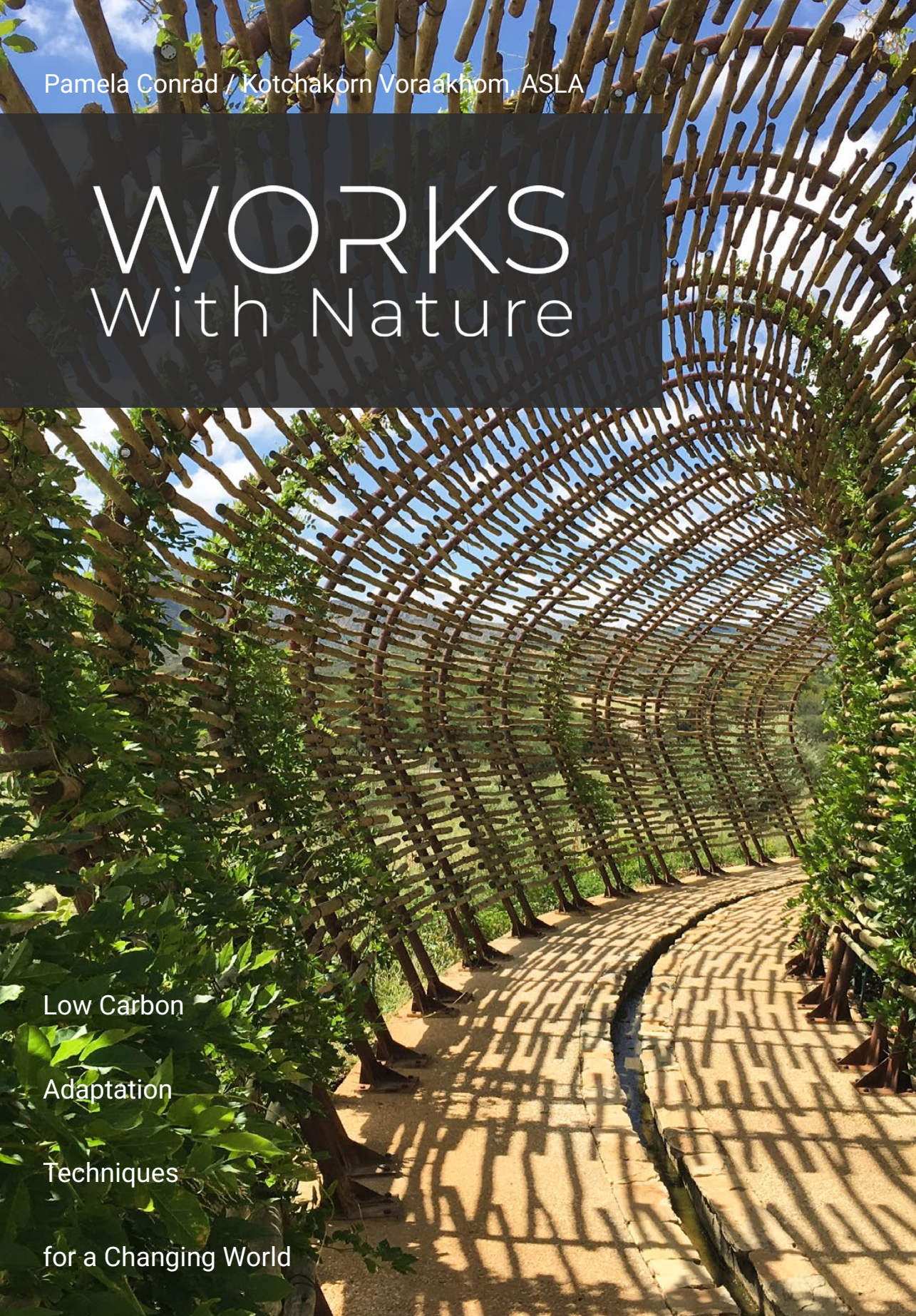
Pamela Conrad / Kotchakorn Voraakhom, ASLA

WORKS With Nature



Low Carbon

Adaptation

Techniques

for a Changing World

WORKS with Nature:
Low Carbon Adaptation Techniques for a Changing World

In the moment we face the twin climate and biodiversity crises, "WORKS with Nature" demonstrates techniques that *WORK*, for adapting, mitigating, and restoring our communities and ecosystems for a more regenerative future. Nature-based Solutions are at the heart of the actions, stepping back to a time where humans lived in harmony with the natural world. By listening to Indigenous knowledge, experts from around the globe, professionals dedicated to restoring this balance, *WORKS* shares examples as inspiration for sharing knowledge and accelerating positive change.

This compilation would not be possible without the many that have contributed to its creation. It is with gratitude, admiration, and care that we share this work as a collective.

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Foreword

Introduction

Techniques

Heat / Fire / Drought

Flood / Inland

Biodiversity

Foreword:

To adapt or ... ?

Kotchakorn Voraakhom

This question is not an option for my city in Bangkok, Thailand. As a country that faces some of the greatest threats to climate change, including rising temperatures, more frequent and severe floods from increased rainfall each year, and harsher droughts, debating adaptation is a luxury we cannot afford. We must adapt to survive. And we need the support of others to help us make a swift transition.

It is no surprise to hear of some of the barriers to adoption of nature-based adaptation, especially in developing countries. Some include a lack of knowledge sharing between countries, developed and developing. Others, are around disparity of technical expertise and guidance for all countries in the world.

As landscape architects, with Nature-Based Solutions built into the core of our work, our goal for this guide is to share. To share lessons learned and our stories, with the intent to help accelerate implementation in communities globally at scale.

While there is no one-sized-fits-all solution, some techniques *WORK* better than others. As we're running out of time, we must share this knowledge and act now.

Introduction:

When It Comes to Climate and Biodiversity, How Do We Choose?

Pamela Conrad

Should we focus on a) climate adaptation b) climate mitigation c) biodiversity or d) all the above?

Through Nature-based Solutions, working with communities, Indigenous peoples, and knowledgeable experts we can do it all.

As landscape architects, we work with multi-disciplinary teams, including environmental engineers and ecologists, to design climate and biodiversity solutions that *WORK* with nature and support viable outcomes with ecological, social, and economic benefits. But a meeting with a United Nations (UN) National Adaptation Plans leader at COP28 last December caught me off-guard.

With the majority of my work focused on coastal adaptation, I naively imagined everyone has been planning for adaptation for decades, and that the global conversation on carbon and biodiversity was progressing rapidly.

However, it turns out that's not the case:

Governments Need Guidance on Nature-Based Solutions

According to the UN leader we spoke to, many countries, especially developing ones, are struggling to even think about adapting to climate impacts like increased flooding, higher temperatures, and longer droughts.

Several key factors contribute to this:

1) Countries do not readily share adaptation lessons learned, especially between developed and lesser-developed countries.
2) There is a lack of technical implementation guidance.
3) There is a shortage of experienced technical professionals in this area.

So, an opportunity presented itself. There are good high-level resources to guide cities – including C40's Achieve a Decarbonized and Climate-Resilient Built Environment resource and the World Economic Forum's Nature-Positive Transition report – but a low-carbon, nature-based resource for all countries, at all scales, and for all budgets is missing. Without some sort of guidance document explaining these strategies and details, many countries' adaptation efforts will fall short.

As an outcome of the Global Stocktake at COP28, the UN is urging parties to develop National Adaptation Plans by the end of 2025 and make significant progress in implementing them by 2030. Throughout 2024, countries and organizations are forming partnerships to accelerate support and ensure the necessary quantity and quality of adaptations.

Landscape architects, civil and environmental engineers, and construction contractors understand success lies in the details and as well as execution on construction sites. We have an obligation to share this knowledge and expertise.

Those who have contributed the least to the climate and biodiversity crises are often those most affected, particularly in developing countries and marginalized, underserved communities.

We must share our collective stories, lessons learned, and work on nature-based solutions with the global community.

There are no geopolitical boundaries in this struggle. We are all in this together.

Document Roadmap

The document is organized by the following categories, each with corresponding techniques and case studies for further exploration:

Heat / Drought / Fire
Flood / Inland
Flood / Coastal
Food Security / Human Settlement
Biodiversity
Low Carbon

Each technique includes an overview of the case study example along with information on how each technique addresses one of the categories including general information on implementation. Basically, how each technique *WORKS*.

While 100 techniques are represented, they are not inclusive of every strategy that exists. Instead, they are meant to be a sampling of approaches from many countries, from various levels of population density, geographic and socioeconomic factors. Some techniques include examples from two different projects. Every case study includes the following information as available to facilitate sharing of knowledge and accelerating positive change around the world:

Location
Who was involved
Lessons learned
Unique features
Costs (if possible)
How the project is constructed
How the project works
What it accomplishes

We hope this serves as a useful reference and inspiration to you.

Definitions

Biodiversity - the variety of life on earth, which is currently diminishing at an alarming rate leading to the "biodiversity crisis"

Climate Adaptation - responding to the various changes due to climate change, including heat, fire, flood, and drought

Climate Mitigation - reducing the causes of climate change, including releasing less greenhouse gases into the atmosphere or increasing their drawdown, which can be accomplished naturally through plant photosynthesis

Global Warming - increase in the earth's surface and atmospheric temperatures due to the release of greenhouse gases trapping in the sun's rays

Greenhouse Gases - gases including carbon dioxide, methane, nitrous oxide, and others that when released are concentrated preventing the sun's rays to reflect and escape the atmosphere, leading to warming

Low-Carbon - strategies that emit less greenhouse gases than traditional methods and may also have the potential to sequester carbon dioxide

Landscape Architecture - a profession of over 75,000 global technical practitioners that are licensed and focus on designing places outside like parks, plazas, campus, transportation corridors, and much more

Nature-based Solutions (NbS) - working with nature to adapt to various global challenges (climate and biodiversity), that provides ecological, social and economic benefits (International Union for the Conservation of Nature (IUCN)

Photosynthesis - the process in which plants convert sunlight, carbon dioxide, and water to create oxygen and energy for itself in the form of sugars

Techniques from Around the World

17 Heat / Drought / Fire
16 Inland Flooding
16 Coastal Flooding
17 Food Security / Human Settlement
17 Biodiversity
17 Low-Carbon

100 Techniques

50/50 rural/urban
50/50 developing/developed

Heat / Fire / Drought

Xerophyte

Sharjah, United Arab Emirates

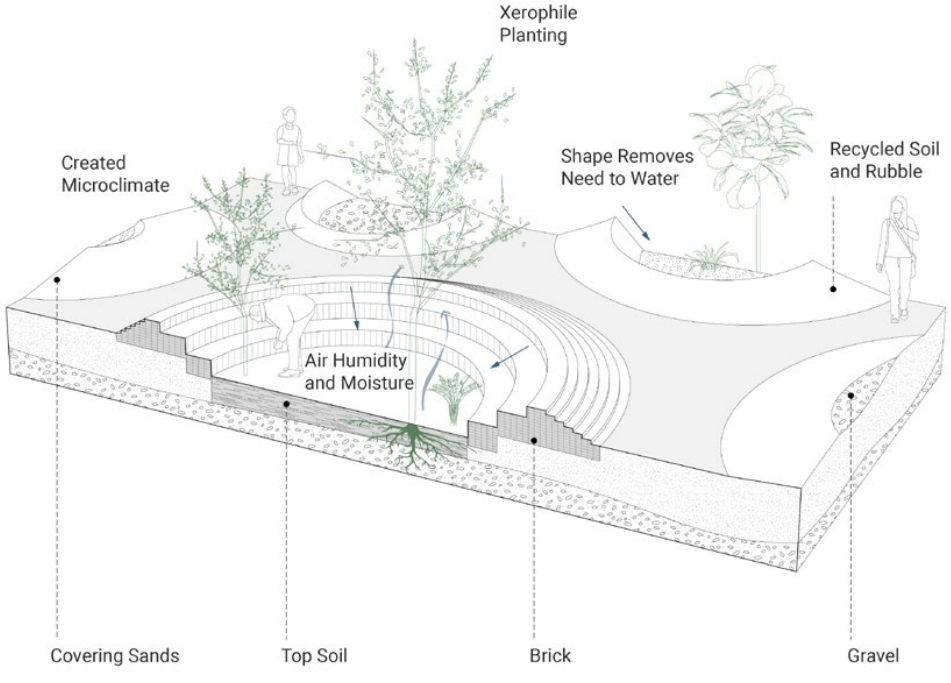
Solution	Drought
Project	Becoming Xerophile
Owner	Sharjah Architecture Triennial
Designer	Cooking Sections, AKT II +
Cost	$ N/A for 0.5 acres

This landscape prototype demonstrates how water-hungry plants in arid cities can be replaced with desert plants. The designers developed it to show waterless gardens in Middle Eastern cities are possible and serves as a model for drought resilience.

With the Al-Qasimiyah School, the installation was constructed in Sharjah, U.A.E. as part of the Sharjah Architecture Triennial. Nine sand bowls in various sizes and forms make up the installation. They were built using dirt and debris left over during the school's transformation into the permanent headquarters of the triennial. Each bowl is designed so that it does not need additional attention. The bowls are filled with xerophile plants, which can thrive in extremely dry conditions.

The experimental landscape includes nine microclimates demonstrating "water without water" (harvesting water from the environment without a direct source) and "water with stones," strategies that societies have evolved over time in many parts of the world to live in desert climates or regions with no or few water sources.

The bowls include earth mounds or dry-stone buildings to regulate heat, humidity, and wind. These forms and structures lessen water stress on the trees planted or cause water to spontaneously condense. The structures maximize the amount of moisture extracted from the water table and air humidity through their materials, depth, and placement, and the shade they create.



Xerophyte Planting Demonstrates Irrigation-Free Landscapes

Fog Catcher

Lomas de Zapallal, Lima, Peru

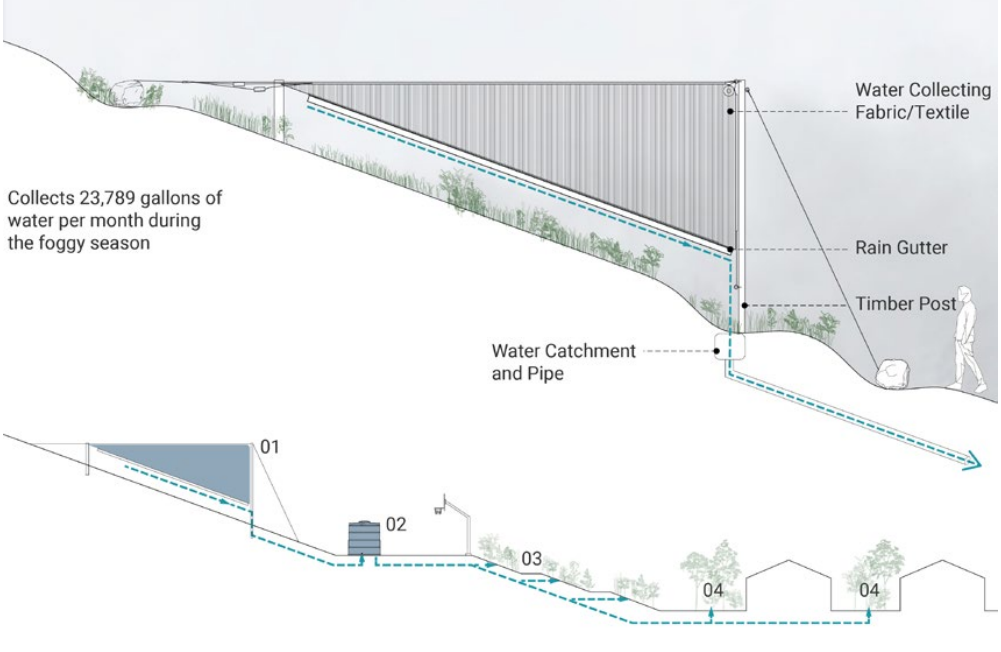
Solution	Drought
Project	SQWATER Fog Collection Project
Owner	Eliseo Collazos
Designer	Traction Design
Cost	$90,623 USD for 6,000 ft^2

To address water shortages in Lima, the project utilizes a dense fog belt. It covers the informal community of Lomas de Zapallal for six to nine months of the year.

The strategy builds upon the Informal Urban Communities Initiative's previous work and includes a unique fog collection technique that provides an additional supply of water. To use the water later to irrigate trees and other vegetation, fog water is stored locally.

This project complements prior, completed fog collectors for household gardens. This most recent phase, which was completed in 2017, includes a large-scale fog collection system designed for steep slopes. It includes a specialized 3D fog collection material, origami water storage tank, soda bottle subsurface wick irrigation, and a fog collection cone. Additionally, it includes an expansion of the household gardens throughout the neighborhood. There is also a public park that features play areas, spaces for socializing and relaxation, which include productive and drought-resistant plants.

Supported by the Robert Rauschenberg Foundation, the project was carried out between 2015 and 2017 by volunteers from Architects Without Borders Seattle, University of Washington students and staff, and residents. A participatory planning process with the 90-household informal community led to improvements of the ecosystem while addressing social inequities in an area facing extreme drought due to climate change.



01
Fog Droplets are Collected on Nets

02
Water Collected by Tubes is Carried to Storage Cisterns

03
Water is Used to Irrigate Community Gardens

04
Remaining Water is Used in Household Gardens and Cools the Neighborhood

Hillside and Detailed Sections of the Fog Catcher System

Cool Passage

Dordabis, Khomas
Region, Namibia, Africa

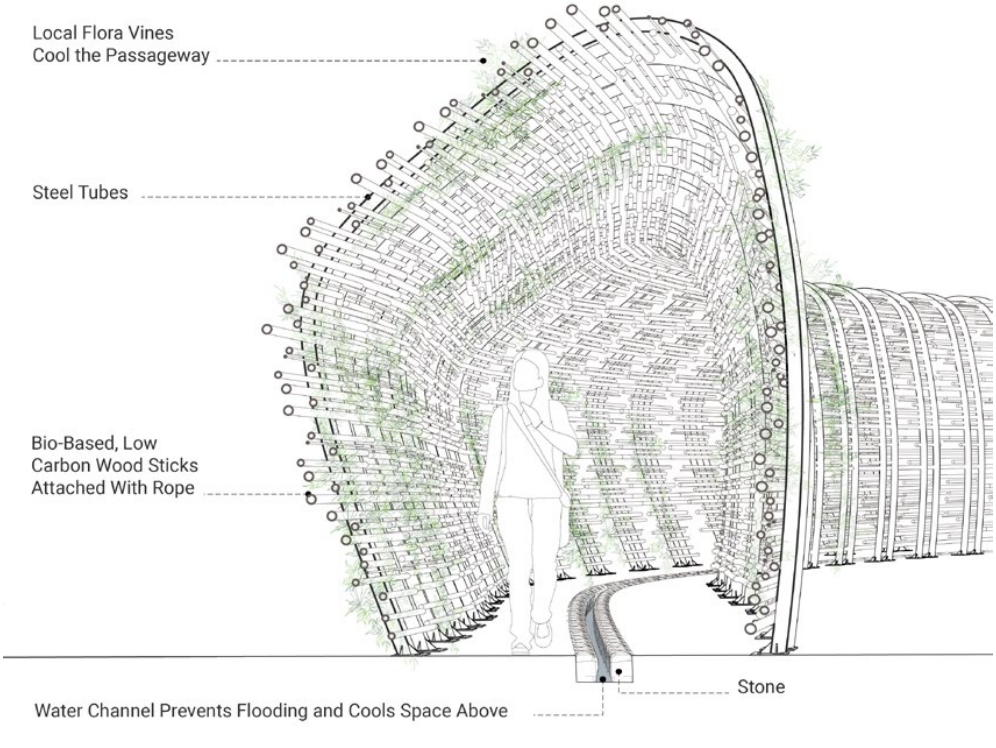
Solution	Heat
Project	Private Ranch
Owner	Private Client
Designer	GREENinc +
Cost	$6M USD for 74 acres

Climate change is worsening heat and water scarcity. But a continuous circulation network that offers moments of respite allows for the comfortable movement of people through the arid Namibian environment.

The landscape's main navigational path is linear but allows for moments for cooling, rest, or contemplation. These moments offer a break from the hostile surroundings. These spaces include arched walkway structures complete with cooling drainage channels, courtyards for contemplation, deep rock pools, and terraced spaces that replicate the natural landscape characteristics of the site.

The purpose of the courtyard structures is to create a cool retreat while shielding plants from cold winds in the winter months. All structures are designed to respect the natural landscape and are molded to fit with naturally occurring rocks and trees. In some areas, they tread lightly but in others they are firmly situated. The use of simple, layered materials enhance the landscape's endemic textures while casting light and shadow in new ways, giving each space a unique life.

To ensure resilience, South African plants were chosen because of their ability to survive the location's harsh weather conditions. Low-carbon materials – such as bio-based wood sticks, ropes, local stone materials, and vines – improve the structure's carbon footprint while cooling the passageways and maintaining the local and cultural sense of place.



Section Detail of the Low-Carbon Cooling Passageway

Attenuation Pond

Gaborone, Botswana, Africa

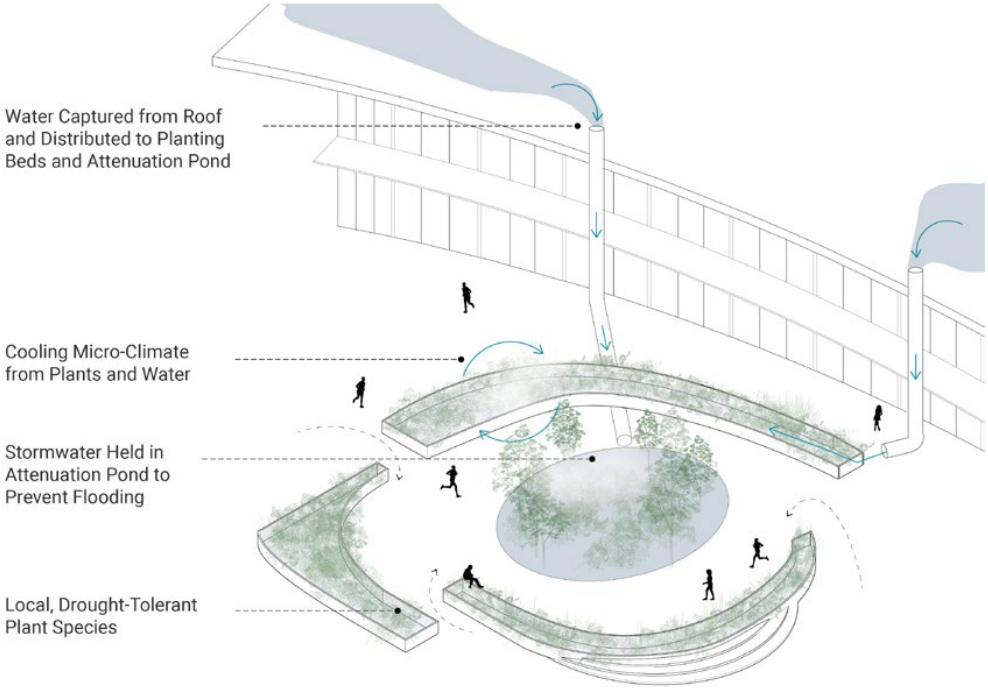
Solution	Heat
Project	Botswana Innovation Hub
Owner	Botswana Digital Innovation Hub
Designer	GREENinc, SHoP, +
Cost	$63M USD for 25 ac (bldg/site)

Gaborone receives only 457 millimeters (18 in) of rainfall on average per year. Water collection is crucial during this period of increasing drought brought on by climate change. In a community with little water, the site's sizable attenuation ponds and green roof absorb stormwater runoff, replenish the groundwater table, and cool the surroundings.

The semi-arid environments of Botswana's Okavango Delta and Kalahari Desert greatly influenced the site design approach. The natural landscape is restored to promote a future that is self-sustaining.

The ponds and green roof make the landscape more resilient to drought while celebrating the beauty and performative nature of restored plant communities. The planted courtyards are irrigated by water captured from the building, while the site-wide and roof landscapes require no irrigation. This is because the designers only selected drought-tolerant plants.

Water concentrates at the attenuation pond, enabling plants to grow. Moisture from the pond and plants cools the surrounding micro-climate, creating a welcoming space for outdoor gatherings. Raised planters also provide more soil depth and support more vegetation over structure. A large portion of the site is situated over an extensive basement or on the building's roof. As a result, the planting design consists of primarily Indigenous plants found in the area, with a focus on succulents that will thrive and restore the local ecosystem.



The Attenuation Pond and Building System Work Together

Green Screen

Tucson, Arizona, USA

Solution	Heat
Project	Underwood Sonoran Laboratory
Owner	The University of Arizona
Designer	Ten Eyck Landscape Architects +
Cost	$1M USD for 1.2 acres

The Sonoran Landscape Laboratory incorporates cooling features to withstand the harsh desert environment, including a green screen for added shade and temperature control.

Due to the thoughtful design and building orientation, vines have climbed up the 50 foot-high (15 m) metal mesh and now shade and cool the building. Native butterfly vine (Mascagnia macroptera) vines were planted on the southern exposure, reducing solar heat gain and connecting the architecture to the landscape.

The screen has led to increased use of the garden and outdoor gatherings. It's a heat island reduction strategy that university staff and students have learned about firsthand through their involvement.

The project was designed as a low-cost, research-oriented, educational public space focusing on water-conscious design solutions and creating urban wildlife habitat and biomass. The faculty asked that the lab be designed to be an interpretive learning experience and use a range of materials that would create an oasis for existing and future students and professors of the program.

As part of the laboratory, five distinct Arizona biomes are represented, which support biodiversity, cooling, and human health.

Fire Regime

Ashland, Oregon, USA

Solution	Fire
Project	Ashland Forest Resiliency
Owner	City of Ashland, Oregon
Designer	See partners below
Cost	$ N/A for 7,600 acres

Decades of fire suppression has led to dense forests of young trees, understory build up, and the proliferation of highly flammable species. The Ashland Forest Resiliency (AFR) project was created to reduce the risk of catastrophic wildfires exacerbated by climate change and improve forest health.

AFR focuses on restoring the forest ecosystem through techniques such as prescribed burning, thinning, and selective logging in high-risk areas. Ecological thinning of young trees around mature trees removes fuel ladders that allow fires to jump into the canopy. It also helps control under-burning of debris on the forest floor. These methods reduce the density of trees and vegetation, creating a healthier and more fire-resistant forest. At the same time, they support forest regeneration, enhance habitat, and limit the risk of large-scale wildfires.

AFR is a collaborative restoration effort between the Lomakatsi Restoration Project, the City of Ashland, The Nature Conservancy, and the U.S. Forest Service. This 15-year stewardship collective allows the U.S. Forest Service to partner with non-profit organizations to build capacity for experimental management and monitoring.

Partner organizations can provide greater expertise in community engagement and public education, alternative management techniques, job training, and on-going monitoring.

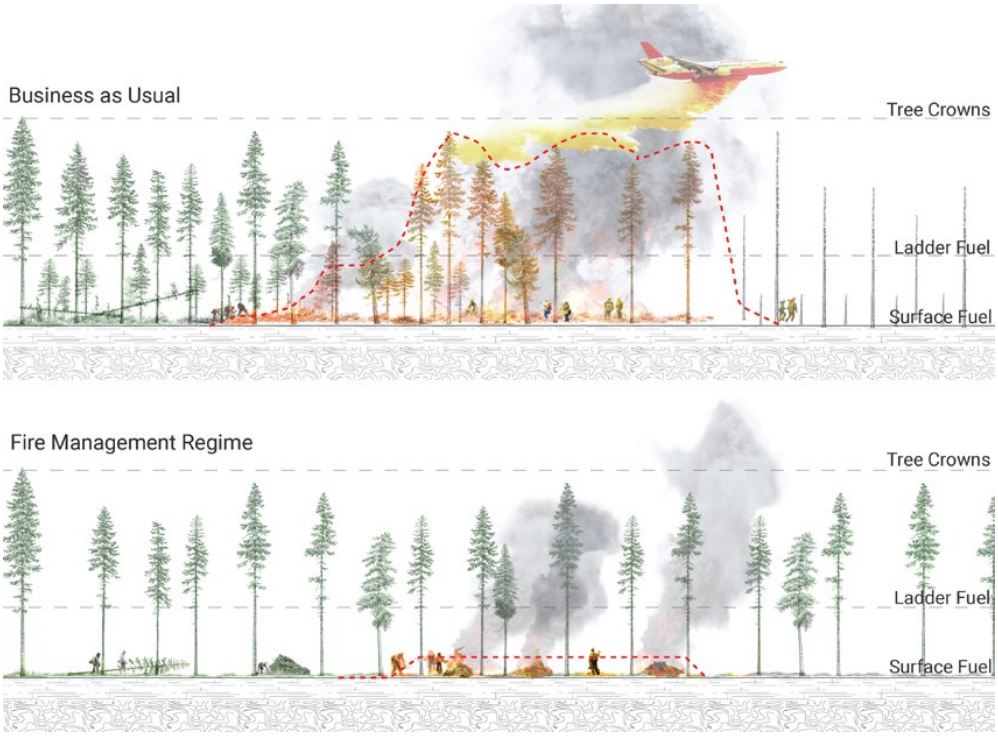


Illustration Depicting Resilient Fire Management Shifts

Firescape

Santa Barbara, California, USA

Solution	Fire
Project	Firescape Garden
Owner	Santa Barbara Fire Department
Designer	Owen Dell & Assoc., B.Goodnick
Cost	$ N/A for 1.7 acres

In the western U.S., wildfires are becoming more frequent and deadly due to dry conditions brought on by climate change and increased development in the wildland-urban interface. This demonstration garden aims to teach homeowners how to landscape in a "firewise" manner.

Four circular zones comprise hardy vegetation, which get taller and require less water the further they are from the house. When combined, these zones provide the 100 feet (30.5 m) of defensible space that California law requires surrounding a residence to stop wildfires from spreading.

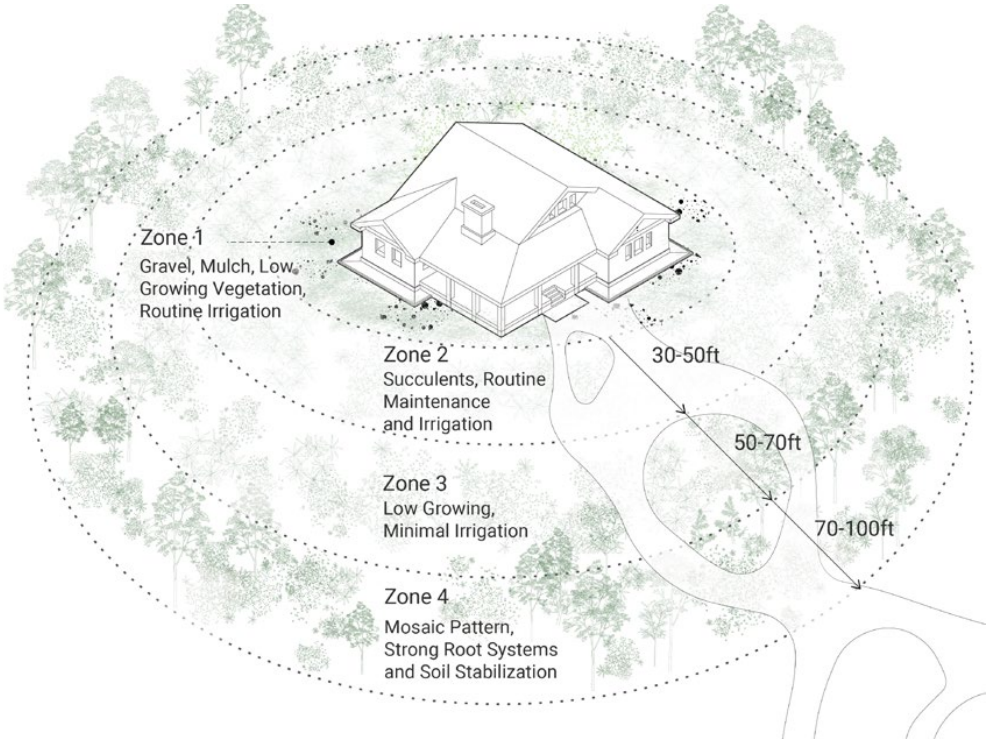
The Firescape Demonstration Garden's native plants create a visually pleasing and naturally occurring vegetative barrier that prevents the spread of fire.

Zone 1 surrounds the home. Any plants here should be low-growing and irrigated. The goal is to avoid providing fuel for fires.

Zone 2 features low-growing ground covers and fire-resistant plants that require some irrigation.

Zone 3 consists of native plants that require little irrigation.

Zone 4 lies farthest away from the home. It consists of native vegetation adapted to long dry seasons with extensive root systems. The plants should be thinned by removing overgrowth and dead material and undergoing a major pruning every three to five years.



Cool Corridor

Medellín, Antioquia, Colombia

Solution	Heat
Project	Green Corridors
Owner	Medellín Planning Admin. Office
Designer	AEU
Cost	$16.3M USD for 173 acres

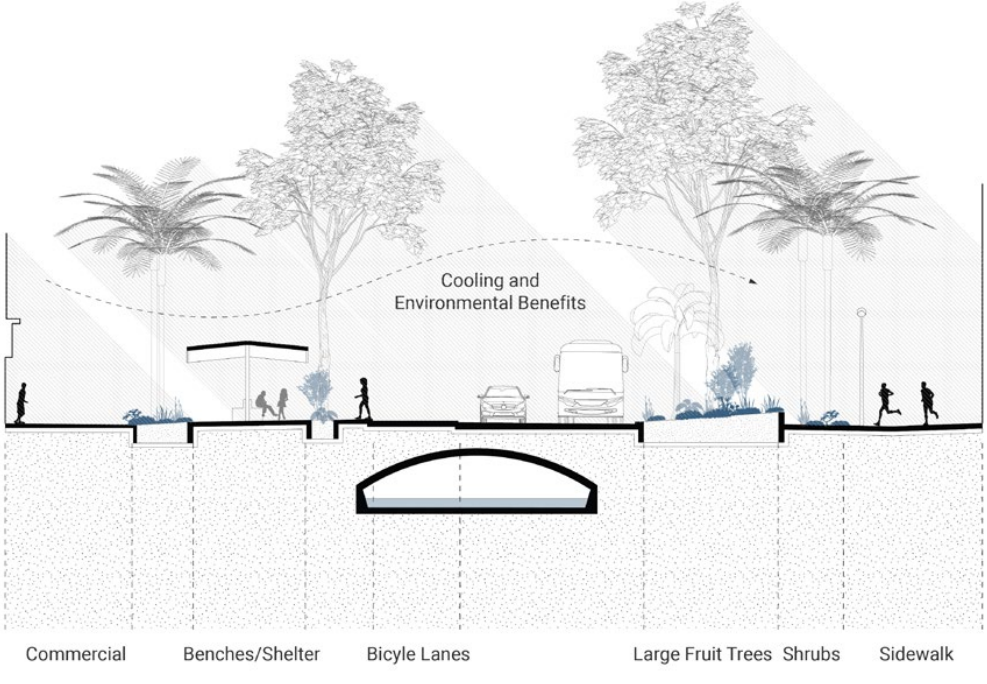
Due to years of intense urban growth, Medellín has seen the growth of urban heat islands, with city temperatures much higher than those in surrounding suburbs and rural areas. Roads and other concrete structures absorb and hold onto heat for a significantly longer period than green spaces.

The city introduced a new strategy for urban development in 2016 that put an emphasis on people and green space. The strategy resulted in thirty Green Corridors featuring 20 kilometers (12.4 mi) of shaded walkways with bike lanes and pedestrian paths along the city's roadways and rivers. These corridors improve or create green space.

