DAR
URBAN RESEARCH
SEED FUND
REPORT
03

SWAP STRATEGY FOR URBAN RESILIENCE

Istanbul's Decommissioned Airport and the Ayamama River Corridor

LCAU
NORMAN B. LEVENTHAL CENTER FOR ADVANCED URBANISM

MIT

Since 2019, the Dar Group and MIT have collaborated on an initiative to catalyze innovative, interdisciplinary research that addresses the design and planning of new and existing urban landscapes in the MENA region, and other comparable arid, semi-arid regions. Through the Dar Group Urban Seed Fund at MIT Norman B. Leventhal Center for Advanced Urbanism and organized through two seed grant calls, the Dar Group has supported nine research projects undertaken by faculty and students from MIT's School of Architecture and Planning. In the first seed grant cycle, projects presented a wide range of research interests addressing equitable heat-resilience at the neighborhood scale to advanced manufacturing of structurally optimized concrete housing. In the second seed grant round research focused on various facets of the recovery, planning, and reconstruction effort in Beirut. These reports share the findings of the nine research projects.

With thanks to the Dar Group for their generous support of this research endeavor, with specific acknowledgment to Mustapha Madi and Daniel Horner for their continued support, guidance, and collaboration.

DAR
URBAN RESEARCH
SEED FUND
REPORT
03

LCAU NORMAN B. LEVENTHAL CENTER FOR ADVANCED URBANISM

Rafi Segal

SWAP STRATEGY FOR URBAN RESILIENCE
Istanbul's Decommissioned Airport and the Ayamama River Corridor

EXECUTIVE SUMMARY

- Set out to design a disaster resilient masterplan for Istanbul's decommissioned Ataturk Airport site
- Researched existing environmental conditions and potential of site to help mitigate urban flood risks in area
- Demonstrated shortcomings of existing proposals for the site and planned a proposal that better aligned with the particularities of the larger Ayamama River Watershed
- Developed a feasibility study for the new proposal and iterated land-use scenarios that ultimately moved industrial quarters to the former airport site
- Translated research into comprehensive adaptive-reuse design proposal for the airport site that reclaims neighboring floodplains and mitigates threat of future urban flooding

3.1 INTRODUCTION

Rapid urbanization resulting in the degradation of hydrological systems is a defining feature of 20th century development. The environmental implications of that process are felt widely today. Increasingly extreme and frequent climate events are endangering critical economic and infrastructural lifelines and are threatening the lives of people who currently live or work in high vulnerability areas. As a result, new paradigms for adapting to chronic risk are imperative to increasing urban resilience. This project seeks to leverage ongoing transdisciplinary research between climate scientists, urban planners, and architects at MIT and other universities in Istanbul in order to study these challenges in detail and to develop innovative strategies that generate value while alleviating urban risk.

The proposal focuses on the Ayamama River floodplain in Istanbul and the former (decommissioned) airport site (Istanbul Ataturk Airport) which has become an urban void. This site, where a heavily channelized urban drainage system discharges into the Sea of Marmara, is poised to undergo major transformation as developers vie for access to an impending master planning process. However, traditional development models may not adequately account for the intensification of land uses further upstream, which signals a high potential for increased flooding in the area. Furthermore, the site which is nestled between several high-density residential neighborhoods, and an access challenged urban coastline may be able to offer vital recreational amenities to millions of Istanbul residents for whom access to open-space is one of the most ubiquitous urban challenges.

This project proposes a novel swap strategy design methodology which relocates, regenerates, and reconnects decommissioned infrastructures and degraded floodplains simultaneously. Through the collection of ground-based meteorological station observations, we analyze historical changes in the mean and extreme precipitation rates in Istanbul. Using this analysis, along with other field-based site studies, we propose strategic planning and design frameworks that:

Key Objectives

- Develop strategies to help mitigate risks exacerbated by climate change
- Transform urban areas under environmental risk into development opportunities
- Guide nature-based solutions for addressing urban environmental hazards
- Support the possibility of relocation as a positive condition to reduce risk and provide improved economic and housing security for affected households
- Introduce a framework to protect community cohesion and resilience
- Establish participatory processes and co-design best practices as vital in urban transformation
- Create a flexible urban strategy rather than a masterplan
- Develop economic incentives for river and floodplain restoration and open space creation
- Provide critical case studies for urban restoration for flood risk reduction projects
- Promote opportunities for ecological restoration and added benefits including increased biodiversity and urban wildlife habitat
- Support improved water quality goals through green infrastructure solutions for urban runoff and industrial contamination affecting the sea of Marmara
- Facilitate opportunities for community education on climate change, natural hazards, and environmental issues
- Reduce long term economic damages from future flood events

Objectives in Detail

This research is most essentially intended to equip urban dwellers with the design and foresight necessary to constructively reimagine our collective relationship to water. This is not just a question of improving the urban quality of life in places like Istanbul, but of survival itself in landscapes increasingly dominated by water. Further objectives designed to achieve this through an urban adaptive-reuse project proposed for the airport site include:

- Developing a methodology to use a hydrological model to inform urban development patterns, decisions, and designs through different phases
- Analyzing climate model projections and their integration into hydrological modeling to inform, test, and develop climate resilient design plans
- Developing a swap strategy and method between the airport and land uses within the Ayamama watershed
  - Refining this into a replicable tool and method for similar cases that face the challenge of redesigning decommissioned airports or infrastructural sites
- Proposing a comprehensive urban design vision plan for the airport
  - To include a new model for an inclusive residential development that attracts new industrial, tech, and mixed-use districts for economic growth
  - Should ameliorate economic losses from airport relocation
- Offering policy recommendations regarding new mixed-use residential developments on the airport site
- Offering policy recommendations for adapting existing neighborhoods around the Ayamama corridor to be more resilient for earthquake and flood risks
- Offering a vision for green infrastructure and public amenity networks

** On February 6, 2023, a 7.8 earthquake struck Turkey and Syria. It is estimated that 24 million people were directly affected, at least 2.5 million were displaced, and more than 56 000 lost their lives. This tragic event showed the devastating effects of a poor building stock. In Istanbul, a city with 16 million inhabitants, and an earthquake inadequate housing stock of about 40%, this highlighted systematic issues in urban planning and policy. While the city needs to renew its housing stock, fear of homelessness exacerbated by the affordability crisis has made people refuse building inspections. It became clear that alternative approaches of urban transformation are urgently required. Accessible open space is also desperately needed to increase resilience.*

This is not just a question of improving the urban quality of life in places like Istanbul, but of survival itself in landscapes increasingly dominated by water.

3.2 PROCESS

A. The Challenges of Climate Change, Flood Risk, River Restoration, and Relocation

Increasing flood risk in cities is caused by a variety of factors, chief among them being land use changes which have affected a given area's natural hydrological cycle. Development creates impermeable surfaces that prevent water from permeating into the ground. Without permeation and absorption of rain, stormwater becomes contaminated as it picks up pollution on urban streets, causing torrential flash floods in neighborhoods located near or on the historic flood way. Local geomorphology, land use patterns, and the number and types of structures in the floodplain all also play a role in the severity of flood impacts.[1]

River restoration through the relocation of assets from floodplains presents a novel way to reduce flood hazard, increase access to open space, and restore hydrological functionality simultaneously.[2] However, it is imperative that urban planners, designers, and policy makers consider the implications of initiatives to relocate homes and businesses away from high hazard areas due to the challenge of finding adequate relocation sites.

This research highlights the opportunity to restore degraded urban floodplains while increasing urban resilience using a novel swap strategy that replaces open space in low-vulnerability areas with open space in high-vulnerability areas. Thus, this swap strategy simultaneously restores the floodplain while providing suitable relocation sites for existing urban development to relocate to. Using the Ayamama River and the decommissioned Ataturk Airport site as a case study, this approach provides a conceptual model for urban designers interested in maximizing floodplain restoration projects in urban centers while reducing risk to built assets and infrastructure without neglecting the rights of relocated individuals to economic well-being, housing, and security.

B. River Restoration for Urban Resilience to Climate Change: Opportunities and Challenges

Urban infrastructural development in the 20th century implemented robust engineering systems such as sewers, curb and gutter systems, culverts, and flood channels to manage urban stormwater and reduce flooding. However, "local engineering structures alone will not provide the long-term protection as hydrology and river dynamics change in response to increased climate variability."[3] In fact, many traditional engineered solutions are increasingly being replaced with "Green Infrastructure" or "Nature Based Solutions" as a way to minimize flood risk, improve ecosystem health, and maximize community benefit by increasing tree cover, reducing urban heat island effect, and providing access to green space and recreational amenities. Other strategies for mitigating urban flooding and building strategies for more sustainable stormwater management systems include Low Impact Development (LID), Room for the River, Sustainable Urban Drainage Systems (SUDS), Natural Water Retention Measures (NWRM)[4], Water Sensitive Urban Design (WSUD), and Sponge Cities[5], to name a few.

While green infrastructure can be implemented in diverse contexts and across many scales, one flood mitigation strategy of increasing interest to urbanists is urban river restoration. River restoration projects can have a wide variety of ecological, physical, and social benefits in urban areas[6] "in support of biodiversity, recreation, flood management, and landscape development".[7] However, it is critical to point out that the exact meaning of "restoration" of dynamic and non-static fluvial systems, especially in the context of climate change, remains of debate — as a result, focusing on social benefits can provide a guiding light in decision making around river restoration.[8] The compounding co-benefits of restoration projects include cleaning up pollution, improving quality of life, reducing flood risk, and increasing property values in nearby areas. These benefits are of increasing study, including the development of an Urban River Restoration Index (URRIx), to evaluate the design, decision making, and improvement of urban river restoration projects and their urban benefits.[9]

Despite the clear benefits of such initiatives, until now there has been little examination of exactly how river restoration initiatives and projects consider relocation of structures and people to make way for these large-scale river restoration initiatives and how residents are involved in the process. In the case of The Cheonggyecheon Restoration Project in Seoul, for example, residents who had moved to the area for manufacturing jobs during a heavy period of industrialization, were erased for the sake of 're-naturalization' of the stream and relocated to an outer suburb of the city.[10] The question of what is restored, for what end, and where relocated people are resettled remains an imperative for addressing equity and justice concerns as well as environmental and ecological considerations.

