RESILIENCE ACCELERATOR

PUNE, INDIA

THE MULA MUTHA PROJECT

JUNE 2019

100 RESILIENT CITIES

COLUMBIA Center for Resilient Cities and Landscapes

BHARATI VIDYAPEETH DEEMED UNIVERSITY PUNE

BHARATI VIDYAPEETH INSTITUTE OF ENVIRONMENT EDUCATION AND RESEARCH PUNE

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PROGRAM OVERVIEW

The Resilience Accelerator Program (the Accelerator), a partnership between 100 Resilient Cities – Pioneered by the Rockefeller Foundation (100RC) and the Center for Resilient Cities and Landscapes (CRCL) at Columbia University, connects cities with design expertise and a global network of practitioners and researchers to expand the resilience value of projects, generate investment opportunities, deepen relationships between project teams across sectors, and accelerate implementation strategies. The Accelerator leverages the strengths of 100RC and CRCL to support the city partners most directly responsible for the implementation of priority resilience projects and is enhanced by local academic partners that coordinate local research to advance the analysis, design, and planning explorations.

The Resilience Accelerator aims to match the research, planning, and design expertise at Columbia with local knowledge and relationships of partner cities to advance pre-design work of high priority projects within the 100RC network by:

- Delivering analyses, visualization of issues, and design in support of project development, and leveraging Columbia and other academic partners to advance resilience-based design, research, and decision-making.
- Facilitating immersive workshops that bring together multi-disciplinary teams to advance strategy, project design, and implementation.
- Convening the perspective of hundreds of international and place-based thought leaders, designers, and technical experts chosen for their ability to facilitate and advise on topical subject matter.

Since the launch of the program in the spring of 2018, the Resilience Accelerator has worked with 13 projects across eight cities in the 100 Resilient Cities network.

PARTNERS

100 Resilient Cities – Pioneered by The Rockefeller Foundation (100RC)

100 Resilient Cities – Pioneered by the Rockefeller Foundation (100RC) helps cities around the world become more resilient to social, economic and physical challenges that are a growing part of the 21st century.

The Team: Saurabh Gaidhani, Associate Director | Michelle Mueller, Program Manager Resilience Accelerator Program | Sam Carter, Director Resilience Accelerator Program

Center for Resilient Cities and Landscapes at Columbia University

The Center for Resilient Cities and Landscapes (CRCL) uses planning and design to help communities and ecosystems adapt to the pressures of urbanization, inequality, and climate uncertainty.

The Team: Kate Off, Faculty Director | Thad Pawlowski, Managing Director | Geeta Mehtam, Associate Professor and Faculty Affiliate | Dillip da Cunha, Lecturer in Urban Planning and Design and Faculty Affiliate

Pune Municipal Corporation, Resilience Office, Disaster Management Cell

Pune was selected as one of 100 Resilient Cities in May 2016. Pune Municipal Corporation (PMC) established a resilience office in August 2017 and Mahesh Harhare was hired as Chief Resilience Officer to lead the PMC effort to understand, analyze, and build the resilience of Pune City.

The Team: Mahesh Harhare, Chief Resilience Officer

Pune Municipal Corporation, Environment Department

The goal of the Pune Municipal Corporation (PMC) Environment Department is to create environmental awareness, promote responsible citizenship, and instill environmentally friendly attitudes among Pune citizens. The department is the lead nodal agency for the Mula-Mutha riverfront development project.

The Team: Mangesh Dighe, Environmental Officer

Bharati Vidyapeeth Institute of Environment Education and Research

The Institute of Environmental Education and Research at Bharati Vidyapeeth (BVIEER), directed by Erach Bharucha, seeks to apply environmental education and research to the areas of environmental science, geoinformatics, and policy.

The Team: Erach Barucha, Professor | Kranti Yardi, Professor | Shamita Kumar, Professor and Vice Principal

College of Engineering Pune

College of Engineering, Pune (CoEP) is commitment to finding solutions to the great predicaments of the day through advanced technology and education.

The Team: Sanjay Kumar Sona, Associate Professor | Arati Siddharth Petkar, Professor

EXECUTIVE SUMMARY

In the foothills of the Western Ghats, the most biodiverse region of India, lies the sprawling City of Pune—one of India's largest and most economically thriving cities. In the hills above Pune, four dams hold much of the water that coursed through the Mula and Mutha rivers when the City was the seat of the Maratha Empire and the birthplace of the Indian independence movement. Today that water flows through pipes into homes, offices, and factories and is discharged as sewage (much of it untreated) into Pune's waterways.

The 2018 drought, like the droughts before it, accelerated the movement of farmers from the countryside around Pune into the city. These migrants seek seasonal work as laborers and service workers for the tech campuses and luxury condos on Pune's periphery. But the supply of affordable housing for low-income workers has not kept pace with demand. As a result, many of the new arrivals settle in informal housing on public land along the banks of the Mula and Mutha Rivers, where housing lacks even basic amenities and is exposed to seasonal flooding from the monsoon.

In this context of mounting environmental and social crisis, the Pune Municipal Corporation (PMC) commissioned a study for a riverfront project that follows precedents from around the world, where rivers are channelized into concrete drains and waterfronts cleared to make way for landscaped promenades and real estate development. We were asked to consider this study and propose alternatives. In collaboration with the Columbia University Urban Design Studio, the Pune College of Engineering, and Bharati Vidyapeeth, we advocate for taking a holistic watershed approach to the rivers, and integrating investments in transportation and sewage infrastructure with community-based planning to address long-standing environmental and social injustices.

Students and faculty worked alongside Pune Chief Resilience Officer Mahesh Harhare to understand the potential of Pune's river ecosystem. Through the course of a semester they developed conceptual designs for how the PMC could re-vegetate the river edges; value ecological features such as the basalt outcroppings and bird habitat along the river; and find engaging ways to connect the people of Pune to the ecological assets of their city and the waters that flow down from the Western Ghats.

Takeaway: If Pune can grow ecological awareness, equitably manage water and provide safe housing and infrastructure for all its people, it can serve as a model of responsible urban growth for cities throughout South Asia.

By the Numbers:

- Pune is the 9th most populous city in India and according to a government index, the most livable.
- An estimated 40% of the urban population lives in slums. During the recent drought this number is thought to have grown from an estimated 1.2 million to 2 million people, with an average of 300 families coming by train each day.
- In 1961 the Panshet Dam burst resulting in a flood that killed as many as 1,000 people in Pune

BACKGROUND

Pune City, located at the confluence of the Mula and Mutha Rivers, is in the foothills of the Western Ghats, one of the most bio-diverse regions in India. Pune has experienced rapid urban expansion in recent years. According to the New York University Atlas of Urban Expansion, Pune's urban extent grew from 5,427 hectares to 45,944 between 1991 and 2011. This expansion continues today while, at the same time, the changing climate brings droughts that accelerate the immigration of farmers seeking seasonal employment. Many of these new residents settle in informal housing along the banks of the Mula-Mutha rivers, creating immense pressure on the City's water resources and civic infrastructure.