In the face of extreme urban heat, these green-filled zones provide cool, fresh air. They link green spaces like curb strips, squares, parks, vertical gardens, walkways, and even some of the hills that surround the city. With small, medium, and large-sized plants–including native and tropical plants, bamboo grasses, and palm trees–the corridors are also intended to resemble a natural forest.

By 2021, the city planted 2.5 million plants and 880,000 trees. Each was carefully chosen to improve cooling, biodiversity, air quality, and carbon sequestration.

Medellín's temperatures fell by two degrees Celsius in the first three years, and officials expect a further decrease of four to five degrees Celsius over the next few decades.



La Playa's Green Corridor Cools and Improves Air Quality

Cooling Court

Tucson, Arizona, USA

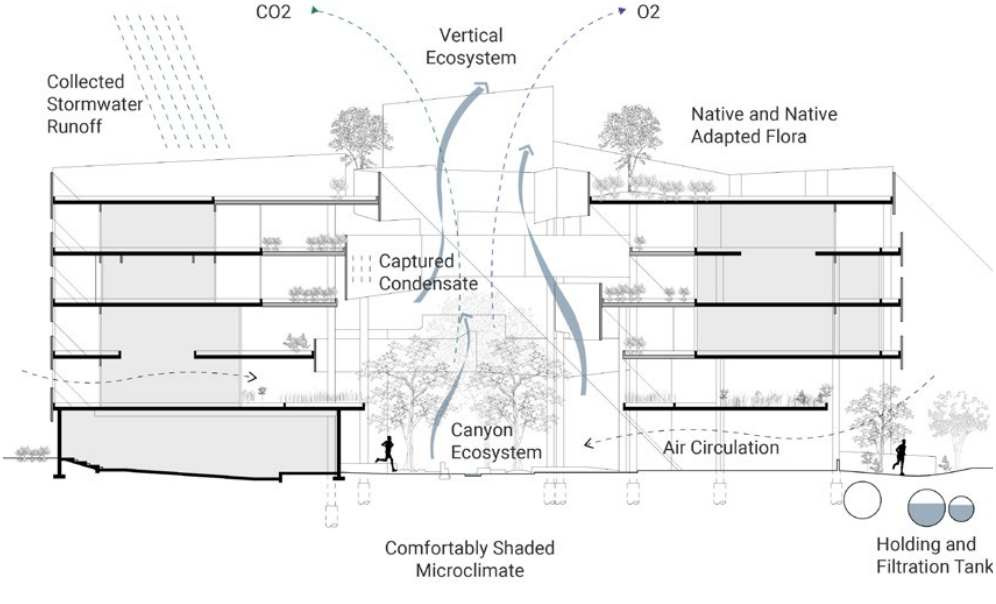
Solution	Heat
Project	Env. and Nat. Resources 2 Bldg.
Owner	The University of Arizona
Designer	Colwell Shelor Landscape Arch. +
Cost	$75M USD for 2 acres

Extreme heat, high winds, prolonged droughts, and intense rainfall are growing risks in the U.S. Southwest. To address these challenges, a five-story educational building features a vertical courtyard ecosystem with native and native-adapted flora and fauna that thrive solely on stormwater runoff, captured building condensate, and reclaimed water.

The central outdoor courtyard, which is modeled after the area's iconic slot canyons, lowers interior building temperatures by generating an external air circulation effect. It has six floors with 5,000 square feet (465 m^2) of covered outdoor study and seating areas next to offices and classrooms.

Converted from a campus parking lot, the building's landscape and structure together minimize the effects of summer heat, lowering energy costs, and enabling the outdoor spaces to be comfortably shaded micro-climates all year round.

The design is meant to create a living model of holistic sustainability. About 20,000 square feet (1858 m^2) of green roof and planting areas–including native and adaptive plants like purple heart, sage, agave, and jacaranda–are incorporated into the building on over-structure decks. The plants were chosen for their drought resistance and light level suitability. Every year, 260,000 gallons (984 m^3) of rainwater are collected for irrigation by a harvesting system featuring tiered planting zones, visible downspouts, and a sub-surface storage and filtration tank.



Features include Water Harvesting and Low Albedo Paving

Adaptive Plants

Madrid, Spain

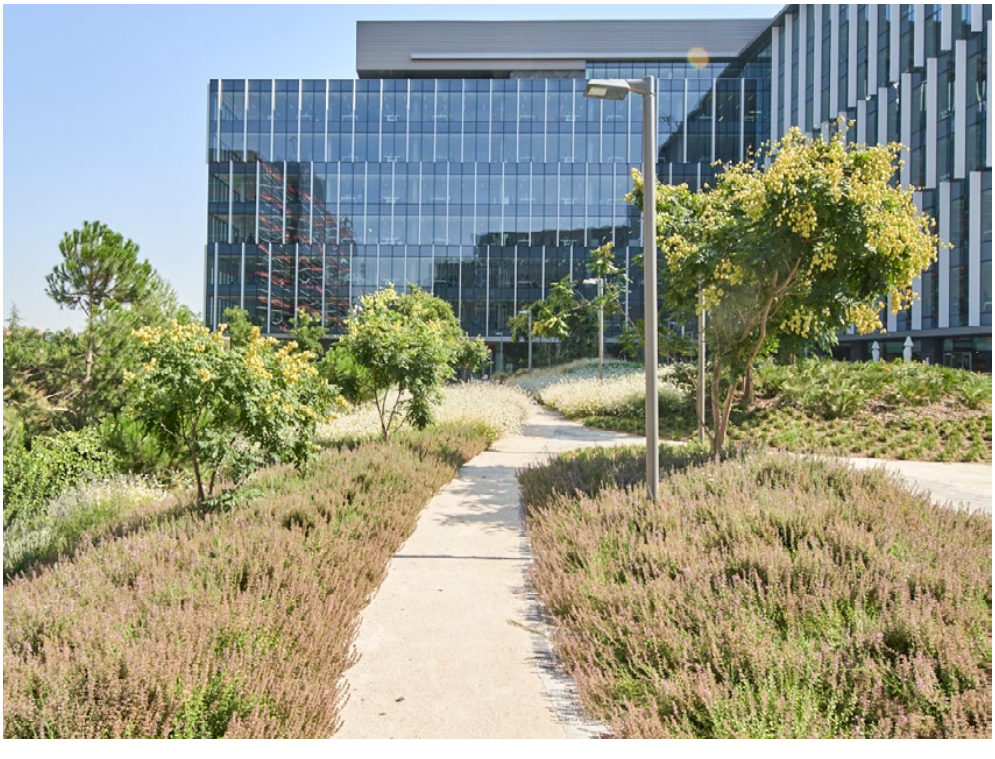
Solution	Drought / Heat
Project	RIO55 Urban Wilderness
Owner	Inmobiliaria del Sur S.A.
Designer	SPACECOOP , L35 Architects +
Cost	$31M USD for 2 acres (site+bldg)

Much of the world is faced with prolonged periods of drought. At the same time, urban communities also need to cool their environments. Many cities are seeking multi-beneficial approaches. At a vacant urban plot in Madrid, the team learned that designing with adaptive plants accomplishes both.

The project aspires to promote innovation, talent, and creativity through best practices with a low-maintenance water conservation approach. Given the limited budget, the most effective site design strategies were to naturalize the lot by using a diverse mix of drought-tolerant, adapted plant species; permeable paving materials; and plants over a parking garage, which also cool the building.

The design includes a flexible open space for the offices and provides event, education, and play space for the public. The naturalistic landscape with sculpted landforms yielded a diverse environment. It creates private, semi-private, and open, democratic places for social interaction or outdoor working.

The gardens have transformed into a thriving ecosystem. Within just a year, they are alive with a rich diversity of colors, textures, and species. They evolved into the shaded “sensory” island seating areas that allow users to almost immediately disconnect and reboot a few steps from their office environment.



Drought Tolerant and Adaptive Plantings Increase Resilience
L35 Photographs / Jose Hevia

Micro Water Harvesting

Solution	Drought
Project	Vallerani Mico Water Harvesting
Owner	--
Designer	ICARDA +
Cost	N/A

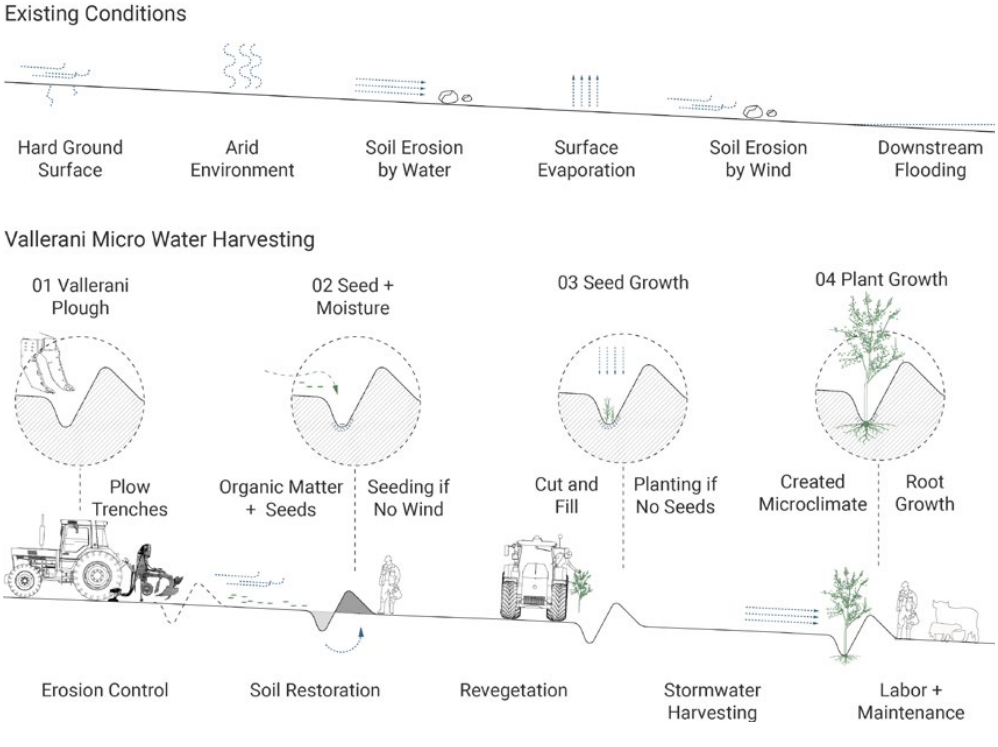
The Vallerani plow was created for extremely arid regions. People living in dry locations face risks related to health, water availability, and food systems. Causes of increased risk include higher temperatures, minimal precipitation, and loose soil.

The plow excavates small basins that capture and hold water and evaporate less moisture than a flat surface.

Since the water is still accessible, the areas around the basin can be planted with a higher rate of success. Plants stabilize and nourish the soil and feed both people and livestock. They support ecological health and create shaded conditions that mitigate extreme heat. Plants improve water retention, allowing different species that are less drought-tolerant to establish later.

The plow was developed by mechanizing a traditional water catchment system from Cabo Verde. It's a cost-effective way to stimulate plant growth as all it requires is the machine. It's currently used in arid locations across the world, particularly in areas facing desertification, such as north and south of the Sahara Desert, east of Gobi Desert, and in Jordan. These areas are expected to face more extreme conditions in the future.

Water conflicts are growing in the region. The plow can mediate these conflicts, giving people the ability to grow food with little water.



Rehabilitated Rangelands Four Years after Water Harvesting (right)

ICARDA/Stefan Strohmeier | 41

Canopy Cooling

Place de Catalogne , Paris, France

Solution	Heat
Project	Paris Landmark Urban Forest
Owner	City of Paris
Designer	N/A
Cost	$10.6M USD for ~3 acres

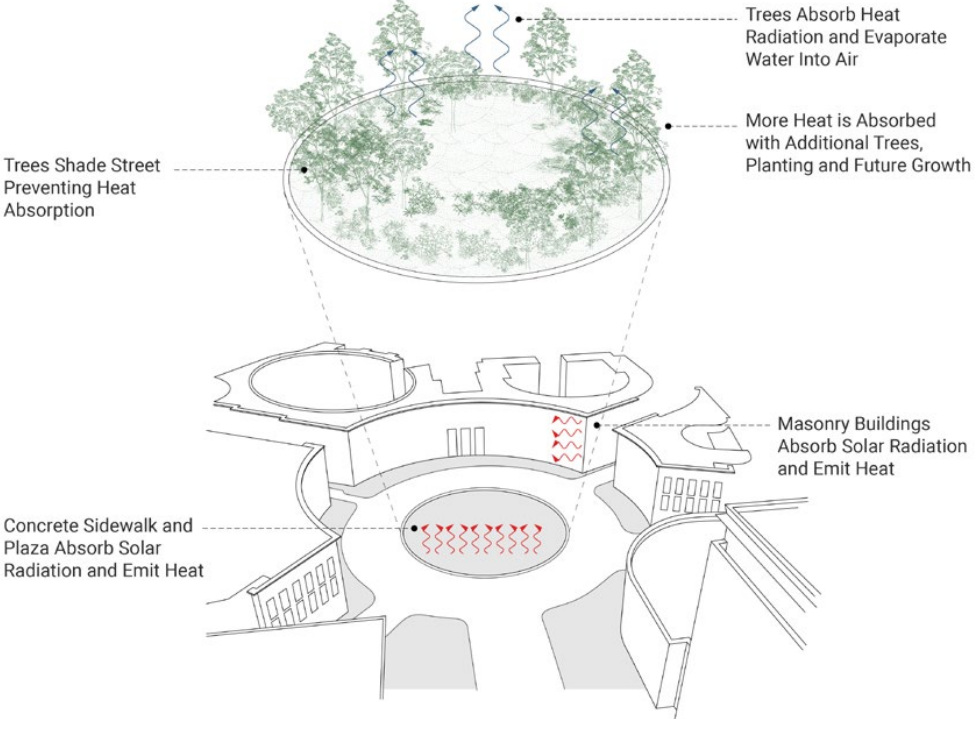
Paris summers have been getting hotter in recent years, especially areas with heat islands. To reduce temperatures, Paris has planted around 40,000 urban trees as part of its climate and biodiversity commitments since 2019.

In the Paris Landmark Urban Forest project, Place de Catalogne was identified as a heat island of concern. It was targeted for urban forestry cooling as part of Mayor Anne Hidalgo's Urban Forestry initiative. Devoid of trees and mainly made up of paved surfaces, the place was also subject to significant noise and air pollution.

Heat islands have many causes, including the extensive use of glass and paved surfaces –such as asphalt, tar, gravel, concrete, etc–and buildings that restrict air flow. Heat is stored in building materials and impermeable surfaces. As these materials warm with solar exposure, they capture and release heat.

Trees and plants play a very important role in cities. They absorb heat and evaporate water into the air, creating humidity and a cooling effect. Trees also shade paved surfaces, which reduce the temperatures of the materials below, preventing heat absorption and release.

Place de Catalogne is now planted with 470 large, medium, and small trees. It shades 60 percent of the area, meeting the city's goals. Over half of the rainwater is managed by surrounding vegetated swales. The city estimates a four degrees Celsius reduction in the urban heat island effect.




PIZZA

Room for Roots

Barcelona, Spain

Solution	Heat
Project	Trees for Life/St. Joan Blvd.
Owner	Ajuntament de Barcelona
Designer	Iola domènech arquitecta
Cost	$4.5M USD for 7.8 acres

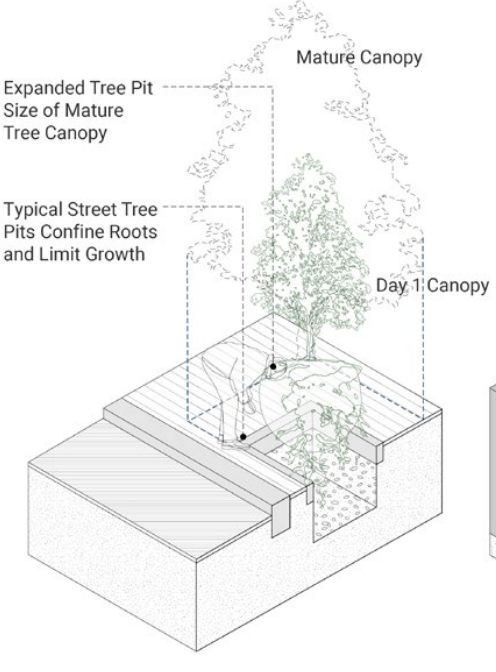
Increased temperatures and more intense heat waves have strengthened Barcelona's dedication to its Street Trees initiative. Street trees that are given the chance to flourish through expanded tree planting pits provide the cooling shade needed as cities absorb more heat.

Street trees also create a sense of natural immersion for people, which enhances the city's health and well-being. By expanding the trees into a continuous network, the city dismantles barriers for circulation and spreads the cooling benefits. Paired with Barcelona's Superblock proposal, many of the warmest areas will see an expansion of trees into their neighborhoods, connecting to green spaces and alleviating inequality in urban greenery.

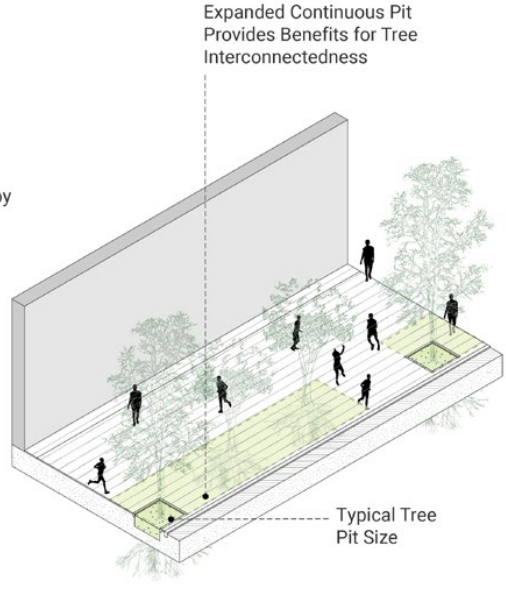
The current goal is to cover 30 percent of the city by 2037. To do so, Barcelona will plant trees in new sidewalk planting pits along its streets and expand its urban parks. More native and heat-tolerant trees will establish long-term plant communities throughout the city, supporting citizens' health and biodiversity.

The city installs and cares for its street trees, providing water, fertilizer, and monitoring. Primary maintenance costs are covered by the city government. The efforts represent a shift away from auto-centric development and a re-orientation of public space for pedestrians. This offers a replicable model for allocating space on the street back to people and trees.

Typical vs. Expanded Street Tree Planting



Expanded Tree Pit Planting



Shelterbelt

13 Provinces in
Northern PR China

Solution	Heat / Drought
Project	Three-North Forest Program
Owner	PR China
Designer	N/A
Cost	$7B USD for 74M acres

Shelterbelts are strategically placed strips, patches, and swathes of trees, plants, and occasionally gravel that address increasing sand storms and soil erosion.

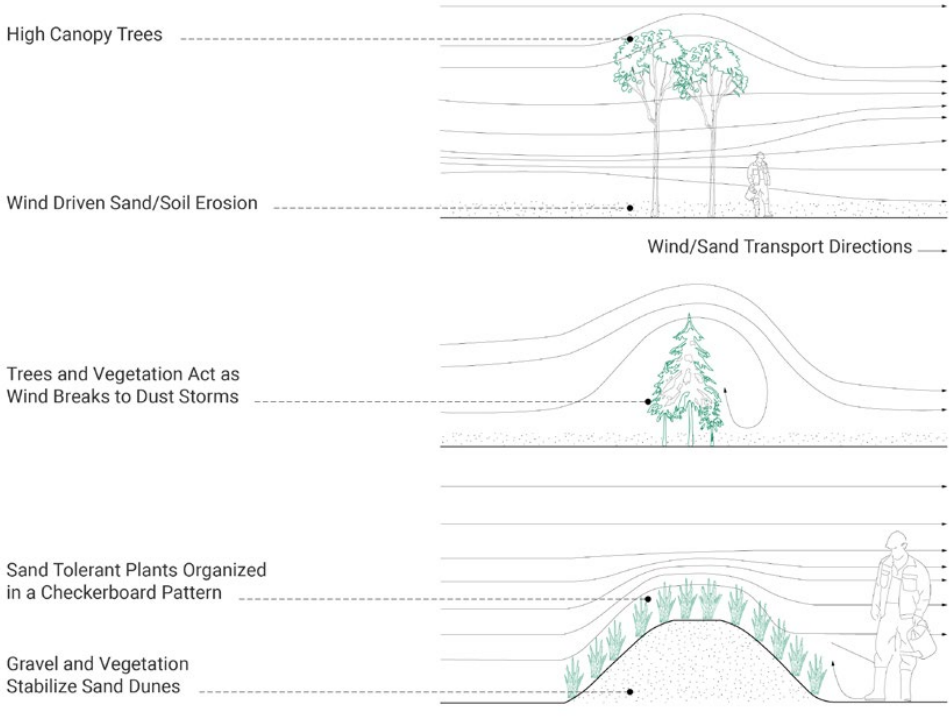
Every year, 3,600 square miles (9,324 km^2) of northern China's grasslands disappear into the Gobi Desert and 2,000 square miles (5,178 km^2) of topsoil can be blown away. These dust storms are extreme and are getting stronger. The agricultural systems of neighboring countries are also negatively impacted by these storms.

Shelterbelts act as windbreaks to dust storms. Trees, plants, and gravel are used to stabilize sand dunes and encourage the reestablishment of topsoil.

To maintain the sand dunes, a belt of sand-tolerant plants is organized in a checkerboard pattern. To keep sand in place and promote the formation of a soil crust, a gravel platform is placed close to the plants. These systems act as a windbreak against dust storms.

The Three-North Shelterbelt Forest Program – also known as the Great Green Wall – in north China is the first world-recognized shelterbelt project.

In the fourth phase, which began in 2003, huge areas of land with less parched soil are planted by aerial seeding, and farmers are given financial incentives to plant trees and vegetation in the more arid areas. To encourage success, the effort benefits from a $1.2B mapping and monitoring system.



Shelterbelt Techniques and Straw Checkerboard Sand Control Barriers. Hotan Prefecture-Xinjiang Uyghur Region (right)

RWEISSWALD / Alamy Stock Photo | 47

Cool Roof

Washington, D.C.
USA

Solution	Heat
Project	ASLA Green Roof
Owner	ASLA
Designer	MVVA +
Cost	$350,000 USD for 3,000 ft^2

Green roofs replace the traditional use of innate materials with living, planted ecosystems. They support urban cooling, reduce energy use and heating costs, while increasing biodiversity and the livability of our cities.

The American Society of Landscape Architects (ASLA) converted a failing traditional building roof on its headquarters into a green one, which keeps the roof surface temperature as much as 43.5 degrees Fahrenheit cooler than on neighboring conventional black roofs on the hottest summer days. In addition, the upgrade reduces building energy use by 10 percent over the winter months.

The headquarters green roof was conceived as a demonstration project. For many years, the roof included monitoring and research components related to temperature, building energy savings, stormwater retention, water quality, and plant performance. The project is located in an urban area with combined sewer outflows and a degraded watershed. That makes the demonstration value of the project important.

Learning is a key point of this project. It explored design alternatives and educated key audiences on the benefits of green roofs as well as the role landscape architects play in sustainable design. Media coverage, site visits, and dedicated educational resources have increased understanding, engaged the public, and inspired others to adopt green roofs.

ASLA Green Roof, Washington, D.C. /
Courtesy of American Society of Landscape Architects /
Michael Van Valkenburgh Associates, Inc.


IBEW

Green Infrastructure Mapping

Saida, Lebanon

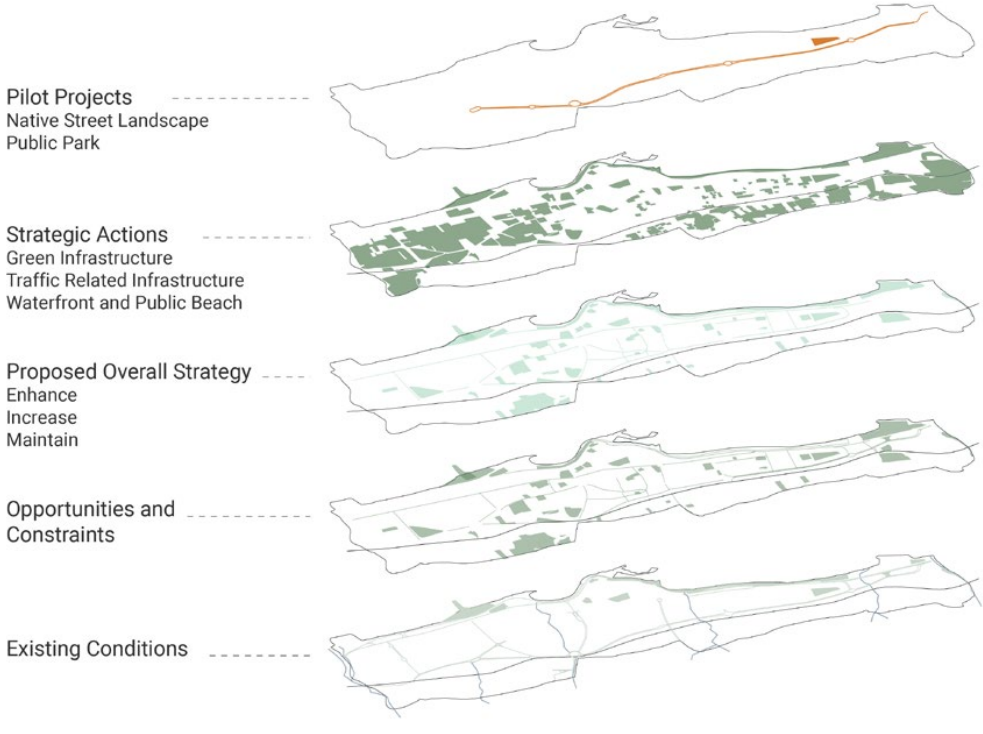
Solution	Heat
Project	NATURMED Project
Owner	MedCities
Designer	Salma Samaha, Yaser Abunanasr +
Cost	N/A

Green Infrastructure Mapping fosters the resilient transition of communities. It enables them to use nature to manage and create healthier built environments. Green infrastructure can range in scale from streetscapes, waterways, and parks up to the regional planning of land for conservation, agriculture, and more.

Preserving, enhancing, and expanding these spaces are crucial for both nature and communities' well-being. Green infrastructure can form networks of sustainably planned green and blue spaces, offering diverse ecosystem services. Municipal engagements, like awareness campaigns and legal frameworks, can support and complement budget integration for implementation.

Saida's NATURMED project, supported by BCN City Council and MedCities, proposes a Productive Green Infrastructure Strategy. Developed with local stakeholders, it aims to revive the city's agricultural heritage, fostering visual connectivity with farmland. Beyond restoring identity, this strategy can generate revenue and increase local collaboration while combating urban heat islands.

The strategy aligns with the World Health Organization recommended nine square meters (97 ft^2) of green space per inhabitant. It integrates nature and sustainable food production so agricultural lands are strategically spread throughout the city. This ensures coherence across various scales and types of green spaces. This approach aims to preserve Saida's essence while enriching the city's fabric.



Mapping (left) and School Activities in Bethlehem and Jerash (right)

Oasis

Solution	Heat / Drought
Project	Anantara Tozeur Resort
Owner	Qatari Diar Real Estate
Designer	Agora Architects Tunisia +
Cost	$45M USD for 304 acres

Strategic regeneration of oasis landscapes restores ecosystems that are disappearing on the edge of the Sahara Desert. Regional landscape restoration can foster a diversity of habitats for plants, animals, and people. Not only are these local plants adapted to grow without high inputs of resources, they also are part of the local food web and provide nectar for insects, shelter for birds, and food for wildlife.

Located in the southwest of Tunisia on the edge of the Sahara, Anantara Tozeur provides a home base to explore the desert culture and landscape.

This landscape was inspired by natural oases of the Tozeur region. The design is rooted in the principle that sustainable landscape design is the best way to combine aesthetic and psychological benefits with the ecological and functional potential of living systems.

This sustainable approach to landscape creates places of value and meaning while also respecting and acknowledging the important functions that nature performs. It illuminates the interactions between a culture's view of its societal structure and its natural systems.

This methodology was also used to select many hardscape materials, including terracotta bricks, pebbles, protection systems of dunes, and wooden fences.

Landscape Shapes Culture and Identity at Local and Regional Scales. ©Anantara Sahara Tozeur Resort & Villas.

Flood / Coastal

Living Breakwater

Tottenville, Staten Island, New York, USA

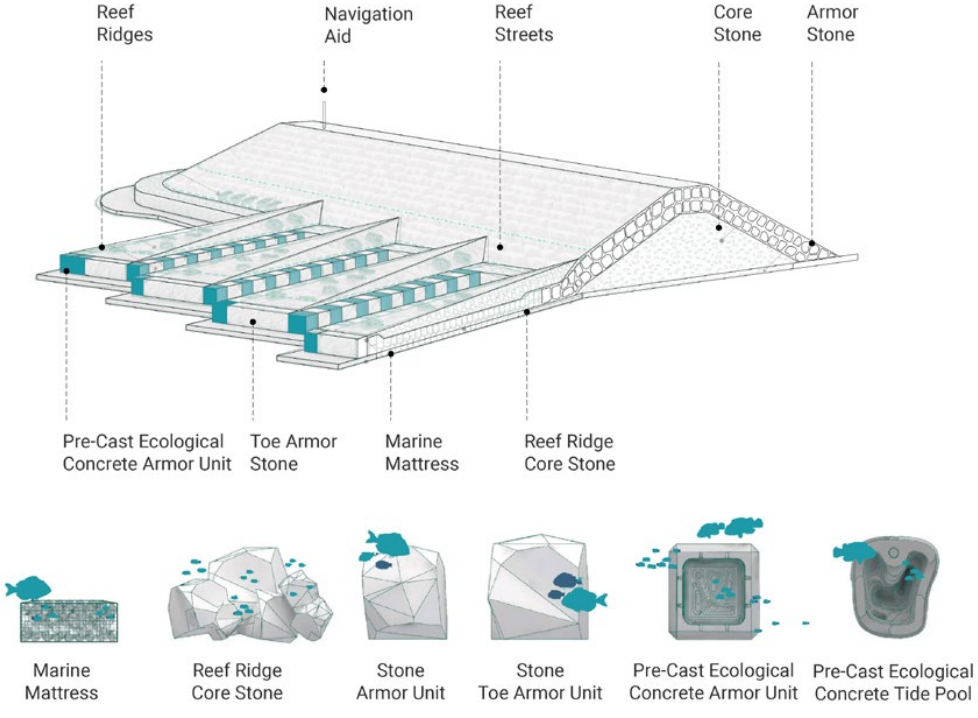
Solution	Flood / Coastal
Project	Living Breakwaters
Owner	NYS Homes/Community Renewal
Designer	SCAPE +
Cost	$107M USD for 2,400 Linear Feet

Informed by extensive hydrodynamic modeling, living breakwaters are partially submerged structures built of stone and ecologically-enhanced concrete units that are designed to reduce the impact of climate-intensified weather events, including damaging waves on low-lying coastal communities. They also slow and, eventually, reverse decades of erosion along the shoreline.

The Living Breakwaters designed for the New York area after tragic loss of life during Superstorm Sandy are also constructed with "reef ridges" and "reef streets" that provide diverse habitative oyster installations are expected after completion.

The project consists primarily of near-shore structures that will break waves, reduce beach erosion, and provide habitat spaces for oysters, fin fish, and other marine species. The Living Breakwaters concept was developed by a large, multi-disciplinary team led by SCAPE as part of a winning proposal for Rebuild By Design, the design competition launched by the U.S. Department of Housing and Urban Development (HUD) after Superstorm Sandy.

Beyond the physical breakwaters, the project aims to build social resilience through education for schools in partnership with the Billion Oyster Project. They also conducted years of engagement through the Citizens' Advisory Committee. The design team also developed an open access Living Breakwaters curriculum for NYC communities.



Technical Details of Living Breakwater Construction. Drawing Modified from SCAPE Landscape Architecture

Participatory Design

San Francisco Bay Area,
California, USA

Solution	Flood / Coastal
Project	Rise-Up
Owner	Marin County and GGNPC
Designer	CMG Landscape Architecture
Cost	N/A

Climate threats can be difficult to communicate. And messages may not turn into action. Participatory Design processes inform communities about data, raise awareness about shared values, and build consensus.

They are as much about enabling people to communicate with one another as providing information directly to participants.

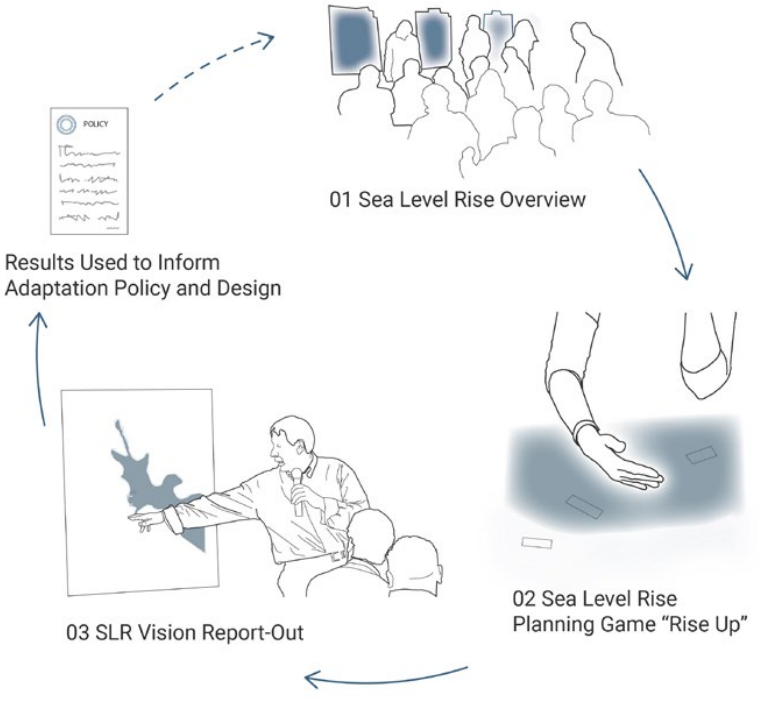
The Rise-Up participatory design model is adaptable, straightforward, and user friendly. The process includes three steps:

(1) Sea Level Rise (SLR) Overview (presentation to community), including Sea Level Rise Basics; Asset and Vulnerability Asset and Mapping; and Adaptation Inventory and Assessment

(2) SLR Planning Game (community engagement). Rise Up: Game of Tides, is an interactive planning game that facilitates conversation with community members. This hands-on game overlays adaptation tools onto plans to develop sea level rise scenarios.

And (3) Vision Report-Out (presentation of community's results). Results are used to inform adaptation policy and design.

Replicating the process would enable comparisons among coastal communities, support strategic thinking, and inform regional adaptations. The designer's role is to facilitate – give the community the tools, step back, and allow them to be responsible for their neighborhoods.



Engagement Process (left) and Interactive Rise-Up Activity (right)


REEF
REEF
REEF
BEACH
DUNE
WALKWAY
ELEVATION 12
ELEVATION 10
WETLAND
RETREAT
SEAWALL
LEVEE
RIPRAP
WETLAND
WALKWAY

Mangrove Restoration

Praslin Island,
Seychelles

Solution	Flood / Coastal
Project	EbA South Project
Owner	Global Environment Facility
Designer	Chinese Academy of Sciences +
Cost	N/A

Mangrove coastal ecosystems can be one of the most cost effective and ecologically beneficial adaptation methods for reducing damages from coastal storms and rising sea levels. The root systems of the mangrove forest stabilize the soil while their entire structure dissipates waves and high waters.

Despite their rapid destruction globally for development and other human-centric activities, there is hope for restoration.

One example from the Ecosystem-based adaptation (EbA) South project restores climate-resilient mangroves and measures how to improve hydrological flow in the Seychelles.