C. Relocating Assets From the Floodplain: The Challenge of Finding Suitable Relocation Sites

Due to centuries of erosion and flood pathways, the relative flatness of floodplains, especially in hilly terrain, has made floodplains prime real estate for industrial development, which requires large building footprints and transportation infrastructure such as roads, parking spaces and loading docks for shipping and storage. Historically, the relative economic benefits of such industrial infrastructure for urbanization may have outweighed their environmental costs. Concrete river channels were built to control and divert water in a predictable direction, reducing flood risk except in the occasion of significant storms, where such channels can create torrential rivers that overtop their boundaries and cause wide spread damage. As extreme weather patterns driven by climate change increase, removal of structures from high vulnerability floodplains and flood zones is increasingly seen as a viable, or even necessary solution. Although there has been an acknowledgement that climate induced relocation may be necessary to ensure people are safe from harm, most governments currently lack policies and institutional frameworks to help interested communities and individuals in relocating.[11]

Relocation planning is fraught with complexity due to long histories of forced relocation in development projects. These relocation plans have often led to negative consequences for residents and communities under the guise of economic growth and redevelopment. Demands for social justice and human rights have led to a series of best practices for rights-based relocation policy to protect individuals and communities, which guide resettlement programs and ensure the rights against forced displacement.[12]

Despite significant documentation on the qualities of adequate housing requirements for relocated residents,[13] there is currently a lack of guidance for cities on how to approach the relocation of high-risk mixed-use neighborhoods that may include industrial and commercial activity. As firms usually choose their locations based on input and transportation costs, resource availability, and distance to market, relocation of industrial assets may not be feasible without a comparable or suitable relocation site. Appropriate resettlement sites are critical because "they ultimately determine access to land, social support networks, employment, business, credit, and market opportunities."[14] Resettlement sites as close to the original location as possible are considered more suitable. Although additional research, particularly discussion with affected residents and businesses, is necessary to understand resettlement site suitability, the following case study highlights a conceptual strategy for identifying suitable relocation sites: the swap strategy for urban voids created by decommissioned infrastructure sites.

D. Swap Strategy for Urban Resilience: Adaptive Reuse of a Decommissioned Airport Site

Land suitability for relocation can be a major barrier to a successful relocation project. Decommissioned infrastructure sites such as airports provide a critical resettlement opportunity because they are generally centrally located and have strong connections to existing infrastructure. Globally, more than half of national airports are in the process of closure or "have an uncertain future."[15]

D.1 Global Airports at Risk: Adaptive re-use of vulnerable airport infrastructure

Some of the largest airports in the world are located at or below sea level. In the United States, this includes: SFO, La Guardia and JFK in New York, and Boston Logan in Massachusetts, to name a few. The extreme vulnerability of these sites raises major concerns on the future of these metropolitan regions and their connectivity to airspace. An analysis by the Washington-based World Resources Institute (WRI) found that with 1 meter (3.3ft.) of sea-level rise, an estimated 80 airports globally would be under water by 2100.[16] The demand for open space and the need to adapt to climate change impacts brings the issue of infrastructure and adaptive re-use to the forefront of conversations surrounding urbanization and resilience.

As cities grow (or shrink), their infrastructural assets become outdated, unused, or are reconsidered to accomplish other social, economic, and environmental objectives (Table 1). Recent examples of landscape approaches to airport redevelopment[17] have identified categories of strategic reuse, including adapt, conserve, convert, develop, and regrow.[18] Well known case studies of airport reuse include Berlin Tempelhof Airport and the Marisol Sucre airport in Quito Ecuador, both of which preserved decommissioned airport sites as massive open spaces, resulting in the creation of critical urban park amenities with limited additional improvements. Other airport projects, including the Denver Stapleton Airport Redevelopment, have created new areas for real estate and housing development. While existing reuse strategies undoubtedly respond to certain urban needs, such as housing and open space, we argue that the proposed strategies currently lack a sufficient contextual analysis which identifies the role of the airport site in addressing increasing exposure to environmental hazards exacerbated by climate change.

Decommissioned airport sites can play a significant role in mitigating flood risk by providing a unique land bank for our **swap strategy**. This strategy enables climate-adaptive relocation of high vulnerability assets from flood-prone areas, which not only restores degraded hydrological systems and protects neighborhoods from urban flash floods but also reintroduces vegetation to reduce urban heat island effects and provide critical recreational amenities. Thus, the proposed swap strategy maximizes the benefits of redevelopment sites while relieving chronic stressors and shocks in areas prone to hazards such as flooding. The following case applies this concept to the Ayamama River Watershed and the redevelopment site of Ataturk Airport in Istanbul, Turkey.

The proposed swap strategy maximizes the benefits of redevelopment sites while relieving chronic stressors and shocks in areas prone to hazards such as flooding.

Source	Strategy	Description	Example
Strategies of Transformation (Harvard GSD Air Manual)	Adapt	Adaptive proposals are those that avoid over-determined “designed” states and aim instead for systemic frameworks and protocols.	Toronto (Downsview Park); New York (Floyd Bennett Field); Berlin (Landscape Park Johannisthal); Berlin (Tempelhofer Park); Irvine (Orange County Great Park)
	Conserve	Projects that undertake conservation engage in the critical process of preserving certain site elements, modifying others, and erasing still others.	New York (Floyd Bennett Field, fig. 4.1), Quincy, Oslo (Fornbeu), Berlin (Tempelhofer), Irvine (Orange County Great Park), Gatow
	Convert	In order to create environments suitable for residential development, agriculture, cultural functions, and energy production, many airfields have been converted into parks. The strategy of conversion depends on the fact that the airport is a site with ample, flat land that can accommodate a wide array of uses and forms. Conversion has four key opportunities: Transform, Recycle, Renerate, On Hold (Farvogiotti, 2018).	Athens (Hellinikon Metropolitan Park); Oldenburg (Fliegerhorst Oldenburg); Chicago (Northerly Island Framework Plan); San Francisco (Crissy Field); Vatnsmýri (Reykjavík Airport); Taiwan (Taichung Gateway Park); Caracas (La Carlota)
	Develop	When former airport sites undergo remediation and conversion, they open up the possibility for the development of new urban neighborhoods.	Oslo (Fornbeu); Denver (Stapleton Redevelopment); Vatnsmýri (Reykjavík); Munich (Landschaftspark München Riem); Casablanca (Anfa Airport); Gatow (Park Landscape and Urban Agriculture Gatow); Taiwan (Taichung Gateway Park)
	Regrow	The strategy of regrowth highlights the importance of repopulating species and habitats that had been diminished, put at risk, or eliminated. It involves the recuperation of a site’s productive or agricultural capacity and cultivates the health of its natural systems.	New York (Floyd Bennett Field); Midway Atoll (Henderson Field Airport); Novato (Hamilton Wetland Restoration); Quito (Parque Bicentenario)
Favargiotti (2018)	Transform	Complete renovation and replacement of “some combination of public park and housing in new urban form”	Denver (Stapleton Redevelopment)
	Recycle	Redesign through natural processes	Frankfurt am Main (Maurice Rose Airfield)
	Regenerate	Partial Conversion	Berlin (Tempelhofer Field)
Authors (Main et. al (2021))	Relocate / Swap Strategy	Airport sites with low exposure to environmental risks such as floods provide an opportunity to relocate vulnerable assets from areas of high environmental risk and restore urban floodplains.	Istanbul (Ataturk Airport)

Table 1. *Strategies for Adaptive Reuse of Decommissioned Airport Sites.*

E. Research Area: Ayamama River Watershed and Ataturk Airport - Istanbul, Turkey

After earthquakes, flooding is the second most common, expensive, and deadly natural disaster in Turkey.[19] The city has grown rapidly since the middle of the 20th century as rural populations began relocating to metropolitan areas for employment and other economic opportunities, settling on the hills and valleys of Istanbul's unique topography. Rapid urbanization away from the waterfront and into the city's deep interior has resulted in sweeping infringement on natural systems that have re-shaped the region's underlying hydrology and increased the city's vulnerability to chronic flooding.[20] The Ayamama River Watershed, a 21 kilometers long waterway with eight tributaries, flows through the industrial, residential and commercial activities of some of Istanbul's most populated neighborhoods (Bakırköy, Küçükçekmece, Bahçelievler, Bağcılar, and Başakşehir), and is an archetypal example of the rapid transformation of agricultural lands to heavily populated residential, industrial, and commercial urban centers resulting in hydrological degradation.

E.1 Urbanization of the Ayamama River Watershed

This development of the Ayamama River Watershed began with the six large-scale regional development plans of the 1960s that defined the Marmara region's future development. These development plans aimed to regulate the city's industrial and commercial development, shifting industries from the historic city center to its fringes, and attracting workers to the surrounding farmlands. Rapid conversion of agricultural land, which was the dominant form of land use until the 1970s, into industrial, commercial, and residential use,[21] has resulted in the creation of large communities of gecekondu, informal housing constructed by workers with poorly regulated construction. Starting from the 1970s, the population of the 28 neighborhoods bordering the Ayamama riverbed increased from 102,617 people in 1960, to 1,238,342 in 1985,[22] to 2,838,503 in 2019.[23]

As the city expanded, massive transportation systems were built to connect the growing city to Europe, Asia, and the rest of the world. One of the first pieces of infrastructure driving development in the Ayamama corridor was the Ataturk Airport, which first opened in 1912 as a military airfield and was converted to a commercial airport with international flights in 1953. The airport's capacity increased in the late 1960s, expanded its runways in 1972, and in 1983 a new international terminal opened with an additional capacity of 5,000,000 passengers per year. With a further expansion in 1995, Ataturk Airport quickly became one of the most critical hubs for international aviation.