The proposed Mula-Mutha River Conservation and Riverfront Project—led by the Pune Municipal Corporation (PMC) and designed by the design firm HCP Design Planning and Management—was the topic of the Pune Resilience Accelerator. The project envisions keeping the river free of pollution, the riverfront safe from flooding, and protected as a continuous public space. Nevertheless, community and environmental groups have criticized the project for its drastic concretization and commercialization of the riverbanks, and removal of native rock forms and wildlife habitat features. The project is also encountering significant implementation barriers owing to complex jurisdictional ownership and management framework. Moreover, the project assumes the removal of informal settlements and the implementation of sewage treatment plants by the Japan International Cooperation Agency (JICA), but it does not address the broader efforts needed to manage solid waste. Increasing water consumption, rapid development of upstream areas, rural versus urban water needs, and pollution all speak to the larger, more systemic scale of vision and coordination required to implement a transformation of the river system.

The Resilience Accelerator Team (the Team)—including partners from 100 Resilient Cities, the Center for Resilient Cities and Landscapes at Columbia University, and the Columbia University Urban Design Program—partnered with the PMC Resilience Office and the Office of Environment Department to develop an alternative approach to the Mula-Mutha Riverfront Project—one that prioritizes the social and ecological needs not addressed in the current plan.

The Team visited Pune in January 2019 to join staff from the Bharati Vidyapeeth Institute of Environment Education and Research (BVIEER) and the College of Engineering Pune (COEP) on site visits throughout the metropolitan area and participate in lectures and discussions about the growing interconnected challenges that urban and rural areas face in the Indian state of Maharashtra. The group looked at different spatial configurations that would advance the PMC's core purpose: protecting the Mula-Mutha river as a public asset and building the overall resilience of Pune.

Over the next four months, Columbia University students developed urban design strategies to improve water management, biodiversity, agriculture, heritage, housing, and social equity, and enable environmental stewardship in light of global climate and urbanization pressures. Students explored these strategies with pilots for six sites representative of Pune's geography along the Mula-Mutha river. PMC officials, the Pune Chief Resilience Officer, and the Resilience Accelerator Team informed the student work with periodic feedback.

This document summarizes the Accelerator partnership, outlines the challenges facing the City of Pune and the state of Maharashtra, offers a set of design principles, and presents a series of alternative project concepts and examples.

ON-SITE RESEARCH

In January 2019, PMC, BVIEER, and CoEP led the Accelerator Team on visits to several sites along the Mula-Mutha including the riverfront at the city core, the Sangam Bridge, a bird habitat conservation area, the new Metro line construction site, and the Bund Garden. Columbia University students formed groups to further investigate six topics: Changing Economy, Housing and Informality, Transportation and Water Infrastructure, Heritage and Culture, the Watershed and Ecology. Students presented their findings to officials from PMC, BVIEER, and COEP. This document highlights findings from their on-site research.

THE WATERSHED

Large dams upstream are controlled by the Irrigation Department, which is tasked with providing water for irrigation in the state of Maharashtra. Flooding is not isolated along the Mula-Mutha. Nallahs, small tributary waterways that run into the Mula-Mutha also overflow.

ECOLOGY

The Western Ghats and Mula-Mutha are critical biodiversity corridors. The Mula-Mutha was once home to more than 10,000 birds and diverse fish species. Today, the Salim Ali Bird Sanctuary is home to a much-reduced number of migratory and local birds and a reminder of the rich biodiversity of the region. This site and its many inhabitants are now threatened by urbanization. A critical ecological issue is that nallahs, small tributary waterways that flow into the Mula-Mutha, have been neglected, channelized, or filled in, disrupting the entire ecosystem.

CHANGING ECONOMY

Pune's economy is transforming rapidly with the rise of the IT sector, which has grown since the 1990s at the expense of traditional agriculture. Gated IT office parks fragment agricultural lands on the urban periphery, and many local people with agrarian skillsets aren't equipped to work in the new IT economy.

HOUSING AND INFORMALITY

Deforestation upstream and climate change cause regular droughts in the state of Maharashtra. This creates migratory pressure from rural to urban areas. While private developers build gated middle and high-income housing units, the urban poor continue to live in informal housing. Twenty-two percent of the city's population lives in 516 existing informal settlements. Most do not have adequate sanitation or clean water, which leads to pollution of the Mula-Mutha.

TRANSPORTATION

Unplanned growth has led to a high reliance on private automobiles in Pune. To decrease automobile usage, the city has made improvements to its bus system, promoted bike usage and bike sharing, and is building three Metro lines. The line planned along the Mula- Mutha may limit access to the waterfront and contribute to water pollution. The current proposal also pairs Metro line construction with an allowance for new buildings to reach a 4.0 FAR, greatly increasing building heights and density along the riverfront.

