Borderline- Part 1

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A large transnational body of water shared by Kazakhstan and Uzbekistan, the Aral Sea was once the fourth largest inland sea on Earth, dried due to Soviet Irrigation practices.

Nine years ago, with the support of the World Bank, the Kazakh government finished the construction of a 14km dyke to raise the level of the sea in the North, restoring its ecology as a massive constructed landscape.

Since then, the water level, and therefore regional ecology, is regulated by a 50m concrete spillway.

The site is both a popular tourist destination and strategic site for fishing.

The government currently plans to raise the Dyke and sea level by an additional 4m to reach the original shoreline, necessitating a reconstruction of the spillway.

As a currently inexistent interface between tourism and fishing industries on site, this project investigates the capacity of architecture to expose the role of the Kok-Aral spillway within its larger sociopolitical network with the introduction of a seasonally interchangeable program.
fiberglass boats near froze near Tastubek Village [20]
underground dwelling entrance near Tastubek Village [20]
underground fishing brigade near Tastubek Village [20]
use of skylights and open fires near Tastubek Village [20]
artwork on ship graveyard
near Jambul Village [20]
Kok-Aral Spillway

viewing platform

spillway
tourbus on Kok-Aral road
near Kok-Aral spillway
food sharing customs in su

Bugen Village [10]
Aral Sea: Liming regional economics:
Aral Sea: 20
North Aral Post-200
By introducing a space itself as a place for socialization among
Interface

metal railing
spillway from North Aral _
closing of Kok-Aral floodgate
access from former seabed
end of fishing season on No
auditorium _ march
students from Kyzyl Orda's
auditorium _ september
tourism season opens amid
lodge and bathhouse access

accommodation of visitors
internal spillway access

visible inner workings of spillway open as gallery
fishing ramp

June

Fishing on site as North Water
viewing platform - august
visibility of “natural” phenom
Fast changes in environment, economy, and technology drive the growth/shrinkage of supporting infrastructure; often rendering the built architecture too static and slow to adapt.¹ **The linear edge of land/water borderlines can become an instrument for transformation, as an infrastructure that deploys responsive architectural types that are more ephemeral, reactionary, and compromising with change.** The capacity for architecture to float offers the advantage of mobility and interchangeability.

resilience
[ri-zil-yuhns]
noun
1. the power or ability to return to the original form, position, etc., after being bent, compressed, or stretched; elasticity.
2. ability to recover readily from illness, depression, adversity, or the like; buoyancy.

floating
[floh-ting]
adjective
1. buoyant or suspended in water or air. "a massive floating platform" synonyms: buoyant, on the surface, afloat, drifting antonyms: sunken, grounded
2. not settled in a definite place; fluctuating or variable. "the floating population that is migrating to the cities" synonyms: unsettled, transient, temporary, variable, fluctuating;

Aral Sea
Located between Kazakhstan and Uzbekistan, the two rivers that supplied the Aral Sea with water were diverted in the 1960s to irrigate the fields that now make Uzbekistan the world's second largest exporter of cotton. The receding sea has left behind a salty desert the size of Switzerland with abandoned fishing towns and boats in what used to be the fourth largest lake in the world. Following the construction of a large dam, fish are now returning to the North Aral sea, allowing for the fishing industry and population to reemerge.
“Borderline” is an exploration of land/water borders as agents of accelerated change to their communities. Fast changes in environment, economy, and technology drive the growth/shrinkage of supporting infrastructure; often rendering the built architecture too static and slow to adapt. The continuous linear edge of land/water borderlines can become an instrument for transformation, as an infrastructure that deploys responsive architectural types that are more ephemeral, reactionary, and compromising with change. The capacity for architecture to float offers the advantage of mobility and interchangeability.

Aral Sea and the Kok-Aral Dam
This project focuses on the shrinking Aral Sea as a testbed for replicable architectural strategies that perform in relation to water, crisis, and change. The Aral, formerly the fourth largest inland sea on Earth (shared by Kazakhstan and Uzbekistan), has been drying since the 1960’s due to the diversion of the rivers that supply it to sustain the growth of cotton for export. Its borders have shifted by more than 100 km at certain points, leaving behind a desert the area of Ireland. By 2007, the sea had shrunk to 10% of its original size. The river flowing from Uzbekistan no longer makes it to the Aral, drying out 120 km ahead. In 2005, the government of Kazakhstan, with support of the World Bank, built the 14 km Kok-Aral Dam to contain water in a small remnant of sea within the country before spilling out towards Uzbekistan onto a massive evaporative desert.