The project team conducted inter-regional activities for capacity building and knowledge management and on-the-ground interventions in three pilot countries – Mauritania, Nepal and Seychelles. They represent three different vulnerable ecosystems (dryland, mountain, and coastal ecosystems, respectively).

This approach is increasingly being used to reduce the impacts of climate change on vulnerable people and landscapes and enhance their resilience.

The project is recognized for its leadership in catalyzing global and regional collaboration and sharing South-South experience and research know-how in ecological restoration and climate change adaptation.

Victorin Laboudallon Plants Mangrove Forsts in the Seychelles.
UN Environment Programme / Aidan Dockery

TRASS - Terrestrial Restoration Action Society of Seychelles, Aidan Dockery | 61

Floodable Park

East Boston,
Massachusetts, USA

Solution	Flood / Coastal
Project	Coastal Resilience Solutions
Owner	City of Boston, MA
Designer	Stoss Landscape Urbanism +
Cost	$142 - $262M USD for 500 acres

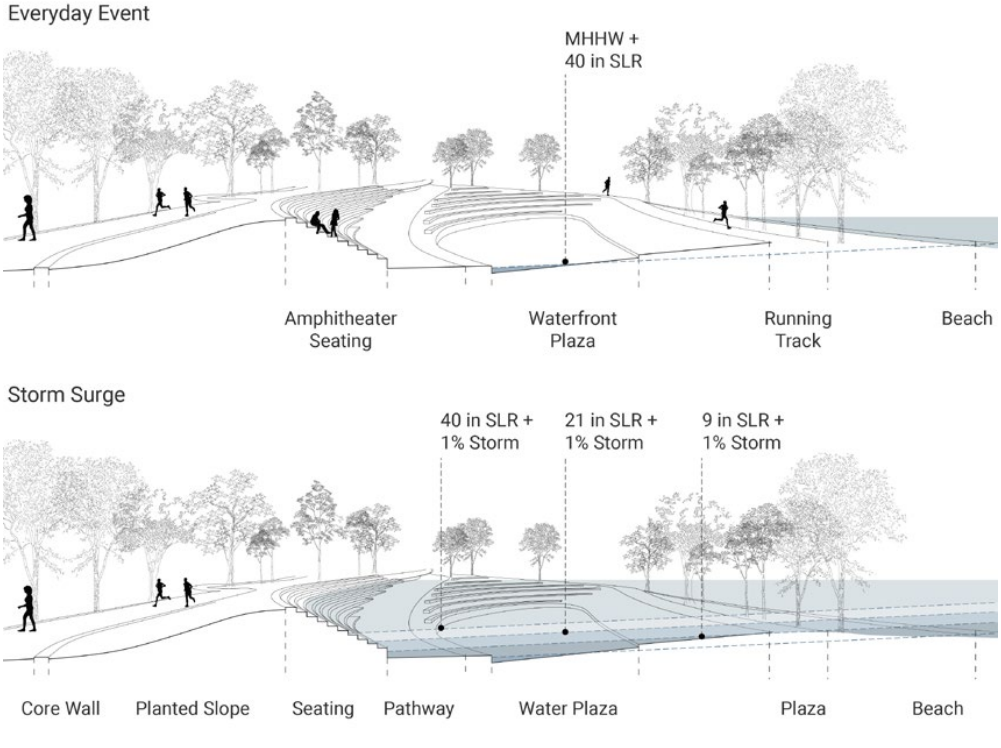
Waterfront parks that can withstand the impacts of increased storms and higher water levels protect inland communities. They also create equitable spaces along waterfronts for public use.

To move forward recommendations made in the 2016 Climate Ready Boston report, the team led public engagement, strategic development, and detailed design efforts. These resulted in strategies for short- and long-term, layered infrastructure and open space.

The planned adaptation of Boston's waterfront protects against successive changes in sea levels and storm effects. It also leverages resilience efforts to create benefits for local communities, the environment, underserved populations, public agencies, and private landowners. The planning process provided both opportunistic and strategic recommendations for implementation, as well as policies, evaluation criteria, and prototypes that can be adapted across the city.

The engagement was multi-pronged and designed to reach individual property owners, public agencies, existing and potential partners, and a wide swath of the surrounding communities and residents. The goal was to build a critical mass of consensus.

Ongoing reports reflected feedback from the community engagement process and input from the steering committee.



Floodable Parks Withstand Storms and Support Community.
Drawing modified from STOSS Landscape Urbanism

Floodable Plaza

Rotterdam,
South Holland,
The Netherlands

Solution	Flood / Coastal
Project	Watersquare Benthemplein
Owner	City of Rotterdam
Designer	De Urbanisten +
Cost	N/A

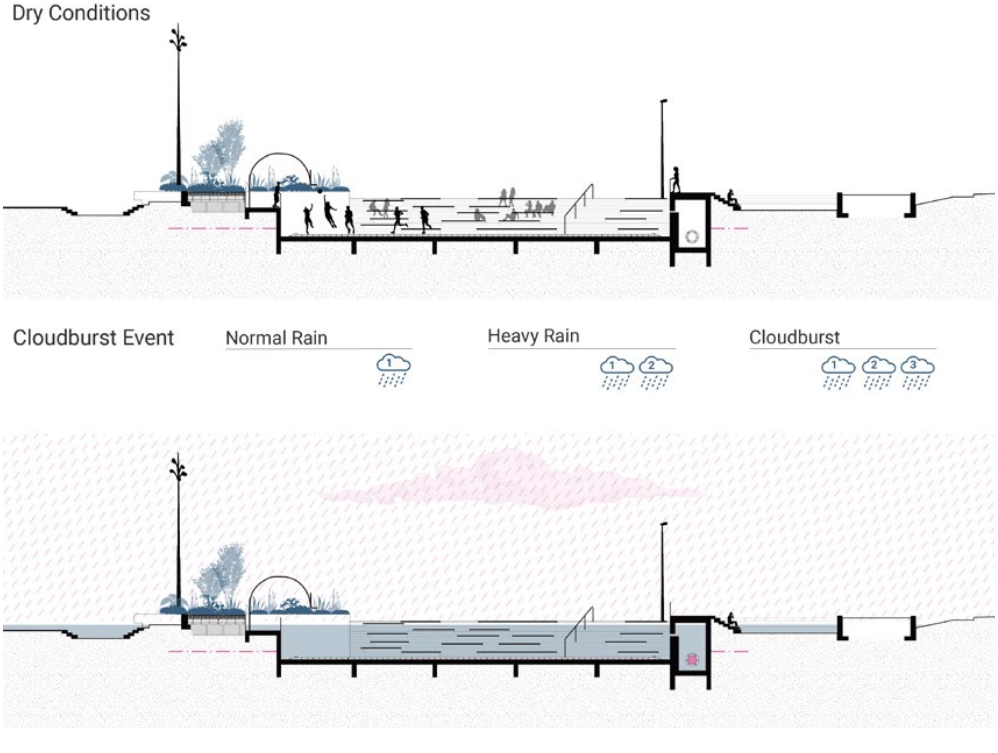
In cities, public spaces can provide amenities and environmental performance. These spaces can manage stormwater in coastal cities with high percentages of paved surfaces.

The Watersquare project employs a multi-faceted approach. It stores stormwater and provides a central community space. The plaza is universally accessible during dry conditions and exciting to watch during rain events.

Three basins catch rainfall. One deeper basin, which, when dry, is a sports venue for the surrounding neighborhood, only catches water during the heaviest storms. The two shallow basins receive water anytime it rains.

Stormwater that falls within the plaza is directed into these shallow basins through polished stainless-steel gutters. All flood-prone areas are painted blue to educate visitors on the functionality of the system during dry periods.

Large existing trees, tall grasses, and vibrant flowers define and divide the area. Artwork by Karel Appel and architecture by Maaskant give the water square a unique character.



Section Illustrations of Dry Conditions vs. Rainfall Event

Coral Garden

Cousin Island Special Reserve, Seychelles

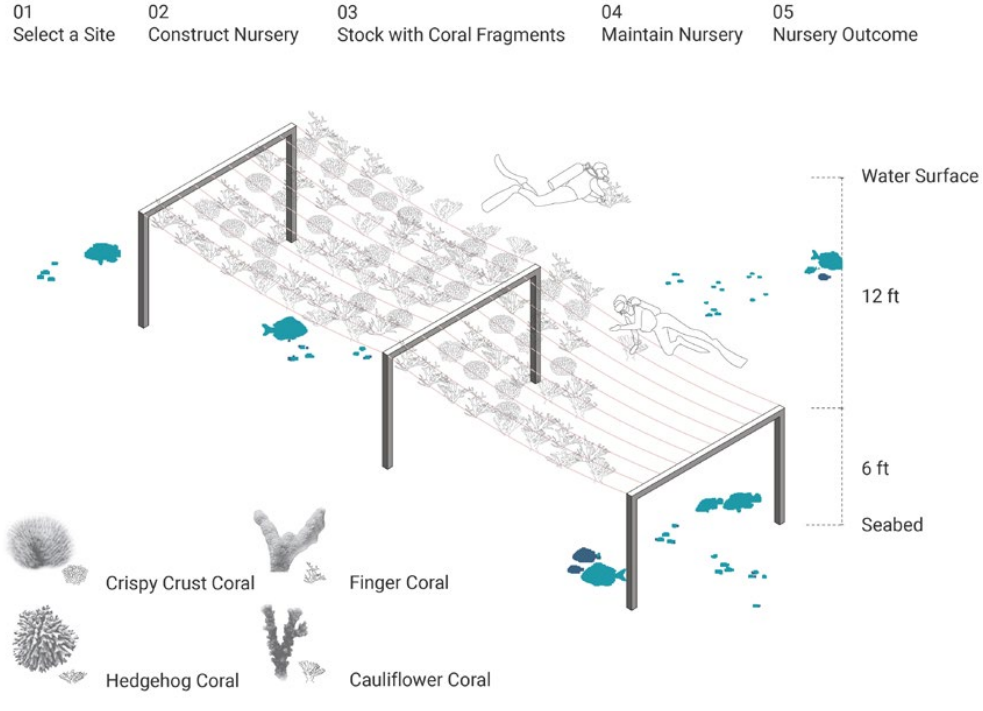
Solution	Flood / Coastal
Project	Reef Rescuers Project
Owner	Nature Seychelles
Designer	N/A
Cost	N/A

Climate change poses a severe threat to marine ecosystems and coral reefs are among the most affected. The impact on these ecosystems endangers millions of livelihoods, particularly in Eastern Africa and the Western Indian Ocean's island communities. Over the last two decades, warming ocean temperatures have led to widespread coral degradation and severe bleaching events.

Catastrophic storms and climate variations have caused over 90 percent of live coral cover to be lost in the Seychelles. While some slow recovery occurred over the years, major bleaching events led to an additional 50 percent decline and not only caused coral mortality but also weakened reef health, resilience, and reproduction.

The reef around Cousin Island was particularly impacted by the 1998 El Niño event with vast areas covered in dead coral rubble with little natural recovery potential. This led to active restoration efforts through the Reef Rescuers Project. The project successfully grew over 50,000 coral fragments in 12 midwater nurseries (nine rope and three net), sourced from donor and opportunistic corals representing 34 species. More than 5,000 square meters (1.2 ac) of degraded reef within the Cousin Island Special Reserve, a no-take marine reserve, was restored using these nursery-grown corals.

The drawing below illustrates how to make a rope nursery, how species are arranged along the rope, and the size of the coral garden.



Detail of Coral Garden Rope Nursery (left). Nature Seychelles' Coral Reef Restoration Project on Cousin Island Special Reserve, Seychelles (right)

Beach Re-profiling

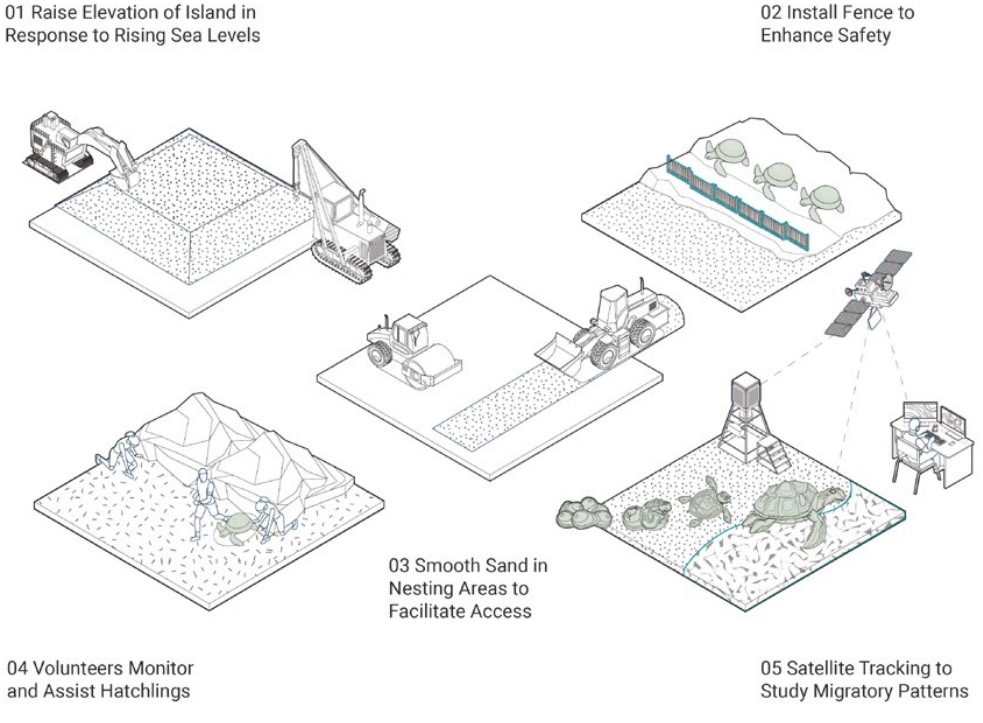
Raine Island, Wuthathi and Meriam Nations Sea Country, Australia

Solution	Flood / Coastal
Project	Raine Island Recovery Project
Owner	Queensland Government +
Designer	See below
Cost	$5.2M USD for 67 acres

Due to the domino effect of climate change impacts, maintaining critical habitat often requires mechanical intervention. The coral reefs surrounding Raine Island have contributed to the formation and maintenance of its sandy beach for thousands of years. Due to coral bleaching brought on by global warming, the coral reefs have stopped growing, which now threatens the existence of the beach. Because this location is a primary nesting site of the green turtle (Chelonia mydas), immediate action must be taken to ensure the beach remains.

The Raine Island Recovery Project aims to preserve the nesting and hatching of the green turtle by re-profiling the beach, raising the elevation of the island, and implementing other strategies. To save the green turtle habitat from sea level rise, the team increased the elevation of the island by around ten feet (three meters) and supplemented the sandy beach. The project will also make it easier for hatchlings to reach the water by smoothing out the sand in the nesting locations. Volunteers are essential to the monitoring and care of the hatchling turtles and are assisted by satellite tracking.

This is a collaborative effort and includes the local government, Wuthathi and Merim Nation Traditional Owners, the Great Barrier Reef Marine Park Authority, BHP, and the Great Barrier Reef Foundation.



Living Levee

Fremont, Union City, and
Newark, California, USA

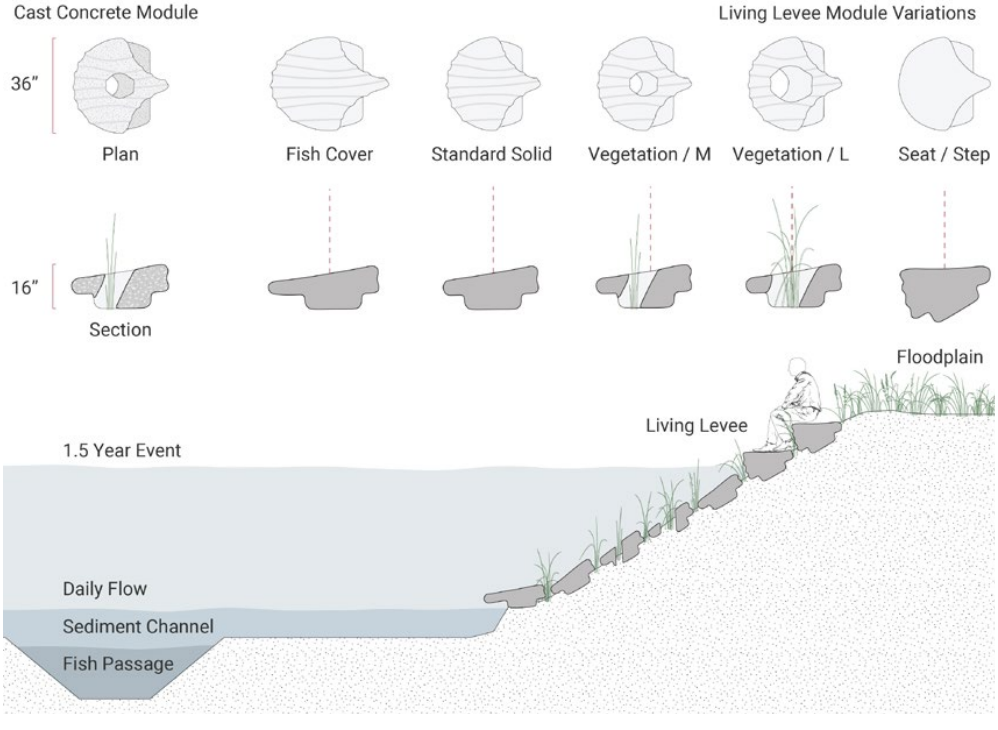
Solution	Flood / Coastal
Project	Public Sediment / Alameda Creek
Owner	Alameda County, California
Designer	SCAPE +
Cost	$31.4M USD for 28,800 acres

As cities develop, they tend to ignore or neglect natural systems. The preference for the built over natural environment eventually leads to negative consequences that must be addressed to achieve a healthy and balanced ecosystem.

The goal of the Public Sediment project is to "unlock" Alameda Creek for sediment, fish, and humans. The project addresses climate challenges at the ecosystem level. It restores migratory fish to their former breeding grounds and creates a linear environment along the restored and floodable stream corridor that fosters stewardship.

In order to deal with shifting environmental circumstances, the team also suggested adaptive management and monitoring. This would result in several changes to the creek's course, such as a low-flow channel for fish, a restricted sediment channel to move material downstream, and recreational access for the general public. A modular Living Levee system made of scalloped-shaped concrete blocks would support the creek's bank while allowing plants to grow through and between the modules, providing protective overhangs for fish and including various visitor engagement opportunities.

The concept was created for the Resilient By Design: Bay Area Challenge to address sea level rise, drowning bayland ecosystems, and sediment shortage.



Living Shoreline Details and Relationship to Water Flows.
Drawing Modified from SCAPE.

Stabilization and Sedimentation

Samut Sakhon, Bangkok Metropolitan Region, Thailand

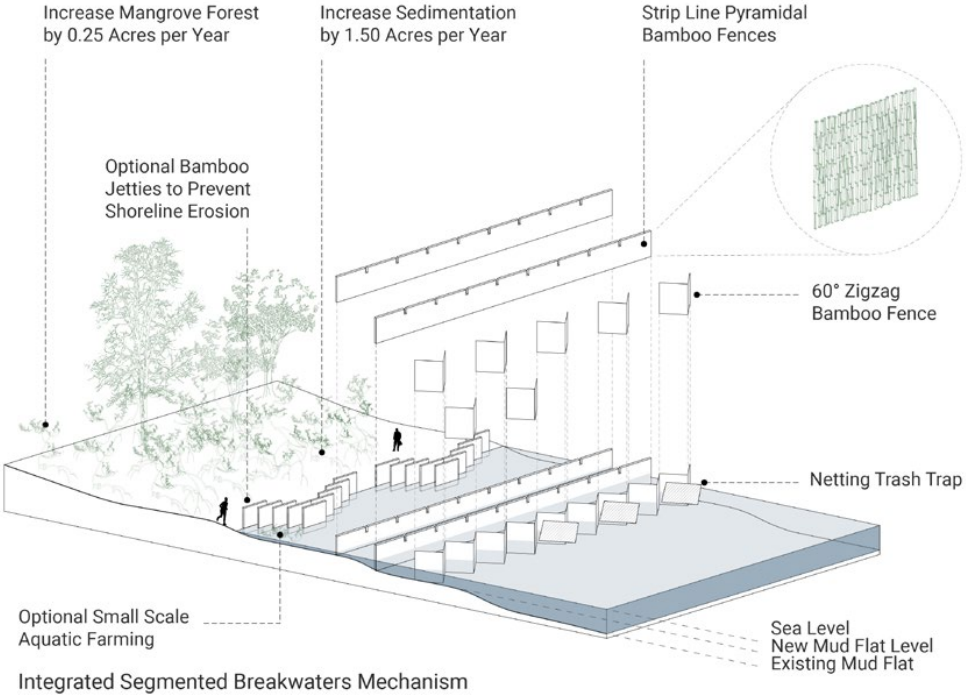
Solution	Flood / Coastal
Project	Ao Mahachai Forest Edu. Center
Owner	Marine/Coastal Resources Dept.
Designer	Lakanapohn Sinparu +
Cost	N/A for 237.2 acres

Mangrove forests are important ecosystems that provide many ecological benefits. But they are under constant threat from human and natural causes.

The region around the Ao Mahachai Mangrove Forest Natural Education Center (AMFC) is considered the most abundant mangrove forest of Mahachai gulf. It is threatened by urban expansion, shrimp farming, industrial land use, severe coastal erosion, coastal flooding, and sea level rise. In order to reduce the hazards associated with sea level rise and boost local adaptive ability, the AMFC's main objective is to protect and restore the mangrove forest through adaptation.

Bamboo fences are inserted as living breakwaters to lower current strengths, permit sedimentary deposits, and ensure the successful replanting of mangroves. Various fence configurations parallel the eroded coastline, especially in the outdoor laboratory where long-term performance is being monitored.

Mangrove afforestation and reforestation is important for socio-economic well-being, the conservation of the coastline, and the accumulation of land behind the bamboo fence. These approaches also contribute significantly to land accumulation and environmental sustainability. Mangrove forests are widely renowned for their ability to withstand increasing sea levels because the sedimentation process maintains their surface elevations.



Integrated Segmented Breakwaters Mechanism

Anirut Rassameesritrakool / Alamy Stock Photo | 73

Sponge

Brooklyn, New York, USA

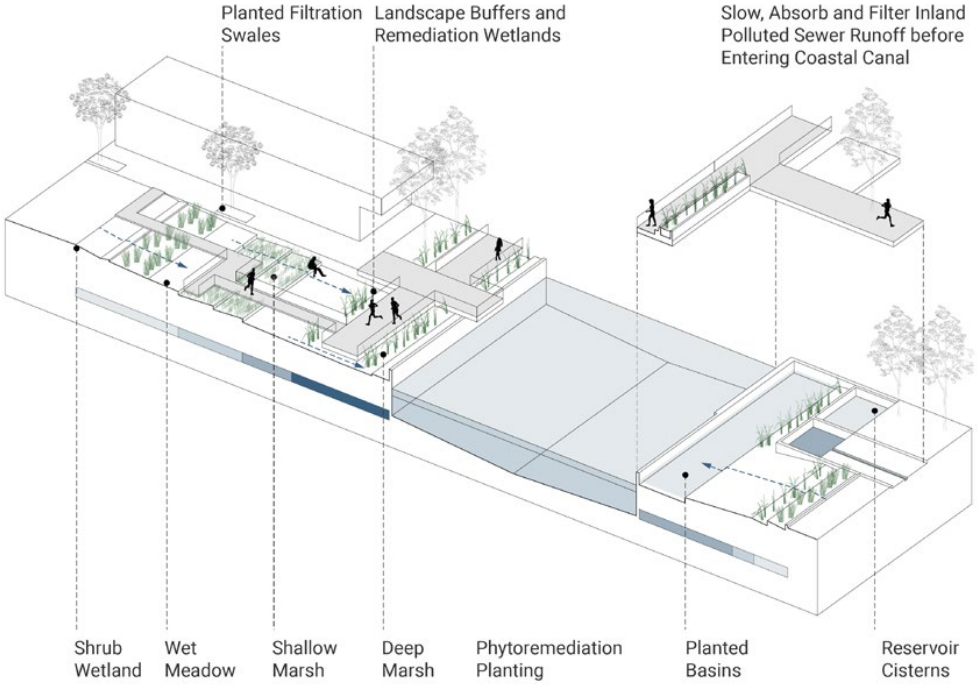
Solution	Flood / Coastal
Project	Gowanus Canal Sponge Park™
Owner	Gowanus Canal Conservancy
Designer	dlandstudio, courtesy Sasaki +
Cost	$11M USD for 11.4 acres

Coastal urban communities face compounding risks – from sea level and groundwater rise, storm surge to toxic stormwater inundation. In cities with combined sewer systems, such as New York, significant rain events cause raw sewage to mix with stormwater runoff, which then overflows into water bodies. Both people and wildlife are at risk due to the hazardous chemicals and bacteria present in the tainted water, but restoring these canals as sponges restores nature's natural abilities.

Like many cities, marine and commercial shipping sectors once flourished along the Gowanus Canal. During that time, factories dumped raw sewage, contaminated runoff, and hazardous waste into the waterway. The former industrial sites behind the now degraded canal walls were home to abandoned and derelict buildings and debris.

Despite the contaminated water and dilapidated walls, the present-day Gowanus Canal still conjures natural beauty. By building a park along its banks that uses the environment to clean the water, the sponge park seeks to highlight and enhance this intrinsic quality.

The name comes from the restoration of wetlands and landscape buffers used to delay, absorb, and filter runoff before it enters the canal. Carefully selected plants are used to metabolize and remove pollutants and heavy metals from contaminated water. The polluted water is first collected in underground storage tanks and then gradually released into the landscape.



System Drawing Modified from Dlandstudio and Susannah Drake, Courtesy of Sasaki

Mobile Messenger

San Rafael, California, USA

Solution	Flood / Coastal
Project	The FloMo
Owner	Resilient By Design
Designer	Bionic +
Cost	N/A

Sea level rise awareness and education is critical to gaining support for adaptation strategies and policies and allowing communities to make informed decisions on issues that affect their neighborhoods.

Thousands of immigrants live in the San Rafael Canal District. This industrious, close-knit community is located below sea level and only protected by old pumps and levees. If nothing is done, eventually sea level rise will force the entire population to relocate.

The FloMo, which was first created as a component of the Resilient By Design: Bay Area Challenge, is a multilingual graphic-covered vehicle that tours the area, projecting potential flood levels using a laser level and a flood gauge. The goal is to provide information directly to communities that may be displaced or severely damaged by flooding and sea level rise.

It is used at school visits, municipal meetings, sea level rise excursions, and flood fairs. The FloMo also travels with a 3D-printed interactive flood model, hands-on engagement tools, and "Flood Line" stickers. The FloMo serves as both a political lobbyist, a keynote speaker, an educational briefing, and a tool for public involvement.

Everywhere it goes—on the streets, in parking lots, at night, it's generating awareness, raising concerns, and sparking change.

Students and Community Members Get Out-of-Class Lessons on Flooding and Climate Change / Bionic


FLOODS AFFECT EVERYTHING
LAS INUNDACIONES AFECTAN TODOS
Yep, that's pretty much everything...
HOMES & APARTMENTS
SCHOOLS
GAS STATIONS
GROCERY STORES
BUSINESSES
PHARMACIES
POST OFFICES

Living Shoreline

Miami, Florida, USA

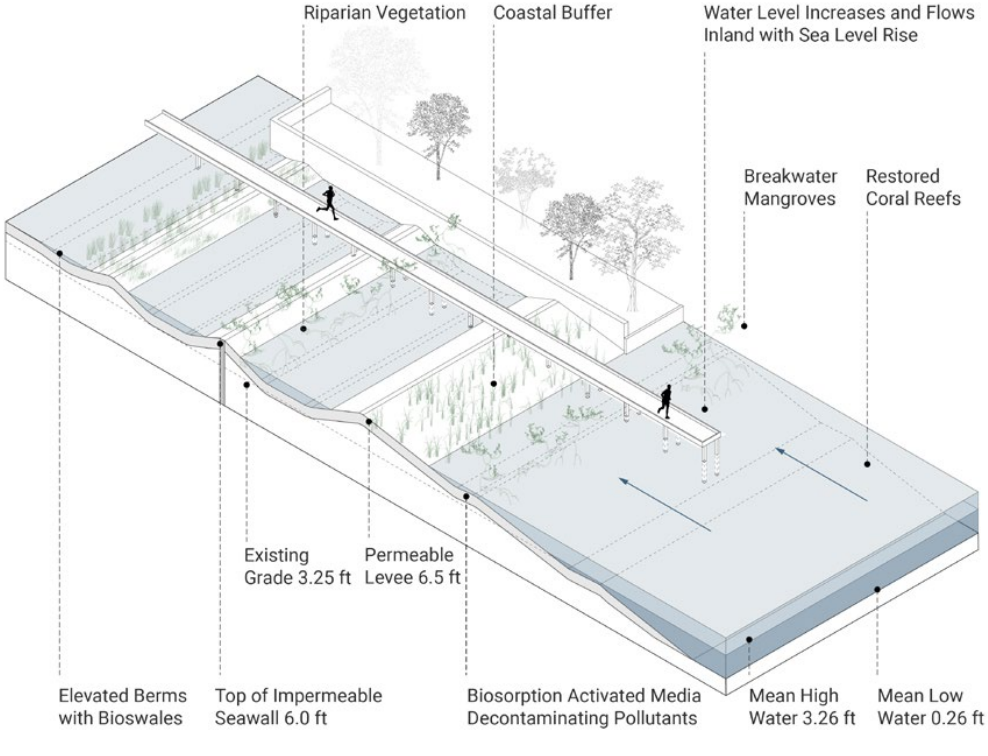
Solution	Flood / Coastal
Project	USACE Back Bay Study
Owner	Dtwn. Dev. Auth. City of Miami
Designer	Curtis + Rogers Design Studio +
Cost	$N/A for 39 acres

Living Shorelines are multi-beneficial alternatives to traditional grey coastal engineering approaches that support flood protection, habitat, and community health and well-being.

This sea level rise adaptation strategy involves raised vegetated shorelines along the coast In Miami, it is complemented by a strategically positioned coastal breakwater islands with mangroves, restored coral reefs on the bay floor, and elevated berms with bioswales. This multi-layered defense system can be phased by landscape type or location, adapting to increasing sea level rise impacts over time.

The original “Back Bay Coastal Storm Risk Management Feasibility Study,” a government-issued proposal from 2020, examined the storm-surge impacts in Miami-Dade County and proposed a fifteen foot-high (4.5 m) concrete floodwall in the downtown heart of the city. The proposal was met with strong opposition from the diverse community. Curtis + Rogers Design Studio, local landscape architecture firm, was enlisted to assess, design, engineer, and visualize an alternative to the single-purpose and unsustainable concrete and steel wall. The process involved collaboration with coastal engineers and ecological consultants to develop a feasible solution.

The living shoreline alternative meets engineering requirements while preserving views, safeguarding habitats, enabling long-term adaptation, and providing additional recreational space. It prioritizes the health and well-being of communities above all else.



Typhoon Triple Dike

Shenzhen, China

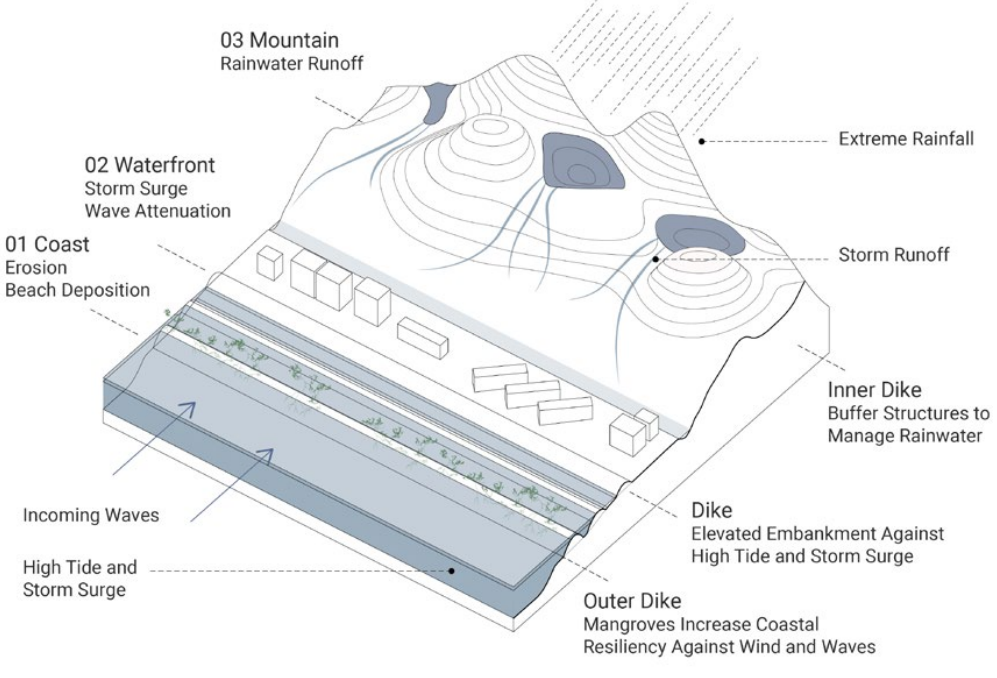
Solution	Flood / Coastal
Project	East Dike Dapeng
Owner	Water Resources Bureau Municip.
Designer	Felixx and KCAP +
Cost	$6M USD for 81 miles in length

Natural elements like landforms and vegetation can provide coastal climate change adaptation solutions that protect communities from storm surge risk while enhancing biodiversity and increasing public awareness.

The East Dike Dapeng project is located on the eastern side of China's Guangdong Province near the city of Shenzhen. Situated along a peninsula, this sea-level rise and typhoon mitigation project protects the local fishing community from coastal flooding, wind, and waves.

By applying a triple dike coastal adaptation approach, this design creates a series of natural storm barriers between the mountains and the sea. The inland Inner Dike is a series of rain gardens that collect and infiltrate rainwater while also providing amenities to the community. The middle Dike is composed of a series of walls with varying heights and orientations that prevent storm surge and wave action from damaging higher elevations. The third Outer Dike uses landforms and mangroves to disrupt and reduce wave attenuation during storm events.

This triple zone system is intended to be scalable and replicable so that it can be applied to other coastal communities in the region. In order to facilitate this process, the design includes materials that are readily available and access pathways and greenspace amenities for the public.