Road networks from Europe to Asia also heavily influenced the development of the Ayamama Watershed. These include E5, opened in 1973,[24] which connects the two sides of the Bosphorus River, and the Trans-European Motorway (TEM), built in the 1980s. These two critical linkages were more recently linked by the Basin Express Road, which currently runs through the low-lying areas of the Ayamama River. Both E5 and the TEM run perpendicularly to the regions' natural topography, which is defined by mountainous watersheds that run north-south. This conflict, between transportation and hydrology, is one of the bases for severe

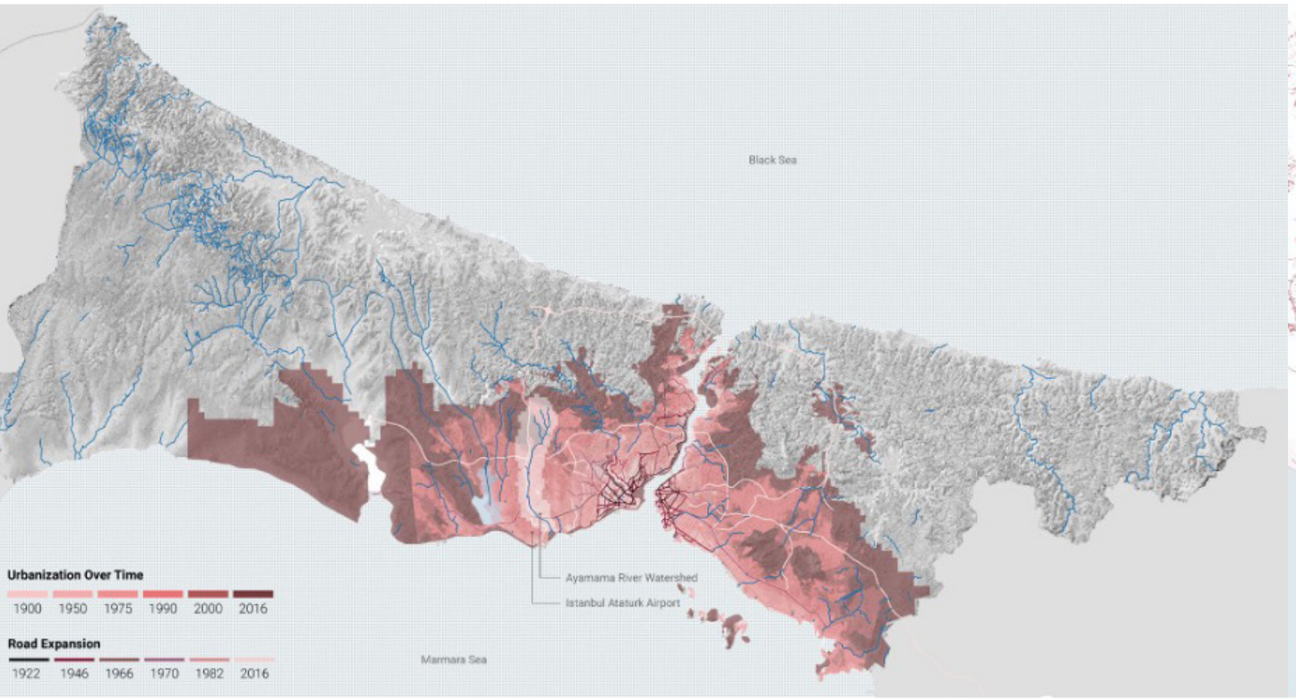


Figure 1. *Map of Istanbul showing the urbanization of Istanbul's watersheds since 1900 and road networks. [Source: Harvard Mellon Urban Initiative, prepared by Nil Tuzcu and Marysol Rivas Brito under the supervision of Nese Dogusan Alexander, 2016.]*

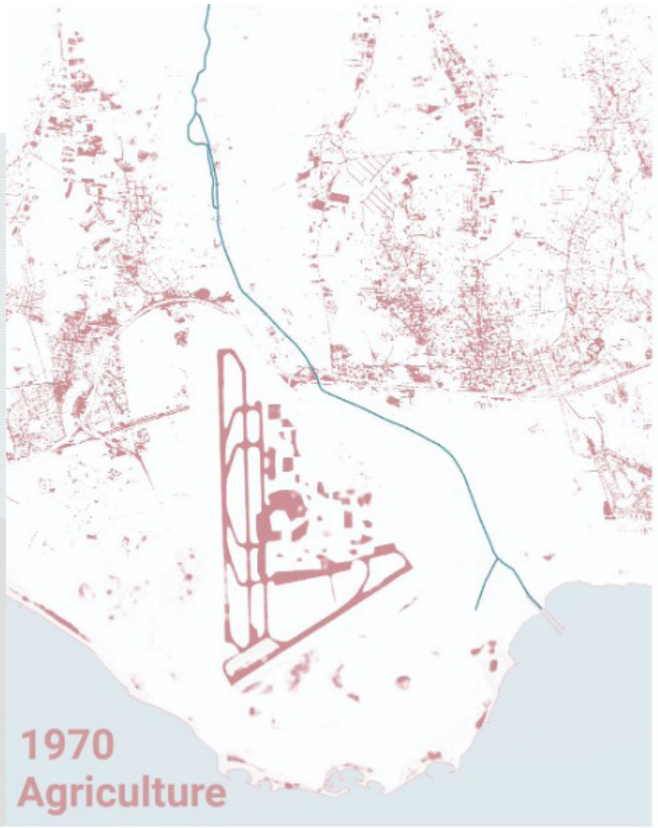


Figure 2. *Aerial imagery highlighting the transformation from agriculture to Industry. In 1970, the airport and scattered gecekondu were the only paved areas, while the watershed for the river remained largely undeveloped. By 2020, almost the entirety of the watershed and surrounding areas have been urbanized. Source: Map Analysis from Authors, Pulled from [Source: Aerial Imagery from Istanbul Metropolitan Municipality (https://sehirharitasi.ibb.gov.tr).]*

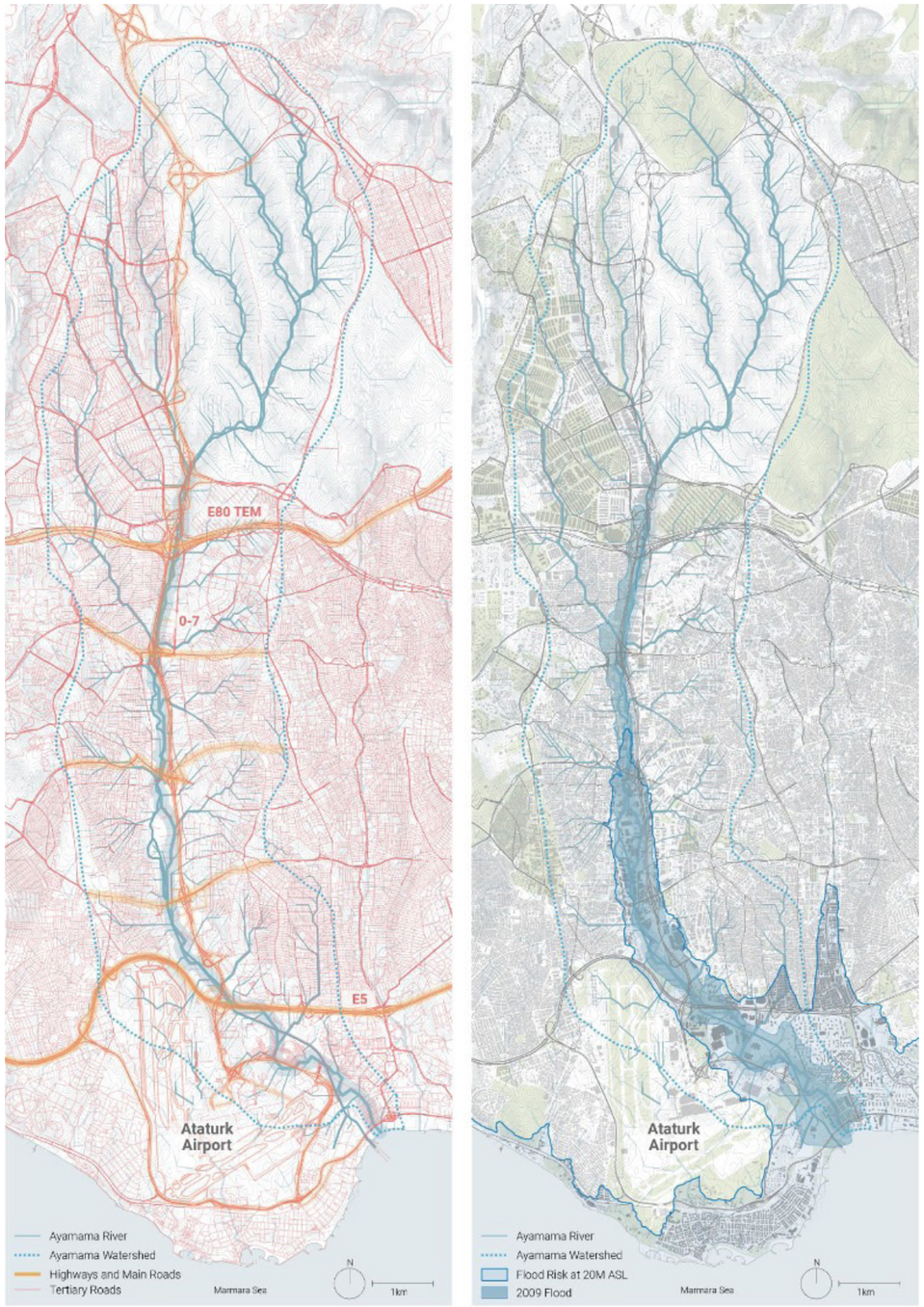


Figure 3. *On left: The Ayamama Watershed with transportation infrastructure highlighted, including the E80 Trans European Motorway, the 0-7 Basin Express Road, and the E5, all of which connect to Ataturk airport. The hydrological system runs North-South, perpendicular to the major transportation arteries, which run East-West. On right: estimated extent of the 2009 floods and the 20m contour line including building footprints and tertiary roads. [Source: Rafi Segal, From Runways to Runoffs, 2022.]-*

transportation disruptions during heavy rains, as undersized culverts can cause backlogs and upstream flood impacts.

Large sections of the river have been channelized in concrete to 'control' the water in the service of enabling industrial and residential activities. Ironically, these channels create high-velocity torrents and have been prone to repeated overtopping. As a result of increasing runoff from urbanization of the upper watershed and increasingly extreme precipitation events, low-lying areas of the watershed have been hit by successive and increasingly destructive flash floods in 1995, 2002, 2009[25], and 2019.[26] The flash flooding on September 9, 2009, caused by 90mm of rainfall in one hour, resulted in 32 deaths with 50 people injured and more than $100 million USD in economic damage.[27] Since then, the Municipality of Istanbul has taken initiatives to further channelize the river and add bicycle and pedestrian amenities to its reinforced banks. However, these types of concrete channels can increase flood velocity, contribute to runoff and pollution, and threaten local biodiversity, causing a condition known as "Urban Stream Syndrome,"[28] which is "characterized by...the consistently observed ecological degradation of waterways (creeks, streams, rivers) draining urban areas."[29]

Flood mitigation measures for the Ayamama River should also address this ecological degradation, since urban flooding and hydrological dysfunction come hand in hand.[30] However, a nature-based river restoration strategy would require the relocation of critical infrastructure and assets, including residential and commercial properties currently located in the floodplain. How can mitigating flood risks restore the local ecology, increase access to open space, without leading to inequitable outcomes for the existing volume and program of uses in the floodplain?

E.2 Analysis of Precipitation Trends in Istanbul

The site surrounding Istanbul's Ataturk Airport has been subject to several major precipitation and flooding events that lead to loss of life and damage to local economy. In order to propose an urban design of the decommissioned airport site that can alleviate the effects of a changing climate and increasing heat and precipitation extremes, we need to gain an understanding how climate has been changing in the area surrounding the airport and the feedbacks between local climate change and urbanization.