Consequently, local biology is returning, and part of the fishing population that left in the 1960’s when the fish population shrank is starting to return to the region for fishing. A mobile community is emerging directly on the Kok-Aral. During the three month fishing season, young fishermen are camping on the remote dam because it acts like a funnel, concentrating fish before being ejected towards the desert. At the end of the season, they return to their respective villages for the rest of the year. The irony in the recovery is that the population is largely returning to the former fishing town of Aralsk, now 15 km from the nearest coast. Two old canneries are being put to use once again, with a third recently constructed. At one point, the fish catch was being brought to Aralsk by helicopter, indicating that the location and fixed nature of the town is no longer appropriate.

As a design project for a fishery/hotel deployed on this linear infrastructure, the dam represents an opportunity for a temporary and resilient architecture that demonstrates adaptations to time of year, water, and patterns of occupation. Design investigation for the thesis relates to how flotation offers resiliency in relation to geography and water level, while also allowing the interchangeability of its components, as a mechanism for growth/shrinkage of its commercial fishing and tourism functions.

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### Investigation: Aral Sea
- Testbed for hydrological change: Aral Sea
- [Site] Kok-Aral Dam
- Seasonality

### Empowering Community By Design...
- Scope of investigation
- Program

### Pt.I: Typology
- [Temporary structures] Dre Wapenaar
- [Adaptability] Makoko Floating School; Lagos, Nigeria
- [Technology] The climatic envelope
- [Form] Conventional water-based vernacular

### Pt.II: Organization
- [Deployment] Plan for Tokyo; Tokyo, Japan
  - Regional opportunities
- [Organization] Linear city proposals
  - City as process

### Global Scope

### Bibliography
"Virgin Lands Project"

The Aral Sea, formerly the fourth largest lake in the world and shared by Kazakhstan and Uzbekistan, is fed by two rivers, the Amur Darya and Syr Darya, which were diverted in the 1960s to irrigate the cotton fields that now make Uzbekistan the world’s second largest exporter of cotton, or “white gold.” The Aral Sea Basin is shared by five countries: Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan and Turkmenistan. The Aral dried to a dismal 10% of its original size in 2007 (divided into four separate bodies of water).
testbed for hydrological change: Aral Sea
Amu River [Uzbekistan]
The Amu Darya originally had a series of tributaries that flowed into the Aral Sea up until the 1970’s. Hydrological works began in the 1950’s, where much of its waters were being taken to irrigate cotton and wheat in the lower basin of the river. In the 1960’s, the Soviet Government completed the Karakum Canal to divert large amounts of water westward. Due to the decreased input of water, the Aral Sea started shrinking. To make matters worse, the hot, dry plains of the Amu Darya accelerated evaporation, not only decreasing the quantity of water, but depleting the nutrient quality of the soils due to the salt deposits being left.

By the 1990’s the Amu Darya’s discharge onto the Aral would stop periodically until its present point: 120 km ahead, due to a dam for irrigation. 1

Syr River [Kazakhstan]
The Syr Darya and its tributaries, similar to the Amu Darya, irrigates massive extents of land for the purposes of cotton and wheat agriculture. It is estimated that the Syr Darya alone is responsible for 5,000,000 acres of cotton growth. Its water diversion also contributed to the shrinkage of the Aral Sea, with a much smaller flow of water than it did in the first half of the 20th century. Due to increased salinification of soils, there is an added need for farmers to incorporate fertilizer into their processes, which makes it downstream into the sea. These chemicals are left as residue on the dried seabed, which then get airborne, to further challenge plant and animal life. Particularly, the local populations have had an exponential increase in respiratory illnesses.¹
Until the 1960’s, the Aral Sea was a barrier that protected Central Asia from the cold north winds, and the large mass of vapor that evaporated from its surface replenished snow and ice on distant mountains.
"Produce millions of tons of cotton at any cost."