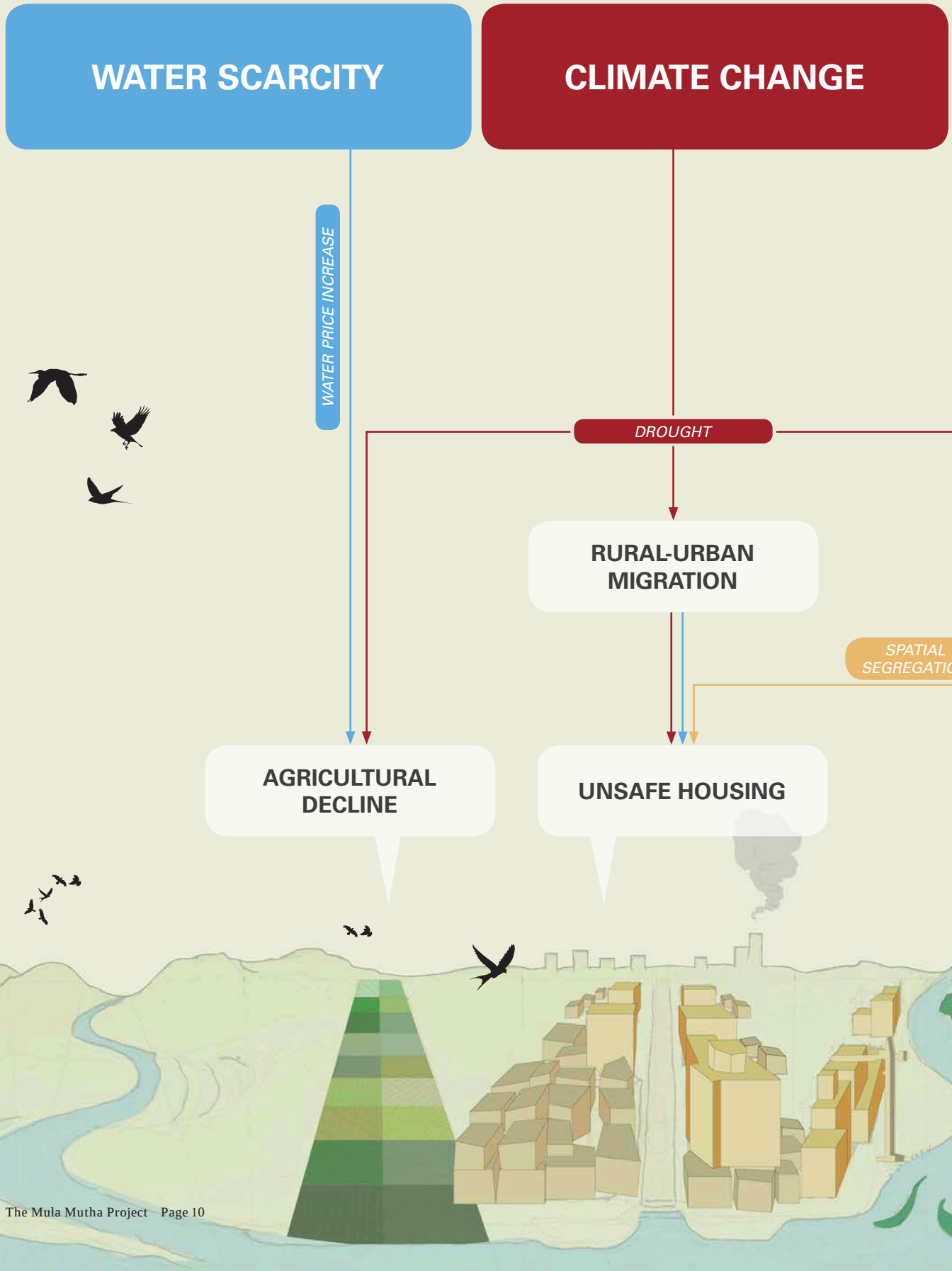
WATER INFRASTRUCTURE

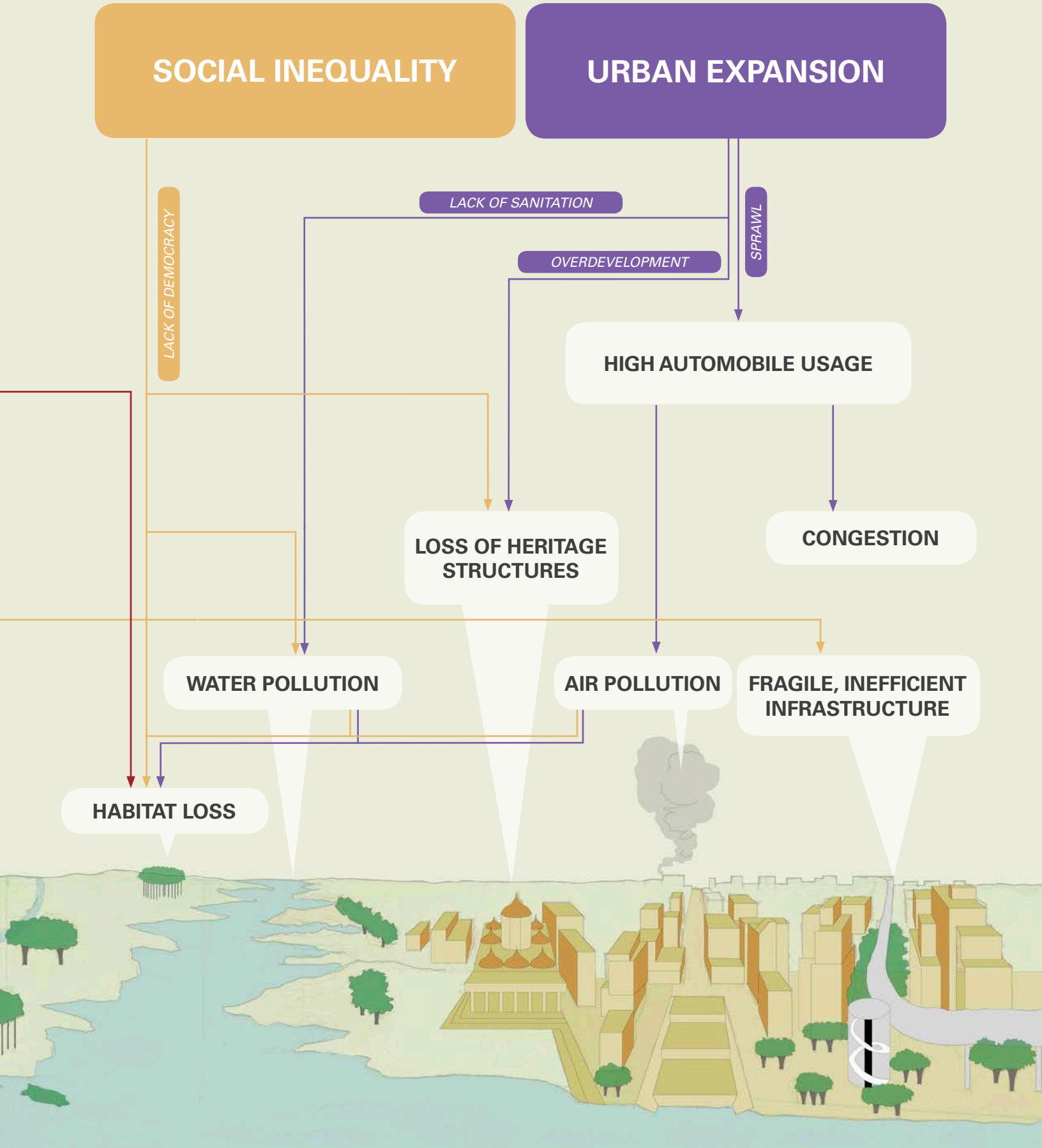
The Mula-Mutha is polluted; there is little oxygen in the river and human waste is visible on the surface. A Japan International Cooperation Agency (JICA) Project proposes to build 10 Sewage Treatment Plants (STPs). Existing treatment plants are at full capacity and there is concern that the proposed STPs may not be sufficient to process the volumes of daily sewage. Bund walls and weirs slow and oxygenate the water of the Mula-Mutha. They also trap silt and clay that traditional potters use.