To analyze historical precipitation trends, our team member Dr. Komurcu identified several local meteorological stations surrounding the airport and requested meteorological data from the State Meteorological Service of Turkey. Dr. Komurcu aimed to merge the information from station observations with that from gridded observational products (climate reanalysis) to analyze historical trends. Gridded products have advantages such as their long record length and coverage area (e.g. global), but their disadvantages include that they are of coarse resolution to analyze changes at local scales, and acquiring these products to cover long time periods amounts to significant computational storage and longer download and analysis times. The main issue with the available gridded precipitation products, however, is that observational data assimilation is only used after a certain date (i.e. 2007), which does not provide a long enough time period to study changes in historical trends. This is similar to satellite retrievals, where high resolution temporal and spatial coverage is only available after a certain date.

Initially, we performed a regional climate modeling study (see Figure 4) for Turkey, generating 3 km resolution climate data for feasibility and demonstration purposes. The high computational expense associated with such modeling and the time required to generate 3 km resolution local climate data (and the need to downscale several Earth System Models (ESMs) under various future scenarios to cover a more realistic range of future changes), however, prevented us from going that route and prompted us to analyze historical trends to understand and use as a proxy for potential future changes.

Aside from CMIP5 and CMIP6, which provide coarse resolution climate projections from various Earth System Models (ESMs) under different future scenarios, we were also aware of more regional studies of climate change from coordinated modeling experiments such as CORDEX, projections of which were used in Istanbul Metropolitan Municipality's official climate report. However, at 25 km, these projections

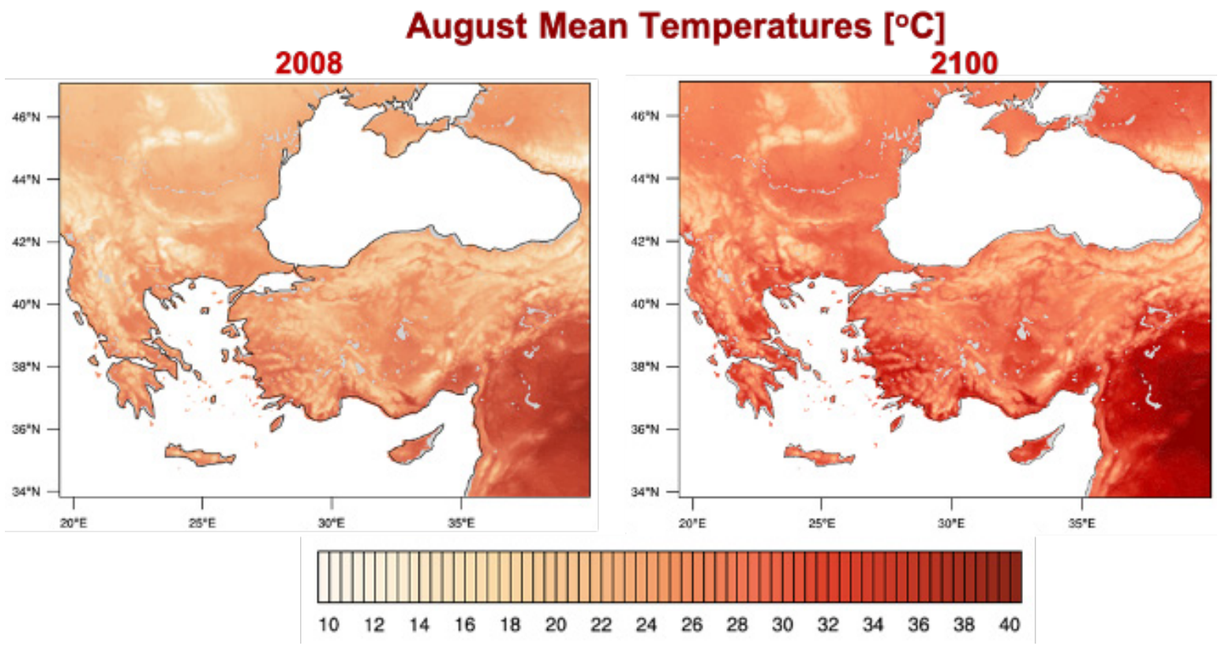


Figure 4. *Projected Changes in August Temperatures [oC] under a high impact emissions scenario based on simulations of team member Dr. Komurcu. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

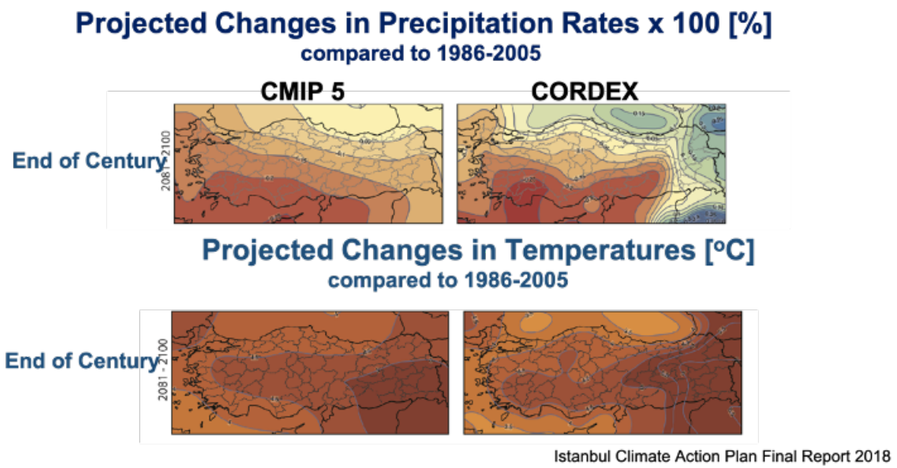


Figure 5. *Projected changes in precipitation rates (top panel) and temperatures (bottom panel) by the end of the century in Turkey from CMIP5 (Earth System Models) (left column) and CORDEX (downscaling of ESM projections using regional climate models) (right column). [Source: Istanbul Climate Action Plan Final Report, 2018.]*

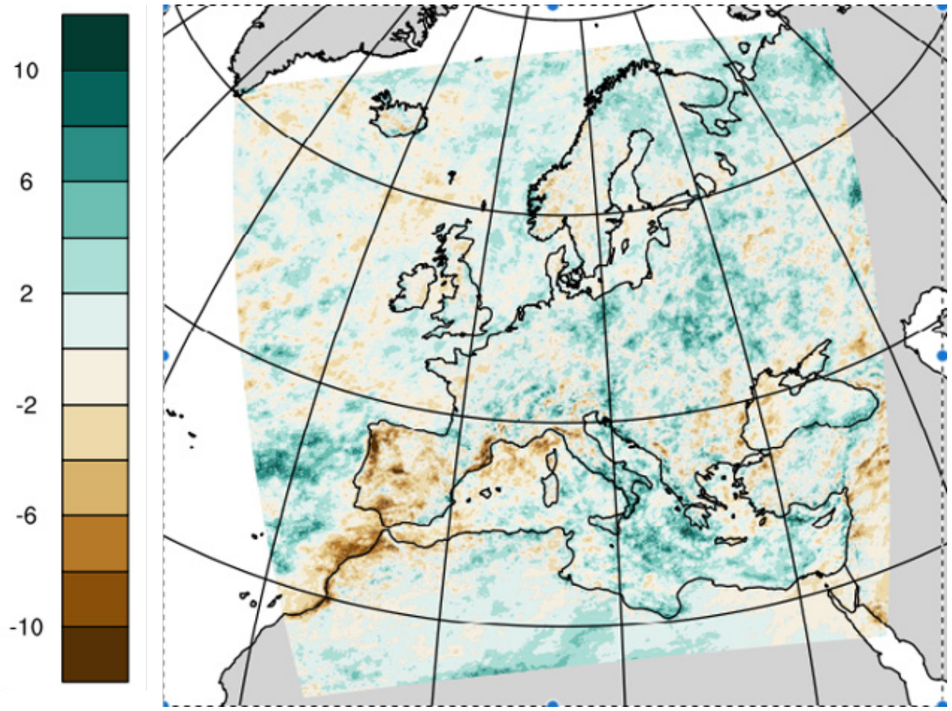


Figure 6. *Changes in the 99th percentile of Daily Precipitation Rates [mm/day] between Mid Century (2046-2055) and Present day (2006-2015). [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

are too coarse for our purposes of analyzing local climate change and changes in climate extremes, see Figure 5.

Upon access to new, high resolution climate projections (12 km horizontal grid spacing) (higher than those used in used in Istanbul's Climate Report). Similar to our initial climate modeling feasibility study (Figure 4), these climate projections provide dynamically downscaled high-resolution climate variables. Figure 6 shows our initial analysis of extreme precipitation rates from this dataset. Closing in on Istanbul, these projections suggest an increase in precipitation extremes on both European and Asian sides of the Istanbul along the Bosporus.

E.3 Considering the Ataturk Airport Redevelopment for Swap Strategy

When it was decommissioned in 2019, Ataturk Airport was serving almost 20 million domestic and 50 million international passengers per year. With a metro station that serves as a connection hub to the city's old and new centers, and close vehicular connections to the E5 and the Basin Express Road to the Trans European Motorway (TEM), the massive airport site is a piece of prime real estate nestled between several high-density residential neighborhoods and close access to the Sea of Marmara. As a result, the decommissioned site offers the potential for vital recreational amenities and access to the coastline for millions of Istanbul residents for whom access to open space is one of the most ubiquitous urban challenges. The current redevelopment strategy proposes converting the airport site into a massive park, called Millet Bahçesi (Nation's Garden), taking inspiration from global precedents like the Mariscal Sucre International Airport in Quito, Ecuador[31] and the Tempelhof Airport in Berlin, Germany. According to the news in Hürriyet Newspaper, of the airport's existing 8.5 million square meters, 5.2 million square meters will be converted to a recreation zone, youth center, museum zone, sports zone, exhibition zone, accommodation zone, living center and disaster gathering area.