The now-frequent salt storms and the effects of the drying of the Aral are not restricted to the region. Salts from the exposed seafloor have been found in the Pacific and Arctic, in the Ganges and Brahmaputra rivers in India.¹
Before then, the Aral exported roughly 40,000 tons of fish annually, and was a sea with many large (100') industrial ships. There were thousands of fishermen, while another portion of the population was employed in the processing plans, canneries, and railroad yards. Trains left daily for Moscow with their cars full of fish. The population was rather large, including 19 villages around the sea with two large cities. 40,000 people lived in Moynaq, Uzbekistan at the southern tip, and 80,000 people lived in Aralsk, Kazakhstan in the northern tip.

Nowadays Kazakhstan and Uzbekistan face an influx of “disaster tourism,” or tourism geared towards observing the visible disaster of the Aral Sea. Especially famous are the iconic rusting ships scattered all over the landscape.

Desertification
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Soviet engineers designed a massive irrigation network with 45 dams, 80 reservoirs, and more than 20,000 miles of canals, that are leaky and inefficient. The Amu Darya's flow is so reduced that it no longer reaches the Aral Sea, now ending 70 miles away.

**Canalization**

Cotton naturally grows in the tropics, due to the humidity. Rain, however, is problematic because the plants absorb water and rot. These plants need sunlight and plenty of water, and therefore are best cultivated in dry areas and irrigated artificially.

**Thirsty Cotton Plant**

The lake's salinization has accelerated the lake's evaporation. With rapid changes in temperature, the surface water has a lower salinity than the bottom water. Surface water thus heats up faster than if the salinity was equal at all depths.

**Salinization of Aral’s Waters**
Exposed Former Seabed
An estimated 43 million metric tons of sand, salt and dust of the former seabed have been picked up by strong winds that now make 150-300 km wide dust storms. The dust is often carried great distances, up to 500 km away, and depleting the nutrient quality of surrounding soils.

Fertilizer and Pesticides
With a lowering of the water table, and increased deposits of salt, local agricultural industry must use more additives in their production, which in turn makes its way down the watershed, contributing to the contamination of soils and the quality of the air.

Smallpox and Bioweapons
The former island of Vozrozhdeniya was the USSR’s testing site for bioweapons such as anthrax, smallpox, plague, brucellosis, and tuleramia. The town of Kantubek once had 1,500 inhabitants, who left in 1992. Many containers holding spores have developed leaks since.
moving borders

As the Aral sea shrank in size, up to 10% of its original size by 2007, it receded from the harbors of Aralsk and Moynaq. Fishermen started by extending their ports by deepening canals. They ultimately relied on helicopters to get their catch to the Aralsk and Moynaq processing plants when needed.¹


Left: Collage image by author.
The 8 mile long Kokaral Dam was built in 2005, to contain water coming from the Syr River on the Kazakh side, as the Amu River on the Uzbek side no longer makes it to the Aral. While the South Aral will continue to shrink, the North Aral will grow to support a fishing community once again.

...regrowth
The [North] Aral ecosystem has since then started to recover slowly with the help of the $85 million 8-mile long Kokoral Dam, mostly funded by the World Bank. This Dam was expected to raise the water level in the North Aral Sea by about 13 feet in five years, but surprisingly did so in 8 months. Salinity lowered to levels much closer to those of the 1960s, and native plants and migrating birds have again started to emerge. Freshwater fish (pike, perch and carp) are finally returning to the Aral. In 2008 fishermen caught 1,500 tons of fish, close to 3,000 in 2011, and 10,000 in 2012*. They began selling locally, but have already started exporting to Russia and Georgia. Two fish processing plants are operating in the [far-from-coast] former fishing town of Aralsk, while a third is under construction. People who left the region when they were young are starting to return to the Aral for fishing. Additionally, the government is attempting to promote tourism to the returning the Aral Sea, as disaster tourism is currently creating one of the largest influxes of tourists to Kazakhstan.
By taking advantage of the 100m stretch of Kokaral dam that flows outward to the Large Aral, one can exploit the brief point of contact between the contained ecosystem of the north and the disappearing landscape of the south.