HERITAGE AND CULTURE

Pune is the cultural capital of the Maratha people. The Mula-Mutha is sacred, in particular at the sangam or confluence of the two rivers. The banks of the Mula-Mutha are a stage for festivals, including the famous Ganesh festival, as well as social interactions, cremations, and recreation. Daily use and festivals also create debris that pollutes the river.

INTERCONNECTED RISK




SOCIAL INEQUALITY
URBAN EXPANSION
LACK OF DEMOCRACY
LACK OF SANITATION
OVERDEVELOPMENT
SPRAWL
HIGH AUTOMOBILE USAGE
LOSS OF HERITAGE STRUCTURES
CONGESTION
WATER POLLUTION
AIR POLLUTION
FRAGILE, INEFFICIENT INFRASTRUCTURE
HABITAT LOSS

DESIGN FRAMEWORK

Throughout the Resilience Accelerator process, the Team used on-the-ground research, consultations with Pune stakeholders, existing plans and projects, and the goals of the Resilience Office to inform the 10 design principles described here. These principles are the framework for design concepts and can serve as guidelines for an alternative approach to the Mula-Mutha Riverfront Project.

The Mula-Mutha is a water system that extends beyond the river's edge in the City of Pune to a network of nallahs and the Western Ghats beyond. The project has the potential to be a broad base, public stewardship campaign around the issues of environment and health; it should be phased and should not be considered or managed as a "mega-project."

The Mula-Mutha Riverfront Project can also advance ecological and social resilience in Pune; address the need for coordinated city and regional resource management; regenerate Pune's ecological fabric; and improve public health and create equitable access to the incredible public asset that is the Mula-Mutha.

The Mula-Mutha Project can:

EMBRACE a phased catalytic approach. Pune can start by creating systems to remove garbage, reduce plastic, and eliminate dumping to improve water quality. The City can focus on sewage at the source and upstream, and develop strategic access points and civic re-vegetated edges.

REDUCE flood risk by following a nature-based and decentralized approach. Pune can learn from past failures of deepened channels and high walls to prevent flooding. The Mula-Mutha can disperse and hold water in decentralized forests, talabs, and other micro-holding systems. This is a cultural approach to integrated water resources management.

INTEGRATE urban fabric at the water's edge beyond the river's redline. The City can connect neighborhoods and their history with the river ecosystem. Informal settlements can be connected with infrastructure and opportunities. Housing with easy access to the river for urban farmers and fishermen should be included in the project.

VALUE AND CONSERVE Pune's natural and ecological features in ways that highlight its unique, biodiverse landscape. The design can also serve as a visual language that's rooted in regional ecology and practices.

LINK LANDSCAPES across the city to create a blue-green network that heals vegetation upstream and in the City of Pune. The project can create habitat corridors for wildlife and people and foster public appreciation of the river ecosystem by creating more opportunities for public access and a commons for all.

PILOT A UNIQUE NEXT-CENTURY MODEL for symbiotic urban, agricultural, and aquaculture uses in India that builds on rural knowledge to create green jobs and training for the next century.

ANTICIPATE informality and build micro-scale sewage infrastructure to address the housing and migratory crisis being exacerbated by climate change.

ADOPT-THE-RIVER! to nurture a management framework that maintains living infrastructure in river segments. Create a stakeholder plan based on social capital and corporate responsibility. Pilot a form of stakeholder engagement that is educational and fun, and that describes the larger picture and potential of the Mula-Mutha project.

ENGAGE AND EDUCATE the next generation of landscape stewards. The Mula-Mutha project can be at the center of an ecosystem and environmental science curriculum for school children. Apply a citizen-science based approach to foster the next generation of river stewards.

IMPLEMENT a watershed/water resources approach. Design a water network and start upstream! Reforest the upland ghats to reduce episodic flooding and maintain a holistic, regional approach driven by the cycle of water. Focus on the health of the local nallahs for river and human well being.

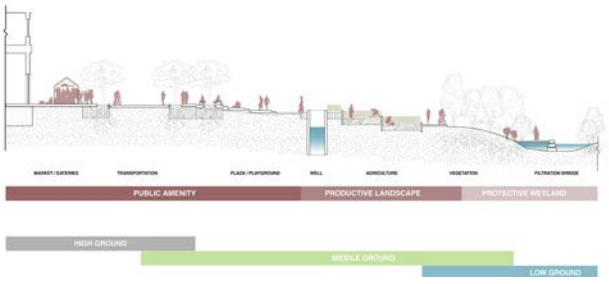
URBAN DESIGN CONCEPTS

Based on the design framework noted in this report and their on-site research, graduate students in the Columbia University Urban Design Program developed seven concept proposals for design projects that address interrelated risks in Pune. These are compiled in an e-book available at www.arch.columbia.edu/programs/9-m-s-architecture-and-urban-design.

The Middle Ground

A Blue-Green Network for a Healthier, Eco-Smart Pune

Richard Chou I Huang Qiu I Tina Pang



Principle: Reduce flood risk by following a decentralized, nature-based approach.

Concept: Urban design guidelines that follow topographic distinctions, with higher densities of buildings at higher elevations, and agriculture or open space in lower, flood-prone areas. The "middle ground" becomes the interface between the city and nature.

Nallah-hood

Toward a Healthy Mula-Mutha

Noah Shaye I Ryan Pryandana I Shouta Kanehira

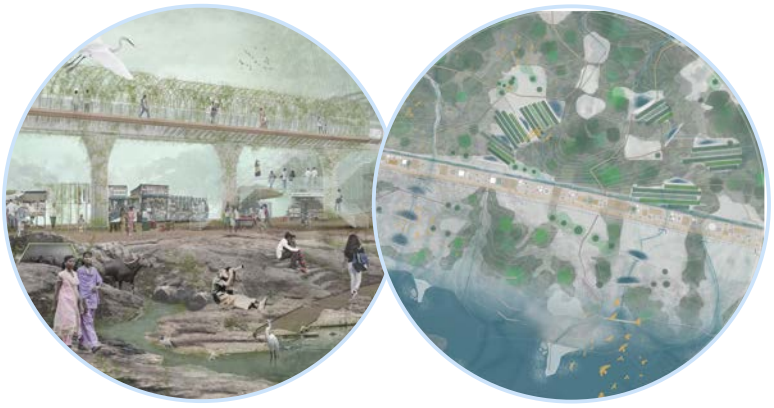
Principle: Link landscapes across the city to create a blue-green network that heals the vegetation upstream and within Pune.

Concept: Community stewardship programs that re-vegetate and maintain small waterways, and are supported by a new political institution with jurisdiction over the watershed.

Metro, Myna & The Mula-Mutha

How Pune's Metro Can Be an Initiator of Ecological Restoration, Livelihood and Habitat Expansion

Alexandra Burkhardt | Maria Palomares | Lorena Galvao



Principle: Pilot a unique, next-century model for symbiotic urban, agricultural, and aquaculture uses in India.