Figure 7. *The Ataturk Airport Redevelopment Proposal includes a plan for a massive urban park of more than 5 square kilometers, that includes a sports zone, garden, evacuation zone, and museum zone, among others. [Source: Aksu, 2019.]*

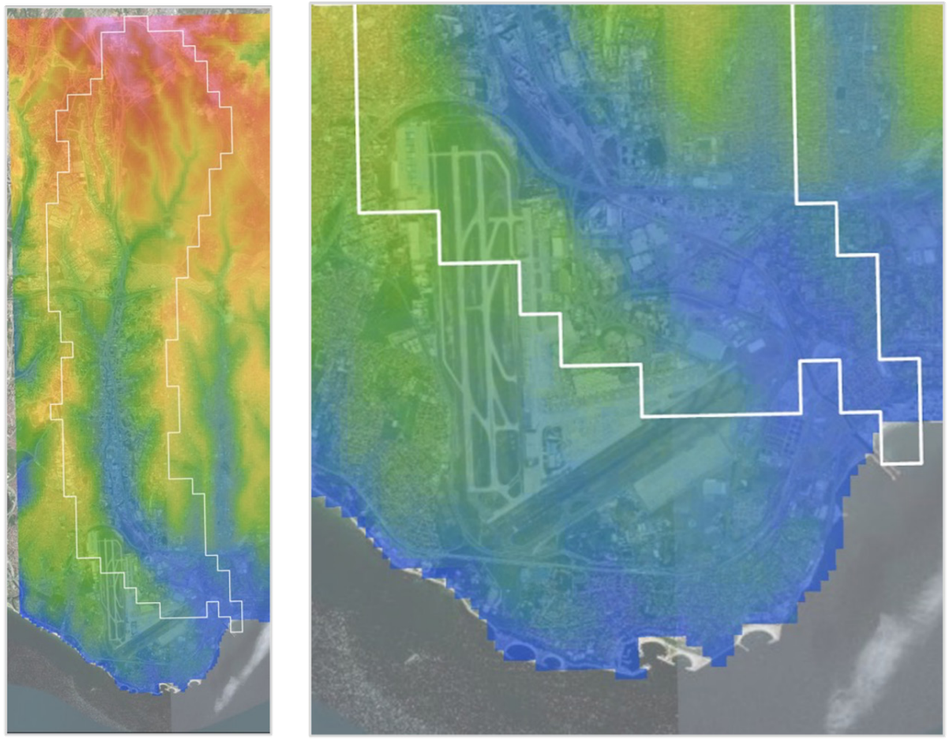


Figure 8. *A hydrological analysis of the Ayamama River shed (Left). The Ataturk Airport is located above the floodplain, straddling two sides of the watershed (Right). How can the decommissioned airport alleviate flooding from a higher elevation? [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

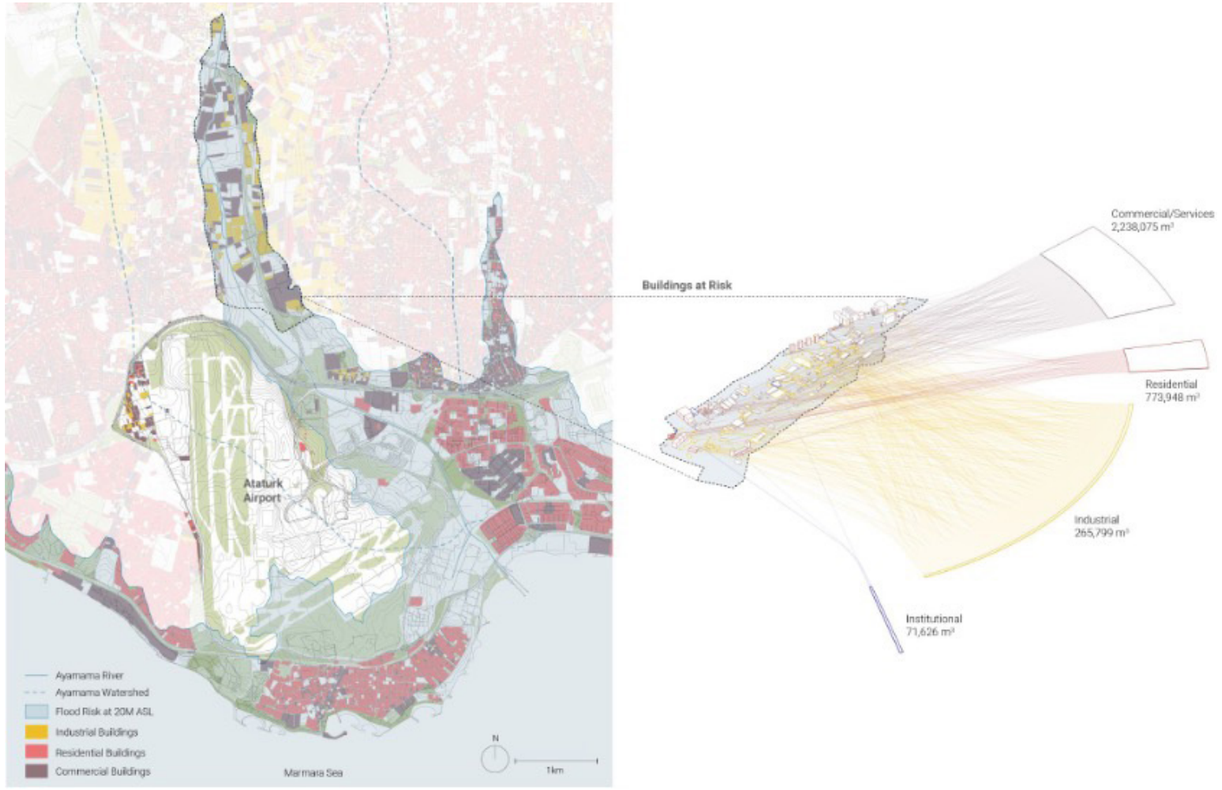


Figure 9. *An analysis of structures located in the middle section of the Ayamama River floodplain, (highlighted at right) reveals primarily industrial and commercial use, with some residential and institutional structures also at risk. This analysis forms the basis of the program for informing the program of the swap strategy redevelopment. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

30 percent of the land will serve as general aviation and 9 percent as military zone. The project was initially planned to be completed by the end of 2021.

While such a project has clear ambition, our analysis reveals several key missed opportunities: First, the airport site is cut off from the surrounding neighborhoods due to massive transportation infrastructure elements on all sides. Second, while the airport redevelopment proposal creates critical open space amenities, it fails to address the economic loss of the airport for the municipality and the loss of jobs for nearby residents. Third, a watershed analysis highlights that the airport site is located high above the flood zone (Figure 8) on top of one of Istanbul's many hills, but the proposal doesn't address the opportunity to relieve flood risk in the Ayamama floodplain. For these reasons, we argue that the project fails to maximize local resilience of the surrounding area to future flood risks and propose an alternative strategy to revitalize the Ayamama river and improve access to quality open space for Istanbul's residents.

E.4. Swap Strategy: Relocate, Regenerate, Reconnect

Because the decommissioned Ataturk Airport is located high above the flood zone, the decommissioned site provides a unique opportunity to contribute to a more resilient future for the Ayamama Watershed by relocating high-risk assets out of the floodplain. Currently, the site includes 5km^2 of flat, open space surrounded by infrastructural connections with existing commercial and industrial activity. Due to the proximity of the site to the

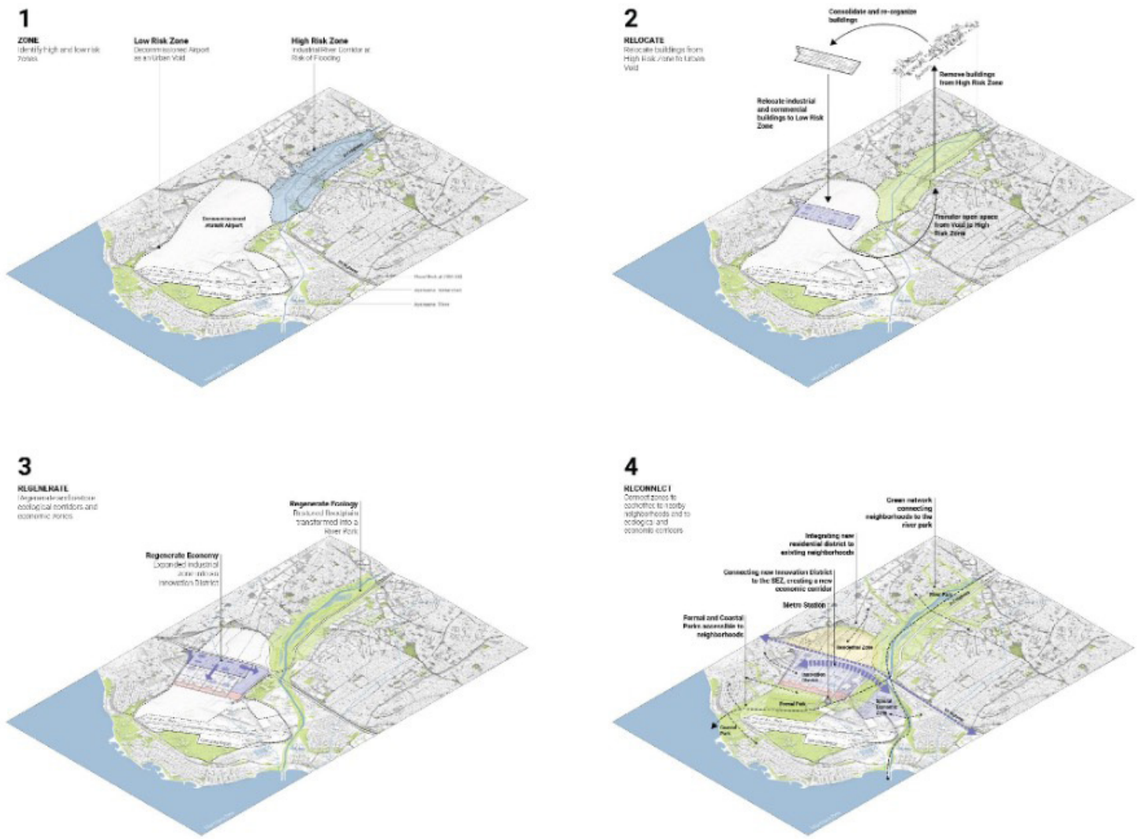


Figure 10. *Swap Strategy Diagrams. Clockwise, from top left: Identification of high and low-risk areas; (2); relocation of vulnerable assets from the floodplain; (3); regeneration of decommissioned airport site and Ayamama River Basin; (4) reconnect floodplain and infrastructure site to the surrounding urban contexts. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

impacted areas from the 2009 floods, implementing a swap strategy in this area presents an opportunity for strategic reorganization of densities and uses around the river corridor, transforming the airport site from an urban void in situ into a repository of valuable open space that can be leveraged to fulfill resilience objectives beyond its own site location. Using the swap strategy to implement the principles of relocate, reconnect, and regenerate, we create a more resilient future for the Ayamama River Corridor.