“The natural space for this transformation is the borderline, where systems of all kinds collide and abrade, as the world breaks up, not into chaos, but rather into new patterns of order.” Lebbeus Woods describes borderlines as collisions between landscapes and the overlay between systems.

In 2010, British photographer Chloe Dewe Mathews hitchhiked from China to Britain. Part of her work, as seen in “Aral: A Dammed Sea,” was documenting the miracle of the return of the North Aral. She witnessed and documented how the youth of the surrounding villages, are once again taking up fishing as an economic activity, after a major generational gap.

Dewe Mathews describes the Kok-Aral during the three month fishing period, when a group of young fishermen have taken to camping (right image) for fishing day and night near the spillway, despite the remote location. Because the dam works like a funnel, it concentrates the flux of fish, providing for a vantage point from which to gather the catch (left image).

After the season is finished, the young men return to their respective villages.
The construction of the dam, which cost approximately $81,000,000 USD, is the third of its kind at the Kokaral site. An earlier example was built in 1992 with rather loose construction, and was destroyed within 9 months in spring 1993 due to a sharp Sea level rise. Its construction was a matter of budget due to the fact that it was built directly from funds by the locals. In 1996, a second attempt to preserve the North Aral was started, with construction finishing in spring 1997. This was the first iteration of the current 14km by 30m layout.
Environmental and biological benefits started to emerge, with increased rainfall, and decreased salinity which boosted flora and fauna in the North Aral. In 1999, the increased water flow of the Syr Darya again washed the dam, in a 4 km segment.

Work on the current dam was completed in 2005. It incorporated the compacted sand of the 1999 dam, with concrete covers and a roadway on top.
The Aral fleet registers 710 vessels, with 570 privately owned and 140 owned by the state. That number is likely to be much larger due to smaller boats not having registration. 483 of these vessels have grants for fishing. According to Mathews’ observations, the temporary camp site on the Kok-Aral site can number as many as 100 fishermen. There is also a long tradition of ice-fishing near the shore of the North Aral in the winter period.

Most water reservoirs in Kazakhstan are filled in the autumn-winter period from October to March and drawn from April to September. “The contradiction is that irrigation requires drawing water in the spring when an increase in water level is in the interest of fishery as fish start to spawn.”

1 Ismukhanov and Mukhamedzhanov (2003).
Tourist Season: Spring + Autumn

With Aralsk’s cold winters (−37.9° F) and hot summers (116° F), especially with the lack of surrounding water to moderate temperatures, the tourist season occurs biannually during the spring and autumn seasons. This means a biannual schedule for the supporting industry, which consists of the Aral hotel, and the tour company Aral Tenizi, which organizes excursions to the ship graveyards, Aral shores, and the Kok-Aral dam.
1. Rescue Industry

While it is not possible to bring the Aral Sea back to its former size and scale of economy, one can create industry for its biggest resource: its people. The two biggest assets of the North Aral Sea are (1.) its fishing industry and (2.) its tourism industry.

**Fishing Industry:**
The construction of fisheries and introduction of fish hatcheries can lengthen the fishing period and provide more employment and stability for the local community.

**Tourism Industry:**
An alternative tourism industry based on positive development can provide a counterpoint to the current disaster tourism that creates humiliation and tension between locals and tourists.

2. Enable Access

The Kok-Aral site is rich in resources, but is remote and inhospitable.

The creation of habitable community spaces is key to creating a more durable community.

**Transportability:**
Access of material supply requires structures that are light and transportable, and flexible to changing programmatic needs.

**Climate:**
The variable climate of the Kok-Aral site requires climatic performance to endure extreme weather in summer and winter periods, thereby lengthening the overlap in tourist and fishing seasons.
3. Motivate Ownership

Ownership of industry, of action.

**Incrementalism:**
Community construction on a **unit by unit basis** allows equitable and integrated participation in community development. The community becomes the sum of individual contributions rather than the single architectural feat.

**Flotation and Interchangeability:**
Flotation offers interchangeability of the unit, as a method for **shrinkage/growth** of individual businesses and measures for their competitiveness.

**Innovative Business Types:**
Ease of adaptations to scale of operation will create businesses that otherwise would exist on land.

4. Empower Longevity

Careful considerations for the deployment of units.

