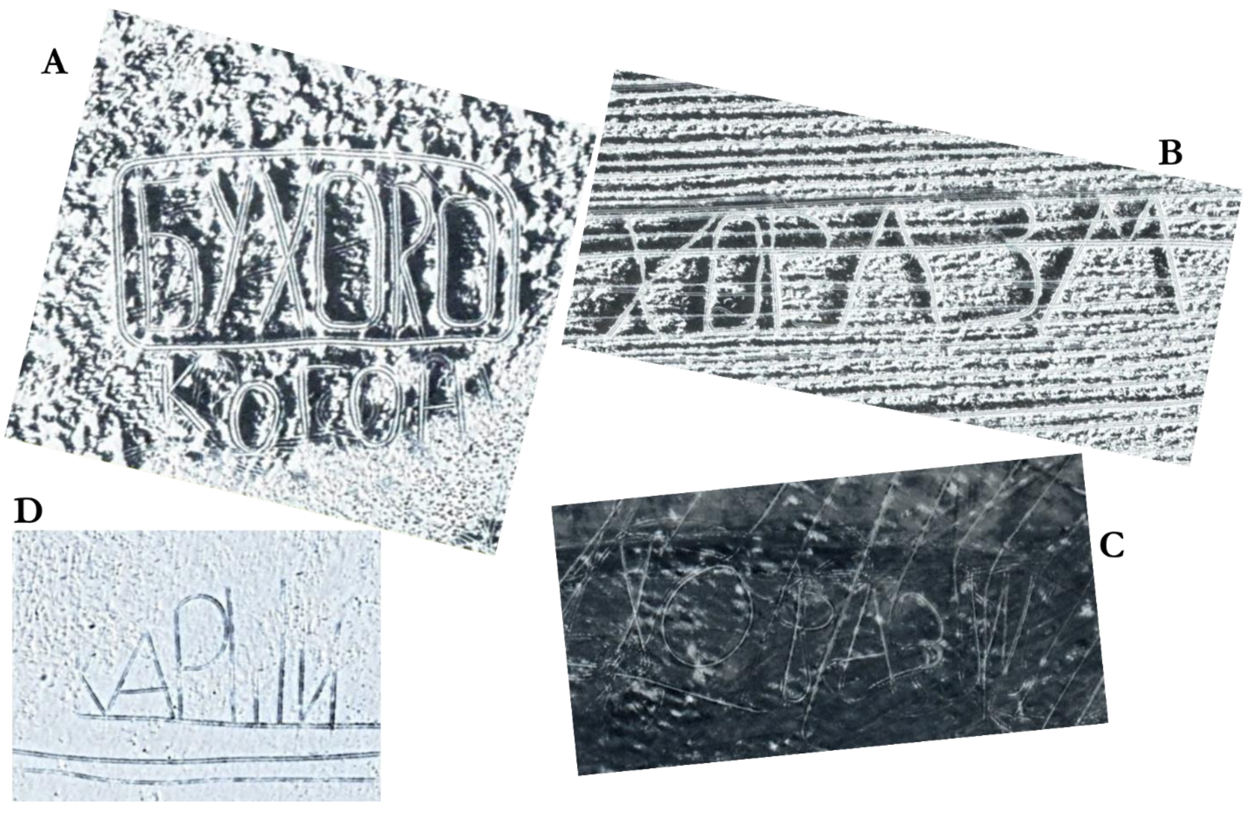

Figure 10: Writing on the seabed in Cyrillic. A: Buxoro Kogan; B-C: Xorazm; D: Qarshi

advocated afforestation of the seabed in a 1990 article. His speech recounting the current large-scale afforestation initiative reminded me of war stories, or the bonding that occurs with disaster. Everyone had come together, even people in power, to unload and load airplanes with seed and do the work of afforestation. He described how in six years everything would be fine, all of this land would be covered in green. Like most of the speeches I had heard, this one was full of statistics on how much was planted, in this case how 1.5 million hectares had been planted in three years. This statistic of 1.5 million hectares circulates broadly, performing the stewardship of the Uzbek state. Speaking at the UN Water Conference in 2023, Saida Mirziyoyeva, President Mirziyoyev's daughter, claimed that "our country has set an ambitious task – to turn the dried-up floor of the Aral Sea into a garden and now almost one and half million hectares are covered with greenery" (2023).

In contrast, through our visual classification we found evidence of afforestation in 2,272 2x2km grid squares. The maximum area with evidence of afforestation is thus 9,088 km^2, 908,800 hectares, or 30% of the dried seabed in Uzbekistan (Figure 11). However, not all squares are fully covered with evidence of afforestation, meaning that these area numbers are overestimations.

One potential reason for this discrepancy between the widely reported 1.5 million hectares and the results of our classification of grid squares with evidence of afforestation equaling 0.9 million hectares is that the number of hectares that have been planted is lower than what is reported. However, there are other possible reasons. A second is the temporalities of Google Earth Pro data on the seabed (Table 3). Twenty one percent of the high-resolution satellite data for the Aral Seabed in Google Earth Pro is from 2004, well before large-scale afforestation efforts began. The consequences of this lack of data are clearest at the seams where

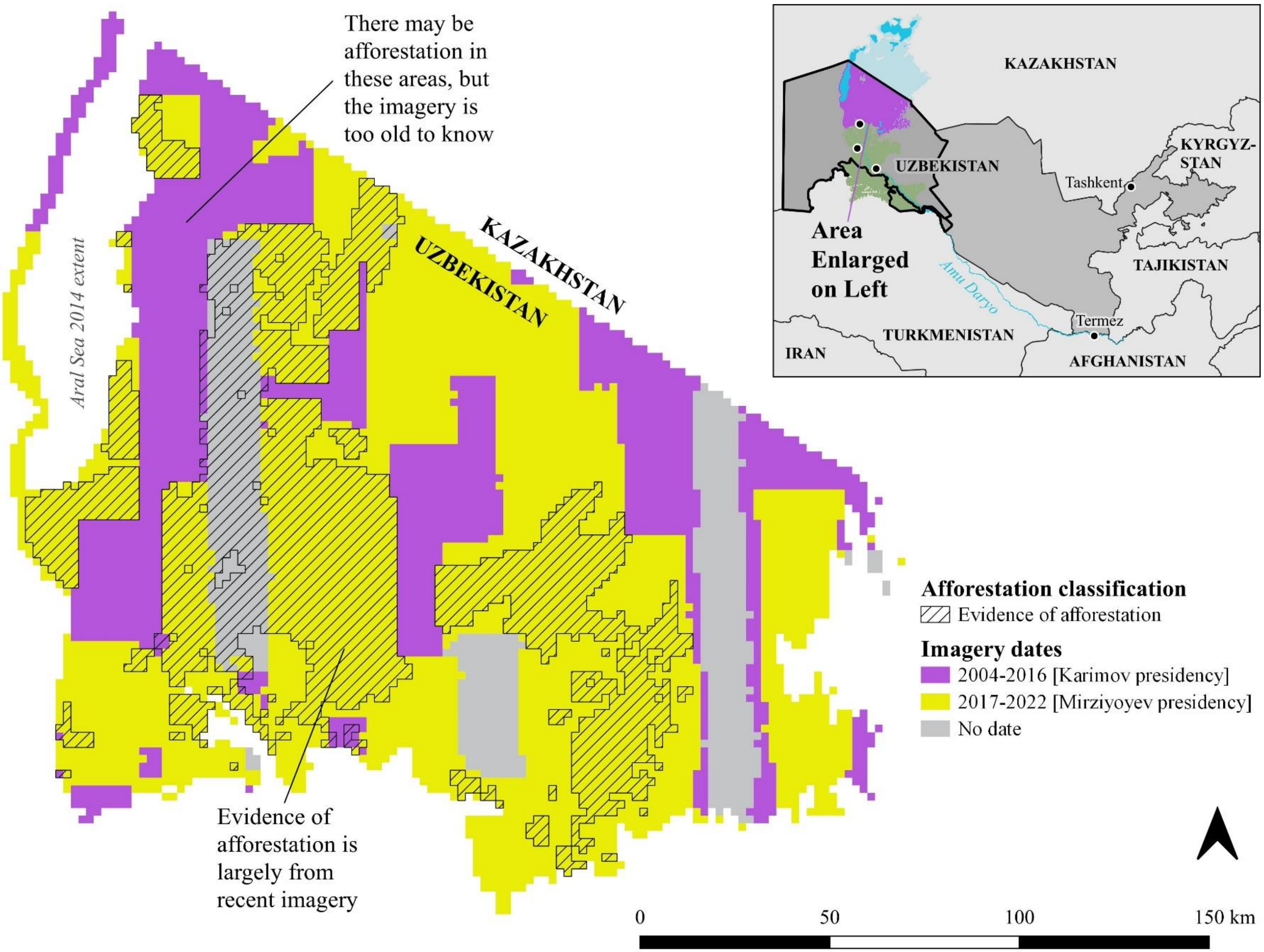

Figure 11: Afforestation of the dried Aral seabed in Uzbekistan and dates of imagery (for squares with imagery from multiple dates, the newest imagery is shown. Imagery with no date is considered to be oldest)

data are stitched together, where afforestation lines are present on the newer side of the seam and absent on the other. Lack of evidence of afforestation is therefore not lack of afforestation, but only indicates that afforestation was not present at the time the imagery was taken. It is unclear why newer data are not available for these areas. Of squares with evidence of afforestation, only 1.5% (n=35) are imagery from 2004-2016. A chi-squared test of independence demonstrates that there is evidence of a significant relationship ($p < 0.01$) between date of imagery and evidence of afforestation on the seabed. This is unsurprising given that the drive for large-scale afforestation

Table 3: Afforestation statistics

Time period	**Yes** Number of 2x2 km grid cells [Row %]	**No** Number of 2x2 km grid cells [Row %]	**Unclear** Number of 2x2 km grid cells [Row %]	**Total** Number of 2x2 km grid cells
2004-2016 [Karimov presidency]	35 [1.8%]	1888 [98.1%]	2 [0.1%]	1925
2017-2022 [Mirziyoyev presidency]	1877 [40.0%]	2803 [59.8%]	10 [0.2%]	4690
No date	360 [39.6%]	549 [60.3%]	1 [0.1%]	910
Total	**2272**	**5240**	**13**	**7525**

began after Mirziyoyev became president in 2017. Finally, it is also possible that the strong winds of the region could have filled in some of the furrows, although we were able to clearly detect furrows from 2014 imagery (i.e. afforestation furrows dug in 2014 or earlier) so this is unlikely.

A second issue, beyond claims about the area planted, is survivorship of the planted seeds and/or saplings. One of the founders of #trees4aral explained that monitoring was very important in their case. It would be good to achieve some visible results to share more pictures of trees they had planted in contrast to the desert around it, and if necessary, they should support the trees in some way. In his conference presentation, Navitskiy also showed a photo of two-year-old plants, indicating that results are already being achieved. Elkin argues that "if afforestation projects accumulate evidence as a means to captivate global attention, then it is especially important to refine and imagine what afforestation initiatives *leave out*" (2022, 16 italics in original). Monitoring afforestation is a thorny issue, compounded by the fact that it can take 3-4 years to know if a tree has survived since much of the early growth is underground in the root system. According to Order No. 48 of May 7, 2012, of the Forestry Committee of the Republic of Uzbekistan, a 50% survival rate in sandy soils is good, 26-50% satisfactory.

There is no direct evidence of survivorship for planted seeds. However, through my participant observation, I did hear that all was not as it was proclaimed. One interviewee shared how he had crossed the dried Aral Seabed from Muynak to the western basin. They went through 80km of area with these furrows and found that "the result is zero" (P3). Repeat afforestation has become necessary. As P3 explained: "so 375,000 [trees] now this year, just to repeat planting in places where not survive. Because again, they used the completely new technology. They started plantation by seedings from airplanes and I don't believe that it will be efficient, but they did, now we will see in another maybe two, three years we will observe if there is any result or not" (P3). The state program has begun to use airplanes to spread seeds once furrows are plowed because it speeds up the process of planting substantially and lowers the amount of labor required compared to sowing seeds by hand or planting seedlings.

Part of the reason for low success rates is that despite the perception that saxaul can grow everywhere, they do in fact require certain environmental conditions, such as groundwater within reach of their roots, that are not uniformly available over the dried seabed.

> *I am on the dried Aral Seabed just past the 'ship graveyard' in Muynak, the major tourist attraction, with two Uzbekistani graduate students, Azizbek and Alisher. For his research, Alisher is mapping sand movement across the seabed. Part of his methodology is to dig holes in the seabed to a given depth and then make return visits*

> *to see how much sand has accumulated in each hole. I watch him try to dig the first hole, but the dry sand keeps filling it in, so he gives up. Then Azizbek comes and digs really, really fast. They eventually got the hole to their desired depth but are not really satisfied because all of the sand kept filling in the hole. Despite this, they still take photos and the GPS location of the hole. I ask Azizbek if they saw a lot of natural saxaul on the Aral Seabed when they did their main fieldwork the previous spring where they traveled more extensively. He tells me no, that when there is natural moisture in the soil, you get saxaul, but mostly, it's just desert. They saw places where the saxaul had been planted and there was nothing. He does not think that saxaul are going to survive with mass planting, because they will only survive when the water table is high enough. As if to emphasize this point, when they dig at their third point, the sand sticks together a few inches down. The soil at the bottom of this hole is very clayey, and because of the saturation of the sand above it, they are able to create the smooth sides of the hole that they had not been able to achieve closer to the former shore.*

This example highlights that the groundwater depth of the seabed, even in a small area, is variable, and as Azizbek indicated, that saxaul – and other groundwater-dependent vegetation – will not grow uniformly across the seabed. When afforestation is rolled out uniformly across the landscape, it is also likely to have varied success levels. While the view from the satellite includes furrows and tree growth after afforestation, ground water depth is not currently measured by satellites – at least at the spatial resolution required for making planting decisions. To identify areas for planting, the view from the ground is also required.

Performance of infrastructure

In this section I demonstrate the dual performativity of afforestation: the promise of saxaul as infrastructure, and the performance of stewardship by implementing actors such as the state. I contrast this performance with what would be necessary for saxaul to take the function – not just form – of infrastructure. A staff member at a bilateral development organization critiqued the lack of care for afforested trees which would be necessary for them to achieve their infrastructural function: “to innovate with, we feel that it’s absolutely critical to have water available for the first two years of these tree plantings, as opposed to the aerial sowing technique, which is kind of spreading your seed and keeping your fingers crossed, right, and there's no, there's no follow up watering" (P1). An intermediate level of care to enhance plant survival and infrastructural function is to plant saplings using a hydrogel that absorbs water when there is precipitation and then releases it slowly. In the first round of #trees4aral planting, they planted seedlings using UPL's Zeba gel, a cornstarch-based product that helps with water regulation (UPL n.d.). For the project's first planting in April 2020, 60,000 black saxaul seedlings (*Haloxylon aphyllum*) were planted on 30 hectares. Of these 30 hectares, Zeba gel was tested on two hectares, in amounts of 15g, 20g, 30g and 35g per seedling. Monitoring from November 2020 indicates survival rates from 30% with no Zeba gel to 87% with 35g of the gel (Figure 12). A second planting for the project occurred next to the original planting in February 2021 (260,000 black saxaul seedlings planted on 134 hectares). After my fieldwork, planting for the project has continued at the new location with work in January 2022 (92,000 planted on 87.2 hectares), and February-March 2023 (131,000 on 131 hectares).

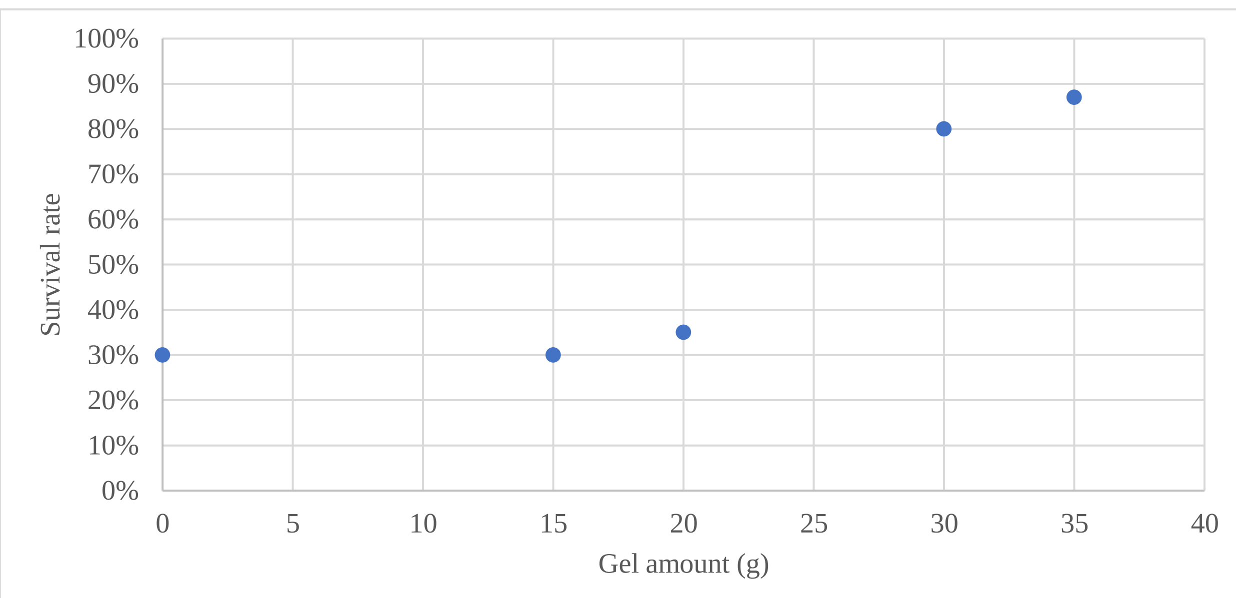

Figure 12: Tree survival rates for afforestation with Zeba gel. 28 hectares were planted without Zeba gel, and 0.5 hectares were planted with each other amount. Source: #trees4aral monitoring report (unpublished)

Despite the success of the Zeba gel pilot, Zeba gel was not used on further plantings. For the 2022 planting, Aquasorb 3005KB hydrogel was provided for free by SNF, a French-based company specializing in water-soluble polymers for agriculture, drinking water and waste-water treatment, oil and gas extraction, mining, and manufacture of paper, textiles, and cosmetics (SNF 2023), and tested on two hectares instead. There is no evidence however that these two hydrogels were taken up at a larger scale, even by #trees4aral. From deep in trying to move the #trees4aral campaign forward, my fieldnotes reveal frustrations about why these hydrogels are not being scaled up with this reflection: "what are the 'innovative' things that should be used to increase survival rates? Is that even cost effective or is it just labor and plants are so cheap that you just plant with poor survival rates and then you plant again?" I suggest that one of the reasons that hydrogels were not scaled up is that for the performance of doing afforestation, in the short term what matters is the form, or promise of infrastructure, through seeds or seedlings put into the ground, rather than evidence of the eventual functioning of mature saxaul as infrastructure. In the longer-term however, performance of stewardship will rely on the ability of saxaul to function as infrastructure by stabilizing soils. There are already rumors circulating over saxaul's non-functioning because of low survival rates. I suggest that this tension between form and function is more pronounced in more-than-human infrastructure, compared to infrastructure like a pipeline or bridge, because trees are both alive and lively and may or may not function as expected – or even live at all after being planted.