Using the swap strategy to implement the principles of relocate, reconnect, and regenerate, we create a more resilient future for the Ayamama River Corridor.

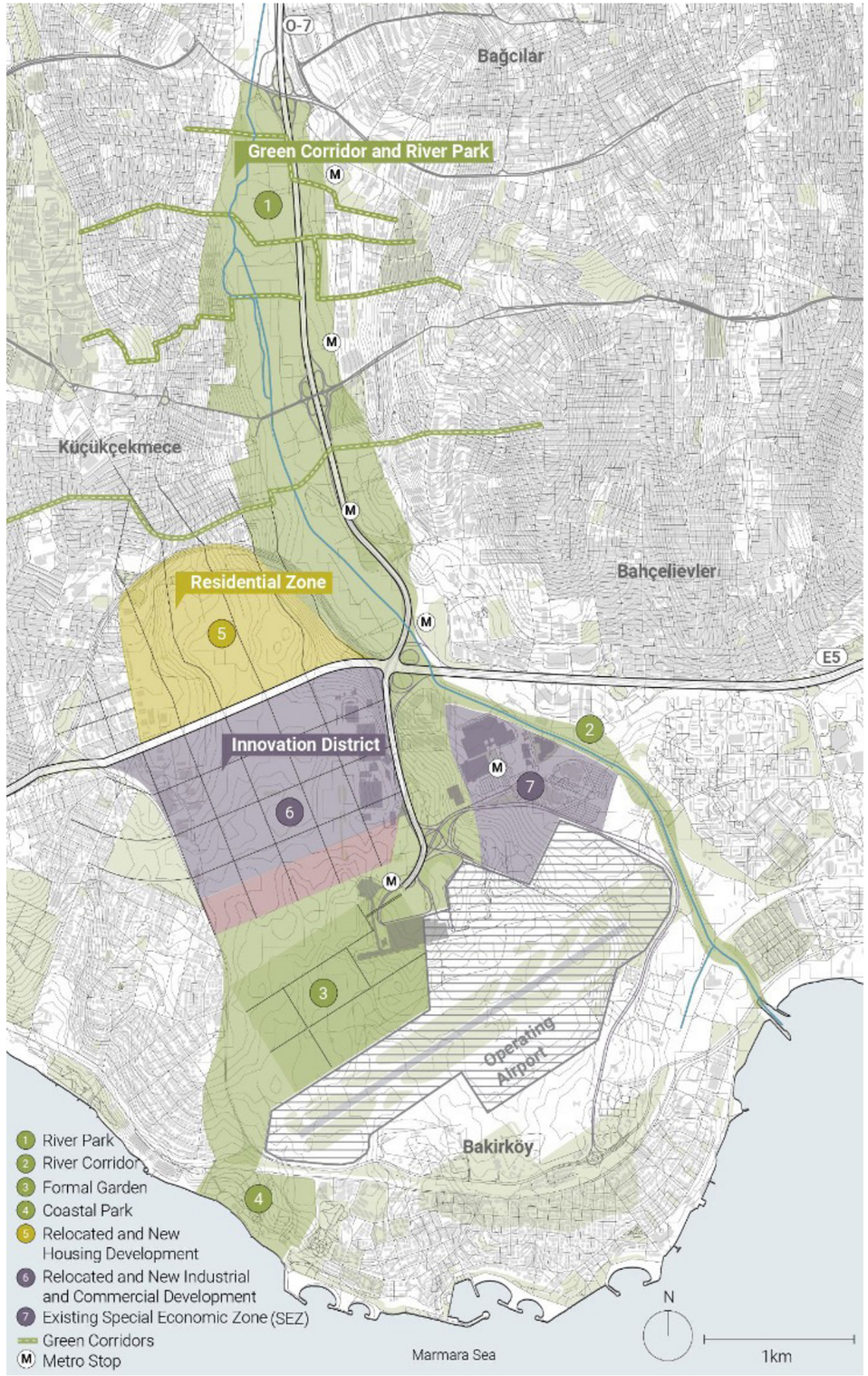


Figure 11. *Final conceptual swap strategy plan: taking inspiration from the program of vulnerable uses in the floodplain, the proposed swap strategy results in the relocation, regeneration, and reconnection of residential, industrial and commercial, and hydrological elements of the Ayamama River basin and the Decommissioned Ataturk Airport. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

E.4.1 Relocate

Acting as a host to vulnerable buildings, the decommissioned airport creates the possibility for industries and residences to relocate onto higher ground. Relocating enables restoration of the floodplain from the Ayamama Floodplain to the Marmara Sea. Relocated industries are re-sited and re-organized on the site to maximize their economic and spatial efficiencies and improve connections to the E5 road network. Relocation incentives for industrial development located in the Ayamama floodplain provide multiple benefits. First, the relocation is close enough that the industrial owners do not lose their input costs, transportation costs, or distance to market. Incentives from local planners to relocate to the airport site can also reduce economic costs in the long run, as they save businesses millions of dollars of future losses from flood damage.

E.4.2 Regenerate

Once industrial buildings are relocated, the Ayamama river corridor can be regenerated by transforming the concrete channel into a revitalized riverbed. The river restoration mitigates flood risk while creating an accessible amenity for the surrounding dense neighborhoods currently lacking open space, contributing to overall well-being and alleviating urban heat island effects. The corridor passes through the former airport site creating a sequence of landscape typologies, starting with the linear river park passing through a formal garden where the architectural heritage of the Ataturk airport building is celebrated and concluding with a coastal park connecting the city to the Sea of Marmara. This new green corridor, estimated to be around 550ha, connects to a larger network that extends to other areas of the city. As the Ataturk Airport was a prominent economic source for the city, the decommissioning of the airport has brought concerns about greater economic loss to the surrounding neighborhoods. By relocating the Industrial assets from the Ayamama floodplain, we can regenerate local economic activity and create more jobs through anew Innovation District, with new industries alongside existing, relocated uses. This siting allows the safety of future economic development assets and provides important new development opportunities.

E.4.3. Reconnect

Located between the E5 Trans-European highway to its North and the coastal highway on the Southern edge, the airport site is currently cut off from its surroundings. The E5 highway was redirected when the airport was built, which created a loop that cut off areas to the north of the airport. By proposing to reroute the E5 highway back to its original location, the patch of land that was previously separated can be reconnected to the Küçükçekmece neighborhood, bringing an opportunity to design new a residential district with mixed-use housing typologies that are socially inclusive and are resilient to earthquake and flood risk. The proposed redirection of the E5 highway also contributes to reducing traffic, further enhancing mobility issues in the city.

These three design actions of relocating assets, regenerating ecological and economic zones and reconnecting both the revitalized river corridor and newly established innovation district, work in tandem under a phased design strategy. This strategy forefronts flexibility as it does not rely on any single, drastic measures, but can accommodate various degrees of change over time. It sets in motion a structured relationship between vulnerability and new development in the city, and introduces new opportunities alongside the urgent environmental action needed, ultimately transforming both sites to a more resilient urban landscape.

E.5. Visions of Transformation Through the Swap Strategy

Figure 12. *A green corridor introduced to unite land and sea along the floodplains once more. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

Figure 13. *The industrial use area relocated to the decommissioned airport site, leaving room for river restoration and new development, addressing Istanbul's housing stock problem. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

Figure 14. *The ecological balance of the river is restored, allowing biodiversity to flourish once again. Istanbul is an important resting stop for migratory birds. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

Figure 15. *After the Swap Strategy, the river is restored to a more natural condition, becoming integrated with a park. New development opportunities are created at the edges where the open space transitions into an urban texture. [Source: Rafi Segal, From Runways to Runoffs, 2022.]*

Summary of Swap Strategy Steps Towards Implementation

The following policy, community, and economic measures must be taken for the swap strategy plan to move towards realization:

Policy

Legal

- Review of international guidelines and best practices for relocation, particularly within UNISDRR and climate change adaptation policies with lessons learned from previous displacement and redevelopment guidelines
- Review of existing policy and legal frameworks at the municipal (Istanbul) and federal (Turkey) level regarding relocation
- Discussions with the City Government and the planning department to create the legal framework required for land swap (learning and building on existing models)

Expansion Of Risk Policy Relocation Survey & Analysis

- Turkey has an urban transformation law (no. 6306) aimed at increasing earthquake resilience. This risk policy could be potentially expanded for climate change resilience
- Support the development of designated Climate Adaptation or Resilience Zones to formalize project boundaries and qualifications (to support additional project area delineation), with attention to multi-jurisdictional boundary overlap/ conflicts

Formalization Of Land Rights

- Review international guidelines and best practices for land rights formalization
- Review of local and federal land rights regulations in Turkey
- Estimation of informal land rights based on existing data sets

Community

Relocation Survey & Analysis

- Review best practices for individual households: needs assessments oriented towards rights-based relocation policy and compensation frameworks

Engagement

- Identify community groups, business associations, residents, rights groups, academic institutions, CBOs, and the like to identify relevant stakeholders
- Develop outreach and engagement plan
- Identify selected Swap Strategy neighborhoods and affected residents; analyze demographic and economic data
- Qualitative and quantitative conversations/surveys with stakeholders and affected parties around a participatory framework

Involvement

- Participation in the design and development of the resettlement zone
- Participation in the design and development of the swap strategy area (parks/open space/restoration)

Economic

Matrix Of Swap Strategy Costs

- Impartial Land and Real Estate Valuation
- Costs related to outreach and engagement
- Costs related to relocation and compensation agreements including land formalization and legal costs
- Costs related to resettlement area / re-housing project development and execution including replacement value and supplementary incentives
- Costs related to floodplain restoration and/or park development

Feasibility Analysis Of PPP (Public - Private Partnership) Models

- Identification of potential private sector partnerships

Potential Funding Sources

- Investigation of relevant public funding and/or financing models for climate adaptation and resilience
- Availability of international development dollars and grants
- Economic Zone incentives / Business district tax
- Environmental restoration resources
- Open/public space funding sources

Summary of Process

1. Began with an extensive, interdisciplinary study of existing urban conditions, weather trends, and disaster mitigation protocols across Istanbul, Turkey
    a. Focused into a review of these parameters at the decommissioned Ataturk Airport
2. Analyzed shortcomings of existing proposals for the decommissioned site
3. Foregrounded viability of Swap Strategy for the airport site with goal of restoring preexisting floodplain
4. Established a base flood model area and clear methodology for feasibility study of this proposed swap
    a. Applied flow discharge model developed by Associate Professor Orkan Ozcan
5. Used GIS data to categorize land use types and permeability
    a. Examined building volume, footprint, and use
    a. Applied findings to understand the program of buildings in the floodplain
    a. Used that information to begin programming the airport site
6. Iterated land-use change scenarios
    a. Altered land use elements in the area of examination from more permeable to less permeable with reference to Manning's Coefficient
7. Compared flood model outcomes
8. Determined the site's suitability for relocation
9. Confirmed merits of relocating industrial use to the airport site
10. Established resiliency of proposal and translated research into comprehensive adaptive-reuse design proposal for the airport site