Marsh Migration

Surrey, British Columbia, Canada

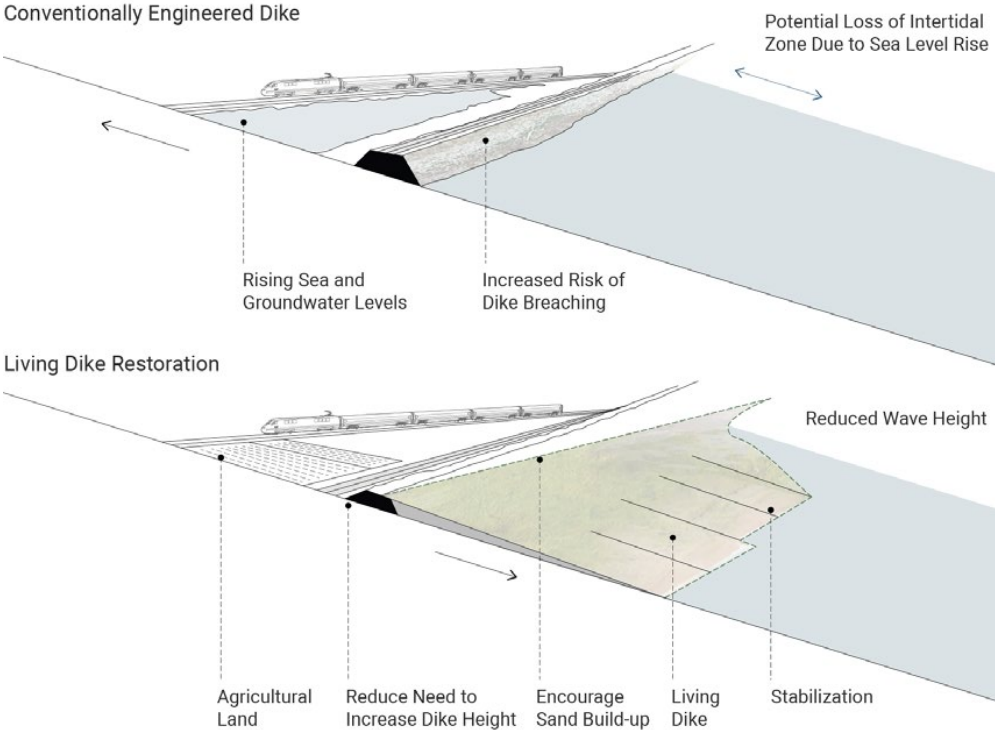
Solution	Flood / Coastal
Project	Surrey CFAS
Owner	City of Surrey
Designer	Living with Water +
Cost	$76 million USD for 5 miles

Coastal marshes can help protect shorelines against rising sea levels by preventing erosion, absorbing wave energy, and building up elevation over time. However, they may need to be re-established to endure changing threats over time.

Mud Bay in British Columbia is susceptible to a number of climate change-related effects, such as increasing sea and groundwater levels, dike breaching danger, reduced coastal habitats, increased coastline erosion, and saltwater intrusion. In response to the increased frequency of coastal flooding and the rising average sea level, the city of Surrey has implemented the Coastal Flood Adaptation Strategy (CFAS), a long-term plan structured to take place over three-time spans: short term (by 2030), medium term (2030-2070), and long-term (2070-2100).

One early project is to install a gentle sloped Living Dike on the coastal side of an existing bay dike that will help the threatened salt marsh keep up with sea level rise. Native marsh species will be planted that will slow stormwater, reduce flooding, and provide habitat for a range of species. The goal is a gradual and natural increase in marsh elevation over time by trapping sediment and organic matter.

This project combines creativity and experimentation. It involves a number of testing, piloting, evaluating, and fine-tuning phases. Each phase offers an opportunity to learn from and improve the strategy.



Eliana Chia/ Fraser Basin Council | 83

Community Adaptation Funding

Gentilly, New Orleans, Louisiana, USA

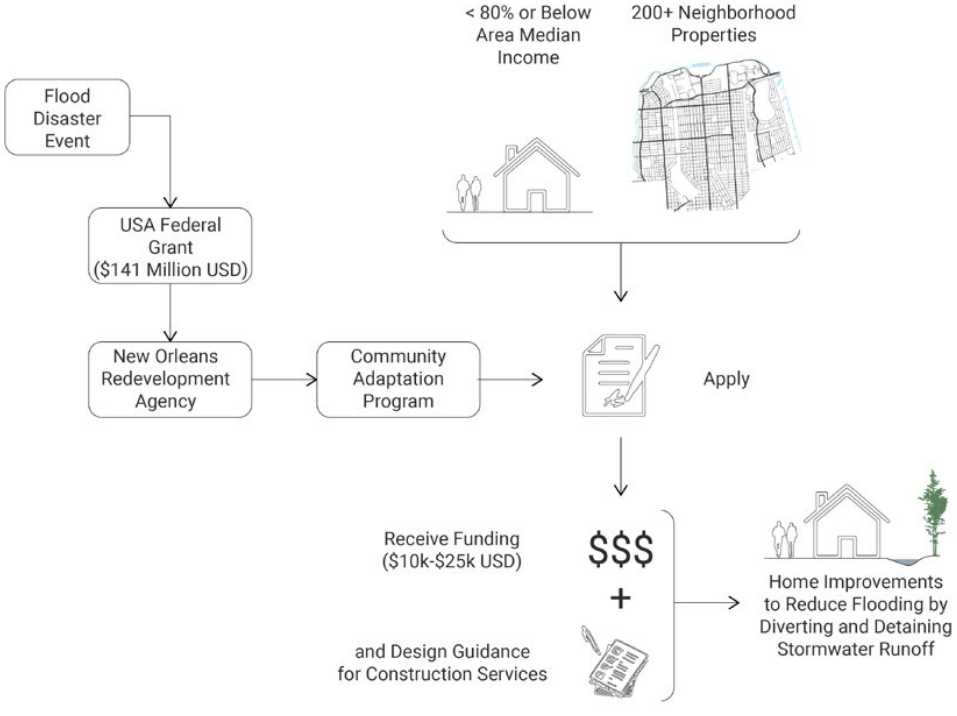
Solution	Flood / Coastal
Project	Gentilly Adaptation Program
Owner	New Orleans Redev. Authority
Designer	APTIM, Design Jones, Dana Brown+
Cost	$111K, 7,054 ft^2 (2222 N. Broad)

Funding for coastal community adaptation is vital because it supports efforts to protect and prepare communities for the impacts of climate change and sea level rise.

Gentilly, a middle-class and racially diverse neighborhood of New Orleans, was devastated when Hurricane Katrina struck and broke through the floodwalls. The city and the New Orleans Redevelopment Authority (NORA) prioritized a new Community Adaptation Program (CAP) with $141 million USD in funds from the U.S. Department of Housing and Urban Development's National Disaster Resilience Competition. This site became the city's first comprehensive "resilience district."

Within this district, owner-occupied single-family households at or below 80 percent of the area median income received $5 million in stormwater management upgrades under the CAP. Homeowners were encouraged to construct and maintain natural stormwater management systems by the city and NORA. The homeowner incurs no costs for the design or installation of the renovations.

It is anticipated that 140 houses would receive between $10,000 and $25,000 in green infrastructure systems—such as bioswales, rain gardens, and trees—that will improve stormwater management. The design team collaborated with residents to create water-absorbing landscapes as part of Gentilly community planning and design.



Community Adaptation Process Provided by the New Orleans Redevelopment Authority (NORA)


ew Orleans:
ir Water City

Sea Terrace

Peninsula, Dar Bou'azzah, Morocco

Solution	Flood / Coastal
Project	Peninsula Promenade
Owner	Espace Developement
Designer	Carey Duncan Design +
Cost	$2.24M USD for 7.4 acres

Adaptive reuse within coastal areas is critical for combating climate change impacts. Former industrial or commercial sites can be repurposed to enhance resilience to sea level rise, storms, and flooding while preserving natural landscapes and protecting local communities. By updating and enhancing existing infrastructure, communities and ecosystems can be protected while supporting sustainable development and reducing overall climate risk.

The Peninsula Promenade project re-visioned an existing waterfront quarry as a functional and usable pedestrian space. The design prioritized placing the primary platforms above potentially destructive high tides and storm surges, while still respecting the features created by the former quarrying activities. The 11-meter (36-ft) elevation change between the road and the coastline was used to install concrete bleachers with a visually pleasing curved shape that provided an ideal area for a variety of individual, group or community activities.

The design offers a place for reflection, gathering, play, and exercise while simultaneously invoking a sense of the site's industrial past. Construction materials and plant species were selected for resilience, durability and ability to withstand the effects of sea spray. This project serves as an example of responsible water and energy usage due to the selection of drought-tolerant plant materials, the use of permeable paving, solar lighting, and drip irrigation.

The Promenade Supports Recreation and Increasing Storms
Carey Duncan 2021 / Jean Claude Laffitte 2021

Flood / Inland

Urban Retention

Bangkok,
Thailand

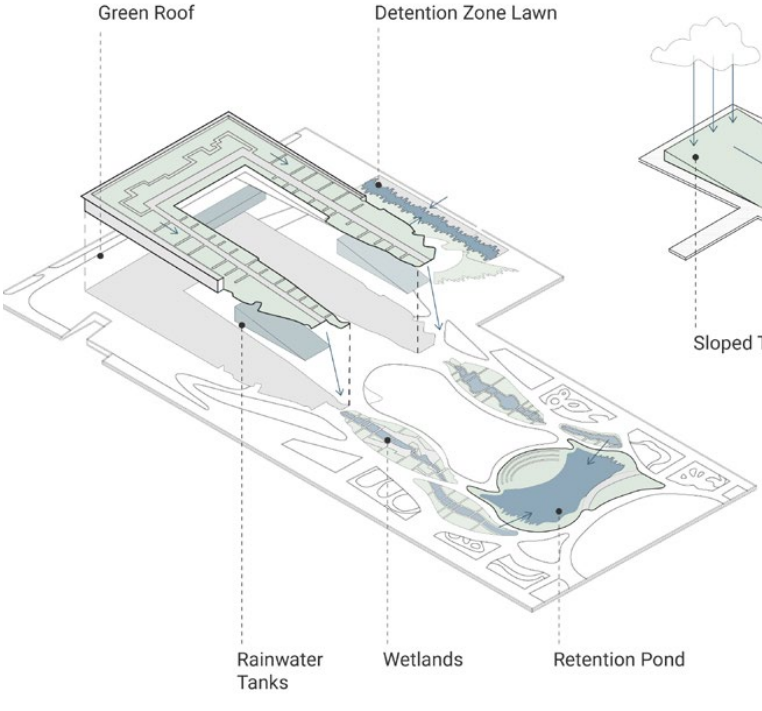
Solution	Flood / Inland
Project	Chulalongkorn Centenary Park
Owner	Chulalongkorn University
Designer	LANDPROCESS +
Cost	$30M USD for 11 acres

Stormwater filtration and retention strategies are critical for managing and cleaning runoff in highly impermeable urban areas especially as storms increase due to climate change. By capturing and storing stormwater below ground, these systems can help prevent surface flooding and reduce the burden on traditional infrastructure. Implementing these strategies create more sustainable and resilient urban environments, particularly in densely populated areas where infiltration space is limited.

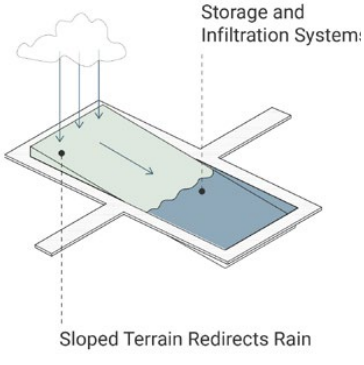
Chulalongkorn Centenary Park is built to adapt to the unpredictable future. The entire park is oriented to form a container for water. Runoff is directed through sloped rain gardens, filtered in the artificial wetland, and then directed to the retention pond by the elevated green roof. A detention area – the park's mid-lawn – provides room for flooding and retention pond overflow. Water from surrounding areas is treated within the park by passing it through a wetland filtration system.

The perimeter edges welcome the surrounding neighborhoods while the core boasts an expansive open space. Smaller contained landscape rooms – like an herb garden, meditation walk and reading area – are placed adjacent to filtration ponds and ring the main lawn. To integrate the park design with the neighborhood, a nearby road was modified to allow for more bike lanes and pedestrian walkways. The pathways within the park align with the perimeter pedestrian connections, creating a seamless pedestrian experience.

Runoff Flow Direction and Storage



Park Topograpy Concept



Illustrations Highlighting Urban Retention System.
Drawing Modified from LANDPROCESS

Landslide Warning and Protection

Medellín, Antioquia, Colombia

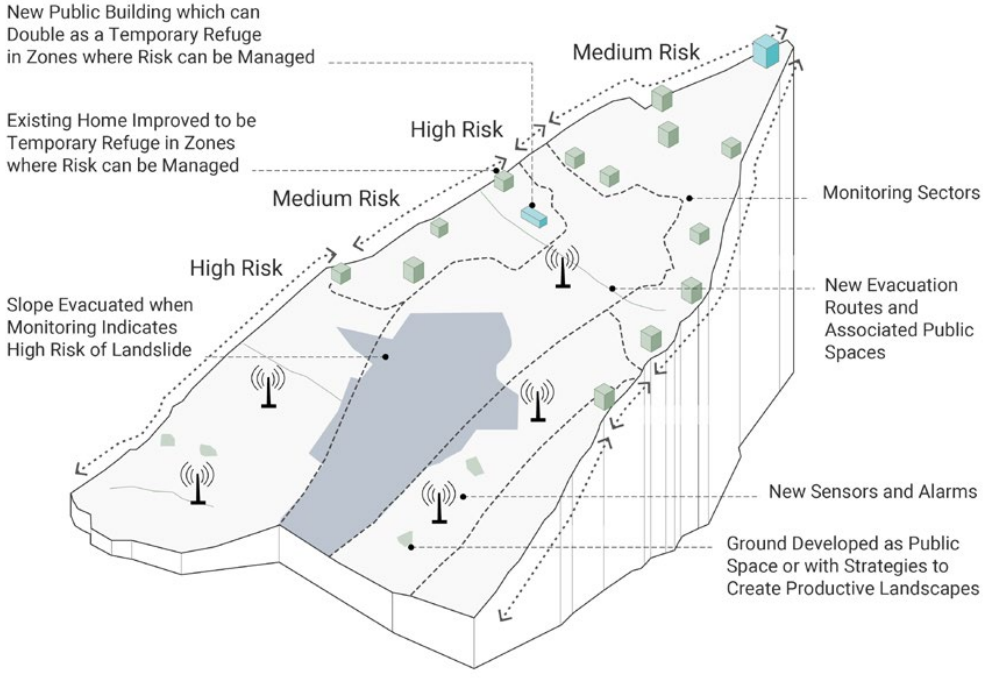
Solution	Flood / Inland
Project	Inform@Risk
Owner	Medellín, Colombia
Designer	Harvard GSD, Universidad EAFIT
Cost	N/A

Climate change adaptation strategies are critical to protect vulnerable communities from the devastating effects of landslides.

Due to unstable volcanic soils on the steep slopes surrounding Medellín, substantial landslides can occur during periods of severe rainfall. Informal communities within the slide zones are at even higher risk because of their socio-economic standing and lack of working infrastructure and government funding. This potentially unstable land will pose increasingly greater risks over time, as climate change brings on heavier and more frequent rain events.

The research and design project, Inform@Risk, analyzes this changing environment and provides design solutions to help those at-risk. The program gathers stakeholders to develop, put into practice, and evaluate strategies aimed at preventing the worst-case landslide scenarios in the densely populated foothills.

Inform@Risk has launched five pilot projects to enhance resilience and safety. These initiatives include developing building evacuation routes and an early warning system, improving soil drainage to prevent saturation, supporting micro-farming on steep slopes to curb erosion, re-establishing protective forests, and identifying suitable land for future settlement expansion. The project applies a methodology that considers the existing political and economic circumstances of the pilot communities and outlines phased tactical remedies that address systemic problems.



Informal Nature-Based Solutions

Dar es Salaam, Tanzania,
East Africa

Solution	Flood / Inland
Project	Realizing Urban NbS
Owner	--
Designer	Kounkuey Design Initiative +
Cost	N/A

A nature-based solution (NbS) is a sustainable approach to address climate change and other socio-economic problems using natural processes and ecosystems.
Informal settlements scattered throughout East Africa are disproportionately and severely affected by the effects of climate change. These smaller and unincorporated communities often have insufficient or outdated water management systems that lead to frequent and damaging floods, which threaten both lives and livelihoods.

The Realizing Urban NbS project addresses these issues by integrating NbS with traditional infrastructure, using a community-led approach and incorporating gender inclusivity and human rights. A Monitoring, Evaluation, and Learning (MEL) framework tracks the effectiveness of NbS interventions, while the Rivers and People plan aims to influence policy and river management through participatory planning. Since 2019, the team has developed seven pilot project sites within four unplanned settlements in Nairobi and Dar es Salaam, integrated over 17 NbS, and is co-developing plans in five additional settlements.

Findings from these efforts have been shared at numerous major conferences and a regional community of practice in the fields of community service, infrastructure, urban planning and management, and construction. Risk and resilience management has been established in Ethiopia, Kenya, Rwanda, Uganda, and Tanzania.

Canal Revitalization

Bangkok,
Thailand

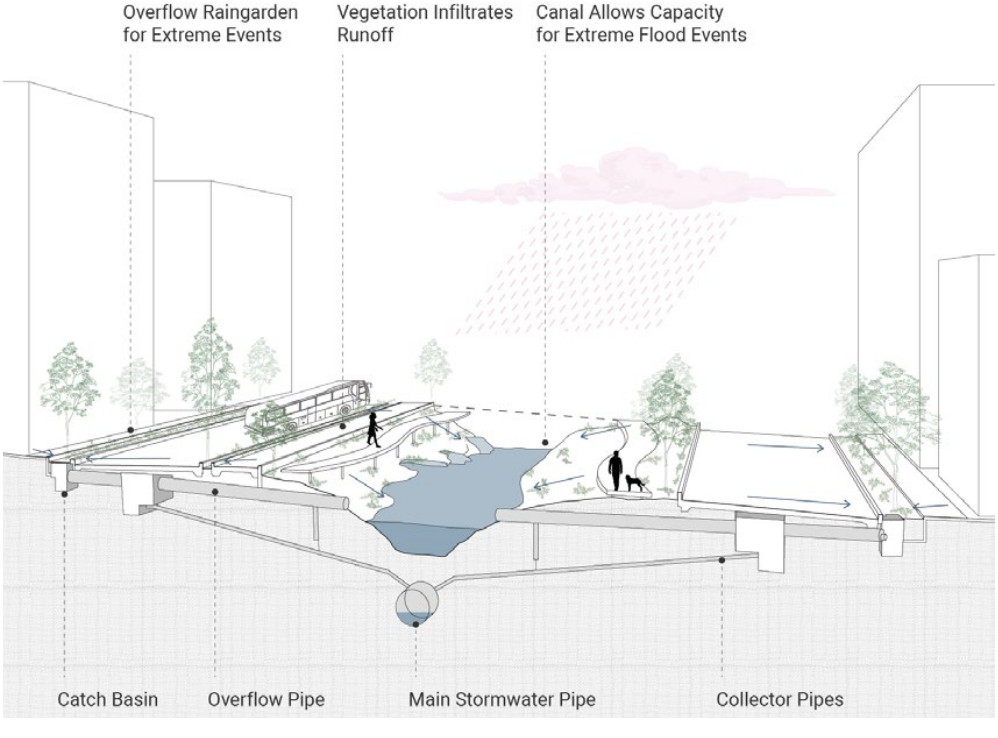
Solution	Flood / Inland
Project	Chong Nonsi Canal Park
Owner	Bangkok Metropolitan Admin.
Designer	LANDPROCESS +
Cost	$30M USD for 2.8 miles

Repurposing degraded or non-functioning infrastructure is a powerful strategy for managing stormwater, restoring ecosystems, and improving water quality. These improvements can safeguard communities, increase local biodiversity, and generate economic opportunities.

The city of Bangkok is extremely vulnerable to the impacts of climate change due to the sinking delta soils, sea level rise, and increasingly more intense storm events. When it was founded, temples and markets used to line canal banks throughout the city, making waterways vital for transportation and community life. However, rapid urban development and transition to road-based transportation has filled in many canals, disrupting the connection between waterways and communities, which caused a decline in vital ecosystem services. Today, these canals are often clogged with stagnant sewage, obscured by modern infrastructure.

The Chong Nonsi Canal Park project seeks to restore the ecological function and public use of the canal by incorporating nature-based solutions into stormwater management design. Strategies include increasing the capacity of the canal for extreme flood events and providing vegetated edges to filter and slow runoff and rain gardens, in addition to traditional stormwater conveyance techniques.

The public can experience both the function and beauty of the renovated canal from an elevated curvilinear boardwalk.



Water Runoff is Collected in Revitalized Canals to Reduce Floods
Drawing modified from LANDPROCESS

Terraforming

Vazhithala, Thodupuzha,
Kerala State, India

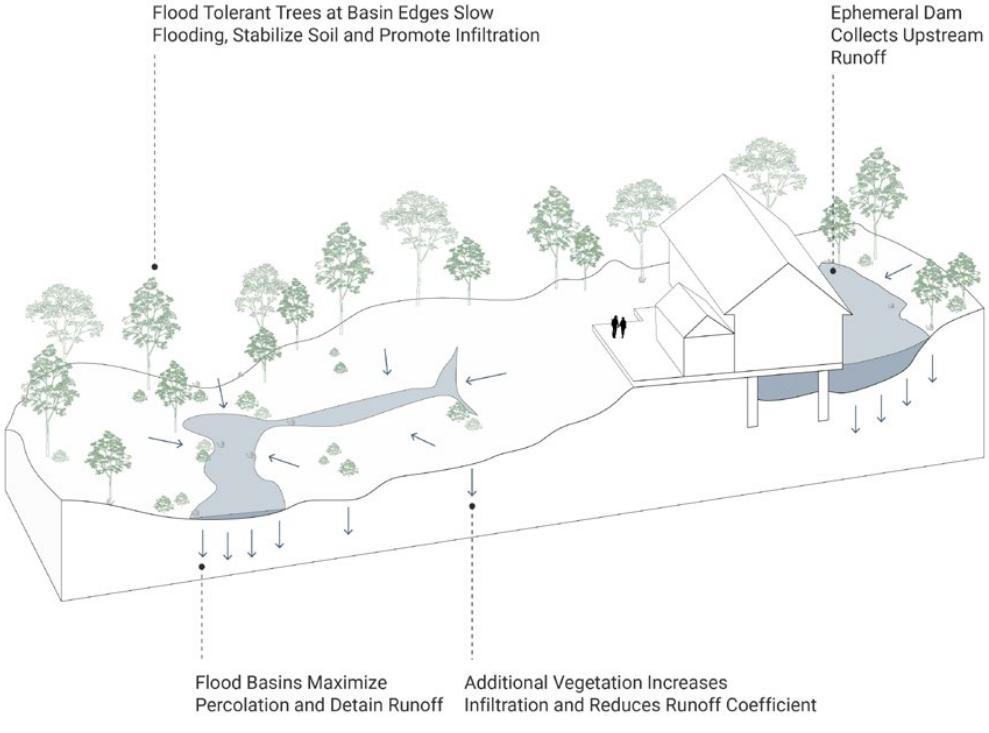
Solution	Flood / Inland
Project	House for the Sun and the Rain
Owner	George Kochuparambil
Designer	Prakrti Living Environment +
Cost	$ N/A for 11 acres

The nature-based strategy of terraforming is an important climate adaptation strategy. It helps stabilize land, improve resilience to climate impacts, and enhance water management.

Climate patterns in India have grown more erratic with wetter conditions coupled with prolonged dry seasons that can last up to six months. This causes seasonal droughts and diminished groundwater supplies. Streams that previously surged during monsoons now largely remain dry. Monsoon rains are more intense but occur in brief, concentrated periods resulting in inadequate drainage, localized flooding, and increased erosion.

The House for the Sun and the Rain terraformed the surrounding micro-watershed in order to manage runoff, enhance infiltration, and improve downstream water flow. It does this by applying several strategies. By creating ephemeral flood-basins to capture stormwater, increase percolation, manage peak outflows, and extend concentration times at the watershed outlet, the project used the surrounding natural and built features to achieve a more sustainable site.

Flood-tolerant trees planted at the edges of these basins boost transpiration, returning groundwater to the atmosphere to stabilize seasonal precipitation patterns. Additionally, ecological restoration within the catchment area boosts infiltration and reduces runoff. The house foundation at the watershed's head acts as a dam, forming a temporary lake that fluctuates with rainfall.



Grading Allows for Water Storage Capacity during Monsoons

Constructed Wetland

Shanghai, Pudong, China

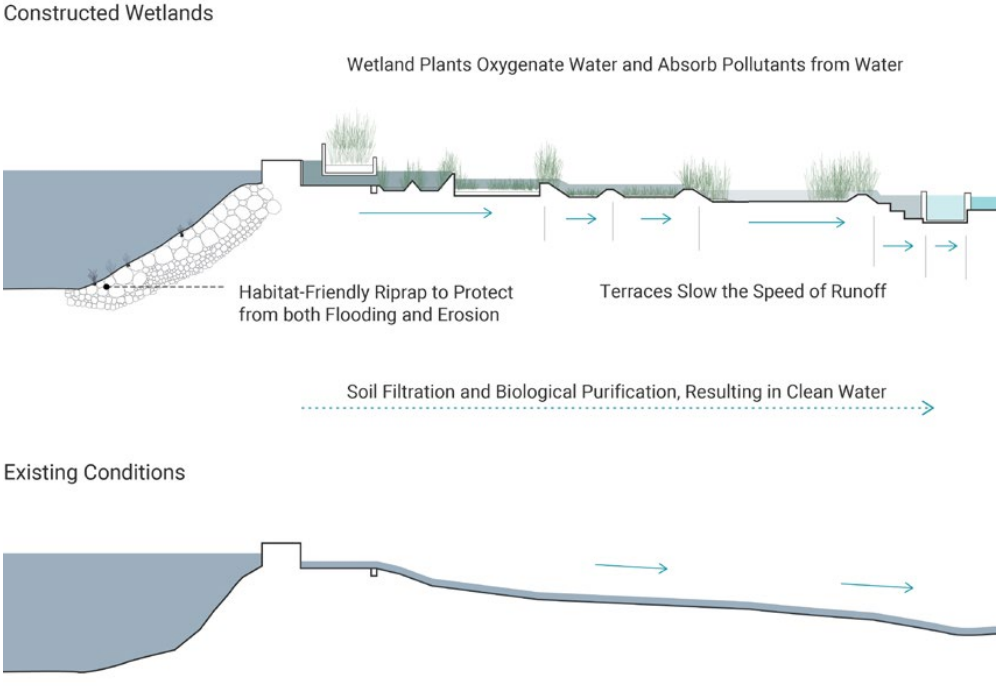
Solution	Flood / Inland
Project	Houtan Park
Owner	Shanghai Government
Designer	Turenscape +
Cost	$15.7M USD for 34.5 acres

Constructed wetlands purify polluted water, manage stormwater to reduce urban flooding, and provide natural amenities for the public to enjoy. They also boost biodiversity, cost less than conventional treatment systems, and improve climate resilience by increasing carbon sequestration.

The Houtan Park project was built on a former industrial site for the 2010 Shanghai World Expo in order to demonstrate green technologies to visitors and continue as a permanent public waterfront park. The park was conceived as a dynamic, self-sustaining system that would cleanse polluted river water, reduce urban flooding, enhance biodiversity, and showcase the regional culture.

The project extends along the Huangpu River with several miles (km) of natural and constructed wetlands designed to purify polluted river water and attract native wildlife. A prominent feature is a linear, constructed wetland running through the park, measuring one mile (1.6 km) in length and between 16.5 and 100 feet (5 – 30.5 m) and in width, which functions as a living machine to treat the river's contaminants.

Its purification process includes a long stonewall waterfall, terraced fields with a "U" pipe system for pollutant capture, an 850-foot (259-m) planted section dedicated to heavy metal absorption, an 820-foot (250-m) planted section for specifically for nutrient removal, cascading terraces for aeration, and a pool for water stability and sand filtration.



Illustrations Depicting Constructed Wetland Flood Protection. Drawing Modified from Kongjian Yu, Turenscape.

Bioremediation Cell

Wadi Hanifah,
Riyadh, Saudi Arabia

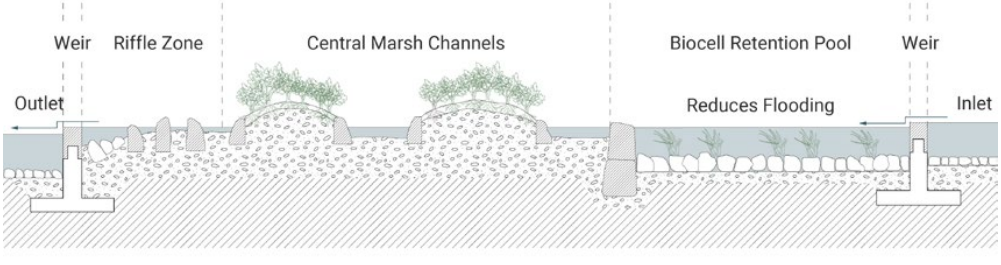
Solution	Flood / Inland
Project	Riyadh Bioremediation Facility
Owner	Arriyadh Development Authority
Designer	Thomson Env Consultants +
Cost	$32M USD for 0.56 miles

Low-Impact design strategies help support human settlement and security without requiring energy intensive processes. By incorporating bio-remediation cells, or treatment wetlands, sewage can be passively treated by working with nature.

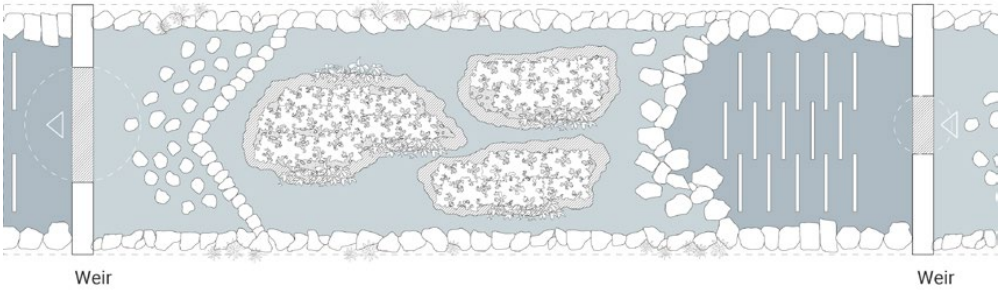
The visible bioremediation facility in Riyadh relies on an approach where algae and plants, which are supported by fish, birds, and insects, break down urban wastewater components. A low-tech infrastructure of bioremediation cells, weirs, pools, and riparian planting provide the habitat required for this ecosystem. The treated effluent is returned to the stream bed or is recycled to accommodate other urban functions, including a river park.

The site contains 134 biocells designed to oxygenate water and support the diverse organisms that break down wastewater nutrients. After collecting at the head pool of the facility, wastewater proceeds through successive biocells, then collects into an aerating outlet pool before being released back into the stream.

Each biocell group is composed of an inlet channel, biocells, and outlet channels. The aeration system in the inlet mixes water to reduce algae propagation and provide the oxygen required for the organisms that break down bacteria. Wastewater enters the biocells at the head pool, proceeds through the central marsh and vegetated islands, and meanders through a riffle zone before cascading through the cells' outflow channel.



Bioremediation Involves Microorganisms, Fungi and Plants which Remove Pollution from Soil and Water



Designed Biocells Oxygenate and Treat Wastewater Nutrients.

River Renaturation

Geneva, Switzerland

Solution	Flood / Inland
Project	River Aire
Owner	State of Geneva
Designer	Superpositions, ADR +
Cost	$99M USD for 123 acres

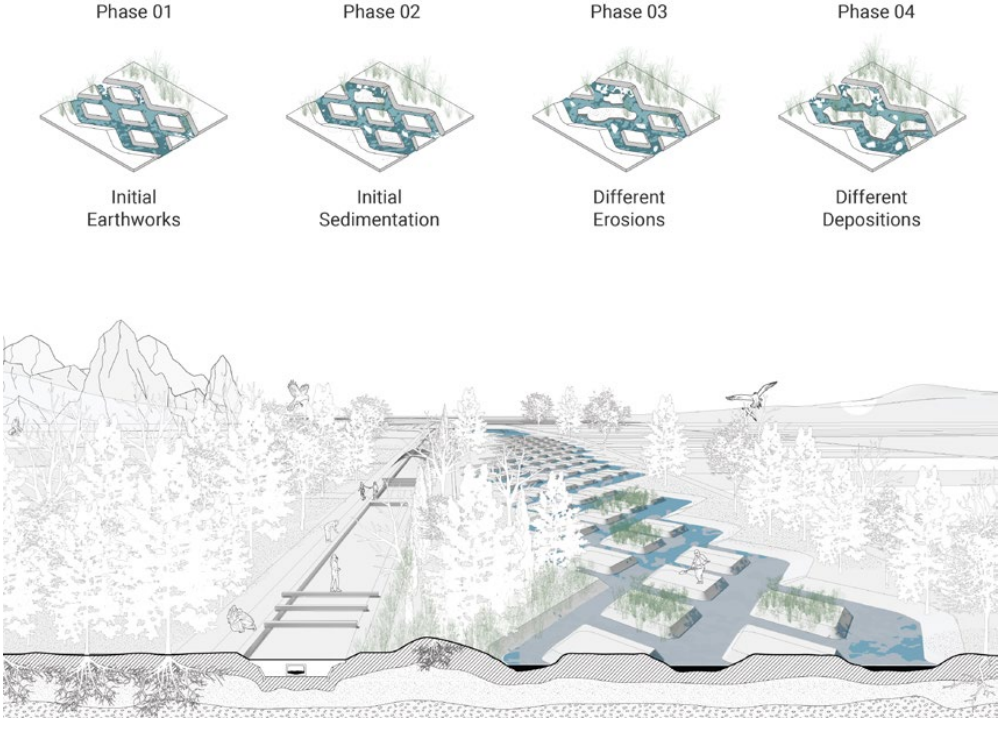
Allowing a river to flow naturally is vital for its ecological health. A healthy river supports wildlife habitats, adapts to increasing floods, transports sediment, and preserves cultural and recreational amenities.

The Aire River, which has historically flowed through farming valleys, was progressively canalized starting in the late 19th century. In 2001, the State of Geneva launched a competition to restore the river to its original form by dismantling the canal. Instead, designers proposed integrating the canal with a larger area that would allow the river to naturally meander.

This project aims to blend ecological needs with cultural transformation by allowing the river to shape itself within a designed pattern. The design features a diamond-shaped layout that interacts with the river's flow, creating a network of undetermined channels. These channels were carefully excavated along the new river course, removing the topsoil and controlling the river's longitudinal profile.

The size of the diamond-shaped islands was configured to accommodate the size of the former meanderings. A year after the new river space was opened, the river's flow and the distribution of materials, such as gravel and sand, had significantly altered the initial geometric pattern.

The remnants of the historic canal system were left largely in place allowing for visitors to witness the transformation from canalization to naturalization.



Bioswale

Lentegeur, South Africa, Africa

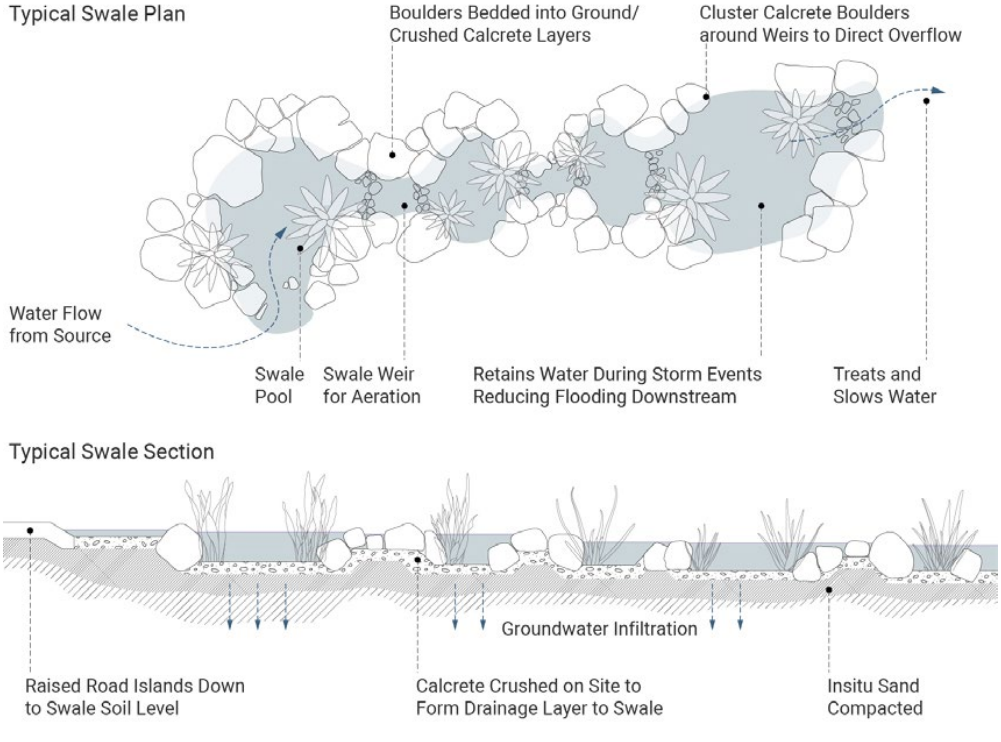
Solution	Flood / Inland
Project	Mitchell's Plain Hospital
Owner	Dept. of Public Works W. Cape
Designer	TKLA +
Cost	~$550,000 USD for 44.5 acres

Within urban areas or predominantly impermeable sites, engineered natural bioswales and retention ponds can play an important role in managing stormwater and increasing flood risk reduction and water infiltration and storage. These simple yet effective features provide essential functionality while simultaneously creating a natural aesthetic within paved surrounds.