The financing of afforestation, which according to the *Oliy Majlis* resolutions for "green coverings" comes from several sources, also reveals elements of this performance. The Uzbek state at national and sub-national levels provides much of the funding. The first resolution identifies that Uzbekneftegaz (Uzbek Oil and Gas), the state-owned petrochemical company, should pay 100 billion Uzbek so'm (UZS) (~11,911,000 USD at the time) for afforestation, which will go toward their debt to the state-owned Aral Sea Region Development Fund. Subsequent resolutions confirm that Uzbekneftegaz has slowly contributed to afforestation efforts, with 57 billion UZS allocated as of November 2020 and an additional 24 billion UZS between November 2020 and January 2022. Uzbekneftegaz is leading natural gas exploration under the dried seabed, and in partnership with other national petrochemical companies, particularly Korea Gas Corporation, has established infrastructure for gas extraction and chemical processing in the Aral Sea region (for more information on gas exploration and processing see Chapter 1).

Because afforestation of the Aral Seabed is a highly visible activity through the broad circulation of statistics as I described above, other organizations have also joined in the performance of afforestation. This has led to a wider mosaic of afforestation with some small area but politically important plots. For example, in November 2022, USAID announced 1.2 USD million for afforestation in the Aral Sea region of Uzbekistan (USAID 2022) and in December 2022, the EU planted 27,000 trees as a "gift" from the 27 member states to the people of Karakalpakstan (Press and information team of the Delegation to Uzbekistan 2022).

The #trees4aral campaign was the first (or one of the first) crowdfunding projects in Uzbekistan, which required the team to adapt crowdfunding infrastructure to the local finance context. One of the things that surprised the original team was the high number of donations received from inside Uzbekistan (Table 4). They had anticipated that most of the support would be international, evidenced by the fact that the website is not available in Uzbek. Overall, 96% of donations were online and from inside of Uzbekistan. However, 95% of these donations were less than 10 USD, with 43% of donations 1 USD or less. The largest of these in-country online

Table 4: Summary of donations for #trees4aral

Donation method	Total (original currency)	Total (USD)	Total trees (10,000 UZS OR 1 USD = 1 tree)	Number of donations
Online - UZS	36,075,123	3,355	3,608	265
Online - USD	4,448	4,448	4,448	94
Offline - UZS	209,843,000	19,518	20,984	6
Offline - USD	20,950	20,950	20,950	2
Total		**48,271**	**49,990**	**367**

donations came from the Tashkent International School where the original team had done in-person events, while most of the money was through offline corporate donations from firms including UPL (maker of Zeba gel), Huawei, and Future Enterprises PTE. According to one of the founders of the #trees4aral campaign, these large contributions reflect the "commitment shown by socially-responsible companies." The disproportionate contributions by a few suggest that calling this crowd funding is a misnomer.

On the other hand, one of my questions when I started my participant observation at IPD was why citizens of Uzbekistan should pay for afforestation. I had several equity concerns. First, the plantation system that largely created the Aral "catastrophe" was state driven, and citizens were already paying taxes that supported state-sponsored afforestation among other things, so why should citizens be asked to step in and finance afforestation directly? Second, millennials are more likely to support crowdfunding initiatives, which means that while those with power in the oldest generation ramped up irrigation and therefore the Aral "catastrophe", the youngest generations are more likely to pay for mitigation if it is done through 'crowdfunding'.

As I have highlighted in this section, the Uzbek state has prioritized the performance of afforestation and the promise and form of saxaul as infrastructure. This performance is one important demonstration of Mirzyiyoyev's "new" Uzbekistan, and the benefits of this performance are not bounded by or limited to the Aral Sea region but rather extend to the rest of

Uzbekistan. One primary benefit of demonstrating the “new” Uzbekistan is mobilization of international development aid for the country, and a better seat at the table in international decision making. This repositioning of Uzbekistan also supports increasing foreign direct investment in local industry and increasing flows of tourists and tourism dollars. International development organizations, such as IPD, USAID, and the EU, also benefit from the performance of saxaul afforestation. While local state and development actors are deeply intertwined with this performance, they are often more concerned with the eventual functioning of saxaul as infrastructure, and were more likely to support ongoing afforestation efforts while critiquing what they viewed as ineffective mass-planting strategies. A relational approach to more-than-human infrastructure, which I analyze below, could open up possibilities for these actors.

More-than-human infrastructure as relational

In this section I show how attempts to control nature through monoculture – either on the cotton or forest plantation – are always incomplete. In these gaps, it is possible to see how more-than-human infrastructure is relational. The pervasiveness of monoculture development was brought home for me through debate that erupted on one of the social media posts I created for the #trees4aral campaign (Figure 13). I had posted a photo taken by Baxtiyor, a staff member at IPD, of horses in saxaul. The original caption was “Saxaul is also important for the animals of the Aral Sea region.” I returned from dinner to several missed calls and messages. In particular, Gulli, one member of the original team wrote me that “We cannot say that saksaul is good for animals. One of the problems that animals eat saksaul and we cannot grow and help the Aral Sea.” Sinan had changed the caption to “Saving Biodiversity is one of the long-term target[s] of the #trees4aral” allaying people’s anger. However, the idea that planting saxaul was a goal in and of itself rather than to support ecosystems stuck with me. Biodiversity in the abstract was acceptable, but saxaul as a habitat for and potential fodder for horses or other animals was not. Saxaul was thus not part of the ecosystem, but green infrastructure, and the campaign had to protect the impression of infrastructural investment from more-than-human entanglements. There has been some movement in recognizing the relationships between saxaul as infrastructure and humans. The team modeling the impacts of dust and salt of the dried Aral Seabed emphasizes the value of human interaction with saxaul such as pruning the trees for better growth in future years, with leafy parts used for animal fodder and wood used for fuel (Akramkhanov et al. 2021).

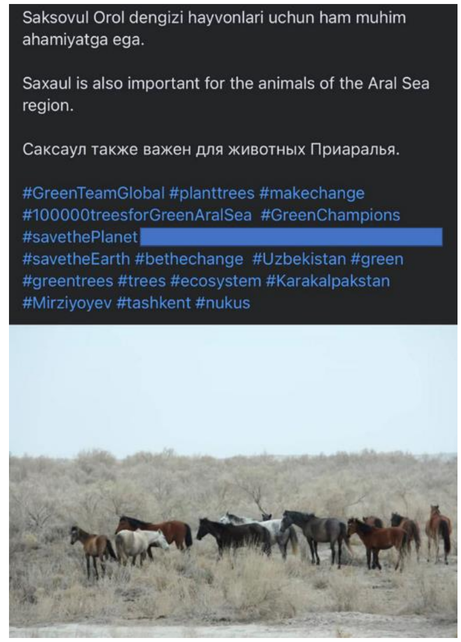

Figure 13: Instagram post with original caption

An example of relationality in planting saxaul as infrastructure comes from the report from a November 2020 #trees4aral monitoring visit explaining how saxaul seedlings should be planted for best survival. The report's detailed step-by-step explanation of the interaction these workers must take with each other, the seedling, with the 'sword', and with the earth itself stands in stark contrast to my description of large-scale afforestation using 500+ tractors.

> Before planting saxaul seedlings, the recommended dose [of Zeba gel] (35 grams per seedling) should be measured on laboratory scales and poured into a plastic cup, on which a mark is made so that each time not to measure. Saxaul seedlings are planted under the sword of Kolesov[18] [Figure 14] by two workers: one works with the sword, the other places the absorbent and seedling in the slot and sets it off. The process of work proceeds as follows: The worker with the sword of Kolesov, standing facing the planting place and holding the sword convex side to himself, plunges it to a depth of 25 - 30 cm and with two to three swings from himself and on himself expands the slot to

[18] The Sword of Kolesov (Russian: Меч Колесова) is a tool developed in 1883 by Alexander Alexandrovich Kolesov for tree planting which was widely used across the Soviet Union and in post-Soviet countries. The design necessitates two workers be involved in the planting process (Ministry of Forestry of the Republic of Tatarstan 2016).

the required size. At this time, another worker, taking absorbent from the bag with the help of a measuring plastic cup with a mark, places it in the slit prepared by the sword and there accurately plants the seedling, making sure that the seedling roots are not intertwined with each other and do not twist. To do this, the seedling right there in the slot is shaken with a quick movement or a pinch of soil is thrown into the slot. After making sure that the seedling roots have taken the correct position, the worker puts the seedling to the flat side of the slit at such a level that the seedling's root neck is deeper than the ground surface by a finger width (1 - 1.5 cm). After that, the worker with the sword again drives the sword to the original depth of 10 cm from the slot and by pushing on himself first pinches the lower part of the roots, and then, by pushing away from himself, the upper part of the roots and the root neck. The hole in the soil left by the sword next to the seedling is filled with soil. Workers then proceed to the same operation with the next seedling. The seedling's root system must be tightly pinched during planting, otherwise the seedling will not take root. If the seedling is not well embedded, it is easily pulled out of the ground.

Figure 14: Sword of Kolesov used for 2022 planting

This multispecies description echoes Elkin's (2022) distinction of planting and growing trees. She theorizes growing trees as a collaborative effort between species, and a relationship that requires a commitment. She emphasizes that seedlings and saplings need care in the first years of their life if they are to survive, which is also true for saxaul. Arslan, a current staff member at DCA discussed this interaction between the plant and human when we visited an afforestation site done by DCA in the early 2000s. He told me *just spreading the seeds* [by airplane] *for mass afforestation does not really work. Seedlings need to be hand planted*. One of my interviewees also had a strong critique of areal sowing. Giving advice to a delegation from Kazakhstan on afforestation he had told them "Guys, it's a stupid idea. Let's use our traditional, by tractors by hands, not by seeds but seedlings" (P3). Planting by hand, or even by tractor is much more labor intensive and time consuming. However, some state organizations, such as a district forestry organization for the area we visited, are returning to their 'usual' (i.e. smaller scale) afforestation efforts and planting seedlings from their nursery.

There is also recognition of the important relationships between saxaul and other species and critique of the current monocultural approach. A staff member at a bilateral development organization explained their problem with the current approach:

> you need to restore an ecosystem, so you go straight to the keystone species, or the climax species of what would normally take quite a long time to actually achieve in a successional way, right? And they've not focused in my view on a more natural or staged succession approach that would involve rebuilding the soil, using other halophytic [salt-tolerant] plants, ground cover, different species, multiple species to create a diverse on the ground ecosystem of flora (P1).

There are also some examples of how monoculture is being subverted from within. The #trees4aral campaign had a narrow monoculture view of afforestation: they claimed to be planting only saxaul, their contract was for solely black saxaul seedlings. The consultant who coordinated the planting told me that only saxaul was planted. So when I unexpectedly met some of the foresters who did the February 2021 planting for #trees4aral, I was surprised when they told me that they had actually planted a mix of saxaul, tamarisk and *qorabaraq*. Despite the mandate for a monoculture plantation, this was not the decision the foresters made.

This use of three species may be in part because there has been some evolution of what is meant by "green coverings" in the legislation. Originally, only saxaul was to be planted. The second resolution on green coverings specifically expanded this to saxaul, *qandim/juzgun* [species of *Calligonum*] and *qorabaraq* [*Halostachys belangeriana*] (Figure 8). The final 2022 resolution expanded this further to specifically "take measures to plant species adapted to desert and salty soil, including *cherkez* [*Salsola paletzkiana*] in sandy areas and tamarisk [*Tamarix leptostachys*] and *atripleks* (*lebeda*) [species of *Atriplex*] plants in saline areas" although the workplan section of the resolution specifies that for the dried seabed only saxaul, *qorabaraq* and *qandim/juzgun* should be planted. While the use of more species is a step towards an ecosystem-based approach to restoration, it is unclear if the implementation acknowledges the relationships between species and intentionally works to support functioning ecosystems, or if this is simply a diversified green infrastructure.

Plantation afforestation

In this section I show why saxaul afforestation should be considered a plantation, focusing on the labor regime of planting and what commodity this plantation creates. I return first to the 500+ tractors moving across the dried Aral Seabed that I opened this paper with, and the engineering battalion that was created from the Uzbek army within two weeks. This labor solution has antecedents in Soviet propaganda that had a strong militaristic view where development was a "battlefield" where they were "attacking the desert" (Obertreis 2017, 468). Uzbekistan requires one year of military service of all men between the ages of 18 and 27, although it is possible to pay for a shorter service and remain in the reserves until the age of 27 ("Uzbekistan" 2023). This differentiation based on ability to pay means it is likely that those serving in the engineering battalion in January 2019 are from families of lower socioeconomic status. Who does afforestation, the conditions of their labor, and how it is remunerated also highlight inequities.

Oliy Majlis resolutions from December 2019 and later show an increasing concern with the labor conditions of afforestation. The December 2019 resolution provides for the employment of 1,000 more people and specifies that workers should be provided with food, special clothing, means of combatting diseases and pests, shelters to live in, transportation to the afforestation site, and fuel, equipment, services and supplies to do their work. These specific provisions in the second resolution suggest that there were logistical problems with the labor of afforestation during the first planting period. Subsequent resolutions also highlight these material aspects of afforestation labor.

News reports from planting in the early 2000s highlight challenging working conditions: “The workers planting the forests live in a camp, 41 kilometres away from the Aral’s former shore, where the sea’s depth once reached 17 metres. They live in barracks, in rather harsh conditions” (Kozlova 2006). On her personal website Kozlova later elaborated on what she means by harsh conditions during that visit: “I was then struck by two things: the water that they drink in the camp - for my taste, even in the form of tea, it was nauseating, and the toilet - where in one building the holes in the floor were not separated even by thin partitions” (Kozlova 2019). This did mean that salaries and therefore overall costs of afforestation were low. Workers earned 70-80USD per month, slightly higher than the poverty line of 60USD per month. This translated into a cost of 150-200USD per hectare compared to typical costs around the world of 500-700USD per hectare (Kozlova 2006; 2019).

For the #trees4aral campaign, planting is done by a district forestry committee, the same people who implement the state’s large-scale afforestation work. The first planting had a total cost per hectare of 256USD of which planting costs were 59USD per hectare. The second planting had a cost per hectare of 173USD of which planting costs were 97USD per hectare. In both of these cases, salaries were low, even lower than those reported by Kozlova for state-sponsored afforestation. One difference is that #trees4aral plantings are done through one-off contracts with the district forestry committees. It is unclear whether the workers who did the planting earned extra money, or whether this went into the general budget for the committees.

Overall, afforestation labor is not forced labor in the same way that cotton harvesting was in Uzbekistan, with the state mandating service. Laboring on saxaul afforestation is connected to poverty and inequality, for families who cannot pay to release their children from military service, or who need whatever income they can get, no matter how small. However, in the context of labor, the plantation in the post-Soviet context also has an uneasy fit. Race and racialized labor are central to theorizations of the plantation (McKittrick 2013). While race also plays a role in Soviet and post-Soviet labor regimes (Rainbow 2019), the plantation in this context has largely resulted from forced collectivization across the Soviet Union rather than racialized labor regimes.

Afforestation of the Aral Seabed is unlike the typical conception of the plantation as an "extractive landscape" (Wolford 2021) because saxaul are not planted to be harvested. I suggest that Wolford's theorization of the plantation needs to expand to landscapes that are extractive and/or commodity producing. In the case of saxaul afforestation, what is being produced by the form or promise of saxaul as infrastructure is spectacle value. This spectacle value helps to cement the Uzbek state as steward deserving of international development financing and takes on monetary value when development finance materializes for projects both within and outside of the Aral Sea region. If the afforested saxaul were to develop into functioning infrastructure, this could be valued, as described in the introduction to this chapter, in terms of ecosystem services provided and the sand and dust storms averted. Saxaul could also be commodified as carbon storage units in the global carbon market.

Conclusion: Restoration in the plantationocene

The Aral Sea region has been subject to decades of monoculture development. In the Soviet era this primarily took the form of cotton monoculture on collective farms, a form of plantation. Cotton plantations have continued past independence. One of the consequences of the cotton plantation, the dried Aral Seabed is now the site of new saxaul plantations. In this paper, I have quantified evidence of afforestation on the Aral Seabed, and probed equity in the doing of afforestation, including labor and finance. Although it is not possible to quantify afforestation 'success' at this point given that most of the early growth is in the root system as described above, the observations from my participants indicate that this large-scale afforestation effort has not been successful. Yet the Uzbek state, and other organizations, have largely continued with their approach. While afforestation may not allay state anxiety about arid lands through the creation of an actual forest, the performance of afforestation is just as important in this case. Saxaul seeds or seedlings perform the promise of mitigation of the Aral "catastrophe" to residents. At the global scale, the planting of trees on the Aral Seabed is not simply an effort to create a forest, but to perform global environmental stewardship to the world. Restoring functioning landscapes or ecosystems becomes less important than narrating hectares planted and showing tractors moving in unison that are a critical part of this performance. These statistics and images continue to shape how the Aral "catastrophe" is mitigated, as large-scale plantations become seen as the only solution.

Despite the recent global interest on landscape and ecosystem restoration through efforts such as the UN Decade for Ecosystem Restoration, I argue that saxaul for both large-scale state afforestation and the #trees4aral campaign should be seen as a form of green infrastructure, rather than relational infrastructure which would entail an effort to co-create a restored landscape or ecosystem. As green infrastructure saxaul have one purpose: to hold down soils. Seeing saxaul as green infrastructure rather than living more-than-human infrastructure being helps to understand the pervasive attitude that saxaul require no care after being planted.

Elkin argues that "We cannot just plant trees, and calculate units to escape, survive, or solve crises." She suggest that afforestation could be done in different ways, or that we "could also learn to love drylands" (Elkin 2022, 5). In the case of the dried Aral Seabed, learning to love drylands cannot be non-intervention even though plant life is expected to very slowly spread across the seabed without human intervention. Learning to love drylands means ending the logics of the plantation, both for agriculture in the Aral Sea region and on the dried seabed. Learning to love drylands means approaching the dried seabed from a perspective of humility to listen to the dried seabed and co-create novel ecosystems (Richard J Hobbs, Higgs, and Hall 2013) with the more-than-human world.