4.3 OUTCOMES

Overview Of Major Outcomes

1. Evaluated flood risk in Ayamama corridor
2. Analyzed climate change with a focus on extreme precipitation intensity in Istanbul using state of the art high-resolution climate projections to inform hydrological modeling and urban design plans
3. Performed comprehensive site and watershed analysis
4. Facilitated opportunities for community education on climate change, natural hazards, and environmental issues
5. Established interdisciplinary collaboration with Turkish academics, practitioners and scientists
6. Proposed methodology for integrating climate projections informed hydrological modeling with urban design
7. Introduced a framework to protect community cohesion and resilience
8. Developed an innovative strategy for adaptive re-use of airport infrastructure for climate impacts (swap strategy)
9. Established participatory and co-design best practices as vital in urban transformation
10. Guided nature-based solutions for addressing urban environmental hazards.
11. Performed case study analysis of airport adaptive reuse and urban waterway restoration
12. Proposed alternative conceptual design for Ayamama River corridor and Ataturk Airport redevelopment site

Outcomes in Detail

As an overview, our design concept introduced multiple programs to the Ayamama river and former airport site, creating a new economic and green corridor. Rather than propose a single masterplan, this project offered a flexible urban strategy to prepare the site in question (and many such others) for weather-related emergencies. It brought together a transdisciplinary team of civil engineers, urban planners and designers, and climate scientists from MIT (Massachusetts Institute of Technology) and ITU (Istanbul Technical University) to study the issues of stormwater management, rapid urbanization, and extreme precipitation events as they related to Istanbul, Turkey. An in-depth analysis of historical changes in mean and extreme precipitation rates using Istanbul airport data was produced through this research to clarify the relationship between urbanization and mean/extreme temperature and precipitation rates in the Ayamama watershed.

Following this research, the team Identified opportunities for large-scale green infrastructure projects aimed at reducing the impact of urban flood events and providing critical open space amenities for local communities. Istanbul's former (decommissioned) Istanbul Ataturk Airport site was chosen to address the intensification and challenges of land use patterns upstream from the river. Strategic planning and design frameworks were developed to optimize spatial relationships between resilient stormwater management and equitable access to large-scale open space amenities. These various studies then informed a vision for the airport and the Ayamama watershed that illustrate the potential phasing strategies for future development, all of which was made to integrate the site into the surrounding city framework.

Next Steps

Move research towards implementation

- Consultation with Istanbul risk policy experts and with the planning department of current and projected urban renewal projects.
- Consultation with Ministry of Environment regarding the cost of loss and environmental repair
- Reach out to/engage community leaders regarding participation in the relocation initiatives
- Engage a local partner to conduct relocation surveys

Collaboration with Istanbul City Government

Create tools to facilitate community engagement

- Exhibiting the research
- Workshops/classes with ITU and other universities
- Incorporate resilience planning into existing public event and planning engagements ongoing at the neighborhood and municipal levels

Collaborate with The River Lab at UC Berkeley

- Case study analysis to learn from successful river rehabilitation projects from around the world, including Global North and Global South megacities
- Engage global network of river restoration experts

Survey similar sites in the global context in collaboration with MIT Sloan/Real Estate Lab

- Identify similar sites (risk factors, physical conditions)
- Locate decommissioned infrastructures that provide critical resettlement and redevelopment opportunities
- Create a database of political / legal conditions

Outputs

Kelly Leilani Main, Joude Mabsout, Rafi SEGAL, Nese Dogusan Alexander, Olivia Serra, Muge Komursu. "Swap Strategy for Urban Resilience: Reviving the Ayamama River Corridor and Ataturk Decommissioned Airport in Istanbul, Turkey." Landscape Architecture Frontiers, 2021, 9(6): 44–58.

Other Potential publications to be undertaken in year 2 (non-peer reviewed and peer reviewed):

On Infrastructure and Adaptive Reuse:

- Paper for design/planning on re-thinking adaptive reuse of mega-infrastructural sites as 'transformational urbanism,' where the reuse of one space incorporates re-reading and readjusting the larger urban/regional context. Proposing a replicable method for adaptive reuse, while presenting the case of Ataturk Airport. The question of redesigning this new 'void' will incorporate the larger context of the Ayamama watershed. This process, the swap strategy, proposes an interdisciplinary team which would bring in a hydrological model as part of the design methodology.

On Climate Change Analysis:

- A report/article on climate change in Istanbul and Turkey based on climate projections analyzed for this work.

On Hydrological Model + Climate Change:

- Article/paper on connecting urban development/adaptive reuse with climate change risks and projections.

Historical Piece:

- Historical development of the Ayamama corridor: how it changed from agricultural land to industrial land.

Broader Impacts

- Although site specific, the conceptual framing and core methodology of this research can be leveraged to promote adaptive reuse and swap strategy planning in other water dominated geographies
- Specifically, this project serves as a model for nature-based, floodplain reclamation efforts in communities increasingly at-risk of climate related disaster
  - It guides students, practitioners, and planners towards a reconsideration of stormwater management as an urban, infrastructural, and even architectural concern
  - The project demonstrates the co-disciplinary thinking and approaches necessary to outfitting our existing spaces for survival in the age of climate disaster
  - It details how to transform urban areas under environmental risk into development opportunities
- The project's core data, historical research, and site analysis can be applied to iterate other design and policy solves going forward
  - The data is valuable as a precedent and benchmark for future work on these rapidly evolving sites
- The project proposal has the potential to critically stimulate social and economic interests across the whole of Istanbul
  - It iterates novel design approaches to housing, commercial, and recreational space on and around floodplain adjacent territory
  - Pushes back against destructive existing proposals
- The project productively models ways to better live with the environment, instead of at the expense of it
  - Importantly helps shift global perspectives on building towards a future of shared climate security

Conclusions

Review of Major Outcomes and Final Thoughts

Although social, economic, and environmental conditions are evolving across the world at unprecedented rates, this research proves the ability of architects, urban designers, and planners to meet these changes head-on, with viable proposals for mitigation and resiliency. PI Williams' team demonstrates both the necessity and feasibility of getting at-risk communities online across the African continent, and leverages data aggregation and analysis as a means of agency and self-determination in underdeveloped nations. PI Norford's team tackles extreme heat events through novel simulations and material studies, all of which are imperative to design in the age of global warming. PI Segal's team considers the merits of floodplain reclamation and adaptive reuse schemes at Istanbul's decommissioned Ataturk Airport in a move that draws on cross-disciplinary expertise to mitigate what is also, among many other things, a cause of economic strain for the city.

These projects together not only strive to mitigate existing crises, they work to anticipate them. They empower dwellers and practitioners with the knowledge and applications necessary to successfully live with massive changes in urban, environmental, economic, and social life, and prepare them for the onset of future conditions. As data on the status of established prototypes continues to come in, these projects together confirm their suitability for further development through future collaborations with the Dar Group.

Notes

1 Veról, A. P., Battemarco, B. P., Merlo, M. L., Machado, A. C. M., Haddad, A. N., & Miguez, M. G. (2019). "The urban river restoration index (URRIX)—A supportive tool to assess fluvial environment improvement in urban flood control projects." *Journal of Cleaner Production*, *239*, 118058. https://doi.org/10.1016/j.jclepro.2019.118058.

2 Veról, Aline Pires, Bruna Peres Battemarco, Mylenna Linares Merlo, Ana Costa Marques Machado, Assed Naked Haddad, and Marcelo Gomes Miguez. "The Urban River Restoration Index (URRIX) - A Supportive Tool to Assess Fluvial Environment Improvement in Urban Flood Control Projects." *Journal of Cleaner Production* 239 (December 1, 2019): 118058. https://doi.org/10.1016/j.jclepro.2019.118058.

3 Serra-Llobet, A., Kondolf, G. M., Schaefer, K., & Nicholson, S. (Eds.). (2018). *Managing Flood Risk: Innovative Approaches from Big Floodplain Rivers and Urban Streams* (1st ed.). Palgrave Macmillan, Cham.

4 "EU Policy Document on Natural Water Retention Measures." (2014). Technical Report. https://doi-org.libproxy.mit.edu/10.2779/227173

5 Y. Jiang, C. Zevenbergen, Y. Ma. "Urban pluvial flooding and stormwater management: a contemporary review of China's challenges and 'sponge cities' strategy." *Environ. Sci. Policy,* 80 (2018), pp. 132-143. https://doi-org.libproxy.mit.edu/10.1016/j.envsci.2017.11.016

6 "What is (ecological) river restoration?" (n.d.). *European Center for River Restoration*. Retrieved June 28, 2021, from https://www.ecrr.org/River-Restoration/What-is-river-restoration. Cited in Verol et. al, 2019.

7 Veról, A. P., Battemarco, B. P., Merlo, M. L., Machado, A. C. M., Haddad, A. N., & Miguez, M. G. (2019). "The urban river restoration index (URRIX)—A supportive tool to assess fluvial environment improvement in urban flood control projects." *Journal of Cleaner Production*, *239*, 118058. https://doi.org/10.1016/j.jclepro.2019.118058

8 S. Dufour, H. Piégay. "From the myth of a lost paradise to targeted river restoration: forget natural references and focus on human benefits." *River Res. Appl.*, 25 (5) (2009), pp. 568-581. https://doi-org.libproxy.mit.edu/10.1002/rra.1239

9 Veról, A. P., Battemarco, B. P., Merlo, M. L., Machado, A. C. M., Haddad, A. N., & Miguez, M. G. (2019). "The urban river restoration index (URRIX)—A supportive tool to assess fluvial environment improvement in urban flood control projects." *Journal of Cleaner Production*, *239*, 118058. https://doi.org/10.1016/j.jclepro.2019.118058

10 Jeon, C., & Kang, Y. (2019). "Restoring and Re-Restoring the Cheonggyecheon: Nature, Technology, and History in Seoul, South Korea." *Environmental History*. https://doi.org/10.1093/envhis/emz032

11 McNamara, Karen E., Robin Bronen, Nishara Fernando, and Silja Klepp. 2018. "The Complex Decision-Making of Climate-Induced Relocation: Adaptation and Loss and Damage." *Climate Policy* 18 (1): 111–17. https://doi.org/10.1080/14693062.2016.1248886.