The Mitchell's Plain Hospital project is the first public building to feature a sustainable urban drainage system that incorporates both overland swales and a detention pond recharge system.

This approach deviates from traditional engineering methods that rely solely on hard infrastructure pipes to convey water offsite and instead aligns with water-sensitive design principles. During construction, natural materials found onsite, like calcrete, were excavated and repurposed to create porous drainage channels and swales for stormwater filtration and storage. This accumulated and stored water supports plant growth and reduces the need for supplemental irrigation.

The swales and ponds were designed to mimic a natural dry water course and blend in with the native landscape. This system manages stormwater by temporarily holding it for infiltration or storage, which concurrently reduces potential flooding and unwanted runoff. Swales near the building collect rainwater from the roofs while those in parking areas handle stormwater from paved surfaces.



Bioswales Capture Urban Runoff, Reducing Inland Flooding
Drawing Modified from TKLA

Rise Above

Houston, Texas, USA

Solution	Flood / Inland
Project	Houston Arboretum + Nature Ctr.
Owner	L.B. Johnson Wildflower Center
Designer	Design Wkshop, Reed Hilderbrand +
Cost	$25M USD for 65 acres (Phase 1)

Aligning a project's plant palette with climate adaptation strategies enhances resilience to climate events, supports general ecosystem services, and maintains biodiversity. It also reduces maintenance costs and ensures long-term sustainability by selecting plants well-suited to future climate conditions.

Situated six miles (9.7 km) from downtown, The Houston Arboretum and Nature Center (HANC) has experienced significant tree canopy loss due to natural disasters. Rather than restoring the arboretum to its former state, the project focused on reintroducing endemic grasslands native to the Houston region.

The initial 65-acre (26 ha) phase restored the site's ravine landscape and established 20 acres (8 ha) of prairie and savanna ecosystems with native plants to showcase the Gulf Coast environment. To enhance resilience against future disasters, HANC incorporated two wetlands for stormwater management and restored the previously flood-damaged riparian ecology.

A newly designed trail system, elevated to avoid seasonal flooding, includes an expanded fiberglass boardwalk and two large, high-elevation bridges to manage flow and reduce erosion. All materials used on the project were selected for their ability to withstand heavy floods. Jute mesh erosion control fabric stabilized the banks and supplemental plug plantings were added within seeded areas to accelerate and support vegetation growth.

Wetlands Detain and Reuse Stormwater for Irrigation and Provide Habitat for Insects, Amphibians, and Birds. Courtesy Brandon Huttenlocher / Design Workshop Inc.

Floating the Future

Berlin, Germany

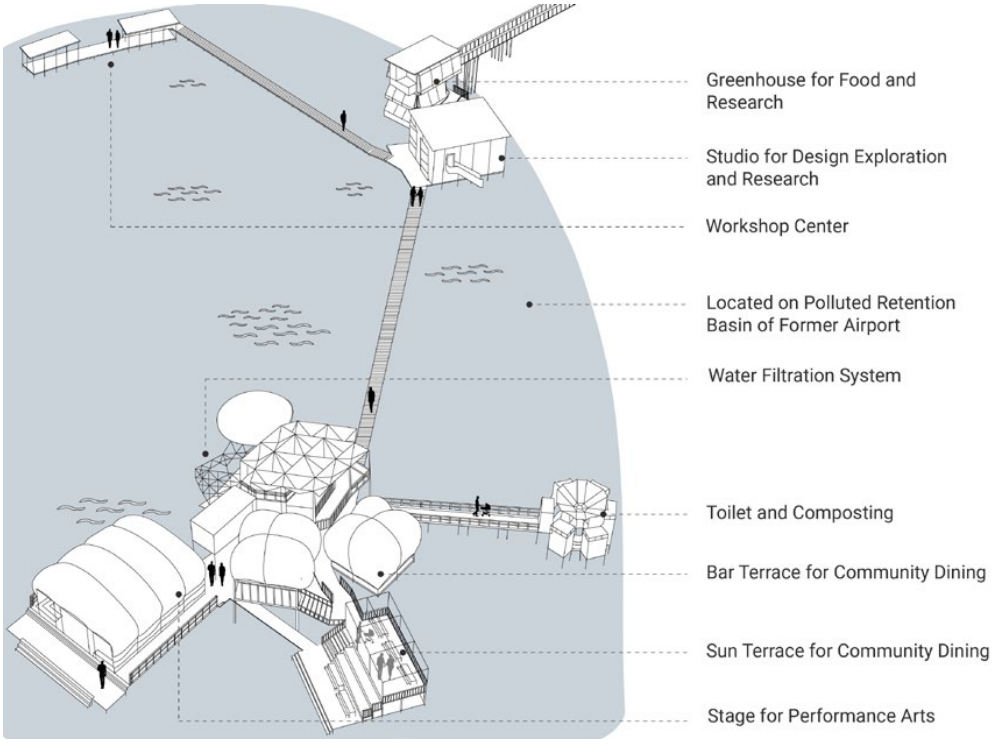
Solution	Flood / Inland
Project	Floating University Berlin
Owner	University of Berlin
Designer	Raumlabor Berlin +
Cost	N/A

Climate adaptation education prepares students to address climate challenges head on and drive innovation in the field. This push for change requires enhanced leadership skills, sustainable practices, education through hands-on projects, active participation, and eco-revelatory immersion.

The Floating University Berlin is a nature-culture educational site developed by over 50 artists, designers, architects, scientists, engineers, neighbors and children. Located in a polluted rainwater retention basin on the former Tempelhof Airport site, this experimental campus actively functions as part of the city's water infrastructure while simultaneously providing habitat for wetland species and forum for education and climate action.

The campus was constructed using sustainable materials to showcase the possibilities of climate-forward design strategies and contains a water purification system connected to Berlin's municipal infrastructure. Serving as a research hub for exploring urban sustainable practices, developing climate change solutions, and addressing resource scarcity and biodiversity loss, the Floating University was collaboratively built by students and educators. The campus consists of learning spaces, workshops, an auditorium, and a laboratory tower for experimental water filtration connected by a series of boardwalks.

All aspects of this one-of-a-kind campus are focused on addressing complex urban issues and applying sustainable practices.



Overview of Floating University. Drawing Modified from Jeanne Astrup-Chauvaux, raumlaborberlin.

Cloudburst Capture

Copenhagen, Denmark

Solution	Flood / Inland
Project	Copenhagen Cloudburst Plan
Owner	City of Copenhagen
Designer	N/A
Cost	$N/A for 21,810 acres

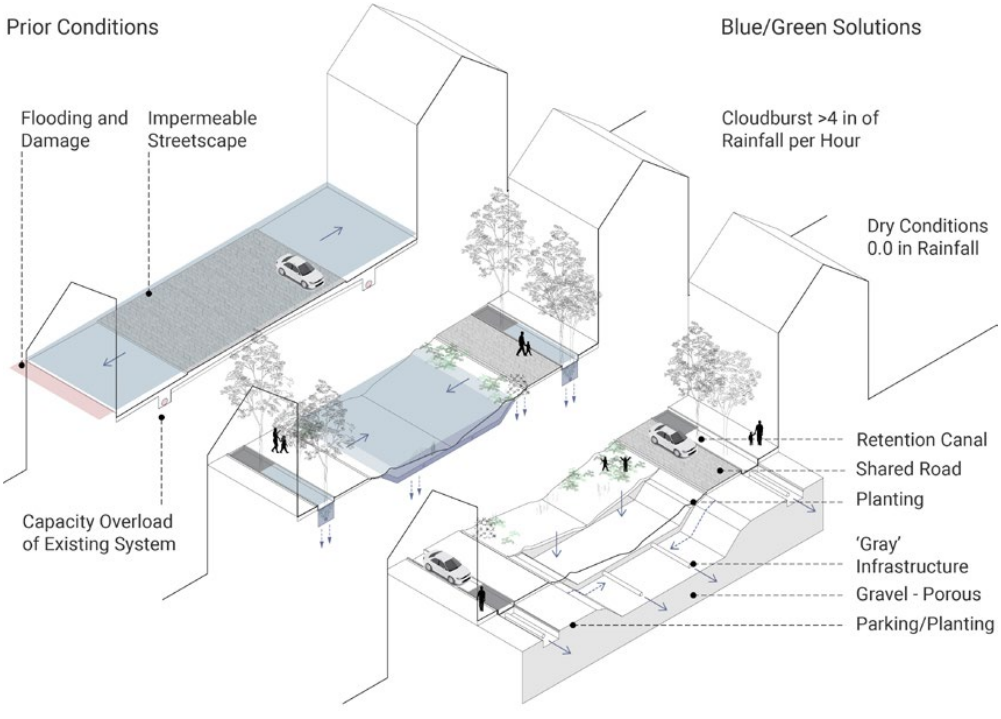
Adapting urban areas to effectively manage severe storm events is crucial for lowering flood risks, protecting property, and ensuring public safety.

In 2011, Copenhagen experienced a 1,000-year storm event known as a cloudburst that flooded the city with three feet (91 cm) of water and caused over $1B USD in damage.

The city responded by developing the Copenhagen Cloudburst Plan focused on installing blue/green solutions. These are surface-level, low-tech, and interactive adaptations rather than traditional underground water conveyance engineering. Examples of these solutions include removal of impermeable surfaces, adding vegetation and permeable surfaces to promote water infiltration, and regrading to control stormwater runoff.

Funded by a public-private partnership known as the Copenhagen Formula, the project involves retrofitting existing cities with blue/green strategies. Private developers supported the government's initiative, which addressed not only flood-affected areas but also upstream and upland regions where the impacts of heavy rainfall are less visible to residents.

The plan established a clear prioritization that started with high-risk areas identified by the climate adaptation plan. It then moved to locations where implementing these blue/green measures were straightforward, which was followed by locations with active urban development. Finally, it addressed regions governed by other policy directives.



Increasing Capacity

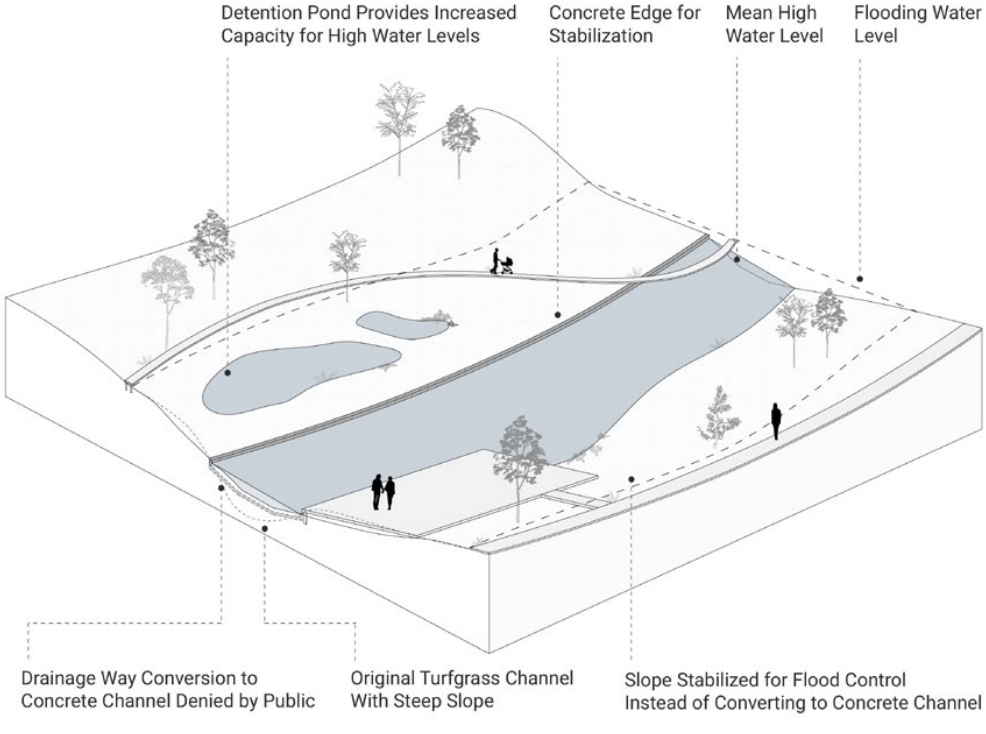
Houston, Texas, USA

Solution	Flood / Inland
Project	Buffalo Bayou
Owner	Buffalo Bayou Partnership +
Designer	SWA Group +
Cost	$58M USD for 169 acres

As storms continue to increase in both severity and frequency due to climate change, it is imperative to reevaluate traditional stormwater management methods to adapt systems to sustainable and resilient design strategies.

Serving as the main drainage system for much of Houston, Buffalo Bayou park is an urban green space that has been reimagined into a multi-faceted asset for all residents. Previously a functional drainage corridor with engineered turf slopes, the design team reconfigured the corridor and restored the natural meandering path of the bayou, removed non-native and invasive plants, created reforestation, and re-established native meadows that once existed on-site. The park contains over 15 miles (24 km) of pedestrian walkways and bike paths that allow both residents and visitors to enjoy and explore the rehabilitated bayou ecosystem.

The existing design allowed for informal gatherings, but the redesign boasts large event lawns, intimate gardens, nature play zones, and plazas that support year-round events. The new Buffalo Bayou Park was funded by a public-private partnership and is designed to bolster against potential flooding. Having withstood three major floods since its inception—including Hurricane Harvey, which unleashed 27 trillion gallons (102 billon m^3) of water on Houston—Buffalo Bayou Park stands as a model for resilient open-space design and planning in areas vulnerable to climate change and flooding.



Hydropuncture

Itztapalapa, Mexico City, Mexico

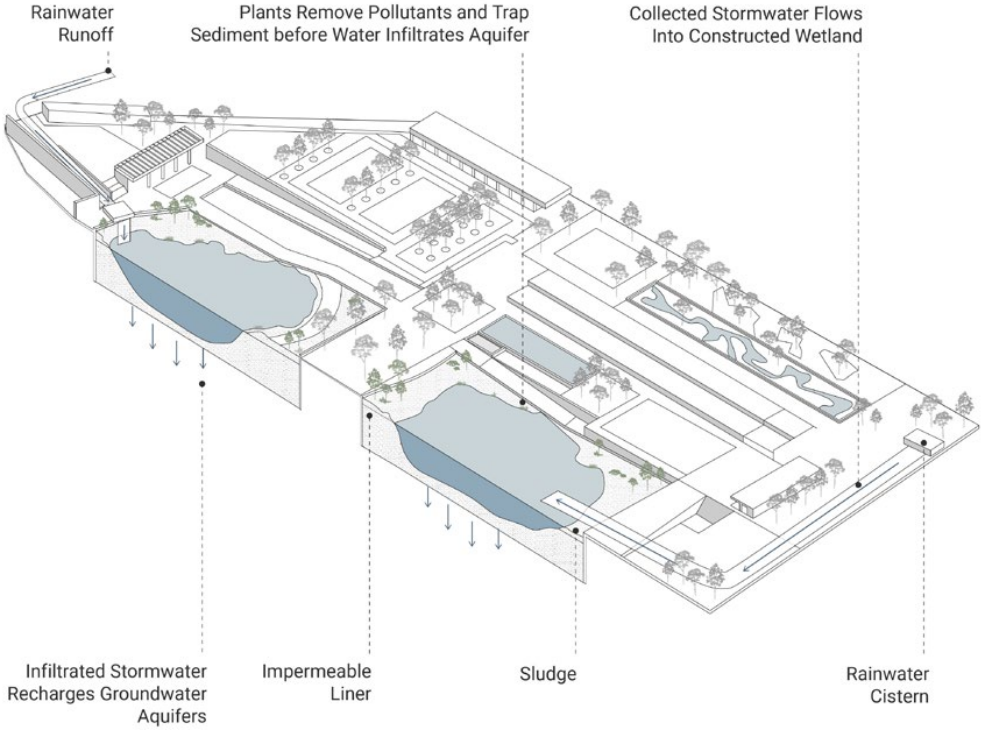
Solution	Flood / Inland
Project	La Quebradora Hydraulic Park
Owner	Iztapalapa district of Mexico City
Designer	UNAM Inst. of Social Research +
Cost	$2B USD for 9.4 acres

Sustainable urban expansion requires permeable solutions that allow stormwater to naturally recharge, mitigate flood risks and contribute to greater resilience.

The La Quebradora Hydraulic Park transformed neglected urban areas into wetlands and reservoirs. This system captures street rainwater, filters it through constructed wetlands that trap sediment and remove pollutants, and replenishes the groundwater aquifer.

The team focused on the geological history of Mexico City and sought to introduce the concept of a wet and soft water basin into the design. The design is one of the first in the city to address the issues plaguing the region by reconnecting surface rainwater to underground water systems in order to alleviate pressure on urban stormwater infrastructure and recharge the groundwater aquifers. This managed stormwater concept also helps reduce uncontrolled flooding while simultaneously providing the 28,000 residents living nearby with new recreational spaces and access to water resources.

Over the last 400 years, Mexico City experienced one of the most severe landscape changes that saw its original 1,100-square kilometer (425 mi^2) lake system shrink dramatically to only 50 square kilometers (19 mi^2) due to urban expansion. This change, caused by a growing population and associated increase of impermeable surfaces, eventually led to issues such as urban flooding, ground subsidence, and reduced aquifer recharge.



This System Captures Rainwater and Replenishes the Aquifer
Drawing Modified from Taller Capital / UNAM

Dechannelization

Bridgetown, Barbados,
Carribbean

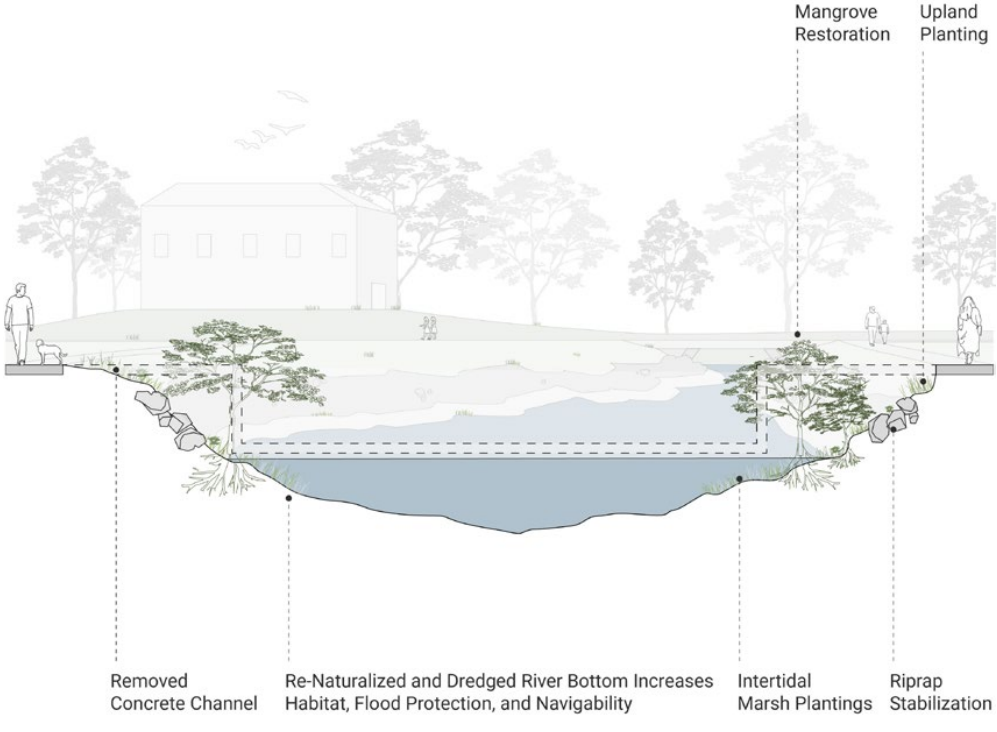
Solution	Flood / Inland
Project	Constitution River Phases I, II & III
Owner	Barbados Gov., EABTI Inc. +
Designer	Talma Mill Studios Ltd. +
Cost	$14M USD for 0.3 miles

Restoring the natural flow pattern and shape to waterways helps prevent floods by letting water slow down and disperse. This de-channelizing strategy is crucial for maintaining native wildlife and plant species as it restores natural habitats, which creates a healthier and more resilient environment.

Historically, Constitution River was a vibrant coastal estuary with black and red mangroves lining the banks and terminating in a large water body connected to the sea. When the river was canalized in 1962, the black mangrove species disappeared from Barbados but can still be found on nearby islands.

The once natural riverbed became a stagnant, debris-filled channel that frequently flooded into nearby areas which included the national hospital. The Constitution River Phase I, II, III projects involved removing the constructed channel and dredging the river to remove sediment and other debris. Natural boulder armored embankments were added for storm control, and the connection to the sea was re-established to recreate the original coastal estuary.

The landscape design included pedestrian amenities and access in addition to several mangrove restoration pilot projects. The mangrove propagules from these successful restoration plots are now spreading along the river edge, re-establishing the coastal estuary environment, and enhancing the flood control capabilities of the project.



Daylighting

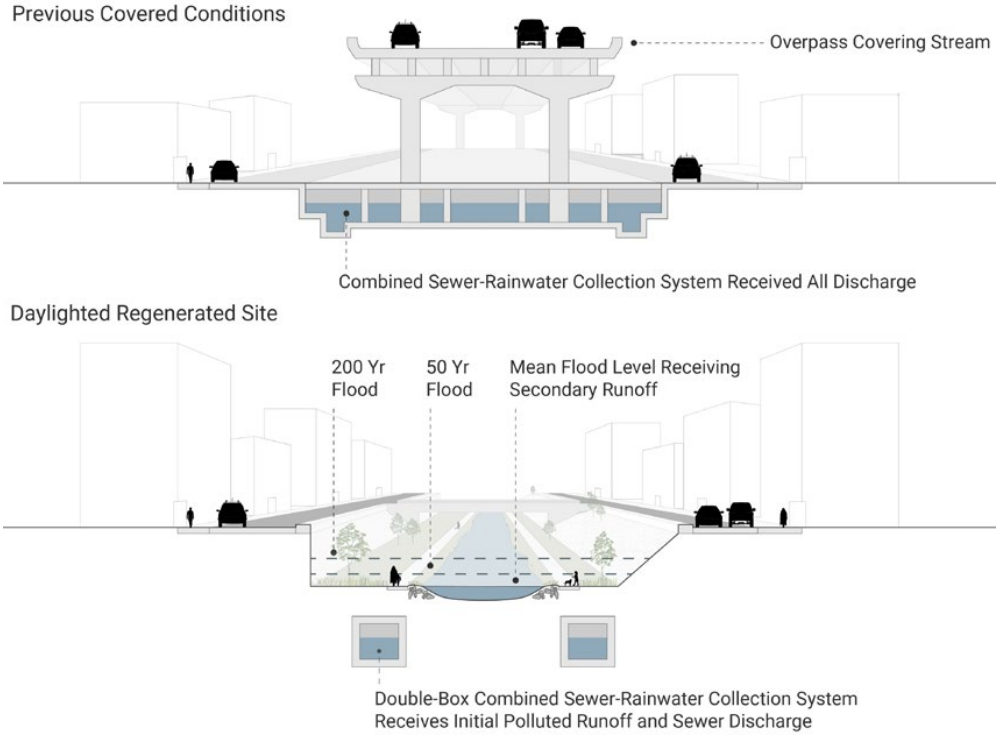
Cheonggyecheon Stream
Seoul, South Korea

Solution	Flood / Inland
Project	Cheonggyecheon Restoration
Owner	Seoul Metropolitan Government
Designer	SeoAhn Total Landscape +
Cost	$120M USD for 100 acres

Within dense urban environments, removing unnecessary infrastructure and daylighting existing waterways helps restore natural flow, manages floods events, improves water quality and supports local wildlife. These upgrades also create inviting green spaces in cities, which enhance community enjoyment while simultaneously making urban areas more resilient to climate change.

The city of Seoul is transforming from a car-centric urban design to one that prioritizes the quality of life of its residents as well as healthy ecosystems. The Cheonggyecheon Restoration Project is at the center of this change. It removed an existing elevated freeway and the linear at-grade concrete cap to daylight the historic Cheonggyecheon Stream. It also led to the redesign of the combined sewer and stormwater system. This required adding 22 new bridges to improve connectivity across the newly exposed waterway and other traffic reducing techniques to ease congestion. This adaptation created a 3.6-mile (5.8 km) green corridor in central Seoul, which provides precious ecological and recreational benefits within the dense urban area.

The redesigned stream section includes vegetated slopes and constructed edge protections against various flood level events. To manage the stream's flow, water from the Han River and various subway pump stations is treated and managed to maintain a consistent depth of 40 centimeters (15.7 inches) within the Cheonggyecheon Stream.



River Transformation (modified from Seoul Solution)

Amanda Ahn / Alamy Stock Photo | 121

Biodiversity

Indigenous Reforestation

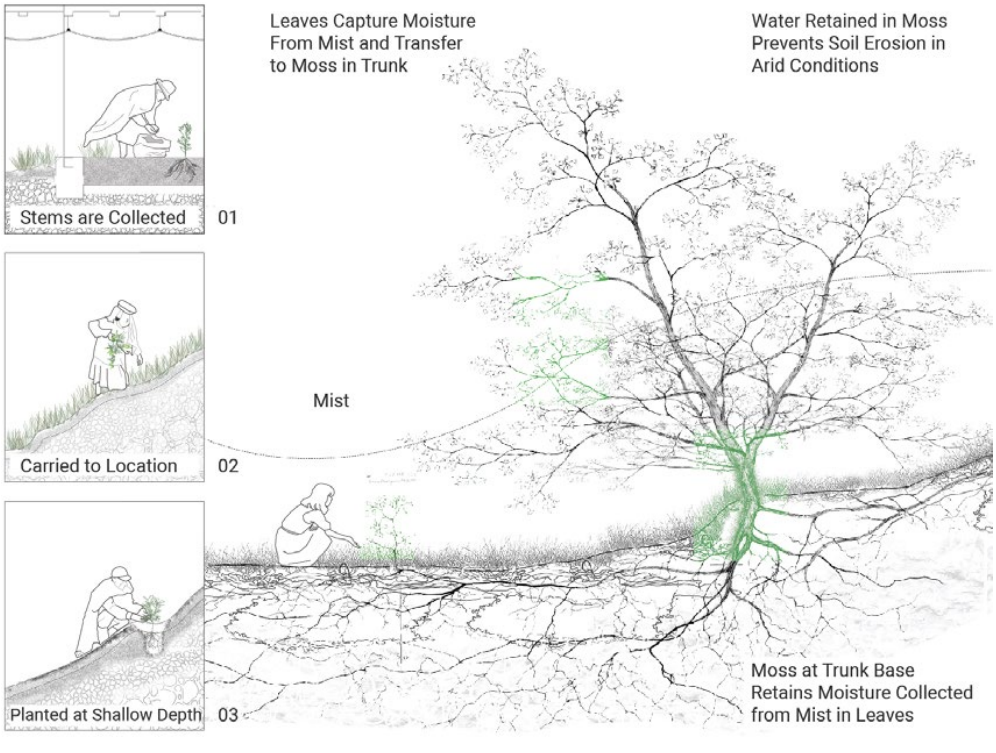
Argentina, Bolivia, Chile, Colombia, Ecuador, Peru

Solution	Biodiversity
Project	Acción Andina
Owner	GFG and ECOAN
Designer	Local implementation partners
Cost	$10 - $15M USD for 2.47M acres

Restoring native species is vital for climate adaptation as they enhance ecosystem health, support local wildlife, and help maintain balanced and resilient natural environments. Large-scale habitat restoration benefits also extend beyond the site to residents, businesses communities, and regions.

Acción Andina is a social movement dedicated to restoring 1 million hectares (2.47M ac) of Andean Polylepis forests and high wetlands. Their restoration and conservation efforts offer economic and environmental benefits to local communities. Native trees are first started in local village nurseries, transported to restoration sites, and then planted on sloped hillsides to prevent erosion, increase biodiversity, and create more hospitable conditions for future tree growth.

This high-altitude forest initiative spans five Andean countries—Argentina, Bolivia, Chile, Ecuador, and Peru—with plans to expand to Colombia and Venezuela. Since 2018, they've launched 22 projects, engaged 25,000 people in restoring nearly 5,000 hectares (19 mi^2), and protected over 11,250 hectares (43 mi^2) of forest. This extensive work and dedication to indigenous reforestation has created economic opportunities for more than 200 communities throughout the regions. These benefits include improved health care and water catchment systems, clean burning clay stoves and solar panels, and securing land titles. This inspiring and successful work will serve as a model for similar projects around the world.



ECOAN and Communities Reforesting in Quelqanqa-Ollantaytambo, Peru / Courtesy ECOAN

Safe Passage

West Vail Pass, Colorado, USA

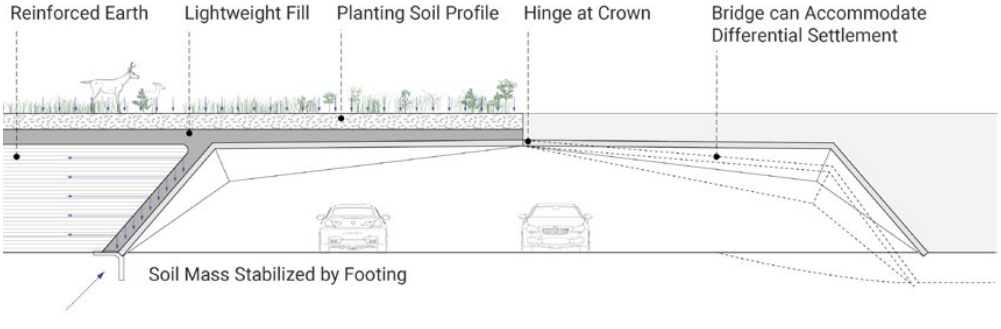
Solution	Biodiversity
Project	'Hypar-nature' Wildlife Bridge
Owner	Animal Road Crossing (ARC)
Designer	MVVA + HNTB
Cost	N/A

Continuity and connectivity are critical to maintain, create, or restore healthy and resilient habitats. As they cross open country freeways, highways, and roads fragment and disrupt wildlife habitats, damage natural systems, and endanger both people and animals.

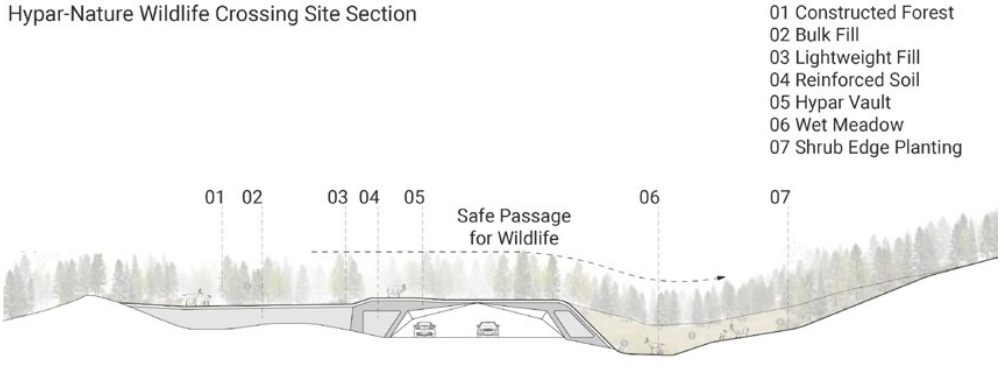
In the U.S., one to two million wildlife-vehicle collisions occur each year which has resulted in $8B USD in damages and around 200 human deaths from deer-related accidents. To tackle these issues and reconnect fragmented habitats affordably, the Center for Large Landscape Conservation introduced the Animal Road Crossing (ARC) International Wildlife Crossing Infrastructure Design Competition.

The Hypar-nature Wildlife Bridge is a unique single-span habitat bridge design that uses prefabricated concrete modules. These cost-effective units can be assembled in a variety of widths to accommodate a wide array of wildlife needs above while maintaining the ideal traffic volume below.

This connection extends the existing habitat across the bridge and over the often-oblivious traffic below by creating a vaulted structure with distinct habitat bands (forest, meadow, shrub) that create multiple zones to safely guide a large variety of animals. The design features hyperbolic paraboloid forms that aim to minimize site disruption, are easy to replicate and produce, cost-effective, and can be assembled to adapt to changing migration patterns.



Hypar-Nature Wildlife Crossing Site Section



Nature-based Land Bridges Provide Safe Passage for Animals. Drawing Modified from HNTB / MVVA

Gathering Place for Tulsa / Tulsa, Oklahoma / Michael Van Valkenburgh & Associates / Scott Shigley | 127

Penguin Parade

Summerlands, Victoria, Australia

Solution	Biodiversity
Project	Penguins Plus at Summerlands
Owner	Phillip Island Nature Parks
Designer	Tract Consultants
Cost	$1.9M USD for 741 acres

Protecting wildlife habitats allows animals to follow their natural migratory patterns and behaviors. This natural tendency is vital for their health and species survival. Allowing visitors to observe these processes in a controlled and unobtrusive manner creates great learning opportunities, promotes conservation awareness, and protects species propagation.

After acquiring the Summerland Estate, a landmark conservation decision in Australia, the historic Summerland Peninsula was carefully planned to enhance and restore native wildlife habitat. Home to the renowned Penguin Parade, the project applied a "first principles" approach to design, significantly expanding habitats, and adding new penguin viewing facilities. The focus was on creating a memorable experience during the approximately one-hour evening event when visitors watch penguins return from the sea to their burrows. This newly renovated facility included design elements like raised walkways with strategic lighting that carefully manage the interaction between people and nature.

The new Penguin Plus viewing area and boardwalks now offer more space for visitors. From designed viewing platforms, guests can get a closer look at the penguins as they make their way to their burrows. The boardwalks are thoughtfully integrated into the natural surroundings and incorporate a lighting design that provides a safe viewing experience without interfering with the penguins' natural routines.