CHAPTER 3: OFF THE MAP AND IN THE SHADOW: WATER, SALT, FISH AND GARDENS IN THE AMU DARYO DELTA IN UZBEKISTAN

> "I would like to once again draw the Assembly's attention to one of the most acute environmental problems of our time: the Aral Sea catastrophe. I am holding a map showing the Aral Sea tragedy — I believe that words are not necessary" (Shavkat Mirziyoyev, second and current president of Uzbekistan, UN General Assembly, 2017).

Jayxun jag'asında ósken bayterek,	A tall poplar grows along the edge of the *Jayhun*[19]
Túbi bir, shaqası mıń bolar demek.	Whose roots are a thousand years old.
Sen sonday sayalı, quyashlı elseń,	You are such a shady, sunny edge;
Tınıshlıq hám ıǵbal sendegi tilek.	Your desire is happiness and peace.

From the State Anthem of the Republic of Karakalpakstan. Music by Najimaddin Muxammeddinov with lyrics by Ibrayım Yusupov

Introduction

I am in a minibus with a group of Central Asian geographers returning from a post-conference fieldtrip to see the ship graveyard in Muynak, the former port town of Uzbekistan. We stop to fill the minibus with methane – a commonly used source of fuel. Because of the risk of explosion everyone has to get out of their vehicles. I notice a commotion at the open trunk of a car parked nearby and go to investigate. The trunk is full of dried fish. Hands frenetically reach in to examine the fish and pull them out. The driver/seller, an older man, makes change from a huge roll of UZS he has in his hands. Some of the younger guys from the bus buy a bag of fish, and we return to the bus. Breaking open a new bottle of Qarataw (the beloved local vodka), they pass around the fish and everyone tears off chunks. The fish is delicious and very, very salty. I watch this cluster of guys sitting around at the back of the bus, some in the back row that holds five people, others sitting in the rows sideways, as they drink shots out of larger clear plastic glasses and eat fish, and I think about how while the Aral Sea was hundreds of miles from where

[19] *Jayhun* [Jayxun] is the Karakalpak name for the Amu Daryo.

we were today – and the remaining water contains no fish – fish remains deeply embedded in the Aral Sea region and in this place creates a sense of bonding.

The fish that I ate on that bus still came from the Aral Sea region – not from the Aral Sea, but from the Amu Daryo[20] delta. While the shrinking of the Aral Sea is well known, in the words of UN Secretary-General António Guterres as "probably the biggest ecological catastrophe of our time" (UN News 2017), the Amu Daryo delta has largely remained hidden, cropped out of the satellite images which document the shrinking of the sea on websites and in documentaries. The vast Amu Daryo delta is, however, home to 11% of the population of Uzbekistan (Government of Uzbekistan 2023)[21], as well as most of the region's more-than-human (i.e. plant and animal) residents.

While the Aral Sea now lies between Uzbekistan and Kazakhstan, the Uzbek state has, since independence in 1991, sought to frame the Aral "catastrophe" as a global problem. As Islam Karimov, Uzbekistan's first president, articulated in his speech to the UN General Assembly in 2000,

> Because of its scope, the Aral crisis has spilled over the boundaries of the Central Asian region; it has become a problem of global importance; its pernicious influence is seen in climate change and biological balance; it has negative effects on health and on the gene pool of future generations. I believe that no one needs to be persuaded of how dangerous and unpredictable the implications of the dying Aral Sea are for Europe and other areas of the planet, or of the consequences of indifference to this problem (Karimov 2000, 16)

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[20] The word *daryo* means river in Uzbek. For this reason I do not call it the Amu Daryo river, since this would be redundant.

[21] The Open data portal of the Republic of Uzbekistan also includes the *o'blasts* of Navoiy and Bukhara in statistics about the Aral Sea region, however I limit the Aral Sea region to the Republic of Karakalpakstan and Xorazm *O'blast*, which encompass the Amu Daryo delta and the maximum extent of the Aral Sea.

In particular, it is the fact that the dust from the dried Aral Seabed travels globally, that has helped to frame this as a global challenge. As shared by the representative of Turkmenistan at the 72nd session of the UN General Assembly, "According to international experts, poisonous salts from the Aral Sea region are present in various areas, such as off the coast of Antarctica, on the glaciers of Greenland, in the forests of Norway and in many other parts of the world[22]" (Ataeva 2018, 23). This toxic dust is also framed as the primary health consequence of the "Aral" catastrophe for local residents in popular discourse, although biomedical evidence does not corroborate this assertion (Crighton et al. 2011; Bennion et al. 2007).

While the global spotlight periodically shines on the Aral Sea, the Amu Daryo delta remains, in feminist theorist Val Plumwood's terms, a shadow place, "all those places that produce or are affected by the commodities you consume, places consumers don't know about, don't want to know about, and in a commodity regime don't ever need to know about or take responsibility for" (2008). The Amu Daryo delta is closely tied to the rest of the world: at one point, Uzbekistan was the second highest exporter of cotton in the world (Rudenko, Lamers, and Grote 2009), and this cotton was both grown in the delta and grown outside the delta using water that never arrived in the delta. Despite the fact that cotton monoculture has been recognized as the main cause of the Aral "catastrophe" due to the increasing diversion of water from the Amu Daryo and Syr Daryo rivers for irrigation that had previously flowed into the Aral Sea, when I presented about the Aral Sea for my participant observation at local schools for International Partners in Development (IPD)[23], the head of our office told me that I needed to remove two

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[22] I have yet to find peer-reviewed studies documenting these claims, which have become more akin to urban legends with wide circulation.

[23] All organization and personal names are pseudonyms.

slides on cotton. The first was a graph of cotton production and irrigated land in Uzbekistan and the rest of the former Soviet Union from 1913 to 2008 (Figure 15) from the work of Djanibekov and colleagues (2010). The second was two historical photos of the cotton harvest. I told him that I thought that this was historical so it would be okay, but he told me that it was too sensitive. We could focus on the drying of the sea and the dust storms and consequences to the local people, but cotton remained out of bounds, in the shadows.

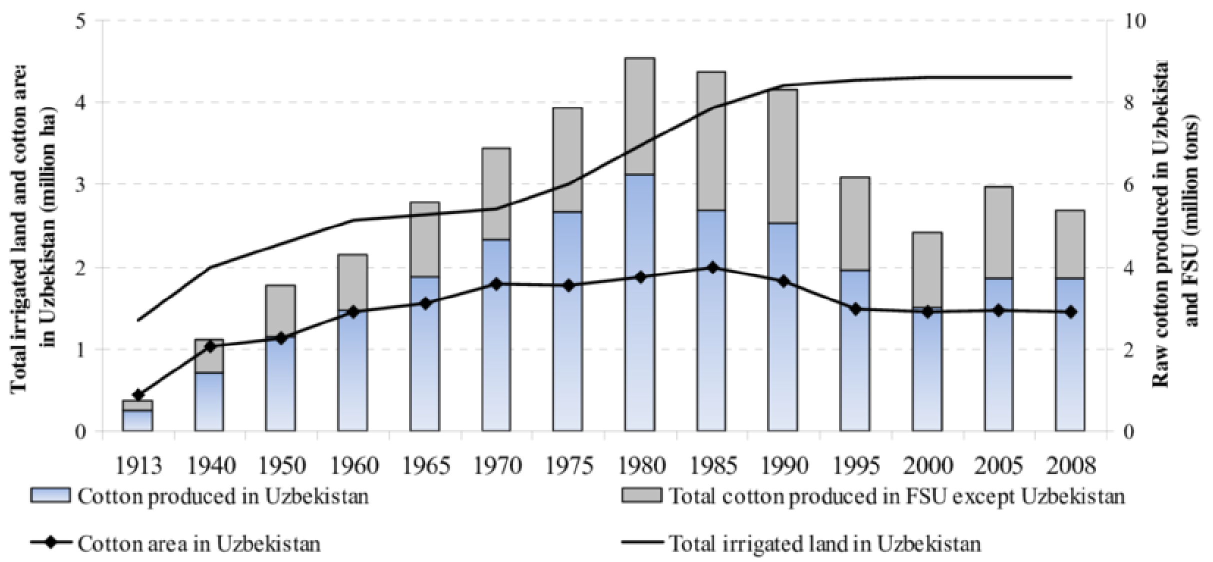


Figure 15: Graph of cotton production and irrigated land in Uzbekistan and the rest of the former Soviet Union from 1913 to 2008. Source: Djanibekov et al. 2010

This paper challenges the framing of the Aral Sea as a global object of catastrophe by spatially shifting the focus to the shadow place of the Amu Daryo delta where the 3.8 million people (Government of Uzbekistan 2023) of the Aral Sea region in Uzbekistan live. Shifting the geographic focus allows me to question the narrative that the sea is gone[24], and therefore no additional water is needed to support the people of this region, to more closely probe the existing and historical flows of water in the delta. I analyze surface water availability in the delta from the

[24] For one articulation of this narrative, see the logo of the UN Multi-Partner Human Security Trust Fund for the Aral Sea region in Uzbekistan which states “The Sea is Gone, People are Not.”

late Soviet era to the present (1984-2021) with careful attention to change over time and different temporalities and the way this affects salt, fish and gardens. Ultimately by attending to this shadow place and its temporalities I subvert simple stories of responsibility for the Aral Catastrophe and argue that resuming flows of water from the Amu Daryo to the region are essential to support the human and more-than-human residents of the delta.

Temporality and the creation of "catastrophe"

There are multiple temporalities at work in the Aral Sea region and the Amu Daryo delta. These include what I call cyclical time, continuous time, and discontinuous time. These are mobilized by the Uzbek state, international and local organizations, environmentalists and others selectively to frame the Aral "catastrophe" as a global challenge requiring support from the global community. In his first speech to the UN General Assembly in 2017, Shavkat Mirziyoyev, Uzbekistan's second and current president held up the now ubiquitous map of the Aral Sea (Figure 16, left), stating "*I am holding a map showing the Aral Sea tragedy — I believe that words are not necessary*" (Shavkat Mirziyoyev, UN General Assembly, 2017). The map shows

Figure 16: Left: Shavkat Mirziyoyev speaking at the 72nd UN General Assembly in 2017. Photo: UzA; Right: Alternative map which adds the Aral Sea in 1991, the year of Uzbekistan's independence. Map by K.F. Shields

the sea in 1960 – the Soviet era, and 2017 ("Today"), and is an example of what I call discontinuous time. This map lays responsibility for the "catastrophe" with the Soviet Union, an entity that no longer exists. The fact that today half of the ongoing "catastrophe" has taken place under independent Uzbekistan is obscured. Independence in 1991 is part of the silence between the before-and-after. The simple act of adding another timepoint can shift the narrative. The map on the right of Figure 16 which shows the extent of the Aral Sea in 1960, 1991, and 2017 tells different story about responsibility for the "catastrophe", highlighting how the decreasing area of the sea has continued under the watch of the independent Uzbek state. The point of this alternative map is not to quantify and attribute responsibility for the Aral "catastrophe", but to contest simple narratives that put all responsibility on the USSR. I want to highlight three factors here that complicate the alternative map in Figure 16. First, the origins of the "catastrophe" predate the Soviet Union (Peterson 2019). Second, water is diverted from the Amu Daryo and Syr Daryo for irrigation – and thus diverted from the Aral Sea – by Uzbekistan, Turkmenistan and Kazakhstan. Uzbekistan is therefore partly, but not wholly responsible for the shrinking Aral Sea after the breakup of the Soviet Union. Finally, the relationship between lake size and volume is non-linear for the Aral Sea. Using the 1960 area of the sea (68,900 km^2) as a baseline, the sea had shrunk 59.6% in area by independence in 1991 and a further 38.3% in area by 2017. Using the 1960 volume of the sea (1083 km^3) as a baseline, the sea had shrunk 74.3% in volume by independence in 1991 and a further 18.9% in volume by 2017 (CAWater-Info n.d.). Interestingly, 2017 was actually a high-water year, and Kazakhstan had to let water out of the Ko'k Aral dam, which lead to a temporary filling of part of the Eastern basin, not shown on Mirziyoyev's map. In this paper I seek to complicate narratives of the Aral Sea based in a discontinuous temporality through a focus on continuous and cyclical time.

Cyclical time helps call attention to the more-than-human residents of the region. Edensor and colleagues (2019b) note that our forms of representation impose linearity on cyclical time of nature, such as seasonal changes, precipitation and winds, and reproduction. In the Aral Sea basin, much of the precipitation, both in the mountains of Kyrgyzstan, Tajikistan and Afghanistan, and in the Aral Sea region itself, falls in the winter. In the spring, snow melts and water flows into the Amu Daryo delta increase. Salt is transported down the river. Fish lay their eggs. In summer, things dry up and winds are stronger. Human and more-than-human time are intertwined, giving a cyclic pattern to many human-environment activities such as washing the soils through a process of flooding and then draining fields to remove excess salts that would stunt plant growth, planting, and harvesting. While these changes occur each year, many cycles are longer such as glacial expansion and retreat in the mountains, and cycles of expansion and retreat of the Aral Sea (Boroffka et al. 2006; Narama 2002). Attention to cyclical time also highlights that not all change is pathological, and that change is non-linear and variable.

Phenomena in continuous time are not necessarily linear or progressive, there are possibilities for variability and reversals. In contrast to cyclical time, there is no expectation that a place will return to a past state. The nearly continuous nature of Landsat is one of its major draws, as scholars highlight the challenge of one-off visual descriptions of landscapes (Turner 2003) or studies that do not use a long enough time period (Kelley, Evans, and Potts 2017). Kelley and colleagues (2017) highlight how short duration studies can miss key political events. This is indeed one of my reasons for using Landsat-derived data: it encompasses the transition from the Uzbek Soviet Socialist Republic to the Republic of Uzbekistan in 1991. In this study, continuous time is most closely recorded by the view from the satellite. Landsat 5, 7 and 8 were/are sun-synchronous, near-polar orbit satellites that completed an earth orbit every 99 minutes and had a 16-day repeat cycle, meaning that images were supposed to be collected at the same point on earth every 16 days. This view from the satellite every 16 days shows incremental change. In this sense the view from the Landsat *can* represent the temporality of 'slow violence', "a violence that occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space, an attritional violence that is typically not viewed as violence at all" (Nixon 2011, 2). In this temporality, the shrinking of the sea is slow and non-linear. With a spatial resolution of 30-meter pixels, the details that make up slow violence, and the people affected, are often hidden, so one must look carefully at Landsat imagery to gain partial insight into slow violence. Seeing these small changes is easiest through time series animation, allowing the eye to watch the changes.

Visualizing the results of slow violence over continuous time on a static map nearly always leads to discontinuous time. In discontinuous time, particular moments or slices of continuous time are taken out of context and put together to tell a particular story. Seeing slow and spectacular violence as relational (Christian and Dowler 2019), I argue that it is the process of picking out and juxtaposing specific timepoints of slow violence that creates spectacular violence. In their work on before-and-after photography, Bear and Palmer Albers identify that "the before-and-after trope works to hide the intervening series of events: the less the viewer thinks about the visually absent period of time…the better it is" (2017, 6–7). Garrard and Carey (2017) highlight how repeat photography of glaciers leaves society invisible. The moments between the snapshots are hidden, obscuring lived experiences and health consequences for local residents as well as causes of and responsibility for the ongoing drying of the sea. The maps and infographics generated through the creation of discontinuous time must be seen as power laden (Wood 2010).

Water policy and law in the Aral Sea region

As codified in the 1970 Principles of Water Law of the USSR and Union Republics, water was "state property, that is, property of all the people," with the central government responsible for planning and approving water usage. In many ways, Soviet approaches to construction and maintenance were a continuation of the Tsarist approach (Teichmann 2007). For the Soviets, any water that was not used for irrigation and reached the Aral Sea was considered waste (Zonn 1999). This notion of wasted water remains pervasive in Uzbekistan today (Oberkircher and Hornidge 2011). In addition, the USSR also sought to leverage water to modernize the country and create a new Soviet citizen. Lenin famously asserted that "irrigation…changes the country; it leads to its rebirth, buries the past and enforces the transition to socialism" (quoted in Teichmann 2007, 503). Lenin's quote also illustrates the Soviet desire for control over nature through, for example, transfer of water from Siberia to Central Asia (P. P. Micklin 1986).

Overall, water governance in Central Asia has not changed abruptly with changes in historical state formation, but can be seen as a series of incomplete transitions (see Jones Luong 2004b for a discussion of transition in Central Asia more broadly). The 1993 Law of the Republic of Uzbekistan on Water and Water Use largely follows the 1970 Principles of Water Law of the USSR and Union Republics. Water remains owned by the state and the state retains control over the use and protection of water. Collective farms were gradually broken up after independence, with local governance generally transferred to new Water User Associations following the Integrated Water Resources Management (IWRM) paradigm (Mukhamedova and Wegerich 2014). The pre-Soviet *hashar*, a system of obligations such as the yearly maintenance of the irrigation systems linked to benefits from irrigation (O'Hara 2000b), has been formalized and is now enforced (at least in theory) by the Water User Associations (Gunchinmaa and Yakubov 2010). Unlike the Soviet period where water was officially free, the 1993 Uzbek water law states that "the use of water shall be subject to payment" and there has been a push for water pricing through various donor projects, such as those of the World Bank (O'Hara 2000a). After independence, the desire of the newly independent Central Asian states to become food secure/self-sufficient has driven water governance internally (Weinthal 2001) while security concerns have driven transboundary water negotiations (Mosello 2008).

Interweaving partial perspectives

In this paper I probe the consequences of the water policy and law in the Aral Sea region for both human and more-than-human residents. Water is a multi-dimensional material, necessary for life, part of human ritual and religion, used for transportation, and generating livelihoods, among other things. Water is also variable across time and space. It flows over the landscape, changes form to ice and water vapor, and picks up traces of the surfaces it moves over, including sand and salt. In order to take these multiple dimensions of water into account, this paper interweaves ethnographic, remote sensing and geophysical data. In this section I review feminist perspectives on objectivity, mixing methods, and triangulation that inform the methods for this research.