Concept: Design concepts for Pune Metro line stations that incorporate multiple benefits including bird habitat, public sanitation, and flood prevention infrastructure.

Nature-Led Central Business District

Huiwon Hong |Yali Zhao |Yinzhe Zhang

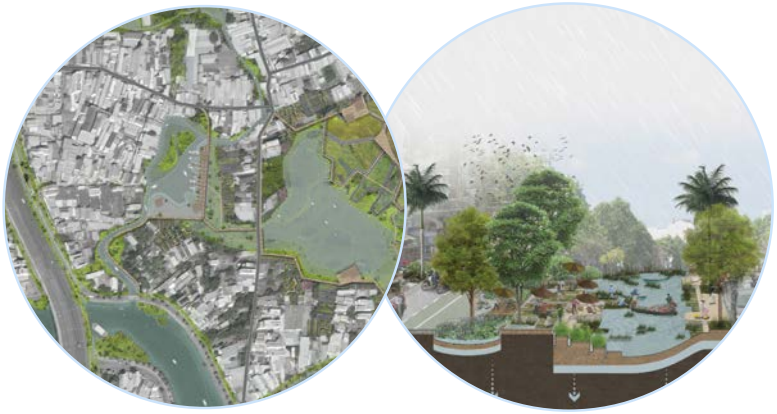
Principle: Value and conserve natural and ecological features to define the biodiverse landscape unique to Pune.

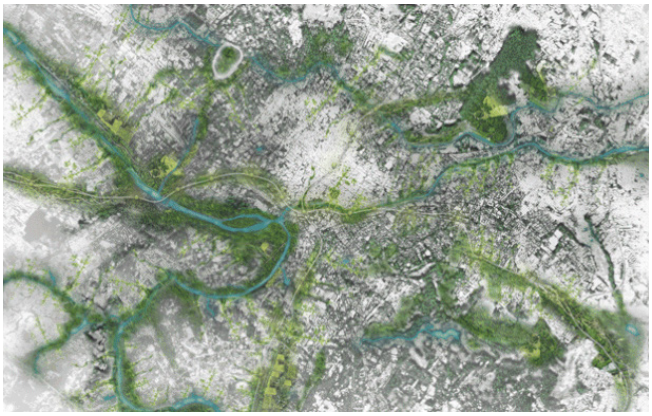
Concept: An easily accessible, vegetated park along the banks of the Mula-Mutha, with high-density development relegated to higher-elevation areas.

Ex Pausing Pune

Nurturing Moments of Pause in a City of Constant Rush

Alexandraos Hadjistyllis | Carolina Godinho | Adi Laho





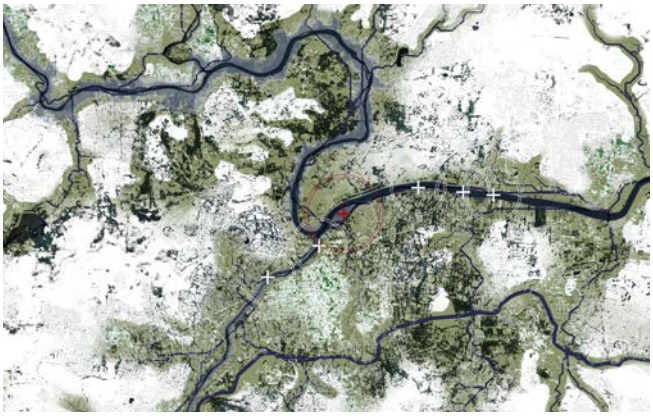
Principle: Reduce flood risk by following a nature-based and decentralized approach.

Concept: A network of Pune's cultural monuments and historic tanks and aqueducts to activate public space and improve drainage and water quality.

Hyper Maidan

Linked, Connected, and Multifunctional Systems

Pei Jou Shih | Donghanyu An | Zilu He



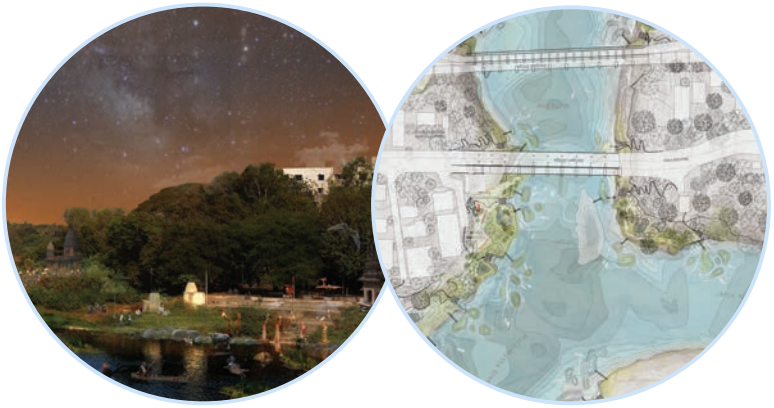
Principle: Anticipate informality.

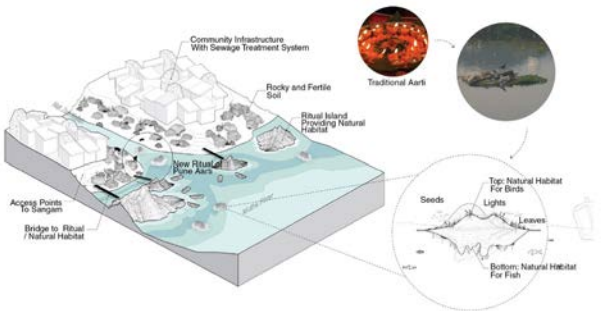
Concept: Integrating seasonal public space with a distributed, neighborhood-scale wastewater treatment system.

Sangam

Leveraging Ritual to Heal Pune's Ecology

Shuo Yang | Jinsook Lee | Keju Liu





Principle: Engage and educate the next generation of landscape stewards.

Concept: Incorporate traditional religious and cultural practice into the management of ecosystems and landscape rehabilitation efforts.

CASE STUDIES: LEARNING FROM THE PAST AND LOOKING FORWARD

Cities around the world are recognizing the importance of rivers for their potential health, economic, and aesthetic benefits. As a result, many are revitalizing their waterfronts to unlock the potential of rivers. However, many of these revitalization initiatives do not consider the river itself. The Pune Municipal Corporation (PMC) and partners have an opportunity to restore the health of the Mula-Mutha, mitigate the deleterious effects of new development, and help communities thrive along the riverfront. The PMC must balance Pune's ecological and social needs to achieve these goals (Otto et al. 2004).

We can learn from global examples where cities are working to remove hard or concrete infrastructure from riverfronts and reintroducing soft vegetated edges. The process to remove hardscape is costly, but the PMC has the opportunity to leap ahead of other cities and create a Mula-Mutha plan and project design grounded in social and ecological goals.