Penguins Plus at Summerlands Courtesy Phillip Island Nature Parks / Penguin Parade / Visit Victoria

Pollinator Boulevard

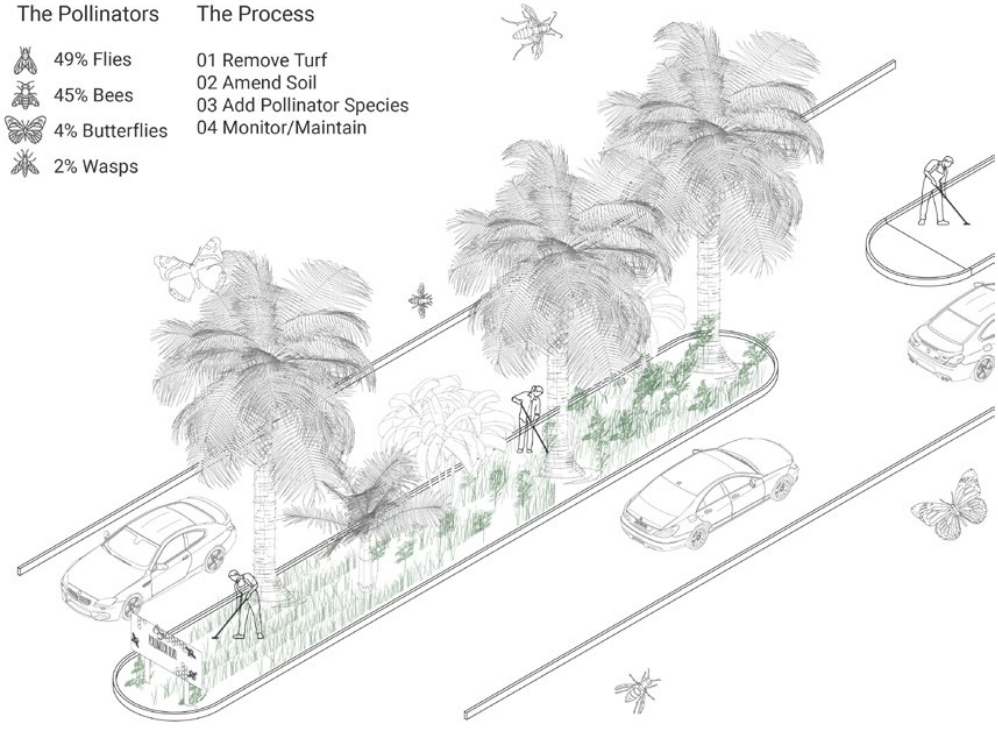
San Francisco, California, USA

Solution	Biodiversity
Project	Dolores Pollinator Boulevard
Owner	City of San Francisco
Designer	BASE Landscape Architecture +
Cost	$35,000 USD for 316 feet

Native and low-maintenance public gardens help improve overall ecosystem health, support vital pollinators, and make urban areas more resilient to climate change by managing stormwater and increasing urban cooling. These sometimes-interstitial green spaces offer viewing enjoyment and enhance community well-being by promoting sustainable living through immersion and education.

The large grassy center medians dividing Dolores Street suffered greatly from San Francisco's drought. Large brown, withered patches of dying grass expanded as supplemental irrigation was reduced to save water. The Dolores Pollinator Boulevard project replaced the dying water-hungry grass with drought-resistant plants well-suited to dry conditions.

The design team worked collaboratively with the local community and various stakeholders to bring the project to life on the first block of Dolores Street south of Market, installing a beautiful, drought-tolerant garden. Given pesticide use harms pollinators, they selected low-water, pesticide-free plants like California poppies, sages, and spider aloe to offer year-round blooms and a welcoming space for bees and other pollinators. The goal is to turn the rest of Dolores Street into a lively network of pollinator-friendly gardens, connecting it to the new garden at Dolores Park and the various school and church gardens along the street.



Urban Habitat

Various Locations,
Worldwide

Solution	Biodiversity
Project	Habitats
Owner	Vestre
Designer	Rethink Studio, Arde, Vestre
Cost	~$10,000 USD for five elements

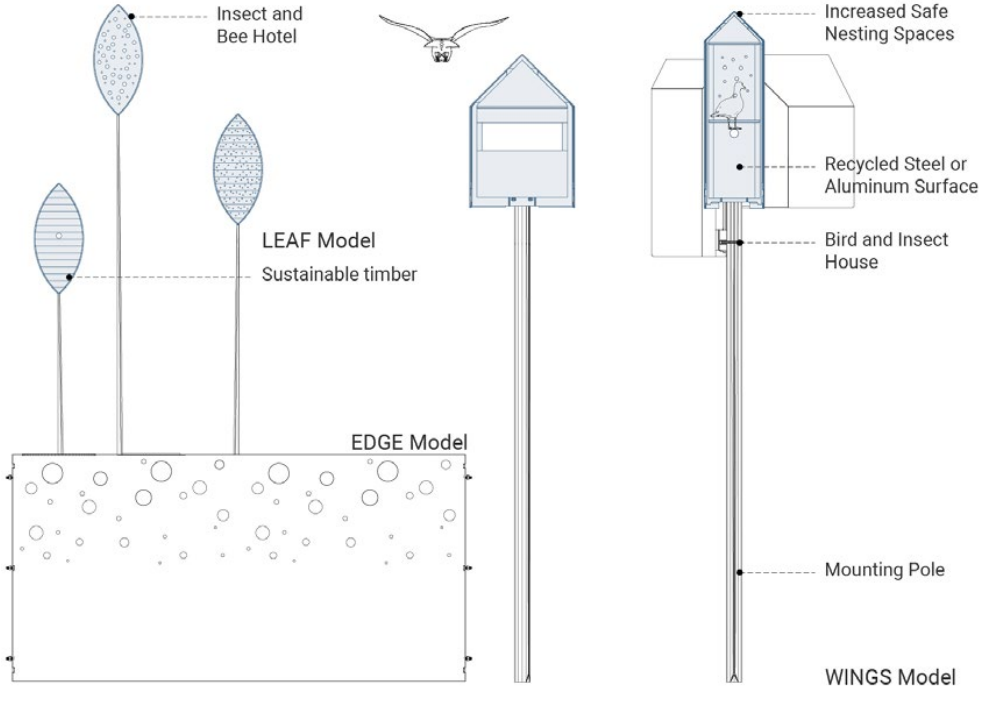
All landscape designs with urban areas must do more than simply green a space. By planting native species, these spaces become opportunities to create habitats for bees, birds, and other insects, which is essential for supporting pollination and increasing local biodiversity. All must do their part.

In 2019, Alexander Qual and René Hougaard each reached out to the Norwegian furniture manufacturer, Vestre, with a shared vision: create a line of outdoor furniture that enhances biodiversity in urban areas. City parks and green spaces are crucial habitats and designers and manufacturers alike are now exploring how smart furniture design and vegetation can boost urban biodiversity. Their passion and collaboration led to the development of the new and playful furniture line called Vestre Habitats.

The EDGE planter design allows for the creation of thriving micro-habitats by integrating natural materials such as stone and wood to be filled with healthy soil, native plants, and even water elements, thereby providing spaces where critters can hide and feed.

LEAF is an insect hotel designed to give them a home in the city and was inspired by the shape of a stylized leaf. Its minimalist, sculptural design can be used individually as a standalone element or grouped together.

The WINGS bird nesting box design addresses the lack of safe nesting sites for birds in urban areas which is becoming a bigger issue than access to food.



Small-scale Interventions Give Insects and Birds Home in the City.
Drawing Modifed from Vestre.

Adaptation Palette

He Dong Qu, Tianjin, China

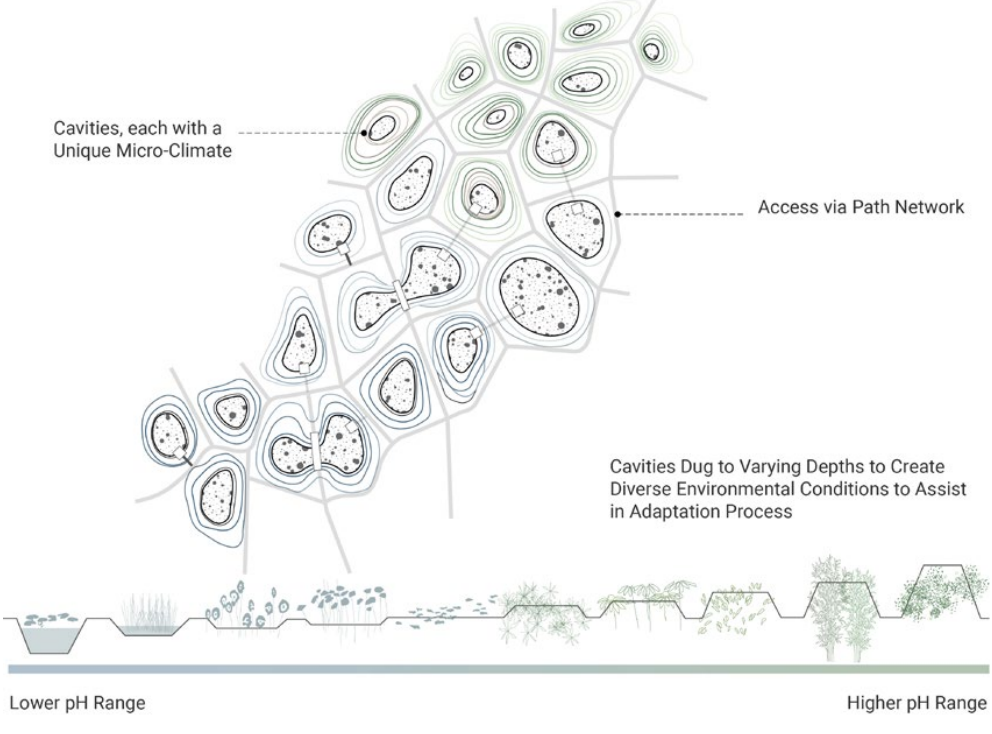
Solution	Biodiversity
Project	Tianjin Qiaoyuan Park
Owner	Env. Construct. and Invest. Co, Ltd
Designer	Turenscape
Cost	$14.1M USD for 54 acres

Natural plant adaptation and succession are key to building healthy and resilient ecosystems. These planting strategies allow native plant species to naturally adjust to changing environmental conditions and recover from unpredictable disturbances.

The Tianjin Qiaoyuan Park project is a 54-acre (22-ha) former garbage dump. It uses a regenerative design approach that embraces the natural processes of plant adaptation and succession and features 21 distinct "bubble" areas. These pockets contain both wet and dry natural conditions that manage stormwater, naturally improve saline-alkali soil, and support seasonal patches of native vegetation.

The design focused on re-establishing natural functions and letting adaptation and succession take their course. The park now boasts a mix of water ponds, wetlands, seasonal pools, and dry cavities that interact with rainfall and groundwater. Seasonal rains improve soil quality in the fast-draining dry areas while deeper ponds capture stormwater runoff and nutrients. The park was initially planted with a variety of ground cover and wetland species, but native plants are allowed to infiltrate and succeed.

Visitors can walk along the red asphalt paths, enjoy the various interpretive signs, and reflect upon the wooden platforms that extend into the ponds and cavities. This immersive design provides hands-on experience by bringing the visitor directly into the evolving landscape.



Plant Palettes Designed for Changing Climates Ensure Future Resilience / Drawing Modified from Turenscape

Riparian Restoration

Yuma, Arizona, USA

Solution	Biodiversity
Project	Yuma East Wetlands
Owner	Env. Construct. and Invest. Co, Ltd
Designer	Fred Phillips Consulting
Cost	$9M USD for 350 acres

Restoring derelict native riparian landscapes is critical for both environmental health and cultural identity. Neglecting or altering these landscapes results in poor water quality or management, decreased biodiversity, and communities disconnected from their heritage.

In 2000, a grassroots effort involving the Quechan Tribe, the City of Yuma, and private landowners began restoring over 1,400 acres (567 ha) of degraded riparian habitat filled with invasive salt cedar, high salinity soils, and trash along the Colorado River. Significant modifications to the river's natural flow and nearby societal issues separated local communities from both the river and their history.

The Yuma East Wetlands project transformed a once neglected and forgotten area into a successful example of native riparian restoration. Since the project was completed, 300,000 native salt marsh plants have thrived and now supply plant material and seeds for other nearby restoration efforts. Bioengineering methods along the river include vegetated slopes, which both prevent erosion and enhance ecosystem services. The banks were also lined with buried willow cuttings and native plantings. Thirteen years later, the newly planted trees had grown into a dense willow thicket.

Today, a coalition of community members and volunteers continues to restore the wetland and riparian ecosystems, reconnecting Yuma residents with the river through new access points, overlooks, and trails.

On-Site Restoration / Fred Phillips Consulting

Urban Forest

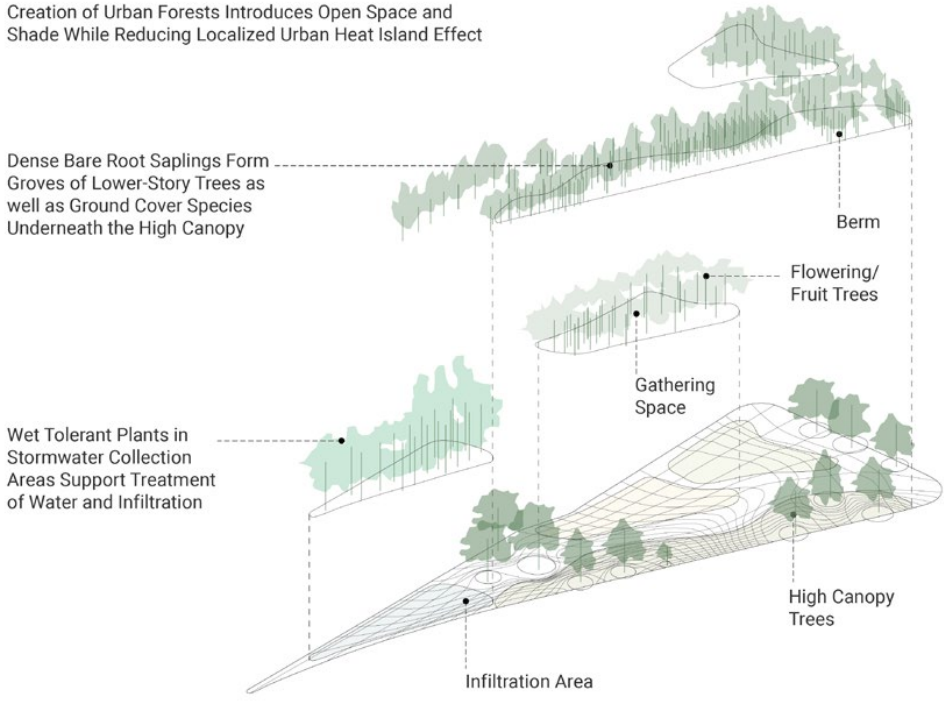
Cambridge,
Massachusetts, USA

Solution	Biodiversity
Project	Triangle Park Urban Forest
Owner	City of Cambridge
Designer	STOSS Landscape Urbanism +
Cost	$3.2 mil USD for 0.82 acre

Prime real estate is typically devoted to income-generating uses, which forces designers to install big landscapes in small leftover spaces. Adapting these areas into urban forests helps to combat climate change by absorbing carbon dioxide, managing stormwater, and reducing the urban heat island effect.

The Triangle Park Urban Forest is a model of urban forestry designed to introduce open space and shade and reduce localized urban heat. Across this 1-acre (0.4-ha) site, which was once used for petroleum storage and as a traffic island, nearly 400 new canopy trees of 20 species have been densely planted. The trees create a layered effect, with tall canopies and lower groves and carefully chosen groundcover. Custom concrete benches, designed in various styles, offer both gathering spots and peaceful areas for people to relax and enjoy the lush surroundings.

One of three small "leftover" open spaces within a rapidly growing urban area, this park was designed as part of a new initiative to create open spaces for both active and passive activities. It caters to small events but also provides tranquil spots where the individuals from the community can sit, enjoy a meal, and unwind. The team carefully developed strategies for site remediation and sustainable stormwater management so that the site would capture and filter stormwater to support lowland vegetation. This approach ensured that the park's stormwater system surpassed regulatory standards.



Triangle Park Supports Targeted Urban Forestry / Drawing Modified from STOSS Landscape Urbanism


Forsyth

Floating Wetland

Chicago, Illinois, USA

Solution	Biodiversity
Project	Chicago Riverwalk
Owner	Chicago Dept. of Transportation
Designer	Sasaki +
Cost	Ph 2/3: $95M USD for 3.5 acres

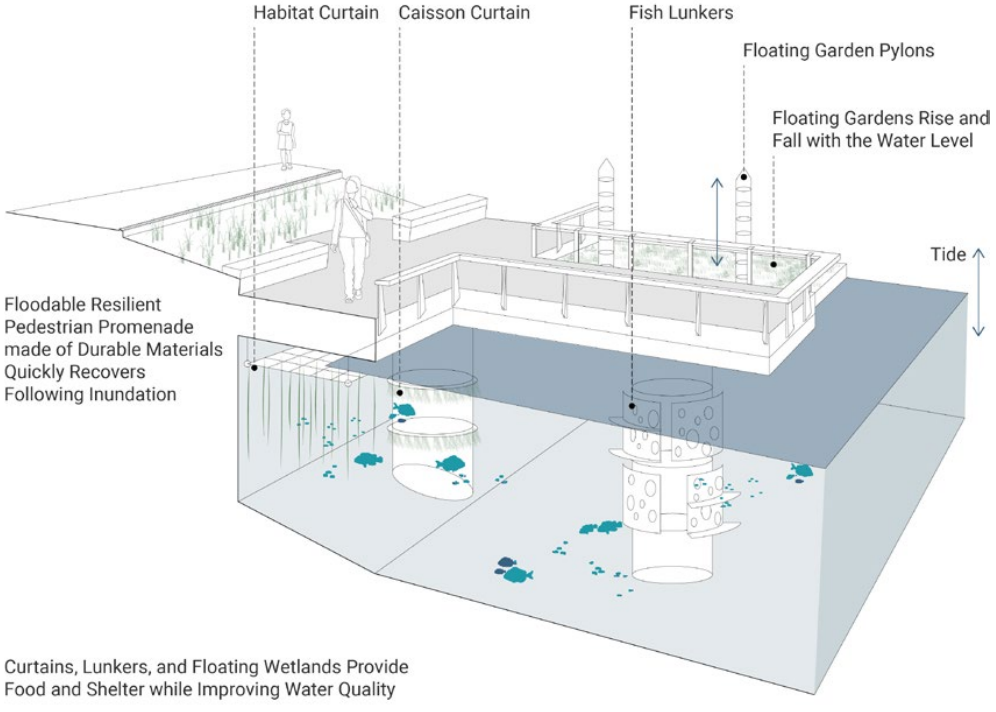
While urban waterways are squeezed by the competing interests of development, access, and industry, they face pressures to prevent increasing flooding and biodiversity loss. Floating wetlands can be a creative adaptation solution to these compounded challenges.

Floating wetlands are nature-based constructed systems that rise and fall with water levels and provide habitat for wildlife while improving water quality. They also provide shelter for fish from river currents and boat activity.

In Chicago, floating wetlands line the six-block pedestrian block along the Chicago River. Beneath the suspended walkway and floating wetlands, limnetic habitat structures made of nylon rope provide a food source for fish through algae that grows on the rope.

Additional fish habitat is provided by carbon steel fish lunkers, which are perforated steel cylinders that provide protection from predatory mammals. The refuge areas beneath the wetlands attract species like bass and yellow perch. Biodiversity is also supported by adding almost 20,000 square feet (1,858 m^2) of new plantings including 66 species of plants, shade trees, and emergent and submergent aquatic species.

The Chicago Riverwalk approach creates a highly flood-resilient urban landscape that can quickly recover following inundation. Durable materials will tolerate periodic flooding events, reducing maintenance and extending longevity. Etched markings on stainless steel pylons visually indicate the changing water levels.



Floating Wetlands are Resilient to Floods and Support Habitat / Drawing Modified from Sasaki


6.0'
5.0'
4.0'
3.0'
RIVERWALK

Buffer Island

Grønlikaia/Kongshavn,
Oslo, Norway

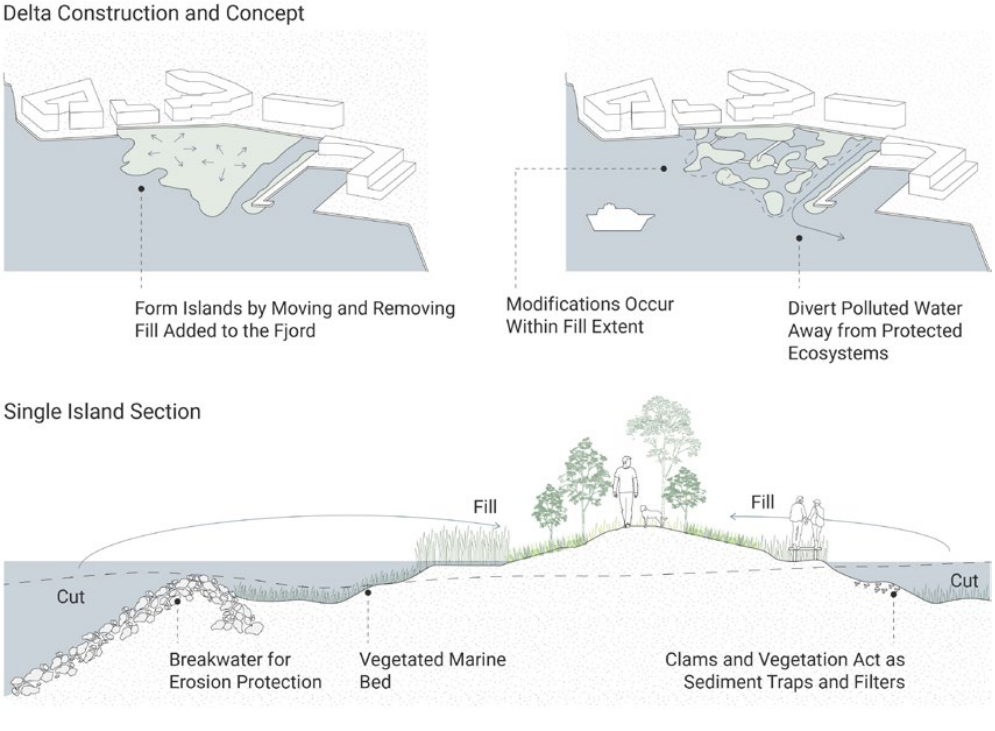
Solution	Biodiversity
Project	Buffersonen
Owner	Port of Oslo, HAV Eiendom
Designer	Asplan Viak +
Cost	$N/A for 5 acres

To support industry and development, many countries continue to fill the open waters of the world. In doing so, much of the intertidal and wetland edge habitats globally have disappeared. Instead of replicating this pattern, fill can be strategically removed to restore historic shoreline edges while simultaneously creating more resilient and biodiverse edge conditions with buffer islands.

In Oslo, degradation of natural beach zones and reduced access to light due to pollution have led to the deterioration of marine life in the inner Oslofjord. Buffersonen establishes an urban example of cutting away human-imported fill for use in creating buffer island beach zones and shallow soft-bottom areas with vegetated marine beds. The ambition is to restore habitats of nearby protected island areas in the fjord and in the Ekebergskråningen nature reserve.

The new island landscape will optimize natural beach zones and regulate the balance between edge access for species and protection from threats, including potential increased storms.

Nature above and below water must be incorporated into the design per the project goals. By reshaping the fjord, this urban ecological approach is set to create a nature-rich, circular, energy-plus area that benefits the natural ecosystem while supporting a socially sustainable, diverse, urban port development.



Cutting Away the Filled Fjord Creates Habitat-Rich Buffer Islands / Drawing Modified from Asplan Viak

High-Rise Habitat

Beijing, China

Solution	Biodiversity
Project	Beijing Olympic Forest Park
Owner	Intl. Olympic Forest Park Dev. Co.
Designer	Tsinghua Planning & Design Inst.
Cost	$420M USD for 1,680 acres

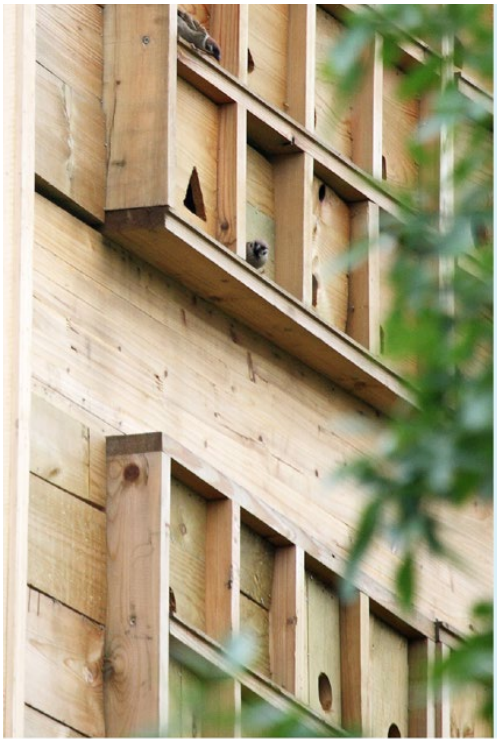
Large-scale urban adaptations are promising opportunities for habitat improvement. Thinking beyond traditional restoration efforts, vertical high-rise habitats may be an approach to consider for reintroducing biodiversity.

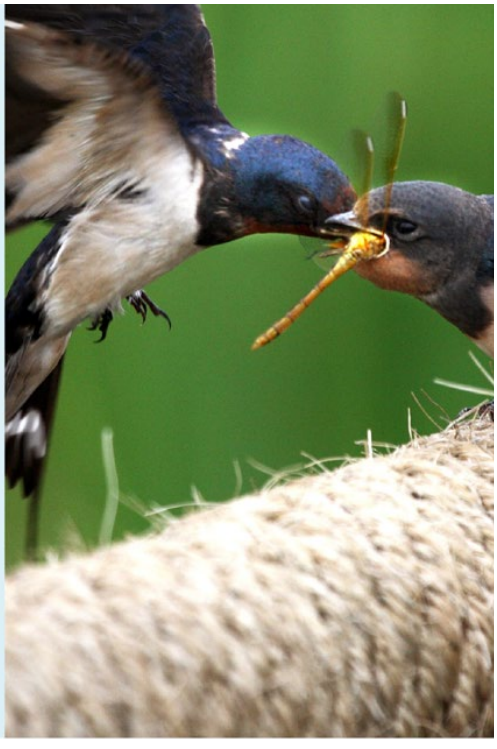
As in the case of the Beijing Olympic Forest Park for the 2008 Summer Games, the redesign of Beijing's largest green space includes a swift tower inside the park designed to protect this endangered local species. It considers the bird's habits, habitat selection, and food sources.

The 24-meter (79-ft) high tower was built to provide a home for more than 1,500 swifts, birds that have lived in Beijing for hundreds of years. In recent decades, the population of swifts has declined as habitats are impacted by development, and many traditional tower structures are demolished and new buildings constructed.

As of 2021, the swift tower was estimated to hold over 2,200 nests. Following its success, more are being planned in the park and throughout Beijing.

Beyond the swift tower, the park provides a variety of spaces that support biodiversity, including a 50-acre (20-ha) lake, woodlands, wetlands, grasslands, and educational facilities. The design incorporates traditional Chinese landscape principles that emphasize the harmony between humans and nature. Modern ecological concepts and techniques were employed in the park to address goals of zero waste and zero stormwater discharge.





The Forest Park is home to a 24-meter high tower for swift birds. Courtesy Beijing Tsinghua Urban Planning & Design Institute.

Floating Forest

Nanchang,
Jiangxi Province,
China

Solution	Biodiversity
Project	Nanchang Fish Tail Park
Owner	Nanchang Gaoxin Real Estate
Designer	Turenscape +
Cost	$24M USD for 137.4 acres

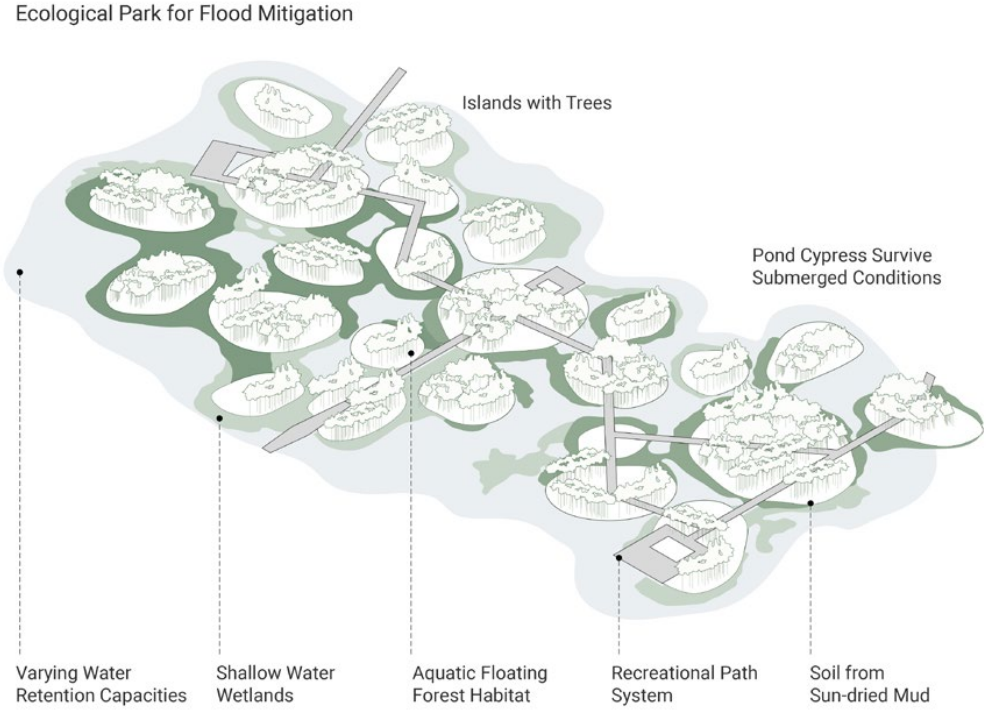
A floating forest is a dense aquatic forest consisting of species chosen for their ability to survive submerged conditions. The forest is occasionally submerged when full water retention capacity is needed, serving important flood retention and ecological functions.

Historically, the Nanchang Aixi Lake green corridor supported many migratory birds. However, over the past decades it was fragmented and disturbed, as it came to support development for 6.5 million people, fish farms, and a coal ash dump.

In an effort to restore the site's historic hydrology and ecology, the Fish Tail Park design transformed the site into a "floating forest" habitat, serving a myriad ecological functions. The forest was created by adding nearly 20,000 pond cypress, planted at nine-foot (2.7-m) intervals.

The habitat is divided between shallow water wetlands, open water, and 68 islands ranging in size. Of the islands, 50 percent are inaccessible to visitors. This ensures less disturbance from human activities and better wildlife habitat. The soil comes in part from sun-dried mud originally found in the fish-ponds.

The primary area of the site is preserved for ecology and provides a key link to nature through its immersive path system. It provides recreational opportunities for the area's growing population.



Elevated Access

Gurugram,
India

Solution	Biodiversity
Project	Sikanderpur Forest Revitalization
Owner	Gurugram Metro Dev. Authority +
Designer	JRA Design
Cost	$356,619 USD for 80 acres

Increased urbanization helps to preserve the world's remaining biodiversity. However, this lack of exposure to the natural world can also increase the barriers between humans and the natural environment, leading to emotional disconnect and disregard.

One way to increase both biodiversity and human connection to nature is by elevating access. The Revitalization of the Sikanderpur Forest inspires human reconnection to the natural rhythms of the forest by restoring the biodiversity of the degraded forest.

Gurugram is a classic example of an unplanned rapid urbanization suffering from flooding, groundwater depletion, air pollution, shrinking open spaces, and rising temperatures. The Aravallis is one of the oldest mountain ranges leading into the city as a ridge forest.

Reimagining the abandoned stone quarry, which had turned to a waste yard, started with analysis of the character and experience potential of the site and identifying entry points, trails, rest points, and waterflow patterns. The site now successfully connects people to nature while mitigating stormwater runoff, averting flooding on city roads, and easing the burden on urban infrastructure. Redirecting the city stormwater to the forest ensures the replenishment of depleting groundwater, simultaneously restoring the ecosystem. The rejuvenated forest has become a thriving habitat for resident blue bucks and a myriad of biodiversity.

Floating Walkway Protects Restored Habitat while Reconnecting Humans to Nature. Courtesy JRA Design.

Eco - Island

Suining City, Sichuan
Province, China

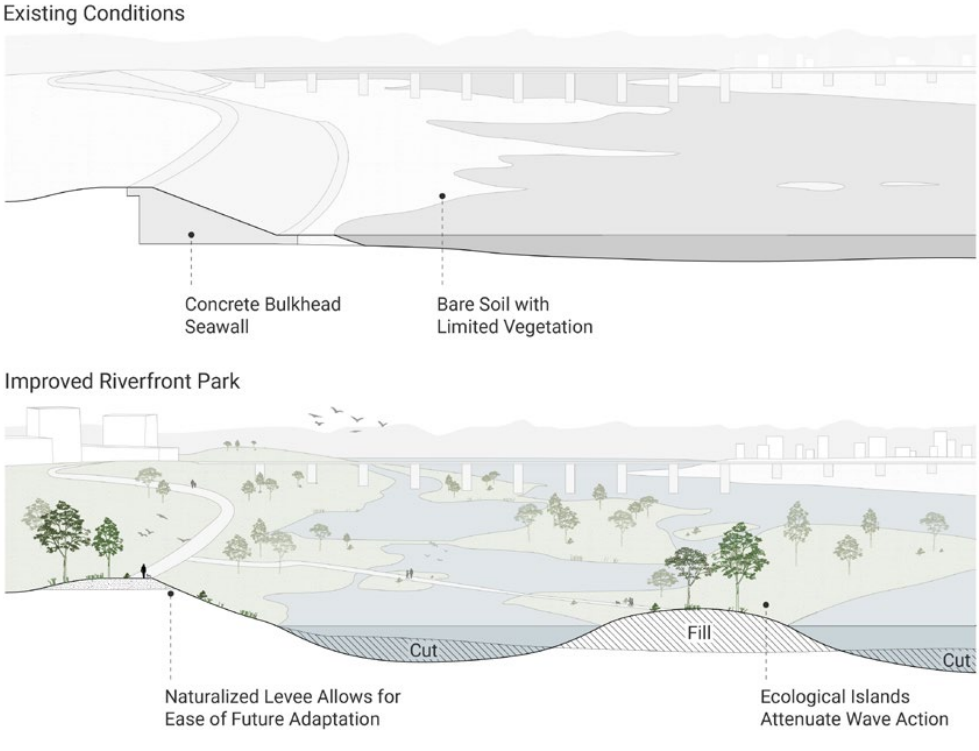
Solution	Biodiversity
Project	Suining South Riverfront Park
Owner	Suining Econ/Tech Dev. District
Designer	ECOLAND +
Cost	$45M USD for 117 acres

Waterways are increasingly more susceptible to severe storm damage brought on by climate change. By incorporating climate adaptation strategies, these areas can be protected in ways that balance safety with the benefits of a healthier environment.

Suining South Riverfront Park stretches along a 2-mile (3.2-km) segment of river adjacent to a rapidly expanding urban area. Prior to 2017, the riverbank was lined with a concrete bulkhead and hydraulic structures that only offered traditional and outdated flood control.

The renovation of this 45-acre (18-ha) section transformed the existing concrete bulkhead into a new naturalized levee design that allows for future adaptation requirements and includes over a hundred different plant species, pedestrian boardwalks, viewing pavilions, and walking paths. The ecological islands were constructed with fill material and are located within the core of the park to act as barriers during more severe storm events.

As a pilot project in Suining's green riverfront infrastructure initiative, this park includes a series of interconnected ponds with aquatic plants that filter runoff, absorb nutrients, and break down organic matter. The islands in the park were created from materials excavated from these ponds. The transformation of the former concrete bulkhead into a vibrant, ecologically functional park not only provides aquatic habitat but also enhances ecological resilience.