Feminist scholars have probed the seeming objectivity of remote sensing data. Litfin calls remote sensing the "ultimate subject/object dichotomy…offer[ing] the tantalizing prospect of being able to leave the earth in order to get a better view" (1997, 31), what Haraway refers to as the "the god trick of seeing everything from nowhere" (1988, 581). While high-resolution imagery and Unmanned Aerial Vehicles (drones) can now see humans and detailed evidence of humans on the landscape including houses, crop and afforestation furrows (see Chapter 2), and harvesting of reeds for roofs, much of the publicly accessible remote sensing data currently has at best a 10-meter resolution, which does not show these people, dwellings and small-scale evidence of human activity. When people themselves become invisible – and even if resolution becomes high enough to make people visible when zooming in – it becomes easy for vision to become totalizing (Litfin 1997), and for critical and interlocking axes of differences that affect the relationship between people, the environment and the state such as gender, race, ethnicity, etc., to be ignored.

Importantly, however, simply aiming for better accuracy, which is often the focus of the remote sensing community, can also lead to what Braun (2021) describes as the "more accurate less meaningful" effect. With any given resolution, what becomes critical is careful attention to what is made visible and what is hidden, including both humans and more-than-humans; imagery does not speak for itself, it requires people to see it, narrate it and analyze it. The question becomes who is considered qualified to speak for and interpret this data, and what are their positionalities (Litfin 1997) and subjectivities (A. C. Braun 2021). For example, for the viewer not familiar with a landscape, remote sensing can both hide (Widengård et al. 2018) and reveal (Lukas 2014) changes to the landscape. It is necessary to make explicit the partial and situated perspectives of both the eye of the satellite and the eye of the narrator.

Instead of the "god eye trick," Haraway (1988) argues what is needed is embodied vision – or situated knowledge - which is necessarily partial. Feminist objectivity comes through a collection of these situated and partial perspectives. Nightingale builds on this idea to argue that "geographers can interrogate the partiality of knowledge through mixed method research design" (2003, 78). She identifies three approaches to triangulation through mixing methods in “epistemologically plural research design”: convergence, complementarity, and divergence (Nightingale 2016). In the following paragraphs I probe each of these approaches.

A classic convergent approach would be to use landscape observations to “ground truth” remote sensing analysis. The goal is for the results to be the same, which then validates the findings from remote sensing. While ground truth data is seen as truth, it is in reality an embodied vision that brings in the positionality and subjectivities of the viewer. For example, several studies in remote sensing show how the categorization of land use and land cover depend on who is doing the ground truthing and creating the categories (Robbins 2003a), calling attention to ground truth data as a partial perspective. There is also a geography of ground truthing, with more observations collected at places that are more accessible (Turner 2003), thus privileging these places as more important or “true”.

Scholars who question whether convergent triangulation of remotely sensed or geophysical data and “ground truth” is sufficient have advocated a complementary approach to triangulation. In a complementary approach, different data sources are analyzed or interpreted together so that each dataset adds something new to the results in order to provide a greater understanding of the same question. Bennett (2020) argues that remote sensing cannot unpack socioeconomic context – and improved resolution does not help this. She argues instead for the “integration” of remote sensing and ethnographic work. Tellman and colleagues (2020) suggest two approaches to this kind of integration. The first is “socializing the pixel”, doing remote sensing and then further explaining the results through ethnographic fieldwork. Bennett and Faxon (2021) take this approach to understand the geopolitics of development in Myanmar, as does Kelley (2018) in her work on smallholder cacao expansion in Indonesia. Kelley adds household surveys to her ethnographic component. The second is “pixelizing the social” where the researcher(s) start with ethnographic data and complement it with remote sensing. An example is Jiang's (2003) work on landscape change in Mongolia. Treating remote sensing as a story rather than the 'truth' she asks, "how can remote sensing analysis reveal additional stories about land and culture?" (2003, 217). Malone and Foster's (2019) work in Oregon on the unintended consequences of no-till agriculture can also be seen as an example of "pixelizing the social", although in addition to remote sensing data they used herbicide analysis of water, sediments and soils.

While Tellman and colleagues suggest that these two complementary approaches can then be combined through convergent triangulation, their two approaches of "socializing the pixel" and "pixelizing the social" are linear, and do not take into account the messy and iterative nature of fieldwork and analysis, particularly when remote sensing data are not just out of sight on the computer during fieldwork for use in a separate analysis, but constantly available and put to use for navigation through the satellite imagery on the Google Maps app on a smartphone. In this way, I constantly shifted my seeing from the view from above to the view from the ground and back again. My view of the Aral Sea region is in some sense a co-production of the view from above and my embodied view from the ground.

The final approach to triangulation is divergence. In her work on community forestry in Nepal, Nightingale argues that the "inconsistencies between the two 'data sets' [ethnographic and aerial imagery] lent insight into the importance of control over the forest" (Nightingale 2003, 85). Her approach is to triangulate for divergence at the level of analysis, highlighting that before bringing the datasets into conversation it was necessary to ensure that "the results from these two methods were robust *on their own terms*" (Nightingale 2003, 83).

Although the analysis in this paper comes closest to complementary triangulation, I suggest that my work does not fit neatly into any of these categories of triangulation. This is because my focus is not on triangulation to better pinpoint the truth, but to weave partial datasets to tell a more nuanced and complex story of the Aral Sea region.

Methods

In order to probe the consequences of water allocation policies for the landscape and the human and more-than-human residents of the Amu Daryo delta, this paper interweaves the partial perspectives of ethnographic, remote sensing and geophysical data. In this section I describe my feminist-mixed methods approach to this work. Doing research in a recently authoritarian setting has meant that I do not have "complete" internally valid datasets that I can compare and contrast. I was not allowed to do environmental oral histories nor talk to government officials. I was only able to access limited geophysical data through the connections I made through my participant observation. Adding to this partiality, the early tasking and experiments with privatization of Landsat (Litfin 1997) mean that there are "missing" observations for years and seasons of all or part of the Aral Sea region. My data are therefore partial in two ways: first, they are partial because they are not complete internally valid datasets. This does raise the question of what a complete dataset would be. When confronted with incomplete geospatial data or databases, there can be a desire to 'fill' these datasets even when complete data are not required (Turner 2003), or to adopt different geospatial methodologies for the gaps (Zubrow 2003). In this work I have embraced multiple partial datasets (geospatial, geophysical and ethnographic) and resisted the urge to fill in the gaps. Second, they are partial in that each offers a partial perspective into the world. Rather than look at the differences between them, I weave together the doubly partial insights from each data source to shed light on changing flows of water in the Aral Sea region of Uzbekistan. I find value in Nightingale's metaphor of an interdisciplinary research design as a kaleidoscope: "when the kaleidoscope is turned, a new pattern can emerge – albeit one that is always partial and situated – and when different patterns are compared, new insights can emerge" (2016, 41). Below I provide detail on each source of data and my pre-processing.

Ethnographic

Ethnographic data is based on nine months of fieldwork in the Aral Sea region of Uzbekistan where I was based in Nukus, the capital of the Republic of Karakalpakstan. I conducted formal participant observation with two different development organizations, one multilateral, IPD, and one bilateral, Development and Cooperation Agency (DCA), spending three months as an intern at each. Overall, my data collection process was iterative. As I identified new themes through the process of memo writing, I sought to bring them into my research. I participated in the daily activities of the organizations I worked with and documented my observations through daily field notes (total 130 days of notes). My data also includes 17 interviews conducted in Tashkent and Karakalpakstan between April and December 2021 and five remote interviews conducted in January and February 2022 after my return to the US (Table 1). I used a snowball approach to identify participants, in order to a) speak with staff at as many development projects as possible; and b) get perspectives on environment and development more generally. Between my participant observation and interviews I spoke with staff at all projects operating in the Aral Sea region in Uzbekistan in 2021. Formal interviews were recorded and transcribed while informal interviews were documented with extensive field notes but not recorded. Interviewees – both formal and informal – provided verbal consent prior to participating. In addition, I traveled extensively in Karakalpakstan and recorded informal daily interactions with local residents and the environment in my field notes. Finally, I amassed a collection of documents including UN resolutions and speeches, speeches of the President of Uzbekistan, and development organization documents, some of which are available online, and some of which were made available through the network that I generated.

My analysis process started during data collection by including reflective and/or analytical memos at the end of my fieldnotes. After completing fieldwork, all of my data were assembled in MAXQDA for further analysis. I derived initial concept codes (Saldaña 2016) from conversations with my participants and re-reading my memos. I used an iterative coding process to apply my initial concept codes (e.g. “state as steward”, “possibility”) and identify and develop additional concepts that emerged from re-engagement with my data through the coding process (e.g. “devaluation”, “temporality”).

Remote Sensing: surface water

The goal of using remote sensing data was to identify temporal and spatial changes and variability of surface water in the Amu Daryo delta. Table 5 summarizes the metrics based on remote sensing and geophysical data that I analyze in this paper. I obtained water data from the Global Surface Water (GSW) Monthly Water History dataset (Pekel et al. 2016) which is pre-processed Landsat 5, Landsat 7 and Landsat 8 data from 1984 to 2021. The dataset provides values of water, no water, or no data for each month in each pixel. Data were available over at least part of the Aral Sea region for all years except 1988.

I created a pixel-level yearly water occurrence metric using Google Earth Engine which is defined as the percent of months where water was identified in the pixel out of months of data for that pixel for the year. I created yearly water extent rasters by categorizing the yearly water occurrence data into permanent water, where yearly percent occurrence was 100%, seasonal, where yearly percent occurrence was greater than 0% but less than 100%, and no water where yearly percent occurrence was 0%.

I also created two summary layers – one raster and one vector – from this yearly water occurrence metric. The first was a maximum permanent water extent raster. If for at least one year between 1984 and 2021 yearly water occurrence was 100% (permanent) the pixel was classified as 'water'. If between 1984 and 2021 the pixel did not have permanent water in any year, the pixel was classified as 'not water'. I also created a maximum lake/river extent vector layer to map of the maximum extent for each of the delta lakes and the mainstem of the Amu Daryo. Importantly, this maximum extent is additive, meaning that it represents all area of a lakebed/river channel that had permanent water in at least one year between 1984 and 2021. It is not the maximum extent of water from one year. Starting with the maximum permanent water extent raster, I used QGIS to remove ('sieve') all areas less than 10 pixels from the composite raster to remove noise and then polygonised the raster for 'water'/'not water' using an 8-connectedness approach. Based on the generated water polygons, I identified the maximum contiguous extent for lakes through reports from the International Fund for Saving the Aral Sea (IFAS) (IFAS 2019) and lakes appearing on OpenStreetMap ("OpenStreetMap" n.d.). I added non-contiguous polygons to a lake extent if they were completely enclosed by the lake polygon, or if they were known to be in the lake area using IFAS documents and the author's ground knowledge.

Additional processing was required for delineation of maximum extent of the mainstem Amu Daryo because flood irrigation is commonly used for agriculture in the Amu Daryo delta which means that the area of many fields was also included in the maximum water extent. I manually removed fields that were connected to the mainstem Amu Daryo in QGIS. These edits

Table 5: Summary of quantitative metrics assessed

Metric	**Data source**	**Temporal resolution**	**Spatial resolution**	**Description**
Yearly water occurrence	GSW	Yearly from 1984-2021	Pixel-level for Amu Daryo delta	Percent of months where water was identified in the pixel out of months of data for that pixel for the year
Maximum permanent water extent		Summary of 1984-2021	Pixel-level for Amu Daryo delta	Raster layer where each pixel is classified as: **water** if yearly water occurrence is 100% (permanent) for at least one year **not water** if there was no permanent water for any year between 1984-2021
Maximum lake/river extent		Summary of 1984-2021	Vectorized pixel-level data for Amu Daryo delta	Maximum permanent water extent of each lake and the mainstem Amu Daryo [process described in text]
Yearly water extent		Yearly from 1984-2021	Pixel-level data for Amu Daryo delta	Raster layer where yearly water occurrence values are classified as: permanent 100%, **seasonal** < 0% and >100% no water 0%
Largest patch		Yearly from 1984-2021	Each of the delta lakes and the Amu Daryo	Largest permanent water polygon for each lake and the Amu Daryo
Patch percent		Yearly from 1884-2021	Each of the delta lakes and the Amu Daryo	Area of the largest patch in a year as a percentage of the total size (combined permanent and seasonal water) of the lake or river in that year
Amu Daryo flow rate	Global Runoff Data Center	Monthly Kerki: 1932-1937; 1952-1989 Chatly: 1931-1973	Two gaging stations: Chatly and Kerki	Flow of the Amu Daryo passing the gaging station in m^3/sec
Water releases to Amu Daryo delta	CAWater-Info	Monthly from 1992-2022	Unknown, somewhere on Amu Daryo at the beginning of the delta	Amount of water released to the Amu Daryo delta, including the total discharge of Suenli and Kyzketken canals and discharge of collector drainage network in million m^3/month
Precipitation	Personal communication	Monthly from 1991 to 2019	Chimbay district	Precipitation per month in mm
Soil salinity	Karakalpakstan Branch of the Agrochemistry Laboratory	One-time measurement in 2021	Active cotton and wheat fields in 2021	Categorized salinity values of salt as percent of dry soil residue: very high >3%, **high** 2-3% and **medium** 1-2% No fields had values below medium.

were guided by a cumulative months of water occurrence raster and current satellite imagery from Google Maps. In the upper part of the delta, the Amu Daryo forms the border with Turkmenistan. Portions of this section of river lying in Turkmenistan were included in the analysis. My analysis is limited to the Amu Daryo that lies within the Aral Sea region. My analysis does not include the canal and collector system of the delta because with the resolution of the Landsat data (30 by 30-meter pixels) many of the canals and collectors do not appear in the GSW data.

I used the ‘terra’ package in R to calculate the area of permanent, seasonal, and no water for each lake and the Amu Daryo for each year. Finally, in order to analyze discontinuities in water over space, I vectorized the yearly water extent raster for each year and calculated the area of each permanent water polygon. I identified the largest patch for each lake and the Amu Daryo. I then calculated the “patch percent”, a metric showing the area of the largest patch of permanent water in a year as a percentage of the total extent (combined permanent and seasonal water) of the lake or river in that year.

Braun (2021) calls for users of remote sensing data to be more transparent about the limitations of their data. Like the Landsat data from which it is derived, the GSW dataset is seemingly complete, but has data gaps resulting from a) missing images, in part due to the privatization of Landsat imagery from 1984 to 1999 (NASA 2021a); b) cloud and dust cover that make some of the imagery illegible, although this problem is smaller in the Aral Sea region than elsewhere; and c) technical issues with the sensors in Landsat 5 and Landsat 7 (NASA 2021a; 2021b). One particular challenge for the Amu Daryo delta is the abundance of reeds and other wetland plants. The GSW data generally does not classify water with growing emergent vegetation as water (Pekel et al. 2016), although these areas would be more likely to be classified as water in months where vegetation was not actively growing.

Geophysical

Geophysical metrics are summarized in Table 5. Salinity and precipitation data used in this paper were gathered as part of the DCA project which were made openly accessible. Monthly precipitation data for the Chimbay district were obtained from one of the consultants through personal communication. Soil chemistry testing was conducted by the Karakalpakstan Branch of the Agrochemistry Laboratory (Karakalpakstan Branch of the Agrochemistry Laboratory 2021b). The Soviet-era flow data I present for the Amu Daryo is publicly available from the Global Runoff Data Center (*The Global Runoff Data Centre* n.d.). Finally, data on water entering the Amu Daryo delta from 1992 to the present is publicly available from the CAWater-Info portal (CAWater-Info n.d.).

Human and more-than-human consequences of water policy

In this section, I weave together three strands to show environmental change and its impacts on local human and more-than-human residents. First, I quantify decreasing surface water flow and area in the delta. Second, I investigate how it is not simply overall decline which matters for the delta, but increasing temporal variability and spatial discontinuity in surface water. Finally, I show the extent of soil salinization in one district of the Aral Sea region and how this links to declining surface water resources. Before beginning, I provide a brief overview of the geography and fluvial geomorphology of the Amu Daryo.

The Amu Daryo is a braided sand and gravel bed river. Before 1960 it had the highest sediment load of any river in the world (Obertreis 2017). The Amu Daryo basin is 535,000 square kilometers and is hemi-arid with nearly all water flow coming from snow and glacier melt in the mountains of Tajikistan and Afghanistan (Schlüter et al. 2013). The mainstem Amu Daryo forms from the confluence of the Vahksh and Panj rivers at the boundary between Afghanistan and Tajikistan. The river then passes through part of Turkmenistan before forming the border between Turkmenistan and Uzbekistan and finally turns north through the Aral Sea region of Uzbekistan where it previously fed the Aral Sea from the south.

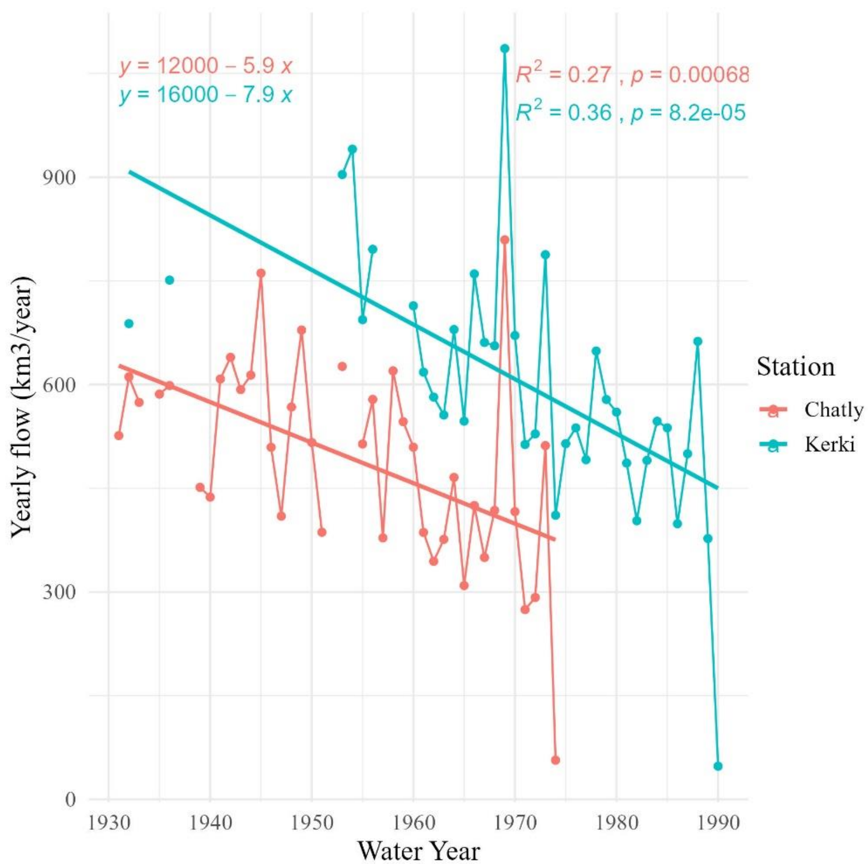
There are many human-made diversions of water from the river for irrigation, the largest of which is the Karakum canal which flows through the desert of Turkmenistan past Ashgabat and diverts 11 cubic kilometers of water each year. Construction on the Karakum began in 1954 and by 1972 the canal was 900km long (Obertreis 2017). Construction petered out in the early 1970s. Upstream on the main tributaries of the Amu Daryo, the Panj and Vakhsh, hydropower is still underdeveloped, but Tajikistan is currently building the Rogun Dam, the world's tallest dam on the Vakhsh. The Rogun Dam could significantly decrease irrigation water in Uzbekistan (Bekchanov et al. 2015). The diversion of water from the Amu Daryo by other states, primarily Turkmenistan, and the upstream control of water through dams by Turkmenistan means that while the Uzbek state has significant power to affect changes to water within its boundaries, it does not have complete control over total flows of the Amu Daryo.