This section provides case studies that highlight cities living with the consequences of hard infrastructure projects and cities implementing new approaches to their riverfront revitalizations.

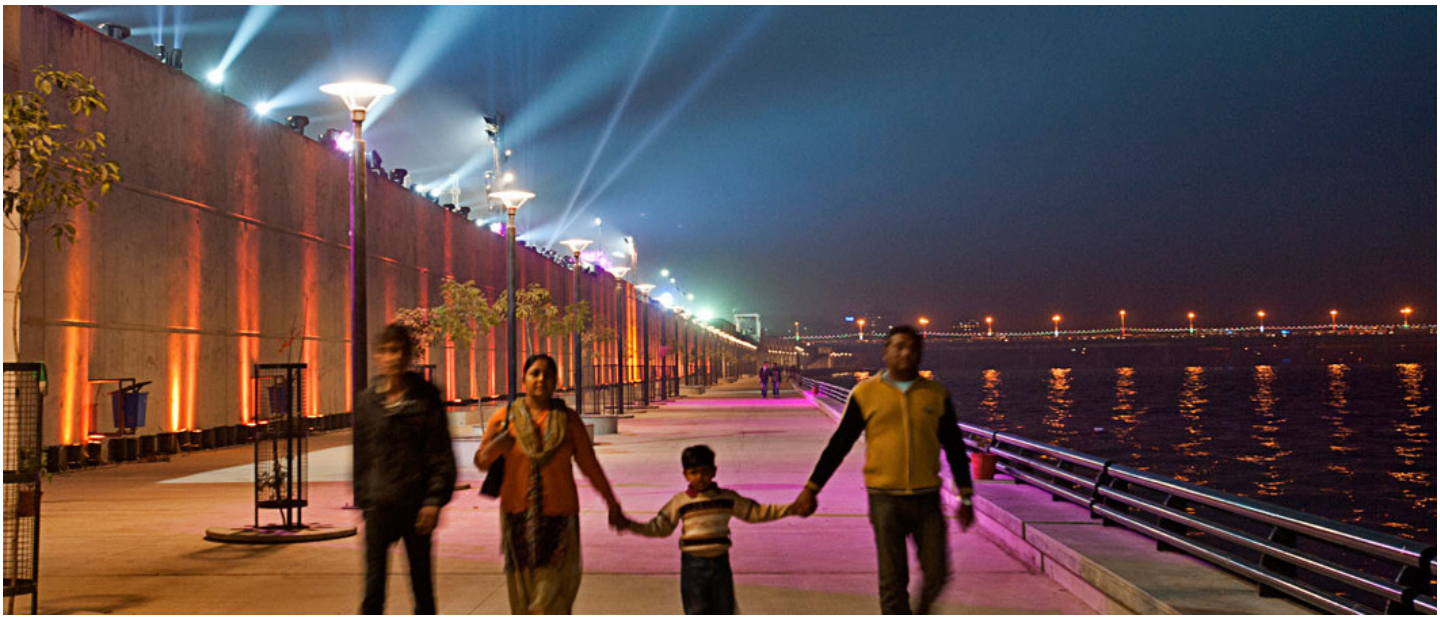
A Commercial Approach
Sabarmati Riverfront
Ahmedabad, India

Before a 2015 riverfront revitalization project, the Sabarmati River in Ahmedabad, India was a perennial riverbed, often dry until flooded by the monsoon. The river was largely polluted by industrial waste and untreated sewage from adjacent slums. To create public access to the riverfront, protect against flooding, improve water quality, and increase real estate values, the Ahmedabad Municipal Corporation (AMC) appointed a consultant to revitalize and beautify the Sabarmati riverfront. The AMC created a special purpose vehicle, the Sabarmati Riverfront Development Corporation, to implement the project.

Funded through sales of reclaimed land, the Sabarmati Riverfront Project engineered the Sabarmati River into a uniform width of 263 meters, with parts of the riverbed reclaimed and the waterfront developed along both banks, each covering a distance of about 11 kilometers. The project was designed to artificially maintain high water levels using water from the Narmada River. With embankments on both sides, the free-flowing river has largely been transformed into a canal.

While the river revitalization has enabled new business opportunities and more access to the riverfront, there have been many negative impacts. Access to the riverfront is not distributed equitably and the fragile riverine ecosystem has not been protected. Groundwater is not efficiently recharged, polluted water is diverted downstream, and heavy use of concrete has exacerbated the heat island effect in Ahmedabad. With increasing temperatures due to climate change and use of hard materials along the riverfront, the AMC is now being asked to reintroduce vegetation and biodiversity into the project. Pune Municipal Corporation has the opportunity to learn from the Sabarmati River, ground its riverfront design in the Mula-Mutha's natural features, and consider how the use of concrete worsens the urban heat island effect.

Learn more:
www.indiatogether.org/gujarat-sabarmati-riverfront-development-model-for-ganga-yamuna-environment



Waterfront Development
Buffalo Bayou
Houston, Texas

The Bayou River in downtown Houston, Texas was straightened in the 1950s. At that time, the Houston Flood Control District proposed using concrete to speed floodwaters out of the city. Local authorities turned down the proposal because of environmental concerns and created a river landscape that was straightened without concrete. As Houston grew, the Bayou River was neglected. In the early 2000s, Houston sought to revitalize the Buffalo Bayou by creating an urban park and corridor with a vision to rehabilitate the Bayou's ecology, expand its drainage capacity, improve its value in terms of scenery and recreation, and revitalize adjacent neighborhoods.

Today, Buffalo Bayou Park is a 160-acre linear park stretching for 2.3 miles west of downtown Houston. The $58 million project is the result of private/public partnerships. The park includes naturalization of gently sloping banks, native landscaping, hiking and bike trails, public art, restaurants, dog parks, and pedestrian bridges. The park transformed the neglected drainage area into a citywide asset. Structures were carefully sited above flood areas and park elements can be submerged during floods, requiring clean up rather than reconstruction. Completed in 2006, the park transformed the area into a functioning green infrastructure and a thriving urban waterfront. The project has been applauded for its social, economic, and environmental benefits. It has generally improved the quality of life of residents by providing space for recreation and improved public health. The project has contributed to the emergence of downtown Houston while simultaneously reintroducing native habitat.

Buffalo Bayou Park was inundated during Hurricane Harvey in 2017. When the floodwaters subsided, much of the park's programmed areas and landscape were damaged. The City and volunteers quickly mobilized and began the process of removing debris and silt, and the park was reopened a few weeks after the storm. Global cities are now looking at Buffalo Bayou Park as a phased model with public-private partnerships that considers local ecology, has increased water storage capacity, and is resilient in the face of extreme weather.