Sacred Grove

Brazil, Nigeria and many other locations

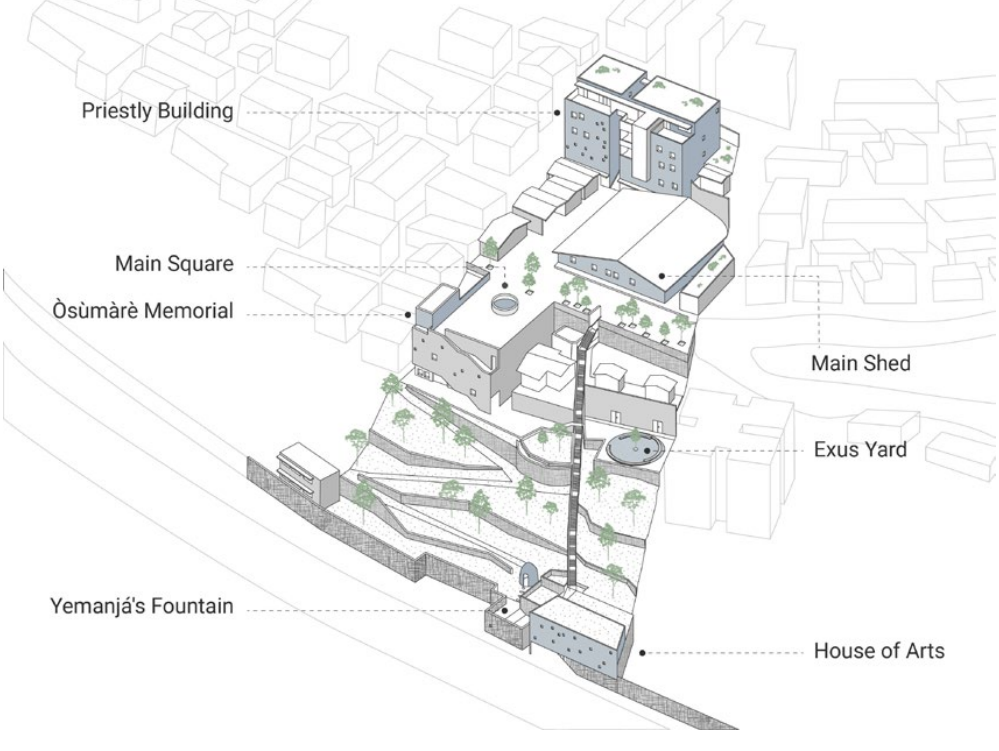
Solution	Biodiversity
Project	Casa de Oxumare, Osun-Osogbo
Owner	N/A
Designer	Brasil Arquitetura/Marcelo Ferraz +
Cost	N/A

Sacred groves are areas of natural forest that contain rare collections of plants and animals preserved by the local community due to their religious beliefs. As a strategy, they hold great potential for the preservation of biological diversity, ecological functions, and maintaining cultural ritual and belief systems.

Sacred groves have historically been a shared property resource, connected to culturally-based conservation strategies. They are typically found close to human dwellings and range in size from a few small clusters of trees up to several acres (~2 ha).

These locations are where participants engage in practices combining botanicals, ritual, music, and dance that call upon natural energies, cultivating spiritual awareness. Afro-diasporic knowledge, memories, and environmental understandings are empowered and made visible through this process. The groves in West Africa, once present in almost every town, have mostly disappeared. In Brazilian towns they are still common despite being difficult to access—a way of protecting them from outsiders. These landscapes, as noteworthy urban green places, influence urban ecology and forge vital connections between communities while supporting biodiversity.

As cities densify, the preservation of these places are increasingly threatened. However, nature and landscape within the city is at the root of the spiritual traditions. Organizations in Brazil are working towards protecting their cultural and ecological significance.



Casa de Oxumare Landscape Scheme / Salvador da Bahia, Brazil / Drawing Modified from Brasil Arquitetura / Marcelo Ferraz / Oshun statue, Osun-Osogbo Sacred Grove, Nigeria (right)

Osun-Osogbo Sacred Grove, Nigeria / Yeniajayiii | 153

Blue Corridor

Shenzhen, Guangdong, China

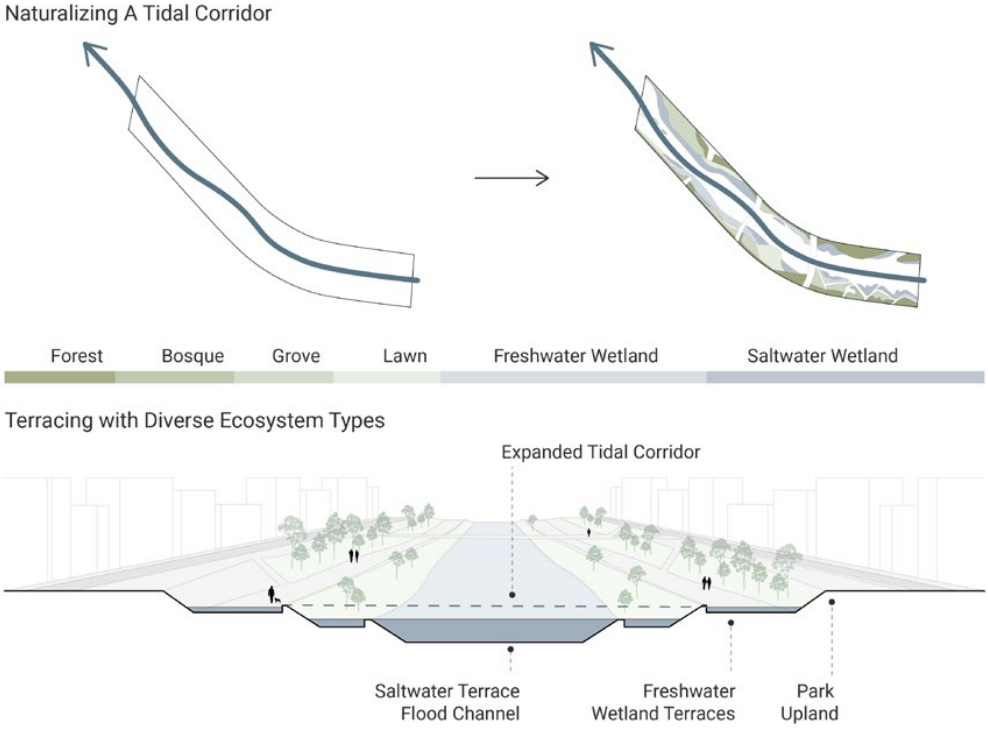
Solution	Biodiversity
Project	Qianhai's Guiwan Park
Owner	Shenzhen Qianhai Construction
Designer	Field Operations +
Cost	N/A

As coastal cities contend with the effects of floods and habitat loss from climate change, reconnecting blue corridors can ecologically rehabilitate damaged sites, leading the way for more resilient ecosystems that harness the impact of large-scale blue-green infrastructure.

In reclaiming a blue corridor, or waterway, both the horizontal and vertical elements that have been constrained or simplified must be diversified to re-establish plant communities. Guiwan Park incorporates three terraces—woodland, freshwater wetland, and saltwater wetland. It demonstrates the vertical stepping that supports multi-strata planting while accommodating a steep elevation change between the park's main road.

Guiwan Park is the first blue corridor to be built for Qianhai Water City. The land forms incorporate native subtropical plantings, including the mangroves that have expanded from 3 to 17 species. Reconnecting the historic watershed, the design restores a series of habitats including 51,000 square meters (12.6 ac) of mangroves, 18,000 square meters (4.5 ac) of freshwater wetland and 255,000 square meters (63 ac) of parkland, naturalizing the tidal corridor.

The park's diverse landscape creates new and unique habitat conditions that have encouraged the return of many endemic species, including herons, egrets, curlew, mudskippers, and crabs. Within the first year, the new wetlands attracted 21 species of macrobenthos, contributing to a healthy marine ecosystem.



The Terraced Blue Corridor Supports Multi-Strata Planting / Drawing Modified from Field Operations

Tiny Forest

Global Project, based in India. Example from Cambridge, MA, USA

Solution	Biodiversity
Project	Dahney Park Forest
Owner	--
Designer	Afforestt, SUGi +
Cost	$N/A for 4,310 ft^2

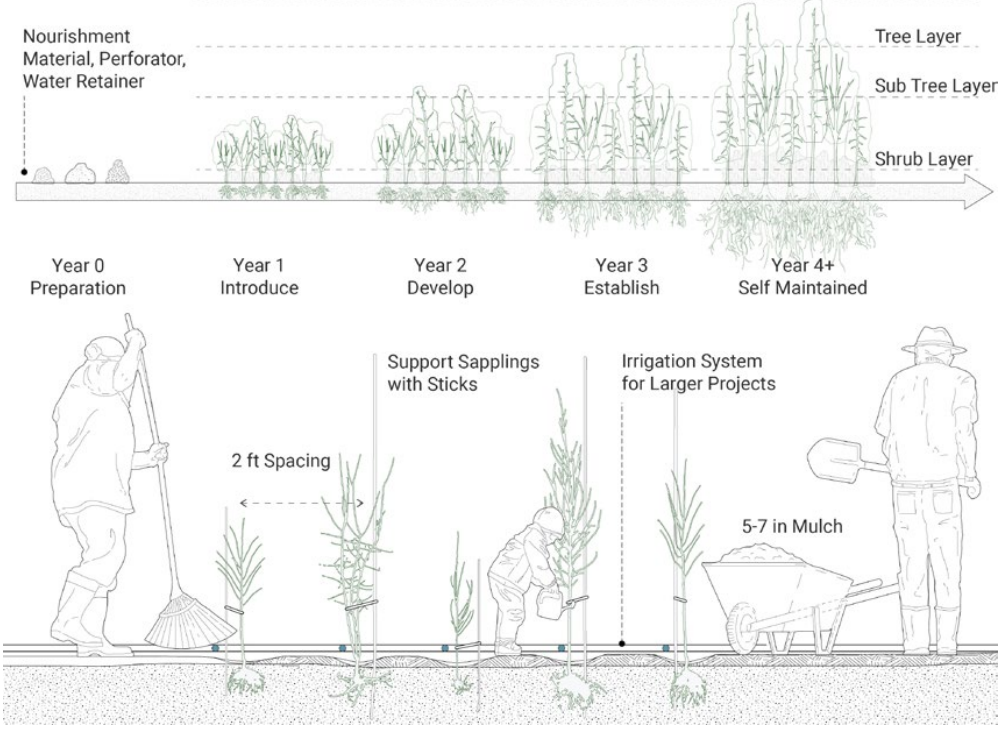
In urbanized places where space is limited, tiny forests are implemented using the Miyawaki Method, which provides significant habitat and carbon drawdown with minimal resources. These adaptations can also support urban cooling, addressing both the climate and biodiversity crises simultaneously.

Demands for agriculture, housing, and other land-based infrastructure increase every year, contributing to rapid deforestation globally. Climate change also threatens forest loss. The fires in 2021 alone caused global forest losses of 93,000 square kilometers (36,000 mi^2).

Reduction in tree cover impacts global temperatures and ecosystem dynamics. However, several organizations and communities work to combat this loss through tree plantings. One organization, called Afforest, based in India, uses the Miyawaki method to plant "tiny forests" throughout the world.

The Miyawaki method uses a deep environment study to create forests that mimic original habitats by assessing the soil composition, planting native species, and incorporating a dense planting pattern.

Two Afforest projects in the Netherlands found that both tiny forests have significantly increased biodiversity. Others, including the Danehy Park Forest, in Cambridge, Massachusetts, note that despite drought and heat waves, the trees had a high survival rate and the forest showed remarkable growth, doubling in height on average.



Danehy Park Pocket Forest, Cambridge, MA / SUGi / Dino Kužnik | 157

Food Security / Human Settlement

Food Roof

Bangkok,
Thailand

Solution	Flood / Inland
Project	Urban Rooftop Farm (TURF)
Owner	Thammasat University
Designer	LANDPROCESS +
Cost	$30M USD for 15 acres

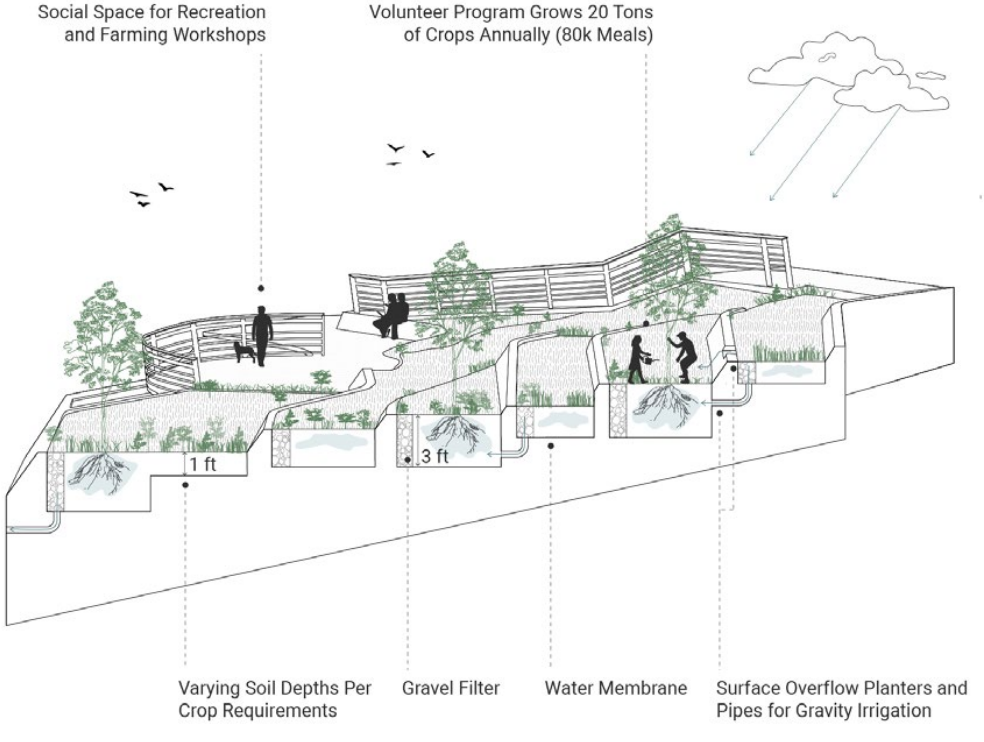
Scarcity of safe food and clean water poses serious risks to human civilization. To address these threats, food roofs can be built by combining the ideas of traditional rice terrace agriculture with contemporary landscape architecture—converting underutilized spaces into productive organic rooftop farms.

Bangkok and cities across Southeast Asia were once agricultural-based societies, plentiful with healthy food. Unfortunately, due to unchecked urbanization, once fertile rice-producing lands have been converted into largely paved urban developments, choking the natural ecosystem and limiting food production.

Inspired by traditional agricultural practices, Asia's largest rooftop farm at Thammasat University integrates the landscape of rice terraces with green roof technology. The descending rooftop slows runoff down by 20 times compared to a conventional roof.

As rainwater meanders through the slopes, each level harvests runoff from the prior cell, forming clusters of micro-watersheds along the terrace, helping to capture and clean the rainwater while growing food for the campus.

Four retention ponds are at the lowest elevation point. They store up to three million gallons (11,400 m^3) of water collectively. By managing excessive runoff during intense storms, these ponds reduce stormwater, helping mitigate unexpected floods and allowing for water use during times of drought.



Urban Rooftop Farms Support Food Production and Education / Drawing modified from LANDPROCESS

Regenerative Rice

Jaoli,
India

Solution	Food Security
Project	Saguna Regenerative Technique
Owner	Saguna Rural Foundation
Designer	Krishi R.S.C.H. Bhadsalve
Cost	50% less than traditional farming

Water resource availability is changing, so new methods of food production are needed. Regenerative rice techniques employ a zero till, scientific conservation agriculture approach that is designed to support areas that rely on rice.

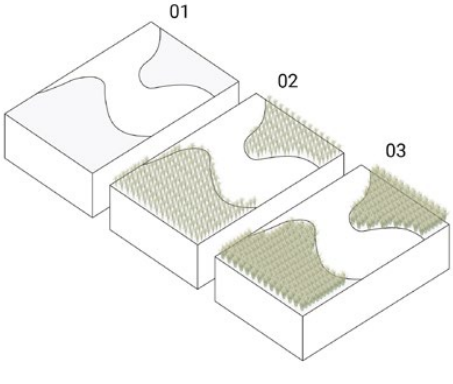
No-till conservation agriculture methods of farming avoid the soil breakdown of tilling. They reduce soil erosion, promote natural production of earthworms, support organic carbon in the soil, and increase crop yields. An increase in food production supports the physical well-being of communities. The reduction in anxiety about food scarcity increases mental health as well.

The Saguna Regenerative Technique (SRT) deployed in India reduces the water requirements for rice crop cultivation by approximately 40 percent, cuts cost of production by 40 percent and minimizes strenuous labor by around 50 percent.

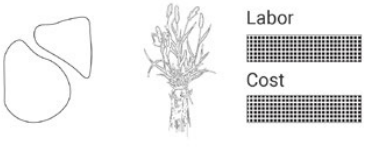
Without the use of gasoline powered equipment, it minimizes the emissions of greenhouse gasses, draws down carbon dioxide into the plants, and sinks carbon into the soil below for long-term carbon storage that ultimately improves soil fertility.

Empowerment is evident in the areas where the annual income of tribal families has risen by four times. Increasing confidence and food security of farmers has also encouraged youth to return to farming.

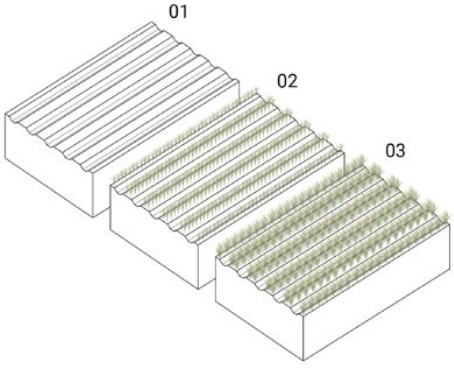
Traditional Rice Farming



Traditional Flows and Patterns of Rice Farming are Inefficient as it Requires Large Carbon Intensive Flooded Areas



Saguna Rice Technique



By Planting Rice in Rows Productivity is Increased, with Higher Water Conservation and Reduced Labor and Cost

Happy SRT Farmer / Parshuram Aagivle / Mogaraj, Karjat / Chandrashekhar Bhadsavle | 163

Homegarden

Mount Kilimanjaro,
Tanzania, Africa

Solution	Food Security
Project	Chagga Homegardens
Owner	--
Designer	Skilled Local Farmers
Cost	N/A

In Africa, the Middle East, and Asia, homegardens are agricultural spaces that offer a supplemental supply of food and nutritional security in both urban and rural areas. These small gardens, which often include hundreds of species of food, herb, and medicinal crops in limited space, are a vital component of family farming and the production of food close to populated areas. These gardens produce crops that are otherwise unavailable or prohibitively expensive at local markets.

The Chagga people grow a multistory agroforestry system on kihamba, or ancestral lands, called the Chagga homegardens. On the slopes of Mount Kilimanjaro, the communities focus on species that are most beneficial for food, fodder, and fruits. They are grown on the rich volcanic soils, supporting a symbiotic ecosystem transition in the forest.

The multi-story agroforestry employed in the Chagga homegardens produces mulch and feed, fixes nitrogen in living fences, shades coffee plants, attracts fewer pests, and provides food for bees.

The gardens have a diversified spatial organization based around zones that produce food crops, coffee and cash crops, medicinal plants, as well as a zone for banana plants and trees used in lumber production. They are also home to animals, including goats and cattle. The homegardens support over 100 different crops, resulting in a rich model of agroforestry land use management model that can be passed through generations.

Vertically Layered Multicrop System Providing Shade to Smaller Crops, Producing Variety and Sustaining Local Economy and Culture

Zone 1: Taro, Beans, and Fodder Grasses, including Cardamon
Zone 2: Coffee and Maize
Zone 3: Fruits like the Banana Tree
Zone 4: Fuel and Fodder from Fig, Silk, Avocado, and Mango Trees
Zone 5: Timber Fuel and Fodder from Teak and Oak Trees

Ulrich Doering / Alamy Stock Photo | 165

Sea Gardening

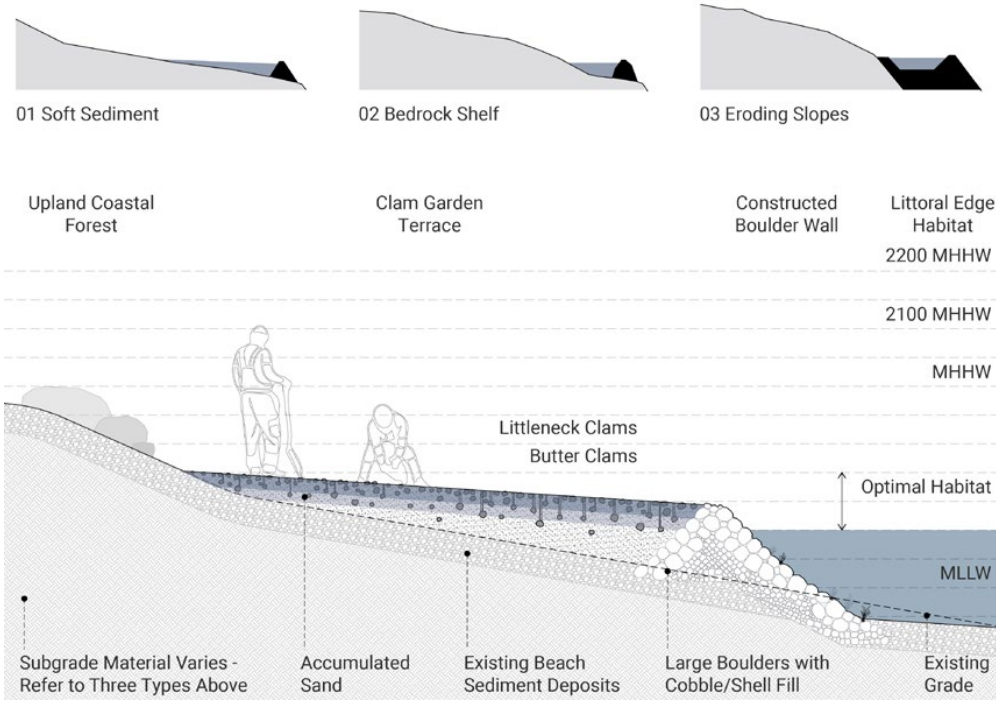
Pacific Northwest,
Canada and USA

Solution	Food Security
Project	Clam Garden Restoration Project
Owner	Parks Canada
Designer	WSÁNEĆ, Hul'q'umi'num Nations
Cost	N/A

Clam gardens are ancient sites along shorelines in WSÁNEĆ territory that Indigenous people tended for thousands of years to enhance the production of clams and related sea creatures. Sea gardening is an important means of protein harvesting for the Indigenous people, but the clam gardens are declining due to sea level rise and related erosion.

From 2014 to 2019, Parks Canada, the WSÁNEĆ Nation, and the Hul'q'umi'num Nations participated in the Clam Garden Restoration project. It included a process of adding stone ledges beyond the existing shoreline, allowing sand to accumulate over time, which supports the shallow water habitat needed for the clams to thrive. The project provided scientists with data on ancient clam cultivating and harvesting practices while restoring traditional knowledge related to clam gardens and their inhabitants.The collective spent five years working to restore clam gardens in the tribal territory. Beyond improving the ecology of two clam gardens, the project also supported sharing Indigenous knowledge, practices, and culture related to clam gardens. The effort was the first of its kind and attracted interest from both the scientific community and neighboring Indigenous nations.

Nearby regional tribes traveled to the site to learn and participate in the project, bringing traditional knowledge back to their own communities for use in their clam gardens. Elders, harvesters, and youth were joined by scholars and were instrumental in the project's success.



Agroforestry

Bugesera, Rwanda, Africa

Solution	Food Security
Project	Rwanda Inst. for Conservation Ag.
Owner	RICA
Designer	MASS Design Group +
Cost	$75M for 3,400 acres

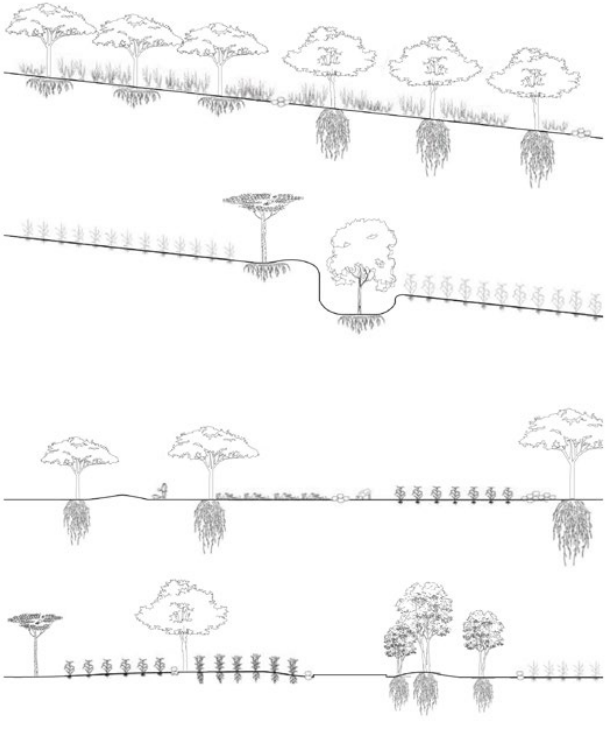
Agroforestry is the process of incorporating agriculture within trees. When designed properly for a specific regional condition and adapting to future changes, it can increase food production while preserving natural resources, supporting environmental, economic, and social benefits.

This practical and low-cost land use management method includes integrating trees and shrubs into cropping systems that increase root diversity, which then feeds the living organisms in the soil. Healthier soil requires less water and additional support, leading to more efficient uses of nutrients, crop pollination, and reduced energy inputs.

In Rwanda, a new campus responds to the growing problem of food insecurity across the region. This insecurity is caused by climate change and increased demand, as the population is expected to double by 2050.

The Rwanda Institute for Conservation Agriculture (RICA) mission is to educate young people in Rwanda about creating sustainable food systems for future generations and transform the farming industry in Rwanda.

Funded by the Howard G. Buffett Foundation, the new campus includes agricultural plots for hands-on learning, solar farm, water treatment plant, and pivot irrigation system. With an emphasis on research, engagement, and bringing other disciplines into the practice of agriculture, the program embodies the ideas of conservation, biodiversity, and community.



Food for Thought

Chicago, Illinois, USA

Solution	Food Security
Project	Gary Comer Youth Center
Owner	--
Designer	Hoerr Schaudt Landscape Arch.+
Cost	$30M USD for 8,160 ft^2

When resources are scarce, it takes equitable approaches to integrate sustainable food practices into the minds of underserved youth. Integrating hand-on learning into after-school facilities can change the lives of future generations most affected by climate change.

Safe, learning environments like the Gary Comer Youth Center are rare in Chicago's low-income South Side. Even more difficult to find are welcoming outdoor spaces like green roofs or gardens where local children can learn to cultivate organic vegetables, herbs, and flowers.

Capital costs support the employment of a full-time garden manager that supervises activities and shares environmental education. The green roof includes eighteen to twenty-four inches of soil to ensure healthy plant material and diverse food crops. Covers are available to protect winter crops from damaging frost and support a nearly continuous growing season that yields around 1,000 pounds (454 kg) of produce annually.

The corridors and classrooms are lined in glass, providing views into the garden and working farm. Ambient heat from the building is directed towards supporting more temperate zoned planters.

Harvests teach entrepreneurial lessons. Food that isn't eaten is sold to local restaurants, supporting self-determination, relationship building, and community pride.

Local Youth Participate in Agricultural Education Programs. Courtesy Hoerr Schaudt Landscape Architects / Scott Shigley

Agrivoltaic

Longmont, Colorado, USA

Solution	Food Security
Project	Jack's Solar Garden
Owner	Byron Kominek
Designer	--
Cost	$N/A for 24 acres

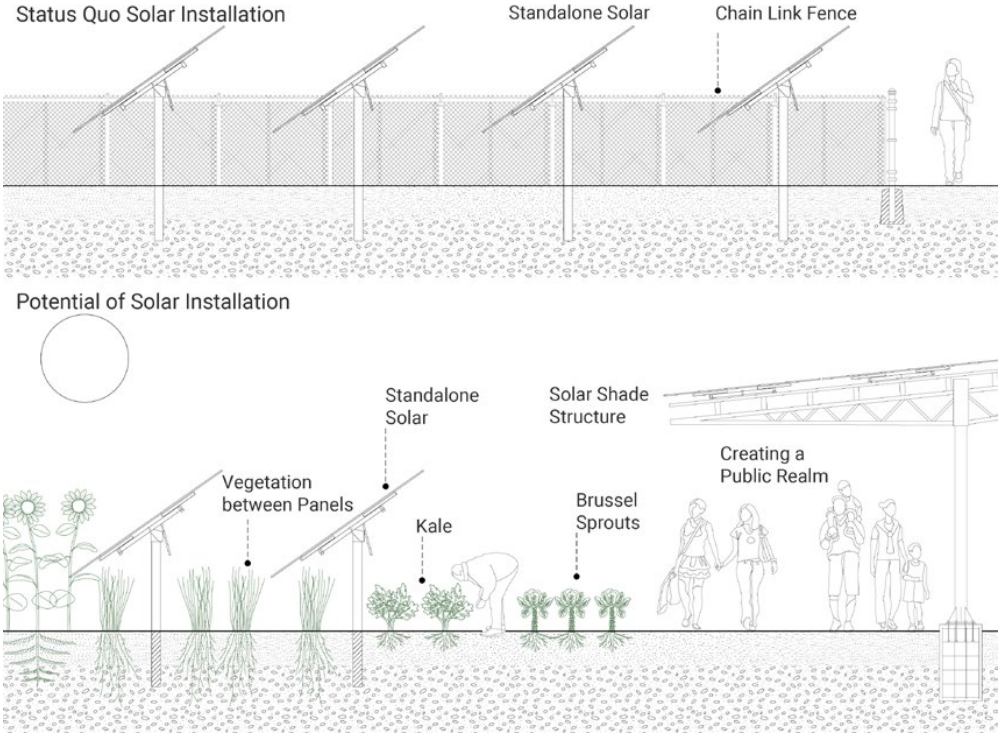
Agrivoltaics provide an adapted way of supporting our food system by co-locating agriculture and solar energy infrastructure. Micro-climates created by the solar panels provide benefits to the vegetation or animals beneath and around them.

In Boulder County, 3,276 solar panels create a 1.2-megawatt community solar garden, enough to power over 300 homes. Jack's Solar Garden is a model for governments, solar developers, and farmers for how to produce renewable energy while continuing agricultural production.

The supporting non-profit, Colorado Agrivoltaic Learning Center, connects students and community members to clean energy, local food, and responsible land use management through agrivoltaics. Hosting on-site tours, the organization teaches how society can improve land use management practices by combining the two practices.

The panels are mounted according to strategically-measured heights and spaced to allow enough sun to reach the crops below. The rows of solar panels are typically mounted 8-feet (2.7-m) off the ground, allowing enough room to drive a tractor under. Planted underneath are tomatoes, turnips, carrots, squash, beets, lettuce, kale, chard, and peppers.

In 2019, a study from the universities of Arizona and Maryland found great benefits in combining solar panels and crops including increased crop yields and energy generation.



Free Roaming

Istanbul, Turkey

Solution	Food/Human Settlement/Security
Project	Istanbul Wetlands Station
Owner	--
Designer	Cooking Sections / CLIMAVORE
Cost	N/A

In a time when wetlands are rapidly disappearing, it's essential to honor the role of herders and the value of free-roaming species and open landscapes. The Station seeks to protect these environments by maintaining traditional pastoralist practices. Collaborating with the residents on the outskirts of Istanbul—a partially re-flooded post-industrial zone—brings forward a unique approach: using traditional Turkish desserts to promote wetland conservation.

For centuries, wetlands, moors, marshes, swamps, mangroves, and mudflats have been drained to "improve" land, despite their critical roles in supporting biodiversity, filtering water, and mitigating floods. In recent decades, however, these ecosystems have gained recognition for their contributions to climate resilience. Bulgarian herders in Ottoman times, along with Turkish people resettled from Greece after the 1923 population exchange, introduced buffalo milk as a staple ingredient. Since 2013, however, urban expansion has increasingly encroached on buffalo lands, fragmenting grazing areas and diminishing shared pastures.

The Station is dedicated to preserving the region's food and ecological heritage, alongside the pastoralist ways of life of the local herders. By mapping disrupted pastures, they aim to enhance the potential of grazing corridors within the broader Food Strategy for the area.

Post-Mining Pastoral Landscapes in the Wetlands Show Remains of Extractive Infrastructure (right)

Future Farming

Salé , Morocco

Solution	Food Security
Project	Med-O-Med School of Gardening
Owner	Spanish IDC
Designer	Islamic Culture Foundation +
Cost	N/A

Immersive knowledge sharing of regenerative planting practices helps ensure food security as we adapt to a changing climate.

The Gardening School Med-O-Med – Bouregreg combines a professional training with a garden center and a cooperative, linking economic rights of youth and women with the rights to a healthy and sustainable environment. Students gain applied experience gardening in Spain, with increased environmental awareness on the Islamic cultural tradition.

The program focuses on local teacher training and enhancing sustainable economic development, with particular emphasis on how public spaces function as a place for cohabitation. It is a project of social and environmental value that creates employment and revenue generating activities. Located close to the rehabilitated landfill of Oujla in Salé, the site has a bioclimatic building, a nursery, a production garden center, and cultural and touristic facilities.

The school promotes a model of sustainable and inclusive development that recognizes and embraces local heritage through the acknowledgement of the values of Islamic culture. It supports the recovery of traditional gardening techniques and the adoption of new environmentally-friendly management models.

Students Gain Sustainanable Gardening Experience in Spain. Courtesy Med-O-Med School of Gardening / Islamic Culture Foundation

Inter-Tidal Table

Loch Portree, Isyle of Skye, Scotland

Solution	Food Security
Project	CLIMAVORE: On Tidal Zones
Owner	--
Designer	Cooking Sections +
Cost	$ N/A for 700 ft^2

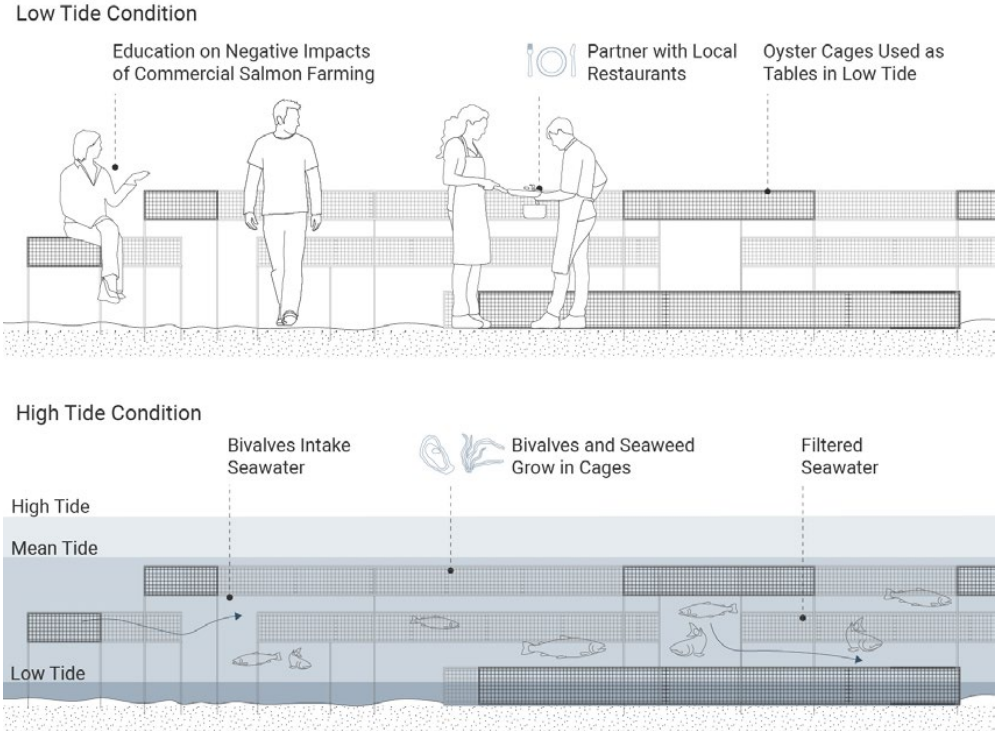
Climate change is impacting our food systems, from supply disruptions to biodiversity and cultural losses. Engaging with diverse groups of stakeholders, including local communities and Indigenous knowledge holders, at a common "table" can underscore the interconnectedness of environmental and societal challenges and ways to sustainably adapt our food system.