Decreasing surface water flows

The lakes of the Amu Daryo delta are supplied by natural distributary channels, irrigation canals, collectors (drainage canals), local precipitation and groundwater. In this paper I focus on the surface water inputs that originate from the Amu Daryo including natural distributary channels, and irrigation canals and collectors. There were two gaging stations that operated on the river during the Soviet period, both in the Turkmen Soviet Socialist Republic. The Chatly station (see map Figure 2) was within the Amu Daryo delta, while the Kerki station was located just after the Amu Daryo enters Turkmenistan, slightly downstream of the Karakum canal. Figure 17a shows the declining trend in flows during the Soviet period at both gaging stations. Looking at gradual change through the perspective of continuous time, results from linear regression indicate yearly flow rate decreased on average 5.9 km^3 per year at Kerki gaging station (upstream) and 7.9 km^3 at Chatly gaging station (downstream). Data for the Chatly station ends in 1973. According to the data, no water flowed past the gaging station in March 1971 and January 1972. The station may have been abandoned due to low flows, at least in part due to diversion of water into the Karakum canal. Post-independence, data is available for the amount of water that enters the Amu Daryo delta. Figure 17b shows that these flows have also been decreasing. Results from linear regression indicate that on average flow rates declined by 0.43 km^3 per year.

These flows feed the eighteen named bodies of water in the Amu Daryo delta – although in my analysis, two of these lakes could not be accurately separated based on available data and were left merged (see map Figure 18, lake/river numbers from Table 6 are referenced throughout the text). An additional three unnamed lakes were created which represent seasonal areas of the declining Aral Sea. The Amu Daryo delta is at this point a hybrid system, included both natural and constructed (dammed) lakes. Recommendations to create artificial lakes in the delta have a long history. Writing just before the dissolution of the Soviet Union, Bortnik and colleagues from the Oceanographic Institute and Water Problems Institute, Russian Academy of Sciences recommend that “it is desirable that part of the Amu Dar’ya runoff be used for the restoration of

A: Historic annual flow rates for the Amu Daryo



B: Annual releases of water to the Amu Daryo delta

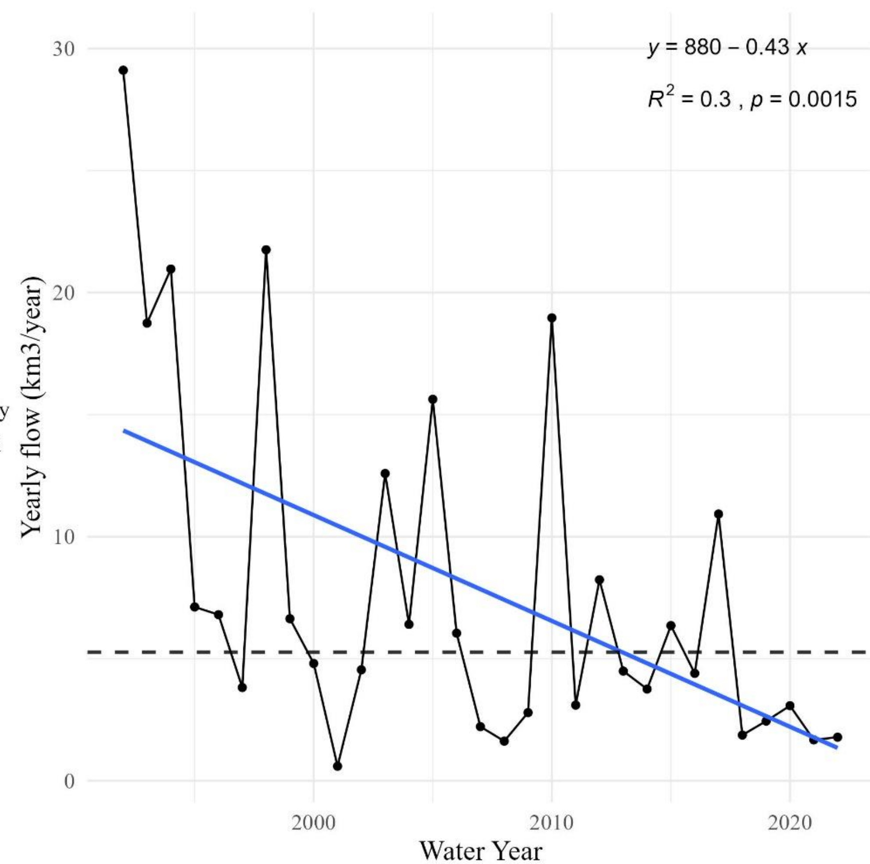


Figure 17: Decreasing flows into the Amu Daryo delta. Graphs include linear regression equation, Pearson R^2 value and p-value for R^2. **A**: historic annual flow rates for the Amu Daryo. **B**: Annual releases of water to the Amu Daryo delta. Data sources detailed in Table 5.

small water bodies, either in the process of drying up or already completely gone" (1992, 321)[25]. The paper contains a footnote by Phillip Micklin, long-time researcher of the Aral Sea and guest editor of the special issue that contained the Bortnik et al. paper, that this restoration effort was in fact already underway. Some of the delta lakes were created through dams as the Aral Sea receded. This includes Muynak reservoir (13) and Mezhdureche (11), Rybachye (15) and Zhylterbas (22) lakes which were created between 2004-2008 under the Second program for the Aral Sea Basin (IFAS 2019). Sudoche lake (18) was once part of the Aral Sea (Butakoff 1853) but the nearby fishing town of Urga had been abandoned by the 1960s due to lack of water (Fieldnotes 9/3/2021). The lake was restored through a Global Environment Facility (GEF) project funded from 1998 to 2004, with construction of low earthen dams (GEF 1998). Three of the lakes were part of the Aral Sea in 1960: Muynak reservoir (13), Rybachye (15), and Zhylterbas (22). There are currently various other dams, canals and spillways under construction by IFAS so that water can move between the delta lakes. Resources for this infrastructure expanded dramatically after Mirziyoyev's visit to the region in 2018 (see Chapter 1), including a presidential decree that appointed one of the largest construction companies as a partner in this work without a tender (P3).

In any given year, some area of a lake may be covered in permanent water meaning it remains wet throughout the year, while other areas have seasonal water and are dry for at least one month of the year. Overall, my analysis of the GSW data shows that there has been a decrease in the amount of permanent surface water across the lakes of the Amu Daryo delta (Figure 19). Permanent water in the delta was at its peak in the early 1990s and then has declined

[25] While the original article was published before the dissolution of the Soviet Union in 1991, the article was translated and published in English in 1992.

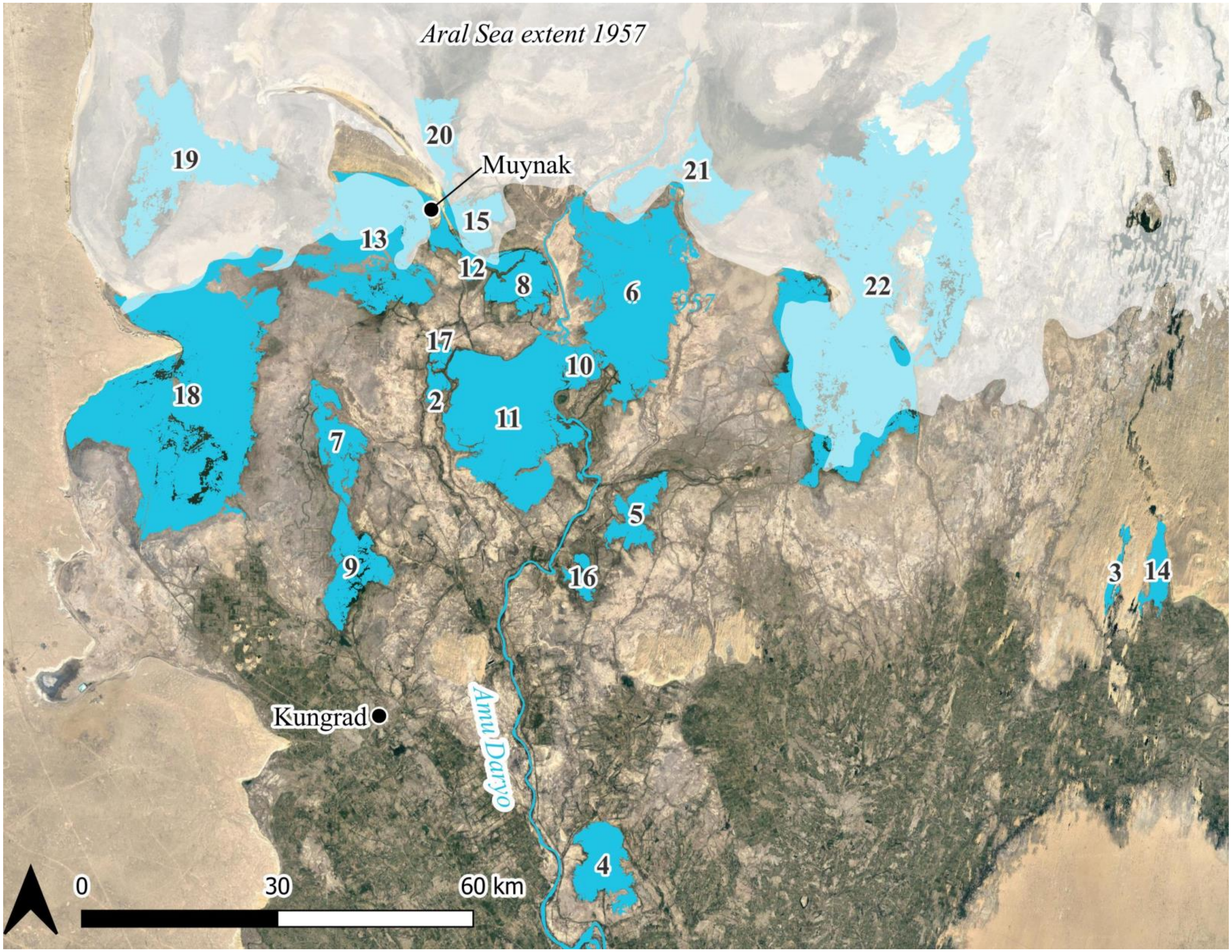


Figure 18: Reference map showing Delta lakes. The numbers of lakes correspond to those in Table 6.

Table 6: Summary information for delta lakes and the Amu Daryo

Lake/river number	Lake/river name	Year of maximum extent	Size range (km^2)	Standard deviation (km^2)
1	Amu Daryo	1998	382.19-872.47	131.56
2	Big Zakirkol	1998	0-9.98	3.03
3	Botakol	2013	4.26-9.41	1.36
4	Dautkol	1991	15.65-77.68	15.07
5	Dawilbay	2010	0-43.05	12.40
6	Domolak	1998	0-298.42	90.43
7	Karadjar & Ilmenkol	2016	0.01-59.97	17.02
8	Makpalkol	1991	0.25-50.88	10.81
9	Mashankol	2016	0-51.68	12.51
10	Maypost	1998	0-24.04	8.16
11	Mezhdureche	1992	6.26-320.42	85.75
12	Muynak lake	1991	0-32.88	8.38
13	Muynak reservoir	1991	0-226.42	48.96
14	Qarateren	1996	19.98-29.9	2.09
15	Rybachye	2016	0-46.27	10.41
16	Shylymkol	2010	0-14.81	5.04
17	Small Zakirkol	1993	0-7.51	2.72
18	Sudoche	2017	100.48-567.59	150.03
19	unnamed1	2018	0-160.73	50.47
20	unnamed2	1992	0-38.72	9.88
21	unnamed3	1992	0-81.27	20.32
22	Zhylterbas	2016	67.77-719.88	149.51

since. Seasonal water has in general also increased, suggesting permanent water has shifted to seasonal water. In the last few years, seasonal water too has declined, perhaps reflecting a shift of seasonal water to no water.

My colleagues during my participant observation would often share what these delta landscapes used to look like when they had more water. Bob and Arslan, staff members at DCA, and I visited the Lower Amudaryo Biosphere Reserve together to learn more about this protected

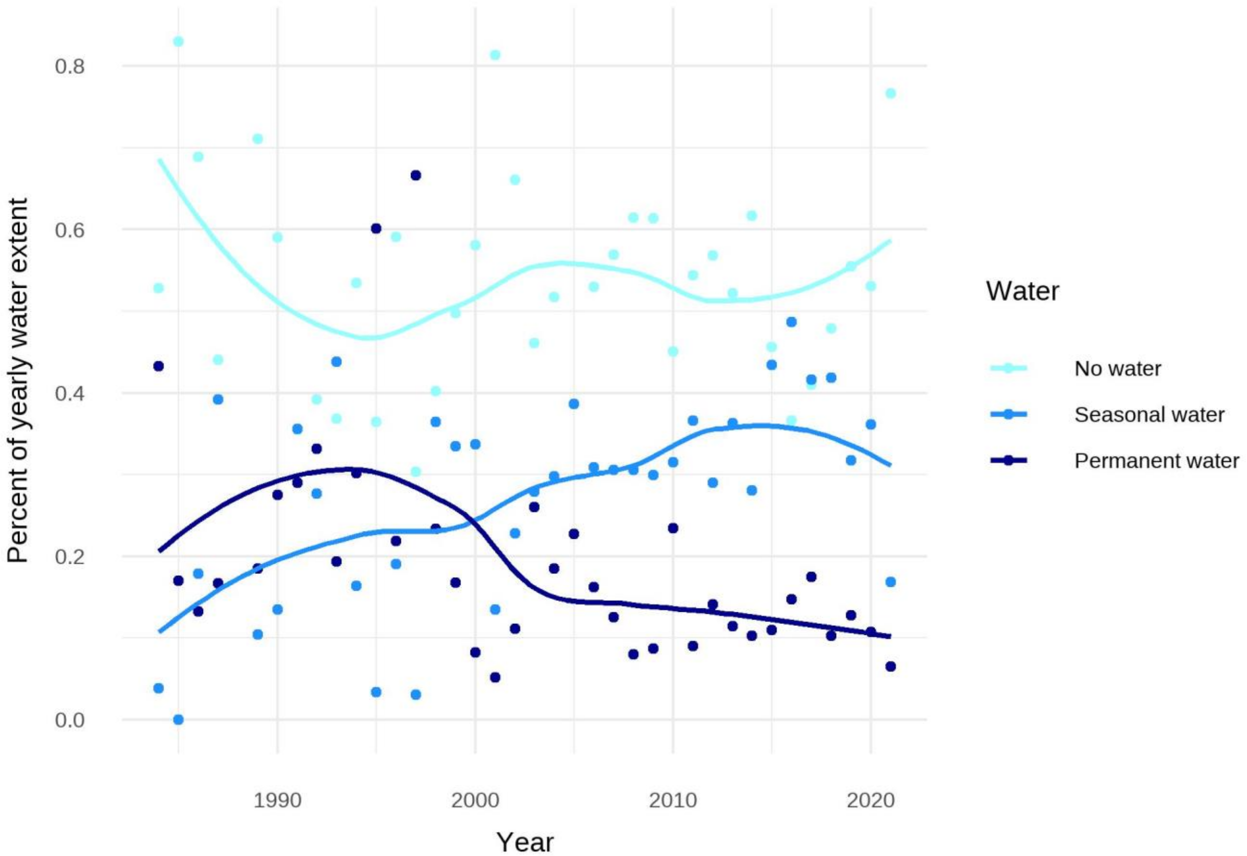


Figure 19: Area of permanent and seasonal water in the maximum lake extent of the delta lakes from 1984 to 2021. Lines are loess lines showing general trends.

area of riparian forest. Driving down to the river with the director of the reserve, Arslan was shocked at how narrow the river was. He told me several times about how much wider the river had been when he visited in his childhood and flows were higher. While the width of the Amu Daryo varies seasonally, the decrease in width over time is much larger and corresponds to the decreasing water releases to the delta since independence (Figure 17b).

This decrease and its consequences for fishers was highlighted during my first visit to Dautkol lake (4) with IPD after a training. We drove up a very steep slope, parking at the top of what turned out to be a dyke, part of the infrastructure creating and maintaining the delta lakes. My colleagues told me that

> *it used to be water right up to where we were standing, but now as I could see it was very dry. This only happened four or five years ago although one colleague from this*

> *area thought that the lake had first dropped in the 2000s. They had never seen the lake so dry before. Before this the lake was 30 kilometers by eight kilometers.*

The discussion then turned to fish, and how there used to be many, many fish in this lake. One colleague told me that he used to fish but doesn't anymore, lamenting that the younger generation also doesn't really fish anymore and the high cost of fish for those who did not catch their own. While this conversation about the drying of the lake and decline of fishing was for my benefit at the beginning, my colleagues continued it amongst themselves for another twenty minutes or so as we drove on.

After this visit to Dautkol, I had tea with colleagues at the university. When I told them about my visit, my colleague told me that *Dautkol is fed by the canals, so there should be some water in it*. I asked him if he had fished in his youth and he said *yes, of course, we just went down to the collectors, every collector had water in it all the time, and every collector had fish, and we could catch them all of my childhood*.