**Supporting Infrastructure:**
Understanding the Kok-Aral as a **linear infrastructure** that will serve as a backbone to a floating community requires design decisions in terms of how to create relationships between the units and clusters of activity.

**System Flexibility:**
Flexibility on the scale of infrastructure guarantees functionality in spite of any possible changes in industry, water level, salinity, and biology.
### fish hatchery
With use of present water level, a hatchery for local fish species requires little maintenance. Hydroponic vegetation allows alternative plant growth, while the fish hatchery is meant to stimulate the regrowing local economy by replacing unsustainable agricultural and fishing practices and provide a basis for education.

### urban infill
Alternative to the growing functions, an urban grid provides an influx of people and movement. The new coastlines will have to confront the relationship between land and water travel, new views and surfaces.

1. **housing fishermen**
Temporal program may house the 100 young fishermen during the Spring and Summer for spillway fishing on the Kok-Aral. This also includes ancillary spaces such as those for drying and processing fish, restaurants for tourists, etc.

2. **tourist lodging**
As a counterpoint to the present “Disaster Tourism”, these units may also morph into lodging for tourists. These provide more comfort amenities, but also are a base from which to educate foreigners.
Architectural Opportunities

As a fishery/hotel project (ecological demonstrator) the Aral’s return indicates an opportunity for an architecture that demonstrates resiliency, and adaptations to water-related changes in salinity, level, location, and species. As the Aral shrank it receded from harbors, it forced its fishermen to extend their ports, and finally relying on helicopters to transport their catch to processing plants once the sea had receded too far.¹ This indicates that a fixed geography is not appropriate for this project, but rather a floating community that houses fishermen and canning facilities, and simultaneously is able to foster a vibrant hotel/tourist community. While flotation offers resiliency in relation to geography and water level, it also allows the interchangeability of its components, as a mechanism for growth/shrinkage of its commercial fishing and tourism functions.

The present site condition as a place of convergence that relies on the three month fishing period demonstrates an ideal place for a temporal architecture.

**Design Opportunity**

The present site condition as a place of convergence that relies on the three month fishing period demonstrates an ideal place for a temporal architecture.

**Kazakh Yurt**

The yurt typology was developed in Central Asia, as a portable dwelling structure for nomads. A compression wheel supports roof ribs, which are also supported by a lattice wall. The structure is covered by fabric for insulation.
Dre Wapenaar is a sculptor and designer that works with canvas, steel and wood to create architectural tent structures that relate to the relationship between its occupants.

**SoundBox Pavilion, 2013**
The SoundBox pavilion takes advantage of the acoustic capabilities of tensile structure. This canvas tent structure positions a large audience around the musicians. Half the audience faces away, to completely engulf the occupant in sound.

**Birthingtent, 2003**
As a project that explores intimate interaction and distance, the birthing tent is a temporary structure for giving birth, and the enjoyment of this moment. The skylight gives views, while a bench on the perimeter is for family, friends and nurses.
Makoko is an example of a resilient, self-sustaining community as a floating slum in Lagos, Nigeria. It was first established in the 18th century as a fishing village, and consists of an urban fabric on stilts, known as the “Venice of Africa.” It is a self-governing community, with an estimated population of 85,840, although could be much higher considering that the area was not officially counted in the Nigerian census in 2007. Community security is the responsibility of “area boys,” young men that defend territory with threat and violence in exchange for money. Due to increasing danger in the area, the government provided a 72-hour notice for eviction before clearing many residences.

1 This Day (May 1, 2009). “Makoko Residents And Their Unwanted Guest”. Africa News
2 UN Integrated Regional Information Networks (September 5, 2006). “Lagos, the Mega-City of Slums”. Africa News.
Nigerian architect Kunle Adeyemi devised a concept for a low-cost public structure. His Makoko Floating school was a triangular frame, taken from the local vernacular of the A-frame roof that resists the heavy rains of Lagos. The structure was set to float with 250 plastic barrels, which creates a rainwater collection system at the bottom. The lowest level platform, the largest, is a 1,000 square foot space that serves as a play area or public space in which fishermen can also make nets when the school is not in session. Classrooms above serve 100 elementary school students. The architect’s intention is that this typology is repeated to meet other public functions such as housing and healthcare.¹