Learn More:
https://developingresilience.uli.org/case/buffalo-bayou-park/

Environmental Restoration and Community Economic Revitalization
The Los Angeles River Master Plan
Los Angeles California

In the 1930s, the U.S. Army Corps of Engineers undertook the cement channelization of the 51-mile Los Angeles River and its tributary streams. The resulting, excessive concretization of the river's banks resulted in poor water quality, habitat destruction, and community fragmentation.

Under the Los Angeles River Master Plan, the City of Los Angeles and partners are working to reintroduce natural areas by creating a network of parks, trails, and bike paths, and are working to remove the concrete embankments. As part of this work, a project under the Los Angeles River Master Plan called Alternative 20 was approved in 2016. This project, a collaborative effort between the City and the Army Corps of Engineers, seeks to restore 11 miles of the LA River by re-establishing riparian strand and freshwater marsh habitat to support local wildlife. Alternative 20 is budgeted around $1 billion USD, but is expected to save the city costs by naturally treating storm water and recharging groundwater.

The City has involved many local nonprofit organizations, schools, and neighborhood groups in the design and development of Alternative 20. Many see the project as an "opportunity for Angelenos to discover their cultural, historic and natural heritage," and there is broad support from environmentalists, academics, the City, and the federal government for the project. There is concern, however, from some groups that the project will lead to gentrification of nearby neighborhoods.

In their report Ecological Riverfront Design: Restoring Rivers, Connecting Communities, the American Planning Association said that "the Los Angeles River may be one of the most abused and degraded of American rivers. Most Angelenos are still unaware that there is a river in their midst. The Los Angeles River Greenway [and associated projects] will enhance the quality of life along the river; connect disparate communities; strengthen local economics; bring awareness to the area's forgotten natural cultural heritage; improve water quality; increase availability of local water resources; protect and restore native habitats; provide opportunities for public art; increased bicycle commuting; and expand recreational opportunities."

The Los Angeles riverfront is a strong example of how a city is working to remove concrete infrastructure and reintroduce green infrastructure into its waterfront development. In addition, we can learn how the City included multiple groups in its planning and implementation process.

Learn More:
http://eng2.lacity.org/techdocs/emg/docs/lariver/LA_River_Reader_Guide.pdf
https://www.nrdc.org/onearth/concrete-river-gets-real

Decentralized Water Treatment
East Kolkata Wetlands
Kolkata, India

Kolkata, India is a metropolitan area with more than 4.6 million people. It's one of the most densely populated cities in India, and a city that depends on natural and decentralized wastewater treatment. The Hooghly River feeds canals that run through Kolkata and into the Bay of Bengal. These canals collect sewage and storm water runoff from the city. Engineered pumps and passive grading then move raw sewage along canals into a wastewater treatment facility in the East Kolkata Wetlands made up of a series of small pools. Over 360 distributed ponds purify the water and provide nutrients for fish. These wetlands are the largest organic sewage waste management system in the world, treating around one million liters of wastewater per day. In addition, these wetlands support the livelihood of over 30,00 residents through the production of rice, fish, and vegetables; the wetlands also serve as an important flood defense for the city.

The East Kolkata Wetlands are a critical asset to the city and are unique in their ability to process human waste through the landscape. Despite this, development is encroaching on the wetlands. With little policy in place to prevent further development, the wetlands are under threat. Activists like Dhrubajyoti Ghosh, an engineer and ecologist who studied and uncovered the waste treatment power of the wetlands, are working to educate and create an understanding of cultural heritage to protect the valuable wetlands. Kolkata provides an unconventional example how a city can treat wastewater by leveraging its natural landscape to create economic opportunity and protection from natural disasters.

Learn More:
https://www.theguardian.com/cities/2016/mar/09/kolkata-wetlands-india-miracle-environmentalist-flood-defence

Reforestation and Watershed Conservation
São Paulo, Brazil

The Nature Conservancy describes reforestation as a process that enables deforested areas to revert to forest, either through natural regeneration or through tree planting. Reforestation reduces sediment and nutrient transport by stabilizing soil; it also reduces nutrient transport by eliminating the deposition of manure and fertilizer to pastureland.

The City of São Paulo, Brazil is investing in reforestation as part of Brazil's Water Producer Program, a program to protect the water supply along the Cantareira water system. The Cantareira water system supplies nearly half of São Paulo's water. The Cantareira watersheds have lost 70 percent of their original forest cover, and this has impacted the sedimentation of rivers and dams, decreasing their ability to supply water. Sediment from eroding hillsides has reached the reservoirs that supply São Paulo and reduced their capacity. In addition, São Paulo is experiencing terrible droughts and high heat, further decreasing the volume of water stored in the Cantareira system. The deforested areas also make the region susceptible to flooding.

In 2005, the Municipality established the first water payment for ecosystem services (PES) called Conservador das Aguas. As part of this program, farmers and ranchers receive about $120 USD per hectare of reforested areas of their fields. More than 3,500 hectares have been reforested as part of this policy. The Nature Conservancy estimates that the region needs to plant about 14,000 more hectares to cut the concentration of sediment in half. This would have significant impacts on the Cantareira watershed. PMC can look towards a program to incentivize reforestation in the Western Ghats as a part of the Mula-Mutha Riverfront Project.

Learn More:
https://www.wri.org/blog/2018/09/help-s-o-paulo-s-complex-water-woes-protect-and-restore-forests
https://www.nature.org/content/dam/tnc/nature/en/documents/Urban_Water_Blueprint.pdf

Community Toilets
Pune, India

The Pune Community Toilet Block Project is as an example of the community working in partnership with the Pune Municipal Corporation (PMC) to implement and manage community toilets. The PMC operates community toilets in slums, and there is an opportunity for the PMC to expand this operation along the Mula-Mutha nallahs and riverbed as a part of the Mula-Mutha Riverfront Project.

The Community Toilet Block Projects, built from the late 1990s to early 2000s in Pune, have features like ventilation and light, a large water tank (because the supply of water might only be for a few hours per day), and separate entrances for men and women. The community hires a caretaker to clean, provide security, and take payment from users. The PMC paid for the land, capital costs, and service connections for each community toilet. By following a similar model and working with communities, PMC can expand its network of community toilets to manage pollution at the source of the Mula-Mutha as a part of the Mula- Mutha Riverfront Project.

Learn More:
https://www.sparcindia.org/sanitation.php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CHANGIN PERCEPTIONS: RESILIENCE IN PRACTICE

by Geeta Mehta

Why Pune should heed the urgent call of this Studio?