The long-term consequences of this decline in surface water were also apparent for gardeners. I was on a traditional "ground truthing" trip for my work with DCA with my colleague Arslan. We were trying to find a set of four randomly chosen points that looked like they were all along one road. When we got close Arslan said, *I know this place. I've been here before. My grandfather's son from his first marriage lives right around here*. We go to the house and Arslan opens the door and calls in, is anyone home. Unsurprisingly we are invited to stay for lunch, and so our stop is prolonged. Arslan's uncle repeats several times that *the soil is good here, but there is no water. He used to have a bunch of fruit – apples, pears, apricots, cherries – and almost all of the trees have died from lack of water.* He takes us outside to show us. He still has one *Jiyda* or Russian olive tree and then one *Irgchtek* or Jujube tree (Figure 20). I had never had a Jujube and neither had Arslan, so his uncle started stripping off the tree and putting small round dark red jujube fruits into my cupped hands until they started overflowing. On the way back into the house he pointed out where there had been a pond maybe 10 years ago. He told us that *they had caught two really big fish*. Demonstrating with his hands he indicated that they were about a meter long. These recollections of Arslan's uncle illustrate the Amu Daryo delta as a shadow place. Lack of water and the corresponding death of trees in this place is tied to cotton consumption in wealthier countries, and the Uzbek state's agricultural policies. After lunch we continued on, eventually abandoning the randomly chosen points for ground truthing and instead continued learning about the land through a series of interactions with other members of Arslan's family. We did take GPS points in an effort to later link types of knowledge together.

Figure 20: *Irgchtek* or Jujube tree

There is a recognition that more water is needed in these systems to support human and more-than-human life. Figure 21 shows the planned area of five of the lakes after the latest infrastructure projects to expand their capacity are finished, along with the size of permanent water in the lake area from 1984 to 2021. The figure shows that since 1984 none of these lakes has gotten close to the desired level. The problem is not lack of infrastructure, but lack of water coming into the lakes. In their publications, IFAS (2019) estimates that an inflow of 5.27 cubic kilometers of water is required each year to maintain all the delta lakes at their desired level [excluding Dautkol (4), Botakol (3) and Qarateren (14)[26]]. In 2022, only 1.79 cubic kilometers of

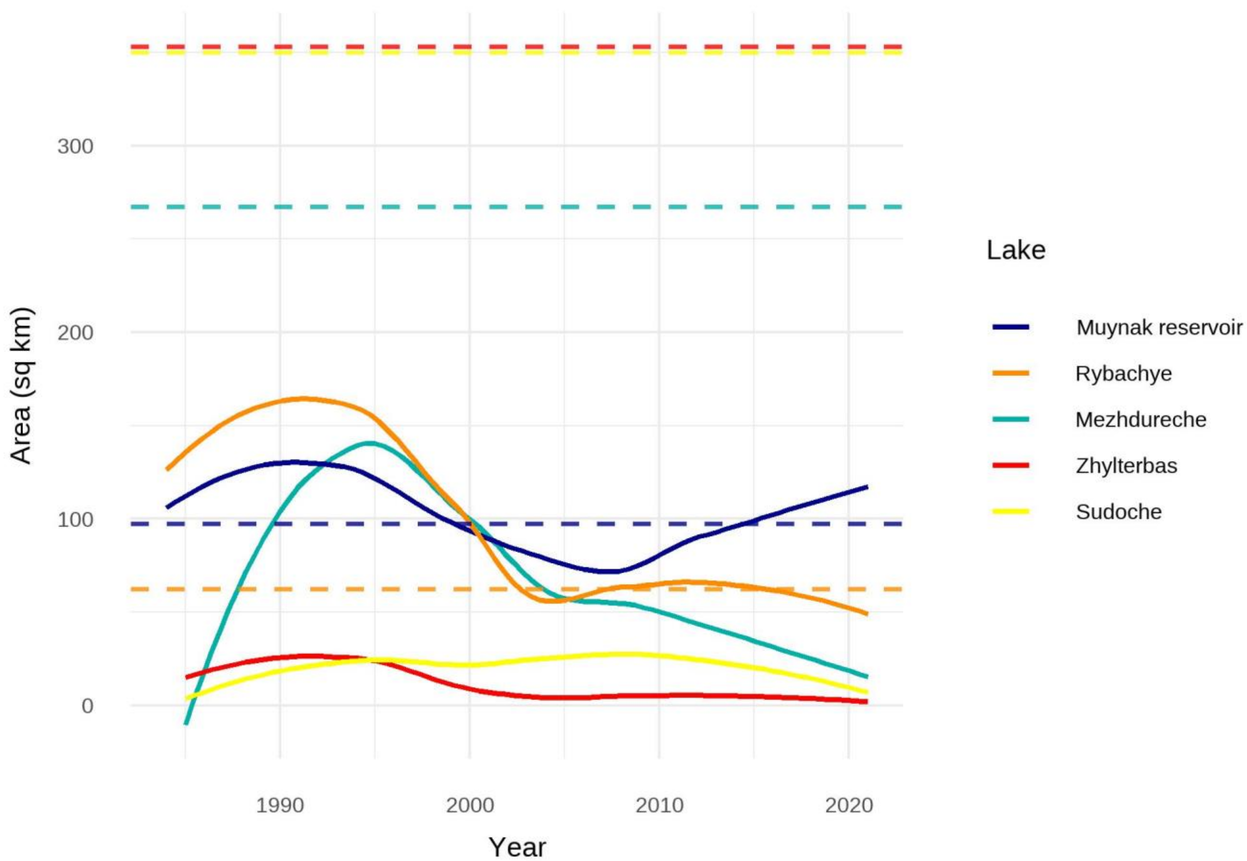


Figure 21: Comparison of actual and desired lake levels. Solid lines indicate the water level of five of delta lakes from 1984-2021. Dashed lines indicate the desired level of each lake as identified by IFAS

[26] Dautkol, Botakol and Qarateren are also fed by the canal-collector system but are more distant and less directly connected to the rest of the delta lakes, and also not encompassed by current IFAS infrastructure projects.

water were released to the entire Amu Daryo delta. The president visited the delta lakes to view the progress on the infrastructure projects in 2018. According to a participant, the president noted the progress on infrastructure but questioned whether there would be sufficient water to fill the lakes. He told me that his team "suggested a number of points, for example, to use these collectors from Khorezm, from Bukhara to faster implementation of water saving technologies and irrigation, to save more water, and *to allocate more water for this region*… As I show you, this year we have only… about maybe 20% of [the water] we demand. From this point of view about what kind of sustainability we can speak?" (P3, italics added). The solutions recommended to the president here are both technical and distributional.

One of the most popular of the technical solutions recommended in the Aral Sea region is drip irrigation, which is seen as a water saving technology that can be applied everywhere. However, a Karakalpakstani[27] development actor highlighted how organizations need to pay attention to the specific context and local knowledge, in this case soil and groundwater dynamics: "[Colleague's name] is also always saying why [do] we flood, why [do] we not using more and more drip irrigation? It's impossible, whoever you meet, whoever the farmer you meet, you cannot convince him or her to use drip irrigation. Because of the salinity, because of the level of groundwater" (P16). In this case, continued promotion of drip irrigation as an efficiency generating innovation erases locally specific knowledge about the consequences of secondary salinization, meaning salinity caused by human action. In the Amu Daryo delta, this occurs primarily through irrigation with saline water, or when improper drainage leads to groundwater levels high enough that water rises to the surface through capillary action, leaving any dissolved

[27] Karakalpakstan is multi-ethnic and multi-lingual. I use the term Karakalpakstani in this paper to denote someone from Karakalpakstan regardless of their ethnic identity.

salts in the upper levels of soils (Ibrakhimov et al. 2007). Much of the literature on salinization and irrigation in arid environments comes from Xinjian, China. While the results are mixed, there are suggestions that drip and mulched drip irrigation can lead to secondary salinization and requires washing of soils (Zaimin Wang et al. 2014; Z. Wang, Fan, and Guo 2019), currently a common – and water intensive – practice, suggesting that drip irrigation may not be the panacea that development organizations and the Uzbek state envision.

Further, suggested technical solutions such as water saving technologies like drip irrigation do not address the root cause of water distribution in the Aral Sea region, but could in fact lead to more water consumption upstream, and less water for those in the downstream reaches of the delta. Increasing efficiency in a variety of sectors, including irrigation, has shown to increase, rather than decrease, use of a resource, in what is known as Jevon's paradox (Y. Wang et al. 2020; York 2006; 2012). Recent research with stakeholders in Uzbekistan indicates that while irrigation efficiency may be improved, these savings will not be fully realized in decreased water use (Hamidov et al. 2022). This was corroborated with an interview with two staff members from an international financial institution, who suggested that they do not call it "water saving" but increasing "water productivity". They said that without a cap in water allocation, you could never see much of that water from improved irrigation efficiency (P25&P26).

Variable in time and discontinuous in space

I now turn from the slow change of decreasing flows in continuous time to variation of surface water in time and across space, which is partly represented through cyclical time. Seasonal water in the Amu Daryo delta is driven by two main factors: the natural hydrologic regime which is driven by snowpack in the mountains of Central Asia (Djumaboev et al. 2019), and particularly during the Soviet era, Central Asia-wide water policy that kept water in reservoirs during the winter and released it during the summer for irrigation (Weinthal 2001). Although current flow data is not available, the gaging station data from the Soviet period are illustrative of flow trends that have likely continued: flows are high in the summer months and lower in the winter (Figure 22a), which aligns with the timing of snowmelt in the mountains. Figure 22b shows water releases to the Amu Daryo delta by month since the independence of Uzbekistan. Water remains variable by season, but the clear cyclical patterns from the Soviet period are now muddied.

Water flows in the Amu Daryo are also variable from year to year. At the Chatly gaging station, flow ranged from 15.43 km^3 in July of 1934 to 0 km^3 in March of 1971 and January of 1972. For Kerki, flow ranged from 20.01 km^3 in July of 1969 to 0.75 km^3 in February of 1975. Post-independence flow ranged from to 6.20 km^3 in July 1992 to 0.01 km^3 in December 2002. This year-to-year variability is due mostly to varying snowpack in the eastern part of the basin. There is minimal water supplied to the Amu Daryo from local precipitation. Figure 22c shows precipitation in Chimbay district from 1991 to 2019, which is broadly representative of precipitation across the Aral Sea region. Median monthly precipitation over this period was 6.8mm, with a maximum of 72.2 mm. Annually, median precipitation was 131.3mm with a maximum of just 253.6mm which occurred in 2003.

This variability of water coming into the delta from the Amu Daryo has also made the surface area of the lakes variable. Table 6 summarizes the variability in the area of permanent water in each of the lakes over time. An interviewee acknowledged this variability, which he said was caused by the fact that “water inflow is not very stable” (P3). Sixteen of the 21 lakes had at least one year where they had no permanent water, and another three had minimum levels

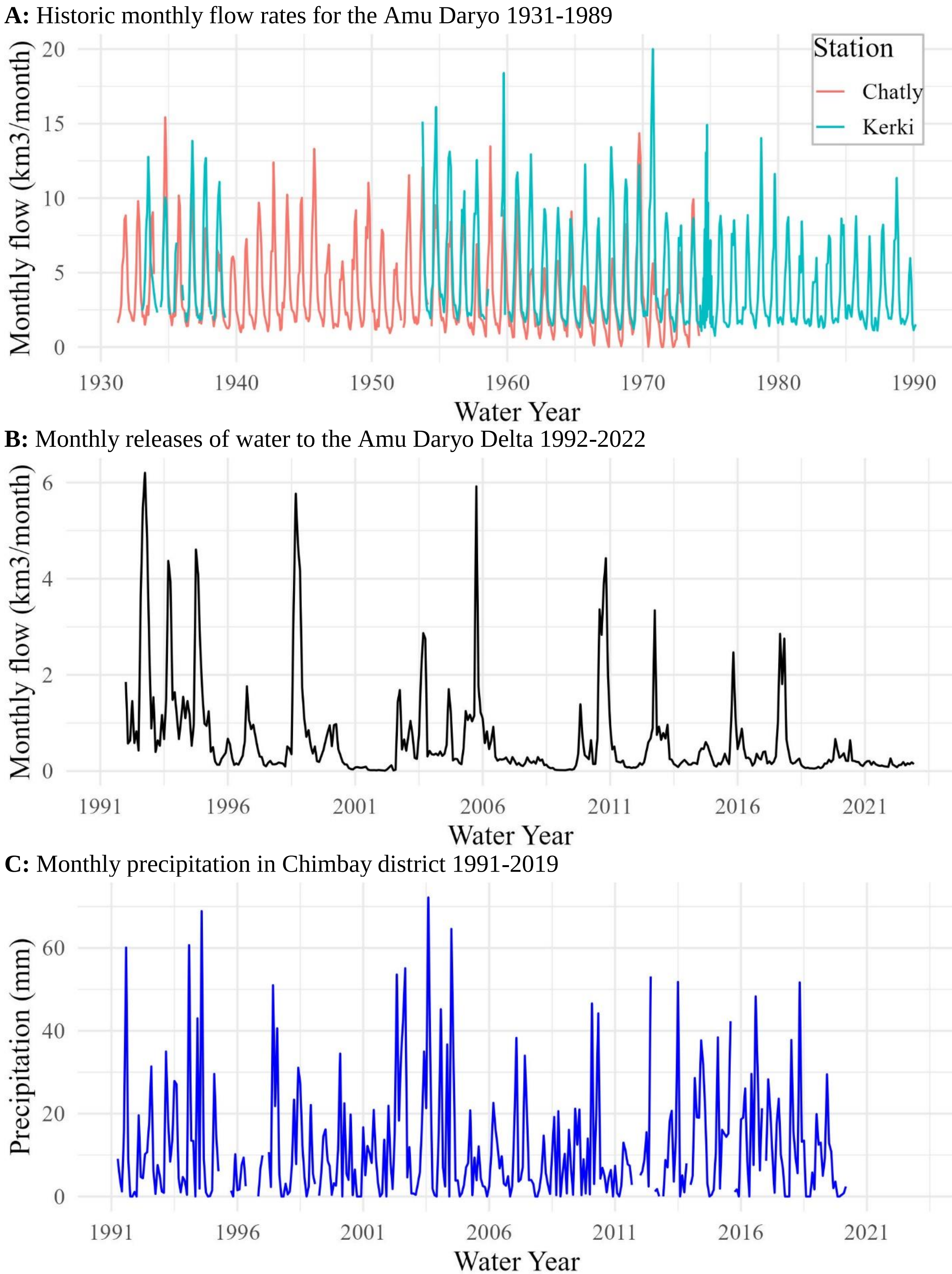


Figure 22: Water variability in the Amu Daryo delta. **A**: historic monthly flow rates for the Amu Daryo delta. **B**: releases of water to the Amu Daryo delta by month. **C**: Monthly precipitation in Chimbay district. Data sources detailed in Table 5

less than one square kilometer. Only Qarateren (14) and Sudoche (18) had areas of permanent water that remained greater than 1 square kilometer over the period studied. The minimum extent of the mainstem Amu Daryo in the delta in 2000 represents only 31% of the maximum area 751 square kilometers in 1984, which has left much of the channel dried as the river has narrowed.

In addition to decreasing total area, the areas of permanent water have become more discontinuous across space. This has implications for the more-than-human residents of the delta's waterways like fish which depend on the waterways of the delta being connected so that they have adequate space. Figure 23 shows the largest contiguous area of permanent surface water in each lake ("largest patch") per year and Figure 24 compares the distribution of "patch percent" (for description see Table 5). Most lakes are not close to being full in most years, although they will occasionally be 50 to 100% full. The fact that some lakes are never "full" reflects the construction of the maximum lake extent as an additive metric rather than the extent of any given year as described above. The median patch percent was 12.9% with an interquartile range of 3.5% to 43.6%. The mean patch percent was 26.5% while the maximum was 100%. These figures and statistics demonstrate the discontinuities of the Amu Daryo and the delta lakes both in space and in time.

Zooming out from the lakes, water is not evenly allocated across the Amu Daryo delta as a whole. On a visit to To'rtko'l, an upstream or southern district of Karakalpakstan, when the deputy district manager was asked by staff at DCA what they needed, he replied, *we have water, everything is good*. This comment by the deputy district manager corresponded with my observations driving and taking the train through Karakalpakstan and Xorazm, where Xorazm and the upstream districts of Karakalpakstan were noticeably greener than the downstream districts due to the allocation of water for irrigation. This inequality in water allocation was also pointed out to me by Arslan during the site visits we made together. He always made a point of comparing the maintenance of canals and collectors and their water levels in the upstream areas of the delta with downstream districts where the canals and collectors were completely dried in the summer months. This spatial inequity maps onto linguistic and ethnic differences in the Aral Sea region. In Xorazm and the upstream or southern districts of Karakalpakstan residents are mostly Uzbek speakers and ethnically Uzbek. In the northern or upstream districts of Karakalpakstan, Karakalpak is the primary language of communication, and residents are heterogeneous, including Karakalpak, Uzbek and Kazakh ethnicities. This spatial discontinuity of water across the delta can be exacerbated by variability represented by cyclical time. In other words, the delta system is more likely to be disconnected across space during times of seasonal and inter-annual low flow, and as flows decrease over time, these disconnections increase.

One example of temporal variability in surface water comes from Sudoche lake (18). When I visited Sudoche lake in April 2021, water levels were relatively high and migratory flamingos had arrived for the summer. Fishing was temporarily banned to give the fish time to reproduce. However, when I returned in September 2021, the water levels had dropped so low that fishing was now banned again – this time due to lack of water.

Spatial discontinuity also has elements of continuous temporality related to the overall decrease of flows in the delta. For example, in the summer of 2021, the level of water in the Amu Daryo was so low that boats that normally were docked in the river became beached. In early 2022, a newspaper article ran an article with photos entitled “New “graveyard” for ships appears in Karakalpakstan” (Kun.uz 2022). This was an apparent comparison to the ship graveyard at Muynak (see map Figure 2) on the bed of the dried Aral Sea. These beached ships in the Amu Daryo delta sat in sharp contrast to the stories I heard from long-term residents.