12 See as examples: *UN Guiding Principles on Internal Displacement* (United Nations 2004); *Handbook on Resettlement: A Guide to Good Practice* (Asian Development Bank, 1998); *Protecting Internally Displaced Persons* (Brookings Institution, 2008).

13 See general comment No. 4 on adequate housing adopted by the Committee on Economic, Social and Cultural Rights in 1991, cited in United Nations. "Basic Principles and Guidelines on Development-Based Evictions and Displacement", Annex 1. A/HRC/4/18.

14 *Handbook on Resettlement: A Guide to Good Practice* (Asian Development Bank, 1998).

15 Sara Favargiotti (2018) "Renewed landscapes: Obsolete airfields as landscape reserves for adaptive reuse," *Journal of Landscape Architecture*, 13:3, 90-100, DOI: 10.1080/18626033.2018.1589147.

16 Lavietes, Matthew. "Corrected-Rising Seas Threaten to Drown U.S. Airports by 2100." Reuters, February 5, 2020. https://www.reuters.com/article/climatechange- usa-airport/corrected-rising-seasthreaten- to-drown-us-airports-by-2100- idUSL1N2A31GA.

17 Ibid.

18 *Airfield Manual: Field Guide to the Transformation of Abandoned Airports* (Harvard Graduate School of Design, 2017).

19 "Flash Floods and Urban Flooding in Turkey," *Climate Change Post*, https://www.climatechangepost.com/turkey/ flash-floods-and-urban-flooding/. Citing footntoes of article as follows: EM-DAT (2010), K.müşcü and Ceylan (2007), K.müşcü and Çelik (2012); Yucil (2015); Tahmiscioglu (2006), in: Aktaş (2014).

20 Turoğlu, Hüseyin (2011). "Flashfloods and Floods in Istanbul," *Ankara Üniversitesi Çevrebilimleri Dergisi*, DOI: 10.1501/Csaum_0000000043.

21 During the 1980s, a new metropolitan governance model enabled the mayor with more political power over administrative actions with new financial resources. Between 1980 and 2000, the local municipalities gained more authority in planning practices then before, and new districts joined the Metropolitan Area. This expansion of the Metropolitan Area altered the administrative system around the Ayamama River Corridor, and Bakırköy got divided into new districts. First, Küçükçekmece's administrative status changed to a district in 1987, and Bağcılar ve Bahçelievler in 1992. The Mass Housing Law of 1984 and the zoning amnesties of the 1980s were significant urban development activities that transformed the Ayamama River Corridor. While zoning amnesties were legalizing the illegal housing stocks and replacing the squatter houses with apartment buildings, the Mass Housing Law created a new housing market for the city›s middle-class and upper-middle-class users.The Housing Development Administration of the Republic of Turkey (TOKI) was founded in 1984 and supported these construction activities with new forms of financial aids until the Mass Housing Fund was abolished in 2001. Neoliberal policies defined the construction activities of the 2000s. With the government's open economic policy, the private sector started to have a more noticeable housing market presence. With its new administrative structure, starting in 2002, TOKI led the construction market with a significant role. Both TOKI and the private construction companies produced commercial buildings and dense residential areas along the Ayamama River.

22 Ilhan Tekeli, *The Development of the Istanbul Metropolitan Area: Urban Administration and Planning* (Istanbul: Kent Basimevi, 1994).

23 Meltem Delibas, "Critical Assessment of 'Stream Daylighting' as an Approach for Renaturalization of Riverine Systems in Urban Areas Case Study on: Ayamama Stream" (M.Sc. thesis, Istanbul Technical University, 2012).

24 Savmi Ersek, "Doğu Marmara Ön Planının Ana Hatları," *Mimarlık,* no: 11 and 12 (1964).

25 Gülbaz, Sezar, Cevza Melek Kazezyılmaz-Alhan, Ayşenur Bahçeçi, and Uğur Boyraz. "Flood Modeling of Ayamama River Watershed in Istanbul, Turkey." *Journal of Hydrologic Engineering* 24, no. 1 (January 2019): 05018026. https://doi.org/10.1061/(ASCE)HE.1943-5584.0001730.

26 Hulya Dinc, "Istanbul Derelerinin Fiziki Değişimi ve Arazi Kullanım İlişkisi," (Ph.D. diss., Istanbul Technical University, 2015).

27 Kömüşcü, A. Ü., & Çelik, S. (2013). Analysis of the Marmara flood in Turkey, 7–10 September 2009: An assessment from hydrometeorological perspective. *Natural Hazards*, 66(2), 781–808. https://doi.org/10.1007/s11069-012-0521-x

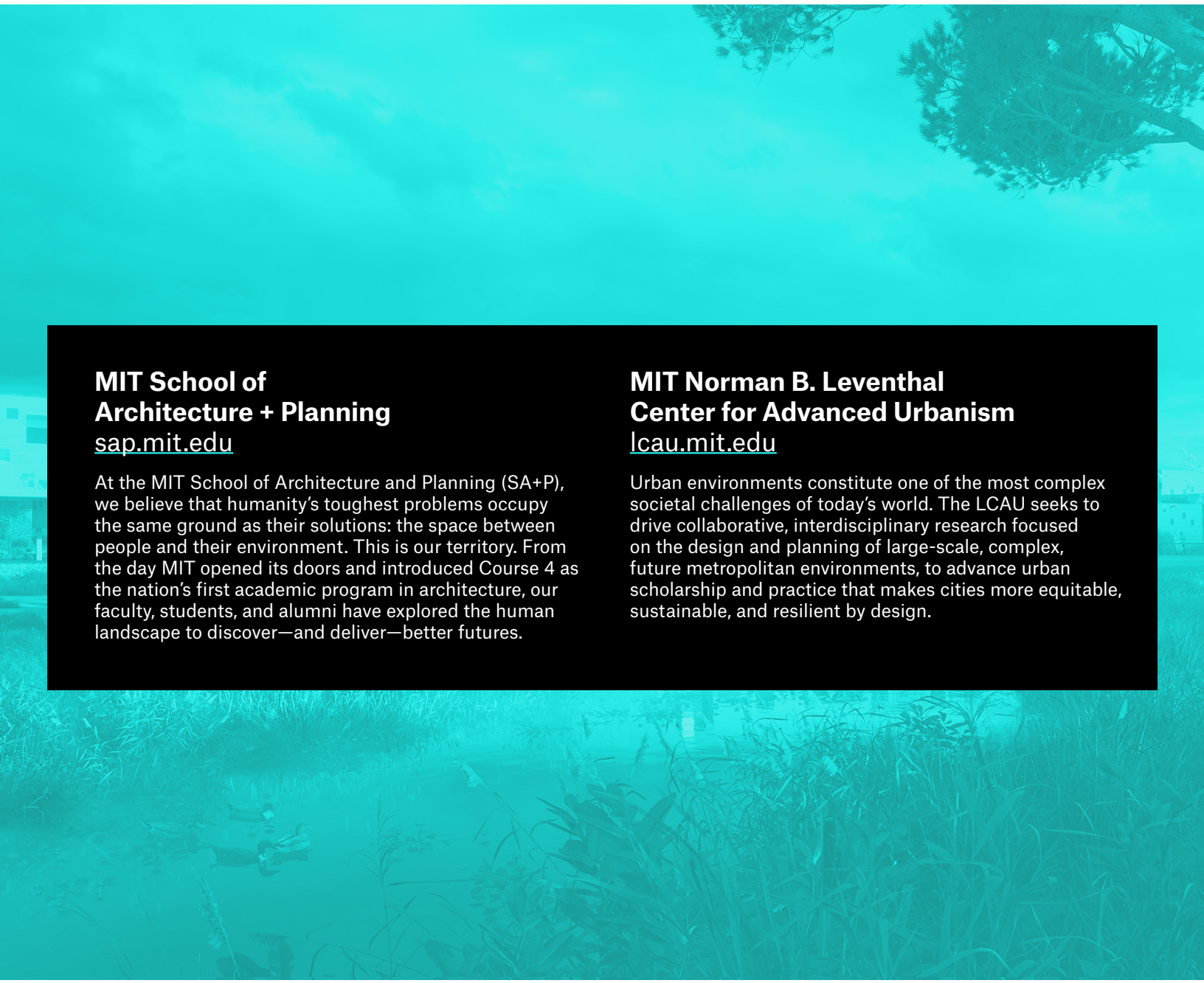
28 Delibas, Meltem, and Azime Tezer. "'Stream Daylighting' as an Approach for the Renaturalization of Riverine Systems in Urban Areas: Istanbul-Ayamama Stream Case." *Ecohydrology & Hydrobiology* 17, no. 1 (January 2017): 18–32. https://doi.org/10.1016/j.ecohyd.2016.12.007.

29 Walsh, C.J., Roy, A.H., Feminella, J.W., Cottingham, P.D., Groffman, P., Morgan, M R.P., 2005. "The Urban Stream Syndrome: Current Knowledge and the Search for a Cure, Cooperative Research Centre for Freshwater Ecology." *Water Studies Centre and School of Biological Sciences*, Monash University, Victoria, Australia.

30 Delibas, Meltem, and Azime Tezer. "'Stream Daylighting' as an Approach for the Renaturalization of Riverine Systems in Urban Areas: Istanbul-Ayamama Stream Case." *Ecohydrology & Hydrobiology* 17, no. 1 (January 2017): 18–32. https://doi.org/10.1016/j.ecohyd.2016.12.007.

31 Carrión, Andrea. "Megaprojects and the Restructuring of Urban Governance: The Case of the New Quito International Airport." *Latin American Perspectives* 43, no. 1 (January 1, 2016): 252–65. https://doi.org/10.1177/0094582X15579900.

DAR URBAN RESEARCH SEED FUND REPORT 03



MIT School of Architecture + Planning

sap.mit.edu

At the MIT School of Architecture and Planning (SA+P), we believe that humanity's toughest problems occupy the same ground as their solutions: the space between people and their environment. This is our territory. From the day MIT opened its doors and introduced Course 4 as the nation's first academic program in architecture, our faculty, students, and alumni have explored the human landscape to discover—and deliver—better futures.

MIT Norman B. Leventhal Center for Advanced Urbanism

lcau.mit.edu

Urban environments constitute one of the most complex societal challenges of today's world. The LCAU seeks to drive collaborative, interdisciplinary research focused on the design and planning of large-scale, complex, future metropolitan environments, to advance urban scholarship and practice that makes cities more equitable, sustainable, and resilient by design.

LCAU NORMAN B. LEVENTHAL CENTER FOR ADVANCED URBANISM

MIT