Pune, with its open-minded bureaucracy looking for innovative solutions for improving their city, would be smart to "hear" the call of this Studio and make the bold changes necessary to become a truly eco-smart city. This is a call to listen to the sound of falling forests, worsening flash floods, drying wells, the people in informal settlements aspiring for a dignified life, and the last cry of species becoming extinct. It is a call to ensure that large infrastructure projects benefit rather than hurt Pune in the long run. Pune's leadership at this time is important because other Indian cities will follow the City's example

The projects described in this document are the work of just one semester, and the efforts of post-professional students from around the world. This is also Columbia University's seventh Urban Design Studio in India, so the faculty, many of whom have life-long experience in India and other countries, are well versed in the complexities of urbanism. Their passion to contribute to a resilient Pune was palpable in the Studio. While the proposals were never expected to be shovel ready, all projects point to the need for course corrections that PMC should consider. They are a collective call for alternative ways of thinking about the Mula-Mutha and mono-use infrastructure, which are different than the intentions underlying the current plans for the Mula-Mutha created by. Bimal Patel that the PMC is considering.

The Studio has seven ideas that Pune can embrace now that follow on the 10 design principles articulated in this document:

1. Think bigger than the current Mula Mutha plan.

While the current proposal of concretizing and beautifying few areas along the Mula-Mutha through amusement parks and promenades are sufficient, such plans should be considered only after a larger proposal to clean and revive the entire Mula-Mutha has been developed and launched. This holistic plan would include not just the river, but also its nallahs and other water holding spaces, bioswales, and productive landscapes along all waterways and in low-lying areas. The projects proposed in this publication show that this does not need to be a massively expensive mega-plan, but a smart, incremental plan where micro-projects lead to a more resilient and sustainable Pune over the next decade and beyond. However, this strategic plan is important and must be made now.

2. Think smaller.

Waste is a design problem that should be solved at the source, rather than accumulated and solved with large engineering solutions. While the current plans for the Mula-Mutha are seen by the PMC as a one-time project and product, river cleaning and ecological restoration is an ongoing process. As such, it is critical to engage all stakeholders, including developers, businesses, institutions, residents, and religious rituals in a systematic, transparent, and accountable manner. While behavioral change is difficult to bring about, once it happens, it will be powerful and make the Mula-Mutha ecosystem cleaner and more robust. Mechanisms such as Social Capital Credits, proposed in some of the projects in this publication, can be developed so that the communities along the waterways become responsible for maintaining and benefitting from this living infrastructure. Micro sewage treatment plants in every community would lessen the burden on the larger sewage treatment plants (STPs) currently being built with the help of JICA, since even the newer STPs are predicted to prove insufficient in the future.

3. Re-envision Pune Metro as a socio-economic "Lifeline."

The Metro in Pune, and metros in other Indian cities, can be re-imagined as a socio-economic development corridor for all, including people in informal settlements and rural-urban migrants who are predicted to increase in number for at least the next two decades. This migration is desirable from the national development point of view, since people make more money, have fewer children, and improve their health and skills once they move to cities. The Pune Metro "Lifeline" could become a beacon of hope and support for people at all levels of the social and economic pyramid, with welcome centers providing information about jobs, housing, health insurance, and education. The Lifeline could include Internet cafes, bathrooms, banks, community centers, libraries, markets, and night shelters that offer affordable, safe sleeping spaces on temporary basis.

Metro columns are numbered, so migrants could register with a welcome center located at a specific column, which could become their temporary address for availing of social services until they find affordable housing. The amenities and social spaces in this network could also become places where the rich and poor rub shoulders with each other, contributing to the unity in "community." The traditional methods of environmental custodianship practiced in India are deeply holistic, and are seen as critical innovations in cities like New York City. It is clear that no government in the world, no matter how wealthy, can care for the environment and face increasing climate risks on its own, so public participation must be part of any progressive resilience plan.

4. Social equity is critical for Smart Cities.

A smart city must be designed to empower everyone, including the poor and women. Harnessing the social capital that every human being brings to the city is important for realizing India's demographic dividend within the short window of time remaining. Gated communities that interrupt the urban fabric and result in social segregation eventually lead to loss of safety and social capital in cities. This has proven to be the root of problems in Brazil, Colombia, and in the newer parts of Indian cities like Delhi. Residential or commercial communities, which are serviced by the poor but do not provide housing and amenities for them, should not be permitted. All new property developments should be required to include affordable housing. Street-based urbanism adds to the safety of a city, while car-centric gated communities of towers hurt the poor as well as the rich. Mixed-use and mixed-income areas that are walkable bring vitality to a city, while shortening travel times for residents. Public transport, public spaces, and pedestrian paths must be gender sensitive with good lighting, visibility, and access.

5. The expanding periphery.

Pune needs tighter control on urban sprawl. Peripheral development, where allowed after careful review, should be high density, which is easier to serve with infrastructure and reduces travel times, while protecting farmlands and forested areas. Increasing property values in urbanizing areas do not make agriculture and forests unaffordable. Arguing for the "highest and best use" of land only holds if the value considered is the financial value alone, at the expense of ecological and social values. The PMC has the responsibility to consider future-facing "values" for Pune and safeguard these values with legislations. Protecting the long-term welfare of the people and broader values is the main responsibility of any government. Preserving Pune's nallahs and ponds on low grounds, and preserving the middle ground as the place for ground water recharge, flood risk mitigation, agriculture, and natural assets should be part of every development plan.

6. Triple bottom line accounting for corporations.

In urban development, Pune can lead the way in harnessing the Indian legislation that requires large companies to commit two percent of their revenues for Corporate Social Responsibility (CSR). Accountable and transparent systems such as Social Capital Credits can be designed so that CSR funds go towards improving nature-based infrastructure, hard infrastructure, inclusive public spaces, and the protection of farmland and forests. Pune can also lead the way in legally requiring that companies above a certain size include the triple bottom lines of financial capital, social capital, and ecological capital in their annual reporting. Social Impact Statements should be required along with the Environment Impact Statements required of every new property development project. This will enhance Pune's popularity as the destination for high tech industries, since the employees at such companies demand a higher quality of life and environment than the more polluted and ill-planned cities in India offer.

7. Urban policies are only as good as their implementation.

Regulatory frameworks to enable and execute holistic solutions will be key to Pune's resilient future. Good urban policies have no impact unless their implementation is strengthened. Making stakeholders, corporations, institutions, NGOs, and Resident Welfare Associations (RWAs) responsible for specific activities and areas that are transparent and accountable can enhance such implementation.

The current public discourse on urban issues, which is mostly centered around the NGOs in Pune, should not be expanded to include education institutions, businesses, and citizen groups, with specific responsibilities. Some innovations proposed in this document may sound not "modern" or "photo op" enough. However, they are more far reaching and necessary for the long-term resilience of Pune than the last-century mega projects currently on the table. We hope that they will be carefully considered.

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