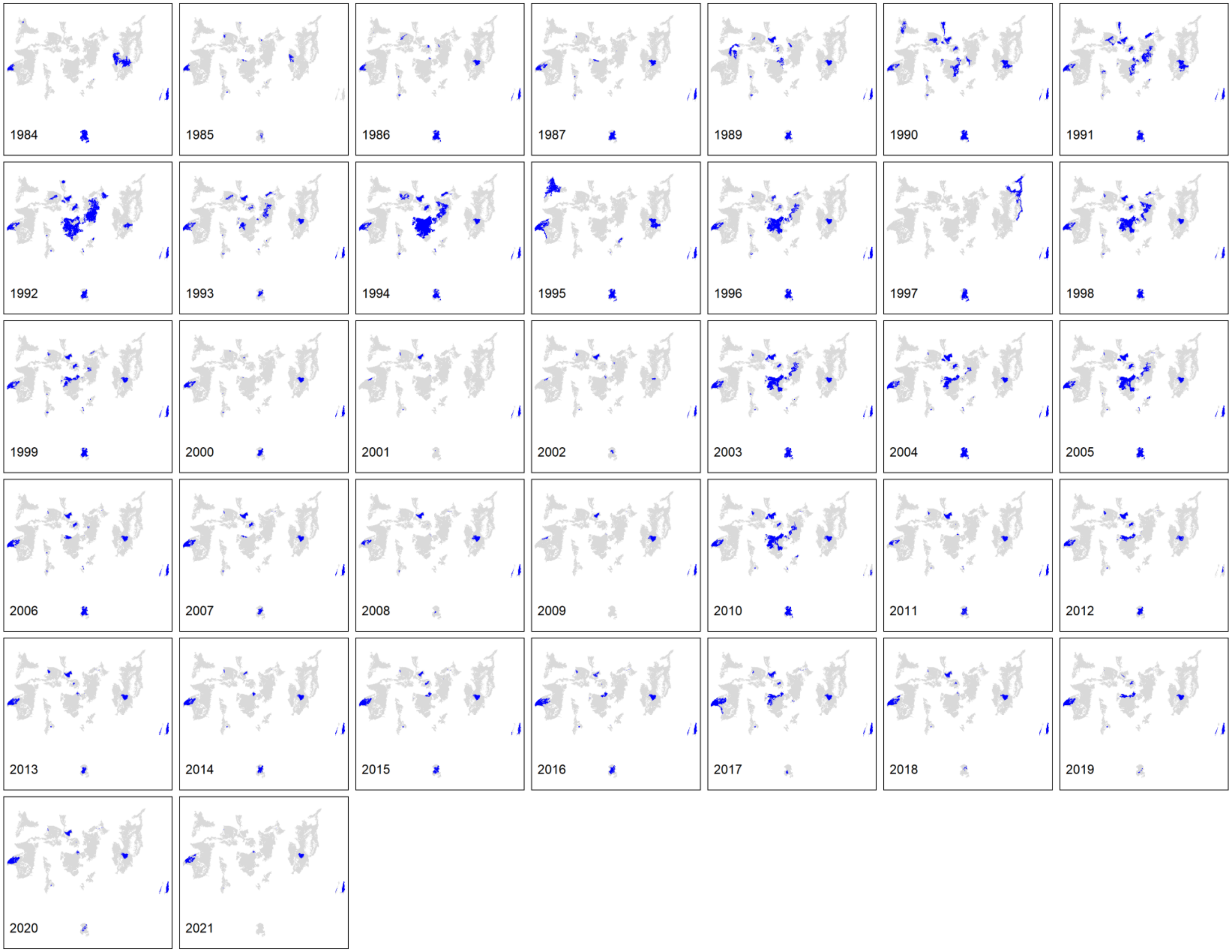


Figure 23: Time series showing the largest area of permanent water per year for each delta lake

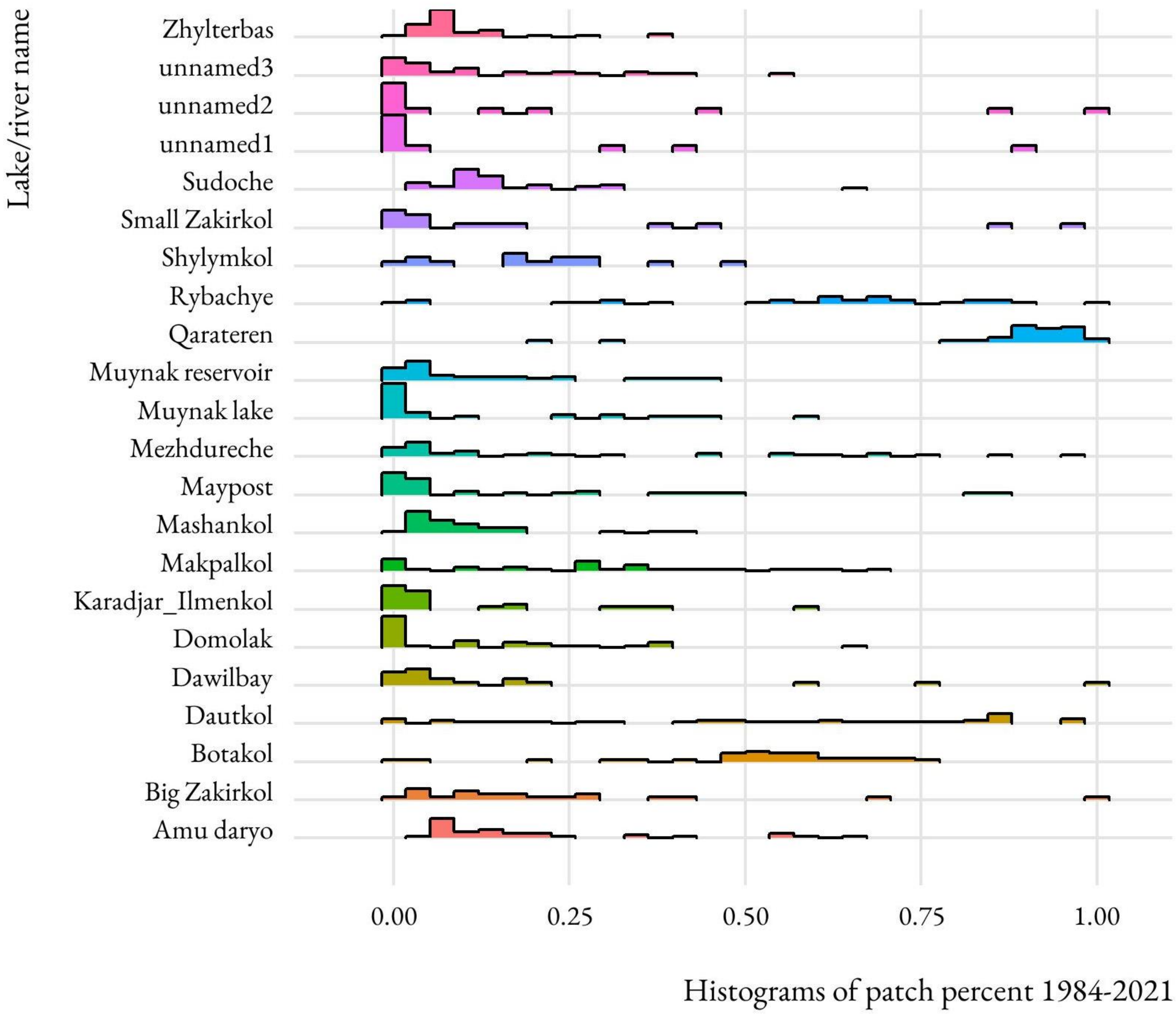


Figure 24: Comparative distributions of the largest patch of permanent water from 1984-2021 in each of the lakes and the Amu Daryo

Sultan, a taxi driver, drove my research assistant and I outside of Nukus, and as we stood on small hill with a cemetery overlooking the Amu Daryo, he pointed out how wide the river used to be, and told us that *ferries ran from Termez* (a border city with Afghanistan, see map Figure 2) *all the way to the edge of the Aral Sea. In my childhood when the river froze in the winter people would cross the ice in horse drawn carriages*. Baxtiyor, a colleague at IPD showed me photos of the team swimming and picnicking on the shores of the Amu Daryo in summer, telling me that *the Amu Daryo used to be like a car, it was moving so fast, like 100 km an hour, it was big, it was rushing, and if you got in you would drown*.

Although I knew the importance of fish for the region, I was surprised that health practitioners highlighted food and water insecurity as the greatest health challenges in my interviews (P6 and P10). Given the pervasive global dust narrative, I anticipated that Aral Seabed dust would have been the greatest health challenge for residents. They told me that chronic dehydration is an issue, and people have to navigate inconsistent and unsafe sources of water for household use. This challenge has been identified by the government, and there have been a series of legislation passed and projects initiated to improve drinking water in the region, most recently a pipeline from Kungrad to Muynak. However, the pipeline only supplies 40% of the real demand for Muynak. Further, one interviewee told me that “last week some of my friends from Muynak they called me and told me, no water. All grapes, all trees in our garden died because even no drinking water in the taps” (P3). These gardens are people’s main source of self-provisioned food, and fruit trees and grapes in particular represent years of investment. This self-provisioned food is important, because as one health practitioner told me, “vegetables are expensive to buy in the north because they have to be brought in because nothing grows” (P10). She highlighted how families need emergency food parcels due to high levels of food insecurity. Water variability also leads to stress. In the car on the way back from a training, Sinan, a colleague at IPD told me

> *I live at the end of the canal. The people earlier on the canal can water their gardens 2-3 times a day, but whoever is responsible for my garden cannot sleep at night, they have to wait and watch for the water to come down the canal so that they can water the garden and there are fights over it.*

Whether water will be available, at what times, and how many people will need it is thus a source of stress. The increasing variability and discontinuity of water in the delta adds to this stress and can increase food insecurity. With decreasing opportunities in the Aral Sea region after the independence of Uzbekistan, increasing numbers of residents, largely men, have moved to Tashkent, Kazakhstan, or Russia for work. This labor migration has left an increasing number of female-headed households, putting increased responsibility on women for food and water security.

In addition to self-provisioned fruit and vegetables, fish from the Amu Daryo and delta lakes are also an important part of the local diet, both by custom and nutritionally. Decline of fish in the delta regions is another source of food insecurity. One day a colleague at IPD, Medet, tells me over lunch

> *My parents are from Muynak, and every weekend we go to the Nukus fish market to get fish, even though it is expensive. We have to go early to make sure we can get* Sazan *that is still alive because otherwise my father will not eat it. You are most likely to be able to get live fish between 10:30 and 11:30am on Saturdays and Sundays. Live fish is more expensive: 55,000 UZS per kilo if it is live and 40,000 UZS if it is not. We boil the* Sazan*. Eighty percent of people buy* Beliy Amur *which is good for frying because it doesn't have too many bones. My favorite is* Karas, *which you eat with* buhanka *[loaves of bread rather than the traditional round and flat loaves of* non*] and onions or green onions.*

Another colleague at IPD explains *my family eats fish twice a week and we go to the fish market. When we eat fish, we all feel great, energized. When I eat* plov [rice with meat] *like today I feel tired and heavy*. Nutritionally fish is an important source of fatty acids (Reed and Norgaard 2010) critical for brain development and function. The loss of fish in the delta lake system represents not only the loss of a preferred food and a cultural tradition, but a healthy food in a country which is said to have the most unhealthy diet in the world (Afshin et al. 2019).

Salinization

I now turn to soil salinization in the delta which is linked both to irrigation practices and decreasing water in the delta and has led to consequences such as field abandonment. I focus on one district of the Republic of Karakalpakstan, Chimbay, which is located in the northern/upstream part of the Amu Daryo delta (see map Figure 25). The district had a population of 114,800 as of 2018 and a land area of 2,200 thousand km^2 (Qaraqalaqstan Respublikası Joqarǵı Keńes 2019). I did part of my participant observation work in Chimbay and had a colleague from Chimbay, which meant that in addition to visiting the region and meeting with government officials, I also spent time with his family. Like other areas of the Amu Daryo delta, the water and soils of Chimbay have faced salinization. My colleague told me he is

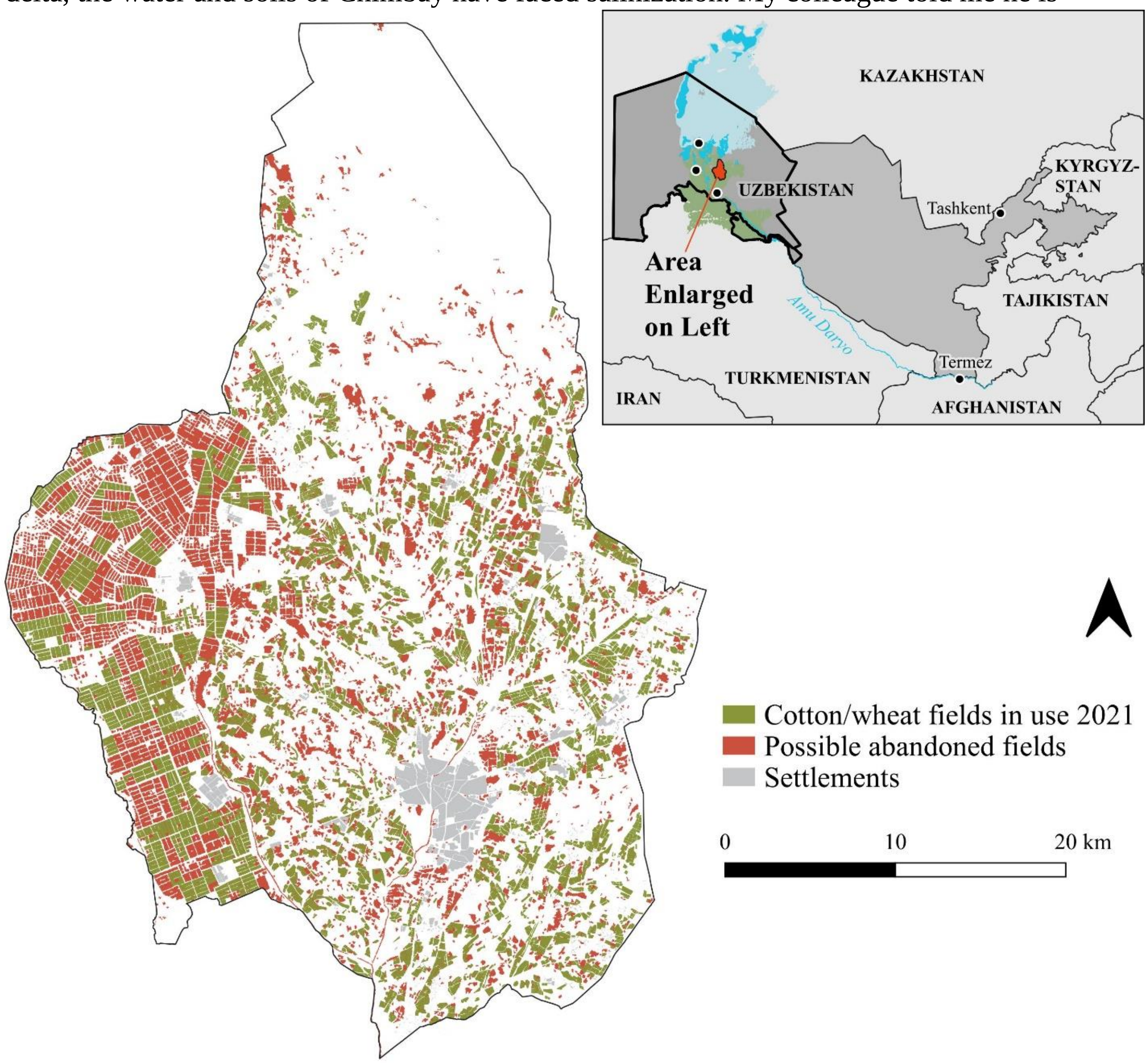


Figure 25: Visualization of fields in use and possible abandoned fields

frustrated because *our people are suffering*. *On the road from Nukus to Chimbay you see salt – it looks like snow. But you do not see that in Xorazm or other regions of Uzbekistan, they have enough water to wash the soils*. The soils of this arid environment are naturally saline, but through secondary salinization many fields have become salinized to the point that they are not suitable for crops and are abandoned. Traveling through the Aral Sea region it is common to see land that has a white crust that at first glance appears to be dusted with snow, but which is actually salt. Seventy six percent of fields tested by the Karakalpak Branch of the Agrochemistry Laboratory in 2021 were designated as "very highly saline" which means that salts make up at least 3% of dry soil weight. None of the fields sampled were classified as unsalinized or mildly salinized (Karakalpakstan Branch of the Agrochemistry Laboratory 2021b). According to information given to landowners/managers as a result of the analysis, very high levels of salinization can result in crop losses for cotton and wheat of 30-60% (Karakalpakstan Branch of the Agrochemistry Laboratory 2021a).

The recommendation for ameliorating soil salinity is washing of the soils, application of excess water by flooding the fields prior to planting to allow salts to be carried away in return flow to the collector network. This is a water intensive process. For very highly saline soils, two to three washings in 6-8 days are recommended, with each washing requiring 4,000 to 6,000 m^3 of water per hectare of field, with highly permeable soils on the lower end of this range, and more impermeable soils on the higher end (Karakalpakstan Branch of the Agrochemistry Laboratory 2021a). Field washing can create water demand as great as the water needed for actual crop production. In Uzbekistan, cotton requires 10-12,000 m^3 water/hectare, while winter wheat requires 8-9,000 m^3 water/hectare (Abdullaev et al. 2009). This washing occurs in cyclical time and needs to be done every year in November and December. With less and less water available in irrigation canals, it has become more difficult to wash soils. During a meeting I attended, an expert estimated that there are 580,000 hectares of arable lands in the region with almost 80% of these degraded. His suggestion: to use groundwater, purified through reverse osmosis, to implement drip irrigation. This proposed solution is, however, very energy intensive.

How many fields have been abandoned? We can use the GSW data in combination with the soil chemistry data to estimate fields abandoned between 1984 and 2020. Because flood irrigation is pervasive and farmers generally have to wash their fields, the maximum permanent water extent (see Table 5 for description) also reveals the accumulation through continuous time of field irrigation and washing data, providing a visualization of all irrigated and/or washed fields[28] between 1984 and 2021. Even if the Landsat imagery misses the presence of water some years due to plant growth in the fields, the accumulation of data over 37 years means that nearly all fields that are or have been cultivated appear in the maximum permanent water extent. According to the Karakalpakstan Branch of the Agrochemistry Laboratory, the 2021 soil chemistry assessment included the entirety of the irrigated area of the district (22,2401 hectares). Fields not tested are either abandoned or used for other crops that do not require irrigation such as melons.

Figure 25 overlays the extent of washed and/or irrigated fields from 1984 to 2021 with fields sown in 2021, providing a rough visualization of field abandonment. Fields in green, with an area of 212 km^2 or 63% of total field area, were in use for cotton and wheat in 2021. Fields in red, with an area of 131 km^2 or 37% of field area, are likely to be abandoned although some of

[28] This water can be assumed to be from irrigation or washing – precipitation in the region is not sufficient to cause this much standing water.

these fields may be used for other crops, such as melons and so were not tested in the 2021 soil assessment, so this visualization may overestimate abandonment. The white areas represent fields previously abandoned, rural residential areas and other non-cultivated rural lands including bare soil. Most of the abandonment is likely due to over salinized soils and lack of water to wash them, although there are other reasons for field abandonment, such as lack of water for irrigation and land tenure issues. These abandonments are a consequence of both Uzbek water and agricultural policy choices but are also grounded in the delta's role as a shadow place for the many global industries using cotton lint and seed to make products including clothing, towels, carpets, diapers, menstrual hygiene products, cosmetics, pharmaceuticals, bank notes, bandages, cattle feed, and plastics (Munir et al. 2020).

Policy and responsibility

I now turn to Uzbek water and agricultural policy of relevance to the Aral Sea region. I analyze legislation (decisions of the *Oliy Majlis* [parliament] and Presidential decrees) related to water and agriculture in the Aral Sea region. I identified legislation through an Uzbek language search of the lex.uz website using the terms *Mo'ynoq*, *Mo'ynaq* [two spellings for the town of Muynak], *Qoraqalpog'iston* [Karakalpakstan], *Orol* [Island, the name of the sea in Uzbek] and *Orolbo'yi* [around the Aral Sea]. In addition, I added legislation I encountered through my fieldwork that was not caught in my original searches.

The importance of water for nature is acknowledged in Uzbekistan's current water law, the 1993 "Laws of the Republic of Uzbekistan Water and Water Use," and there are several provisions specific to the protection of fish and fisheries in the law. A national water strategy for Uzbekistan was adopted in 2020, which will guide policy through 2030. This strategy recognizes that the current 1993 water law is out of date and that there is an urgent need to develop a national water code. Priorities of the strategy include improving data availability, improving the water resource management system and the incorporation of "smart water" digital monitoring, expanding the use of water-saving irrigation technology, improving irrigated lands and reducing soil salinity, introducing principles of a market economy into water management, introduction of principles of integrated management of "surface, underground and return water", developing interstate relationships in Central Asia on transboundary water issues, and building of human capacity in the water sector. Questions of water distribution and use are "rendered technical" (Li 2007) by solutions that focus on repairing infrastructure, increasing water-use efficiency, and privatization and marketization of water resources. Most of these water policy goals are set up to continue cotton monoculture and the Amu Daryo delta's role as a shadow place for the many global industries using cotton lint and seed. Discussion of the Aral Sea itself in the strategy is limited to the goal of introducing integrated management, which includes systematic planning, developing a new water law and an action program to attract technical assistance funds, education around water protection, rational use of water, and implementing water protection zones and taking into account water for ecosystems. The expected result is "preservation of natural water sources and water-dependent ecosystems, including taking measures to ensure stable supply of water resources to the Aral Sea region", although how this will be done and what indicators will be used to measure this are not specified. A presidential decree from 2021 sets specific goals towards achieving this strategy but does not provide any further specificity on water for the environment.

Other legislation includes a presidential decree from late 2020 entitled "On urgent measures to improve the effective use of water resources and land reclamation in the Republic of Karakalpakstan" that does not include any mentions of water for the environment, ecosystems or the restoration of an ecological balance, or the broader goal of implementing IWRM. Instead, the decree is a workplan for canals to maintain, water-saving technologies to implement, pumping stations to be "transferred to the private sector based on the principles of public-private partnership," etc. Other legislation related to water in the Aral Sea region is about specific drinking water supply projects, structural changes to the Ministry of Water Management, and establishing regional centers of the Research Institute of Irrigation and Water Problems of the Ministry of Water Management, including one in Karakalpakstan. Finally, there has been some legislation to support the construction of infrastructure for the creation of lakes in the Amu Daryo delta.

Conclusions

In this paper I have woven together ethnographic, remote sensing and geophysical evidence to show the impacts of the Soviet and later Uzbek state's water distribution policy on the Amu Daryo delta. I have highlighted that overall, the flow of the Amu Daryo – the primary water source of the delta lakes – has decreased over time. A focus on continuous time highlights this decrease which is largely due to increasing diversion of water from the Amu Daryo for irrigated agriculture, although may in part be due to other factors such as climate change. At the same time, surface water in the Amu Daryo delta is variable over time and space. Part of this variability is cyclic, since the largest input to the Amu Daryo is spring and summer snowmelt in the mountains of Tajikistan and Afghanistan. Snowfall in the mountains is also variable, meaning that spring and summer flows of the Amu Daryo are variable year-to-year. Increasing discontinuity over space is tied to both cyclical time through seasonal variability and continuous time through the slow and non-linear decrease of flows entering the delta. My focus on cyclical and continuous time in the paper has allowed me to avoid the “catastrophe” rendering of discontinuous time.

In this weaving I have viewed each source of data as a partial perspective. For example, the resolution of the GSW data makes it difficult to “see” the network of canals and collectors that sometimes brings water across the delta, but I can gain insight into these both from my eyes, and more importantly, the eyes and stories of my participants. The flow data from the gaging stations of the Soviet period provides insight into the delta from before the earliest memories of nearly all people living in the delta, but the data ends before the present moment, and insights into variability of the water in the present is provided by data from the Uzbek state about flows into the delta. What is essential to this weaving process is my embodied experiences in the Amu Daryo, viewing the landscape, having conversations with residents, and asking myself constant questions that appear through my fieldnotes, in short, the unquantifiable experience of fieldwork and living in the Aral Sea region. Simply accepting the premise that all perspectives are partial, and all knowledges situated is not enough. One must be sufficiently grounded in a place to be able to weave together all of the threads.

In the shadow of the Aral Sea “catastrophe” there is a local and developing catastrophe in the delta of the Amu Daryo. My weaving shows that this is a landscape that is shaped around and depends on water. Fish require year-round water; increasingly fragmented and seasonal water are insufficient. The human residents of the delta depend on water for drinking, gardening, fishing, and their livelihoods. One of my colleagues at the university told me *when there was water, the people in Karakalpakstan were lucky. The delta was a place with lots of animals and lots of fish and life was really good*. The residents of Karakalpakstan should not have rely on luck, water for human and more-than-human needs of residents must be prioritized.

However, apart from the few mentions of the need to consider the environment and ecological balances when determining water usage limits (“intakes”), Uzbek water law and policy does not address water prioritization and distribution within the Republic of Uzbekistan. The gap I have demonstrated between water currently allocated to the region and the IFAS plans to fill the delta lakes is not addressed in any specific or meaningful way in policy. Equitable allocation of water is something that cannot be achieved by technical solutions. Rather the Uzbek state must take responsibility for how state water and agricultural policy have continued to create the Aral “catastrophe” and make the Amu Daryo delta a shadow place since independence, and work toward more just futures where the human and more-than-human residents of the delta have sufficient water to meet their needs.

CONCLUSION

This dissertation has sought to see beyond catastrophe in the Aral Sea region of Uzbekistan by starting from the premise that the region is still a place of value to its human and more-than-human residents. Though there is general consensus the Aral Sea will not return to its 1960 baseline, I have provided examples of ways to repair the physical, social, and more-than-human infrastructures of the region. This work has used a feminist mixed-methods approach to probe both the human and more-than human worlds of the Aral Sea region, including trees, water, salt, gardens, fish, insects, and agricultural crops including mung beans and kendyr.

In Chapter 1, I unpacked the Aral Sea as a "Zone of Ecological Innovations and Technologies." I have shown how the ideology of innovation, justified through the devaluation of the Aral Sea region as "catastrophe" erases history, depoliticizes the Aral "catastrophe", obscures power relations, and ignores local knowledges and practices. I provided examples of both state-led and international development organization-led initiatives that operate within and bolster this ideology of innovation, including building the new Muynak, piloting crop rotation of mung beans, "improving" distribution techniques for trichogramma, testing Zeba gel, and holding the Global Disruptive Tech Challenge. The devaluation of the Aral Sea region also justifies economic development through extractive industry and chemical factories, including increased natural gas exploration, pumping and processing and gravel mining. Chapter 1 suggests an alternative to the ideology of innovation in the ethos of repair, which is founded on the intrinsic value of the Aral Sea region. An ethos of repair builds on local knowledge and practice, learns from the history of the region including previous development interventions like kendyr cultivation, attends to power relations, and at its heart repoliticizes the Aral "catastrophe".

In Chapter 2, I focused on one approach to mitigation of the Aral "catastrophe" within the Zone – large-scale plantation-style afforestation of the dried seabed through the native salt-tolerant tree saxaul. Visual classification of the dried seabed using Google Earth Prodata shows that afforestation area is less than that promoted by the state, and that tree growth has been largely unsuccessful in newly afforested areas to date. Since the primary goal of saxaul planting is to stabilize the soils of the dried Aral Seabed, I argued that saxaul should be seen as more-than-human infrastructure. This more-than-human infrastructure is performative in two senses. First, it provides the promise of an improved future for Aral Sea residents. Second, the Uzbek state performs environmental stewardship through the process of afforestation. For both of these performances, plant growth is not required – the act of planting is enough. I also have shown that the labor and finance of afforestation is inequitable.

Chapter 3 moves south from the dried Aral Seabed to the Amu Daryo delta where the 3.8 million people of the Aral Sea region live. Bringing together remote sensing, geophysical, and ethnographic data I have shown how flows of water into the Amu Daryo delta have decreased over time, and how the surface water in the delta is variable over time and increasingly discontinuous across space. This variability and discontinuity have increased the food and water insecurity of Aral Sea residents as fish numbers have decreased, gardens die from lack of water, and drinking water sources are intermittent. Soil salinity has also increased, and fields have been abandoned due to the lack of water to wash the soils to remove excess salts. Legislation, including the new water strategy for 2021-2030, has not sufficiently incorporated the needs for environmental water.

There are several cross-cutting themes from the chapters of this dissertation with implications for both scholarship and policy. I first turn to scholarship before elaborating on policy recommendations.

Scholarly contributions

This research contributes to several scholarly conversations. First, this work builds on that of Anna Tsing (2015) to show life in post-socialist, post-Soviet ruins. This research also answers calls in Critical Physical Geography to attend to 'crappy landscapes', showing how the Aral Sea region has become devalued, while also insisting on its intrinsic value.

This dissertation contributes to work in development geography and development studies through attention to arid lands, de-exceptionalizing the Aral Sea by putting it in the context of development in drylands more broadly. Viewed this way, the Aral Sea region is one example of a long history of framing deserts as wastelands and using this to justify improvements such as irrigation and afforestation. Probing the Uzbek state's ideology of innovation also shows how past development interventions are forgotten in the search for the new.

This dissertation adds to conversations on the political ecologies of the state by showing how performance contributes to the creation of the state as effect. One example is performance of environmental stewardship through afforestation of saxaul. The statistics of hectares planted and images of planting and mature saxaul that circulate both bring this state performance into global forums, and also continue to shape how mitigation of the Aral "catastrophe" operates. The "new" Uzbekistan comes into being partly through this performance. The construction of the new Muynak is also performative, changing the built environment to reflect how the "new" Uzbekistan has swept away ruins from the Soviet past. This work unpacks the performance of "before-and-after" maps of the Aral Sea region, and how these maps continue to reify the distinction between the Soviet Union and the Republic of Uzbekistan as they place blame for the Aral Catastrophe on the Soviet Union.

Finally, this work builds on nascent scholarship of human-environment interaction in the Aral Sea region. Since the Aral Sea is a paradigmatic example of environmental catastrophe, there is an assumption that it has been thoroughly studied. However, there is limited scholarly work with a critical perspective on human-environment interactions, at least in English, that goes beyond simple narratives of the Aral Sea as a lesson of the dangers of state socialism and cotton monoculture. Much of this work comes from environmental historians including the late Maya Peterson (2019), Julia Obertreis (2017), and Christian Teichmann (2007). William Wheeler (2021), an anthropologist, has made an in-depth study of fish and fishing in the North Aral Sea. Kristopher D. White (2013) is one of the few geographers to have worked in this area. It is my hope that in addition to contributing to the general scholarly conversations listed above, the articles from this dissertation will find their way into undergraduate classes in geography and environmental studies to provide the next generation of students a more nuanced understanding of the Aral Sea region.

Policy implications

The Amu Daryo is a transboundary river with riparian countries of Tajikistan, Afghanistan, Turkmenistan and Uzbekistan. As I highlighted in Chapter 3, Uzbekistan does not have full control over the water of the Amu Daryo flowing into the country. Diversion of water for agriculture through canals such as the Karakum in Turkmenistan, and development of hydropower in the mountains of Tajikistan such as the Rogun Dam, change, and often lower the flows of the river. Flows may decrease further if the Taliban successfully completes a proposed diversion of water into Afghanistan (Rickleton 2023). However, Uzbekistan does have control over the allocation of water within its borders. I highlighted Jevon's Paradox in Chapter 3, where increased efficiency of a resource often leads to more, rather than less, use of the resource. This has been shown to hold for irrigation in general, and new research with water managers in Uzbekistan suggests it is likely to occur in Uzbekistan. Increased irrigation efficiency is thus likely to lead to agricultural expansion – not decreased water use. In order to meet minimum flows to ensure connectivity of the delta water system, an environmental flow policy is required. This should be included in Uzbekistan's new water law and must include provisions to monitor and enforce this policy. In prioritizing the environment as a water user, Uzbekistan can set a powerful example for the rest of Central Asia.

Repair of the Aral Sea region can begin when the Uzbek State acknowledges the role that it has played in the Aral "catastrophe" and ensures adequate water for the environment for the future. Unlike the ideology of innovation which prioritizes large-scale measures for the entire Aral Sea region, I suggest thinking of repair as a patchwork quilt. It will be small, localized measures that when stitched together cover the whole region. Technological and innovative solutions will form a part of this quilt but should not be the dominant drivers of repair. Repair must be grounded in history and local knowledge. Repair must include knowledge and practice of Aral Sea residents, and they must be centered in decision making processes – but moving to an ethos of repair cannot transfer responsibility from the state to residents.

Repair of the Aral Sea region also requires ending the plantation – of both cotton and saxaul. Saxaul still have a place in the repair of the Aral Sea region, but they cannot be rolled out over the landscape like a carpet: they grow in areas where there is sufficient groundwater, and they require a certain amount of care as saplings. Repair means co-creation of infrastructure by humans and more-than-humans, instead of seeking to control saxaul as "green" infrastructure. This means moving beyond a single species to a polyculture approach.

While farmers are no longer required to allocate a percentage of their fields to cotton and forced labor in cotton harvesting has officially ended, cotton still plays an important role in Uzbekistan's economy. I have argued that Uzbekistan's cotton fields, and the Aral Sea region in general, represent a shadow place, where environmental degradation is allowed so that cotton consumers in high income countries do not have these environmental consequences at home. In this way, the Aral Sea region is deeply imbricated in many industries including fast fashion. There has been recent attention on the consequences of the fashion industry – and fast fashion in particular – for global climate change. The fashion industry is estimated to contribute 8-10% of global carbon emissions (Niinimäki et al. 2020), and there are increasing calls in the media for consumers to move away from fast fashion for the sake of the planet (for example Cerullo 2019; N. Davis 2020; Stallard 2022). Sometimes these articles also include other environmental aspects of the fashion industry at a global level such as water consumption and microplastics, but what is often left out are the historical and current consequences of the fashion industry for the human and more-than-human residents of these shadow places of the global cotton trade such as the Aral Sea region. Ending the cotton plantation in Uzbekistan also requires change at a global level.

The future of the Aral Sea

Early in my fieldwork, I visited Sudoche lake, one of the delta lakes, with a group of "foreigners" – people from outside the former Soviet Union. One man who had been living in Nukus for nearly a year several times expressed his disappointment *that people had let the landscape become like this. Why couldn't it just be restored?* he asked me, as if being a researcher I should have the answer to this question. I tried explaining that this would require a complete shift of the economy and agricultural system of Uzbekistan, and the loss of livelihoods across the country, but he remained of the perspective that this place was a disaster that should be “fixed” completely. This experience was not unique, but the first of many such interactions I would have where people wanted to know why it was not possible to just refill the Aral Sea. My approach in answering these questions was both pragmatic and hopeful – an approach that I have tried to weave into my dissertation. For those reading who still want to know about the future of the Aral Sea, here is my answer in short. The Aral Sea will not return to its 1960 form in my lifetime. Water is essential for the life of all of the people in the Aral Sea basin, and it is not possible to divert all of the flow of water through the region back to the sea for the time it would take to restore the sea.

However, it is possible – and I argue necessary – to see beyond catastrophe and to repair the Amu Daryo delta. This requires ensuring that a sufficient amount of water reaches the delta to keep the entire system connected for the survival of fish and other instream and riparian species. This will mean changing how water is allocated at the national level. Repair will also require continuing the work IFAS has done to build dams and canals so that the delta system remains connected and that ecosystem functions persist. The delta has become and must remain a hybrid system and can become an example of how the human and more-than-human worlds can co-create a thriving landscape for all residents. The questions of who repair is for, who will do it, and who is responsible will remain crucial, and will need to be continually revisited.

APPENDIX: TIMELIEN OF MAJOR EVENTS IN THE POLITICAL HISTORY OF THE ARAL SEA REGION

Pre-Tsarist

Eighteenth-early nineteenth centuries: Three Uzbek khanates revived by strong dynasties, centralized states; British and Russians begin rivalry for Central Asia.

1820s: Kazak Great Horde is last of three hordes to come under Russian control.

Tsarist

1865-68: Russian conquest of Tashkent, Bukhara, and Samarqand; Khanate of Bukhara becomes Russian protectorate.

1873: Russians capture Khanate of Khiva.

1876: Russians incorporate Khanate of Kokand

1881: Turkmen territory annexed into Guberniya of Turkestan.

1917: Bolshevik Revolution begins establishment of Soviet state.

Soviet

1918: Bolsheviks declare Turkestan Autonomous Soviet Socialist Republic (ASSR), including most of present-day Central Asia in Russia.

1921-27: New Economic Policy expands cotton cultivation in Central Asia.

1924: Soviet Socialist Republics (SSR) of Turkmenistan and Uzbekistan formed

1929: Tajikistan SSR established, northern territory added.

1930: Karakalpakstan Autonomous Oblast detached from Kazakhstan ASSR, transferred to Russian Soviet Federative Socialist Republic

1932: Karakalpakstan becomes an ASSR

1936: Kazak and Kyrgyz ASSRs given full republic status in Soviet Union; Karakalpakstan transferred from Russian Soviet Federative Socialist Republic to Republic of Uzbekistan.

1985: Election of Mikhail S. Gorbachev as first secretary of Communist Party of Soviet Union, heralding impact of Moscow reform programs in Central Asia.

1989: Moscow names Islam Karimov first secretary of Communist Party of Uzbekistan.

Post-Soviet

1991: Independence of five republics, Islam Karimov becomes the first president of Uzbekistan

2016: Islam Karimov, first President of Uzbekistan dies

2016: Shavkat Mirziyoyev becomes the second president of Uzbekistan

2021: Aral Sea region declared a “Zone of Ecological Innovations and Technologies”

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