The multi-species table is a reclaimed material piece that offers a venue for the sustainable capture of oysters, scallops, and mussels, offering them habitat before they are harvested. It serves as a functional art form to promote shellfish farming as a model for sustainable food production and climate resilience.

Aquaculture in Scotland has become increasingly dominated by the salmon farming industry in recent decades. The Climavore project challenges this rise, which has contributed to the release of excrement, antibiotics, and parasites into local waters.

The installation serves as a multi-species home for shellfish to breathe and filter water, but also a public platform to discuss how to transition from open-net fish farms towards regenerative aquacultures.

The impact extends beyond the table itself through collaborations with local restaurants and communities. Most importantly, it establishes a new relationship between people and their food choices, fostering a deeper connection and raising awareness about the environmental impact of daily diets and industries like salmon farming globally.



Care Hub

Cape Town, Western Cape,
South Africa

Solution	Human Settlement and Security
Project	HOPE: The Nex - Indawo Yethu
Owner	VPUU and HOPE Cape Town
Designer	TKLA +
Cost	$160 USD per ft^2

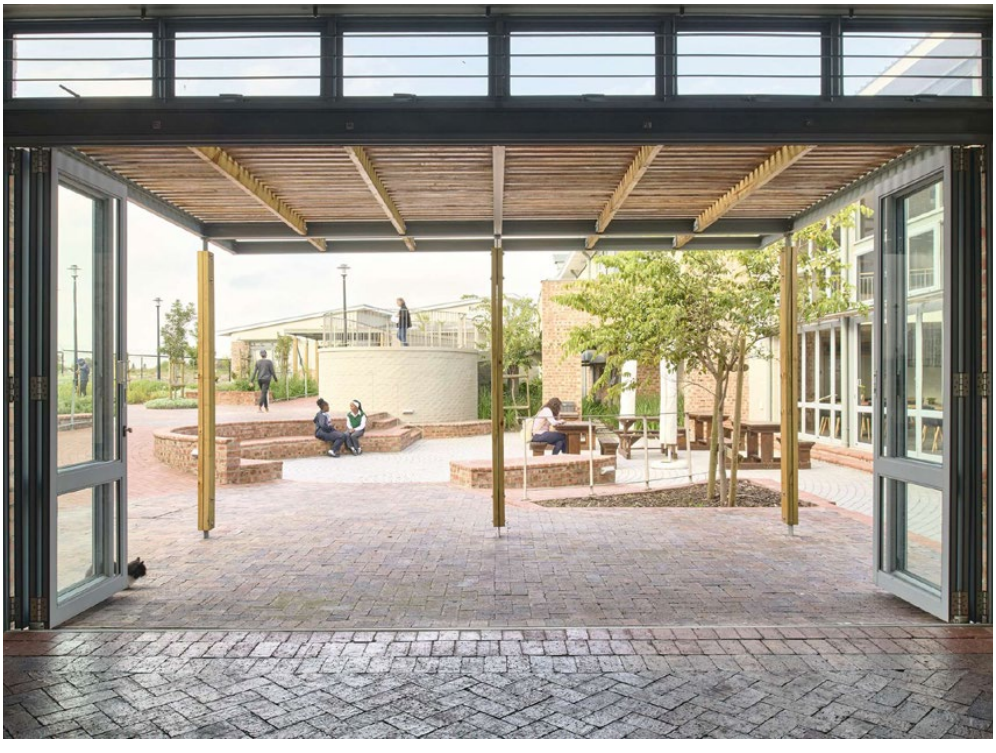
Facilities that support human health and recovery will be of increasing importance as climate change increases with the threat and spread of disease. Adaptations as such are critical to future community resilience.

Despite already challenging conditions, HOPE Cape Town is an exemplary non-profit model that aims to raise the quality of life of communities. Emphasis is placed on children, adolescents and their families in situations of poverty, HIV/AIDS and related illnesses.

HOPE: The Nex is a multi-purpose facility that provides—together with government departments, civil society partners and a variety of organizations—the Delft community with a home away from home where children are nurtured, an educational hub where teaching and learning take place, and a safe space where people can access services and assistance, without traveling far away.

The buildings are thoughtfully configured, related to how people move between the various uses. The landscape was developed with the same priority as the interior spaces as determined through the engagement process. The result is a series of outdoor 'rooms' supporting movement, gathering, and socializing.

The site employs a resilient plant palette well suited to the sandy environment, developed from plant knowledge gained and tested on a nearby project. With this approach, the garden flourished quickly, providing a green respite from otherwise harsh and dry landscape.



HOPE- The Nex – Indawo Yethu Facilites for Human Health and Recovery / TKLA

Indigenous Landscape Assessment

Solution	Human Settlement and Security
Project	Te Tangi a te Manu
Owner	New Zealand Inst. of LArchitects
Designer	G. Lister, R.Lambert, A.Titchener
Cost	--

As the climate and biodiversity crises increase in intensity, more resources are needed to fully integrate cultural knowledge systems into current design and management of adaptation efforts.

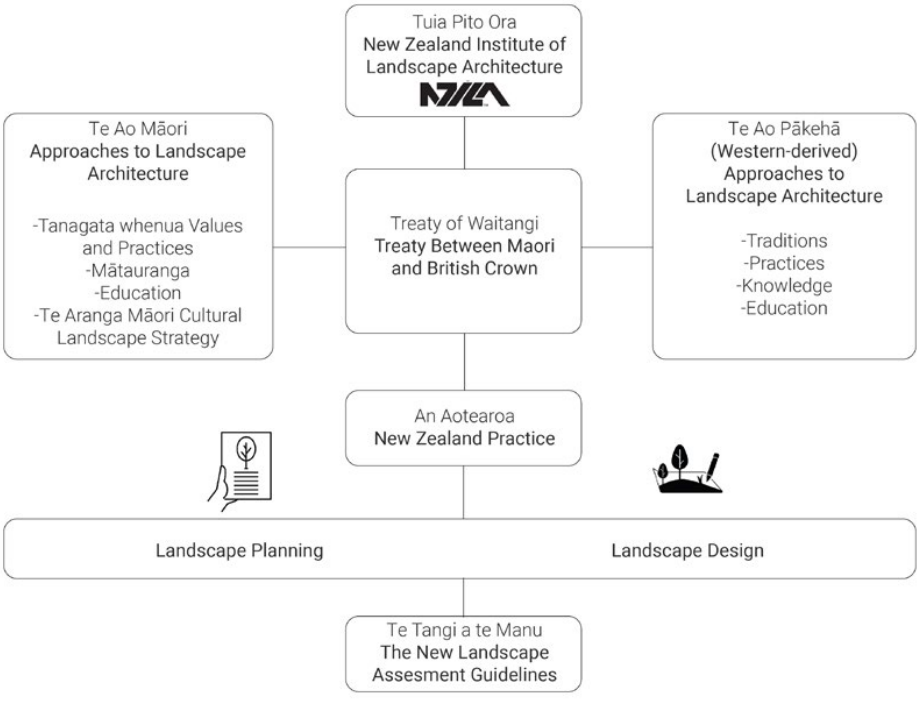
Te Tangi a te Manu - Aotearoa New Zealand Landscape Assessment Guidelines, published in 2022, are a key resource for professionals working in resource management.

The guidelines were published by Tuia Pito Ora New Zealand Institute of Landscape Architects and are the result of more than four years of collaboration led by Te Tau-a-Nuku collective of Māori landscape architects.

The publication brings together collective knowledge of landscape architects working on landscape assessments under New Zealand's legislative framework. The work represents the collaborative input of the profession and gives landscape architects and allied professionals a stronger platform from which to assess and manage landscapes.

While the guidelines are specific to Aotearoa, they are also globally significant in the sense the assessment practice is diverging from places elsewhere in the world.

A key factor of the guidelines' development success was effective engagement with tāngata whenua, the team's commitment to mātauranga Māori and the recognition given to pūkengatanga — the knowledge and expertise held by and relating to an iwi (tribe), hapū (sub-tribe) or whānau (collective of people).



Ātea a Rangi 2017 / Boffa Miskell | 183

Cultural Land Management

Gujarat, India

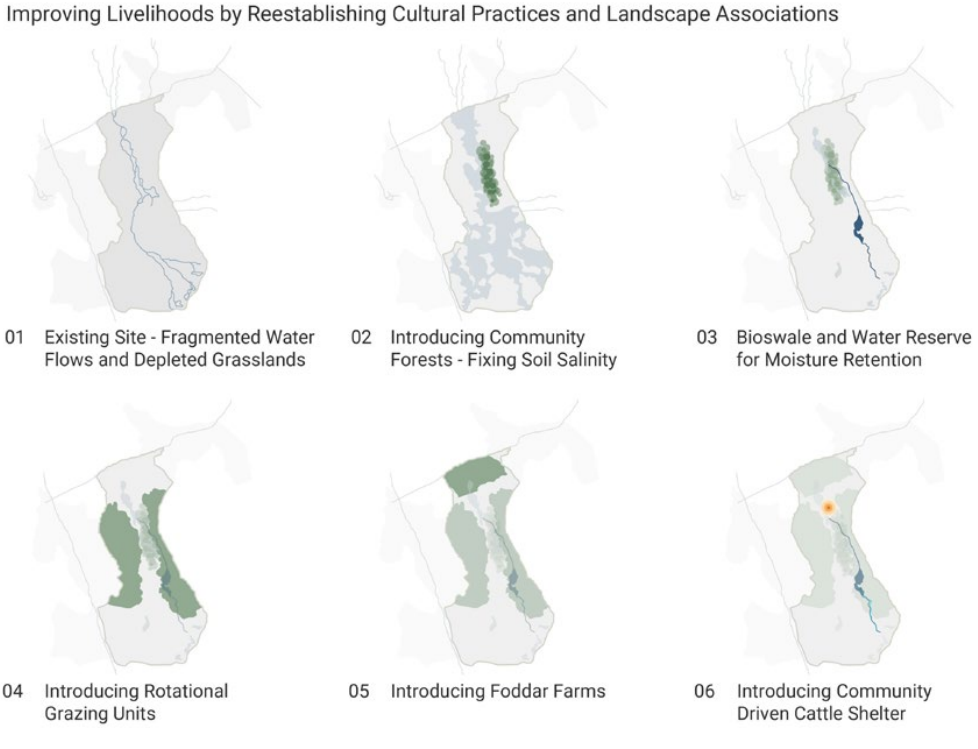
Solution	Human Settlement and Security
Project	Persisting Dynamics
Owner	Prasanna Mattikop
Designer	CEPT University +
Cost	$ N/A for 80 acres

There has always been a nature-culture interface and relationship between humans and nature that allow settlements to flourish and adapt over time. But climate change and reckless anthropocentric activities have hampered the ecology of Gujarat region further displacing the people from their land. Indigenous communities in India are undergoing a rapid shift in their way of living and abandoning their cultural practices for a variety of reasons, resulting in the loss of ancient wisdom deeply rooted in their place of living.

A subtle intervention of soil restoration, waterway reconnection, and agricultural management could act as a catalyst in upgrading their livelihoods, bringing back cultural associations and practices, thus strengthening their ties with the place--securing the future of this cultural landscape.

"Persisting Dynamics / A Tale of Displacement" investigates the correlation between pastoral farmlands and the depleting grasslands of a mud-flat region, along a significant Ramsar wetland.

Persistent dynamics are visible through the mobility of water and the dependent cultures that gathered, settled, survived, and progressed along this wetland system. Several beliefs, practices, and facts play a background role behind the "tales of displacement" the communities faced and eventually with time reached Nalsarovar. These displaced communities have subsequently paved the way for the formation of the cultural landscapes of this region.



Steps for Introducing a Landscape Restoration Program / Drawing Modified from Prasanna Mattikop

Connected Communities

New York City, New York, USA

Solution	Food Security and Settlement
Project	Connected Communities Guide
Owner	NYCHA
Designer	Olin Studio, Thread Collective +
Cost	~$100,000 USD for 1.1 acres

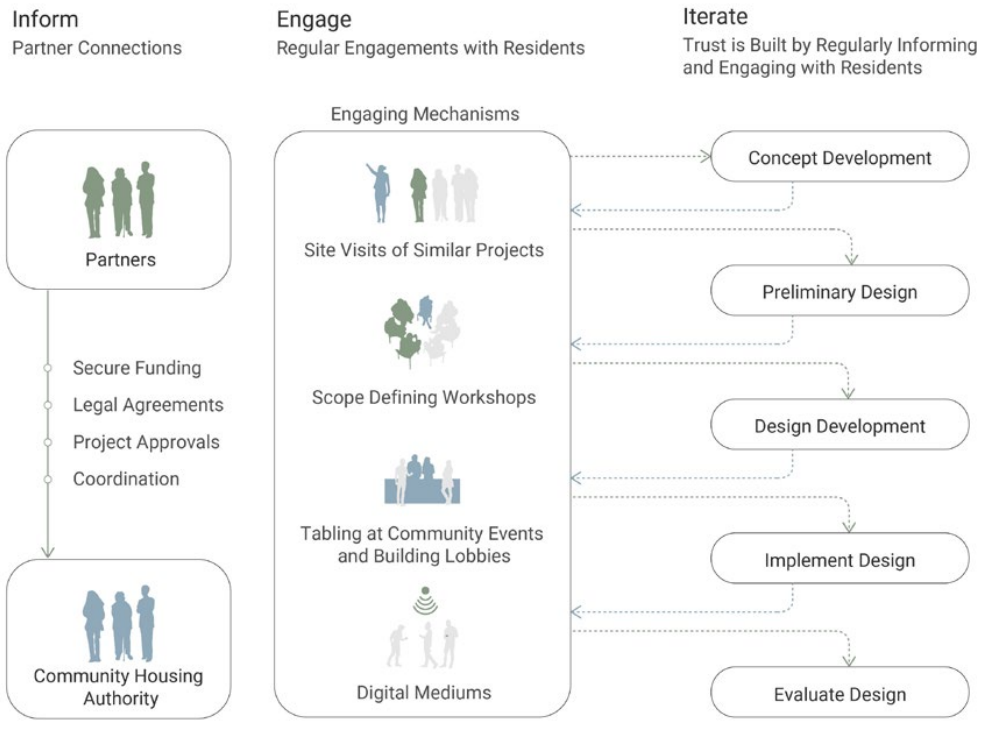
Without meaningfully engaging with communities that have been historically underserved, marginalized, and under-represented can lead to exacerbated challenges with housing and food security especially as the threats of climate change increase. By incorporating processes that lead to more connected communities, longer term resilience can be achieved.

The New York City Housing Authority Connected Communities Guidebook was produced to address urban design issues on their campuses in a holistic manner. Through a process of research, analysis, and workshops with residents, designers, and decision-makers, the publication consolidates priorities for urban design, including urban agriculture, and community engagement.

One outcome of the process is the farm at Red Hook Houses West in Brooklyn. It is NYCHA's first educational farm built in collaboration with Green City Force.

A study developed by the City University of New York in 2019 showed that over 80 percent of the young adults who participated in the resident work-training farm program were successful in either job or college placement afterwards. The farm has recruited over 200 residents to serve on the farm, 31 of them local to the immediate neighborhood.

At the farms, not only can residents grow food, but also bring their compost in exchange for free produce, thereby diverting organic waste from the waste stream.



Engagement that Leads to More Connected Communities / NYCHA Farms is the First Community Farm on Public Housing Property in New York City (right)


IKEA

Eco-Stewardship

Naboisho, Kenya, Africa

Solution	Human Settlement and Security
Project	Eagle View Camp
Owner	Saruni Basecamp
Designer	HM Design +
Cost	$1M USD for 15 acres

Creating public-private partnerships based on the principles of eco-stewardship can preserve culture and nature, serving as a key solution to supporting at-risk human settlements and security in the face of climate change.

The Eagle View Camp at the Mara Naboisho Wildlife Conservancy demonstrates this success north of the Maasai Mara Game Reserve, a world-renowned UNESCO World Heritage Site in Kenya. It is a public-private project that is fully owned by the Indigenous Koiyaki Maasai people. The local Maa-speaking Koiyaki community has a lease agreement with a private lodge operator, Basecamp Explorer, to promote wildlife protection and conservation.

Before the camp renovation, the facilities and site were dilapidated. The eco-conversion restores the natural woodland savanna environment while having minimal impact on the ecology of the site, utilizing only the previously disturbed areas. No trees or shrubs were cut during construction.

The camp sits on a natural escarpment, situating buildings and landscape elements within a natural experience while supporting the local Maasai community. Social and ecological values were a priority in the planning, now providing a significant number of new jobs for the Maasai community. The local Maasai people provide tours featuring local medicinal plants. The project also supports the local community significantly through fees generated, including the opportunity for guests to set out on safari with local guides into the savanna.

The Maasai People Educate Visitors on Local Medicinal Plants / Hitesh Mehta / HM Design / Saruni Basecamp

Seaweed Farming

Zanzibar, Tanzania, Africa

Solution	Food Security
Project	Zanzibar Seaweed Farming Industry
Owner	Local Farmers
Designer	Zanzibar Seaweed Cluster Initiative+
Cost	N/A

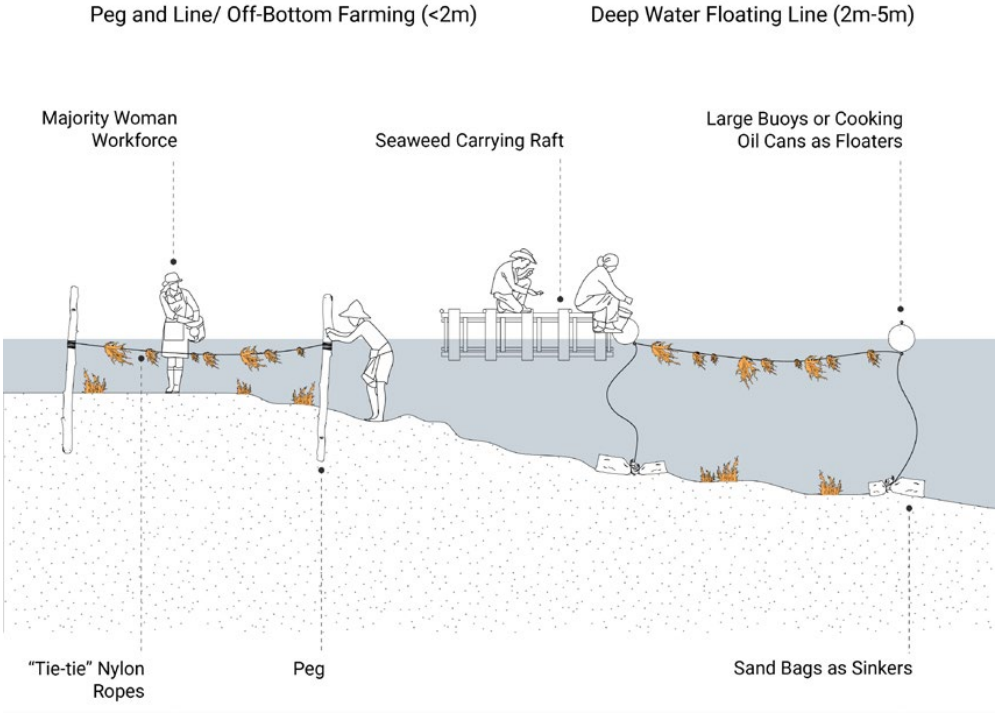
As fish populations decline, seaweed farming offers an alternative nature-based solution to human livelihood and prosperity that promotes food security and carbon drawdown.

As a leading seaweed producer in Africa, Zanzibar deploys many seaweed farming operations that are small-scale, occurring in the intertidal zones of marine conservation areas, close to mangroves and coral reefs. Since women make up the majority of seaweed farmers, this activity is an important and viable endeavor to improve their economic and social status within the community.

Farmers use the peg and line, or off-bottom, farming method in the shallow intertidal areas. They tie seaweed to nylon ropes that are stretched between two wooden pegs, cut from land-based plants. The branches are tied to these lines using thin nylon ropes called "tie-tie." The seeds grow for six weeks before harvesting. When harvesting, farmers remove the lines and the seaweed before tying in new seaweed branches.

Other methods such as deep-water floating lines have been developed. Here, farmers tie seaweed on nylon ropes and deploy a floating device in deeper water (2-5 meters (6.6-16 ft)). The cast method is where farmers use rubber bands to attach seaweed to rocks, hoping the seaweed will vine and attach.

Only recently have new methods for aquaculture and marine conservation surfaced, with Zanzibar acting as a test site for seaweed farming's adherence to new global standards.



Seaweed Farming at Uroa, a Fishermen Village on Zanzibar's Center-East Coast

Seaweed Farm / Uroa, Zanzibar / Wikimedia Commons / Moongateclimber 2010 | 191

Cultural Regeneration

Puhinui Catchment,
Manukau, Auckland,
Aotearoa New Zealand

Solution	Human Settlement and Security
Project	Te Puhinui Regeneration Strategy
Owner	Eke Panuku Development
Designer	Resilio and Te Waiohua +
Cost	$146,000 USD for 7,324 acres

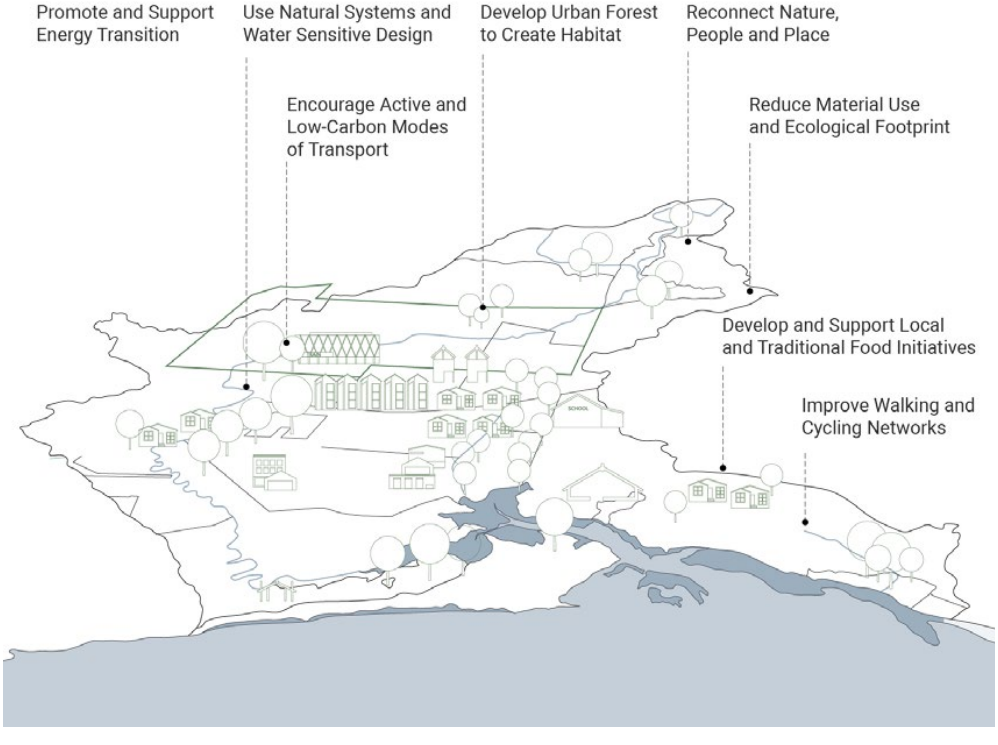
While Indigenous, traditional knowledge and values are often underrepresented, their wisdom of living in harmony with nature holds value lessons into adapting to the climate and biodiversity crises.

The Te Puhinui (Creek) Regeneration Strategy, is a comprehensive initiative utilizing a living system wellbeing approach to design that integrates western ecological and regenerative development concepts with Indigenous protocols, frameworks, and narratives.

The strategy sets out core values, a clear purpose and vision, principles, responsibilities, and identifies strategic initiatives, design guidelines, and programs for future projects. These respond directly to the creek, its inherent challenges and opportunities, alongside current issues related to population growth, urban development, ecological degradation, climate adaptation, social deprivation, and building community capacity and capability.

The purpose of the strategy is to realize the regeneration of the watershed so its diverse communities can prosper culturally, physically, spiritually, and mentally.

The framework aims to strengthen and build relationships and projects within the larger region providing methods which, brought together in the right manner will help shift the creek watershed from its current state to realizing its full potential and ultimately achieving Te Ora oo Te Puhinui - a healthy and prosperous creek ecosystem.



Waka Ama (traditional Maaori canoeing) on the Manukau Harbor with Matukutureia / Drawing Modified from Resilio Studio


NGĀTI KAHU

Low Carbon

Gabion Artifact

Birchgrove, New South Wales, Australia

Solution	Carbon
Project	Ballast Point Park
Owner	Sydney Harbor Foreshore Auth.
Designer	McGregor Coxall +
Cost	$6.6M USD for 6.4 acres

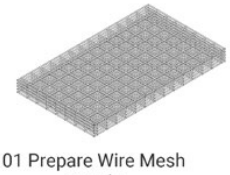
Often adaptations require physical changes to the landscape. Walls, retained hillsides, and elevated edges are needed for protection of rising seas, increased storm surges, more intensive periods of rainfall, and landslides that increase due to widespread fires. With most emissions from the built environment coming from solid concrete walls made of high emitting ordinary portland cement and solid steel members, we need lower carbon natural solutions that are more affordable, flexible, and readily available while still meeting performance standards.

The use of gabions is one such alternative. The construction is simply made of wire mesh panels secured together, filled with stones or other loose fill materials. Many times the fill can come from aggregates found locally on a site or even salvage concrete that has been broken into pieces.

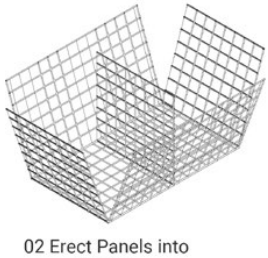
At Ballast Point Park in Australia, the landscape architects were inspired by the site's history as a quarry, which informed the creation of gabion walls using a "modern ballast" of construction rubble, which reduced the need to import material to create retaining walls.

Supporting earthen retaining walls are faced with gabion baskets containing recycled building rubble and contrast with the site's quarried sandstone outcroppings.

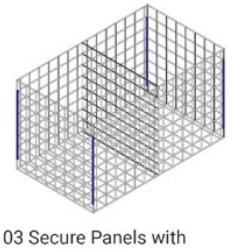
Construction waste about twice the weight of the Eiffel Tower, 22,200 tons, was diverted from landfills, by repurposing it for use in gabion retaining walls.



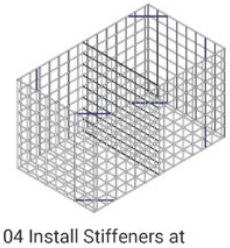
01 Prepare Wire Mesh Panels



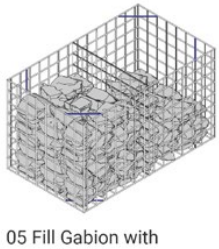
02 Erect Panels into Gabion



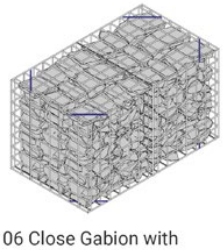
03 Secure Panels with Binders



04 Install Stiffeners at Corners



05 Fill Gabion with Stones



06 Close Gabion with Wire and Binders

Gabion Installation Process. Drawing Modified from Luna Kim / Anping Enzar Metal Products Co., Ltd.

Solar Classroom

Buffalo, New York, USA

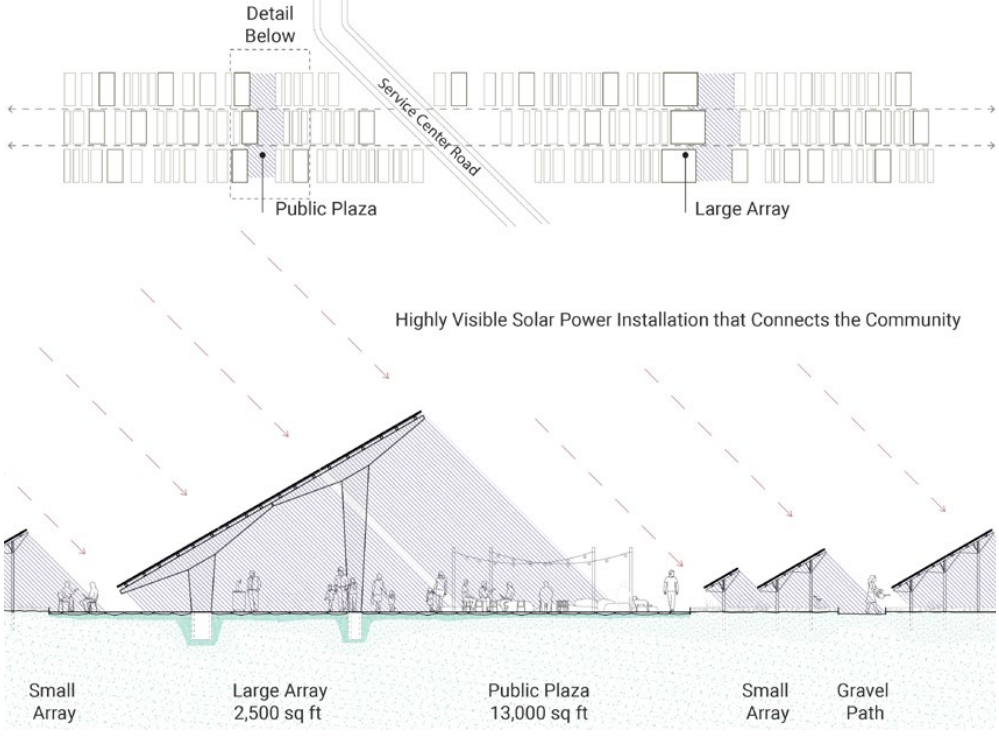
Solution	Carbon
Project	Solar Strand
Owner	University at Buffalo
Designer	Hood Design Studio
Cost	$8-$14M USD for 3 acres

Adapting landscapes to support single-purpose renewable energy generation is a missed opportunity. When adding facilities such as solar panels to a site, complementary uses can be added such as education spaces that also cool places when facing extreme heat.

Solar Strand, University at Buffalo, New York, is a solar array intentionally designed to be an accessible community and educational space. The landscape invites students of all ages and community members into the installation. Walkways take visitors right up to the panels, which vary in height from four feet to 28 feet (1.2-8.5 m). The lower panels can be touched, while the taller panels create a powerful visual impact. Amid the panels, the public spaces, which function as classrooms, are made up of concrete slabs recycled from old sidewalks. Restored wetlands and expansive meadows surround the entire installation, creating a new harmony between renewable power and nature.

This project supports the university goals of becoming carbon neutral by 2030 and is in partnership with the New York Power Authority. The original proposal was a power facility protected by a chain-link fence, but the university envisioned an installation that was highly visible, beautiful, and connected to the community.

A quarter-mile-long (400 m) array generates enough energy to power 700 on-campus apartments, saves $100,000 in electricity costs and emits 400 fewer tons of greenhouse gasses each year.



Turf Alternative

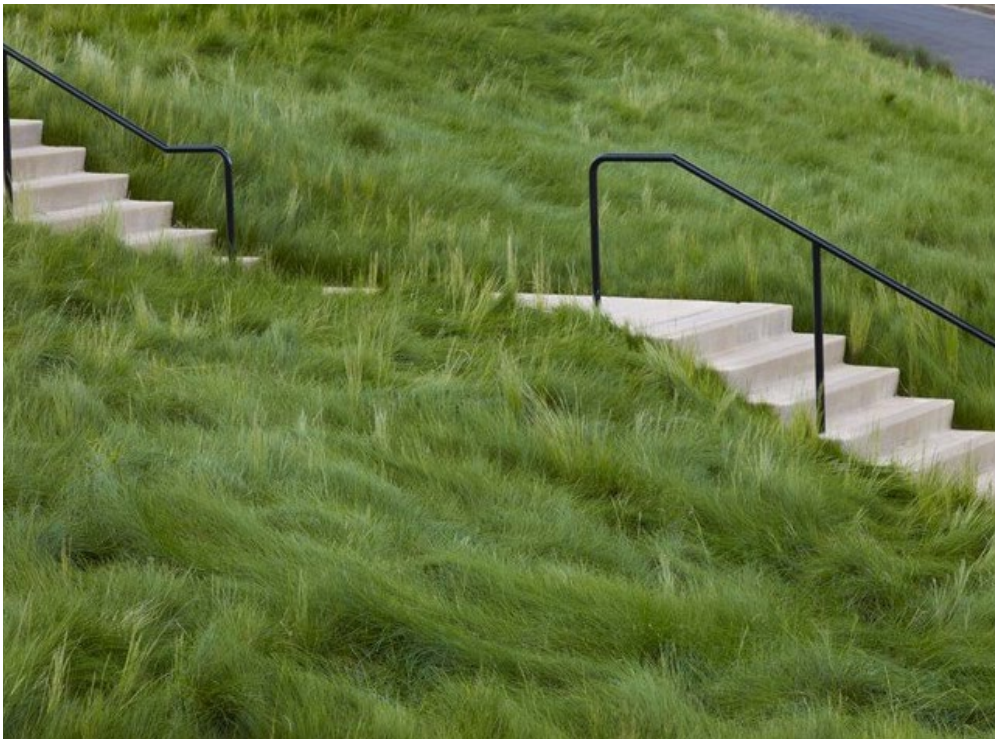
Marin, California, USA

Solution	Carbon
Project	Fort Baker at Cavallo Point
Owner	Equity Community Builders LLC
Designer	Office of Cheryl Barton
Cost	$6M USD for 40 acres

While manicured lawns may look “green” they are far from it. Due to gasoline powered maintenance, application of fertilizers and pesticides, and release of greenhouse gasses due to decomposition, high-maintenance turf is a net emitter. However, by adapting landscapes to utilize native, drought-tolerant meadow species that do not require frequent mowing, watering or fertilizer, a “no-mow” lawn still provides the use functionality and flips into becoming a carbon sink.

This approach is demonstrated in the adaptive resuse of a former naval post transformed by the U.S. National Park Service (NPS) into a regenerated pubic space. Half of the site was restored using native or adapted landscape plantings. Habitat regeneration and planting methods meet the NPS policy requiring genetic natives. Around 58,000 plants were propagated from seed harvested on the site itself. Mown lawn is only found in critical gathering areas or vantage points. Here it became clear that genetic native plants can triple their growth size in one season. Site management upholds integrated pest management and green housekeeping practices, while maintaining vegetation to reduce urban wildfire risk.

One mile (1.6 km) of trails increases connectivity and gravel covers all parking surface areas, which act as primary infiltration zones. Bioswales catch and infiltrate surface runoff. Low-flow irrigation systems serve much of the site, while the character-defining historic Parade Ground is a “No water zone”.



Native Meadows are Sustainable Alternatives to Lawns / Courtesy Cheryl Barton

Bamboo Crib Wall

Thankot, Nepal

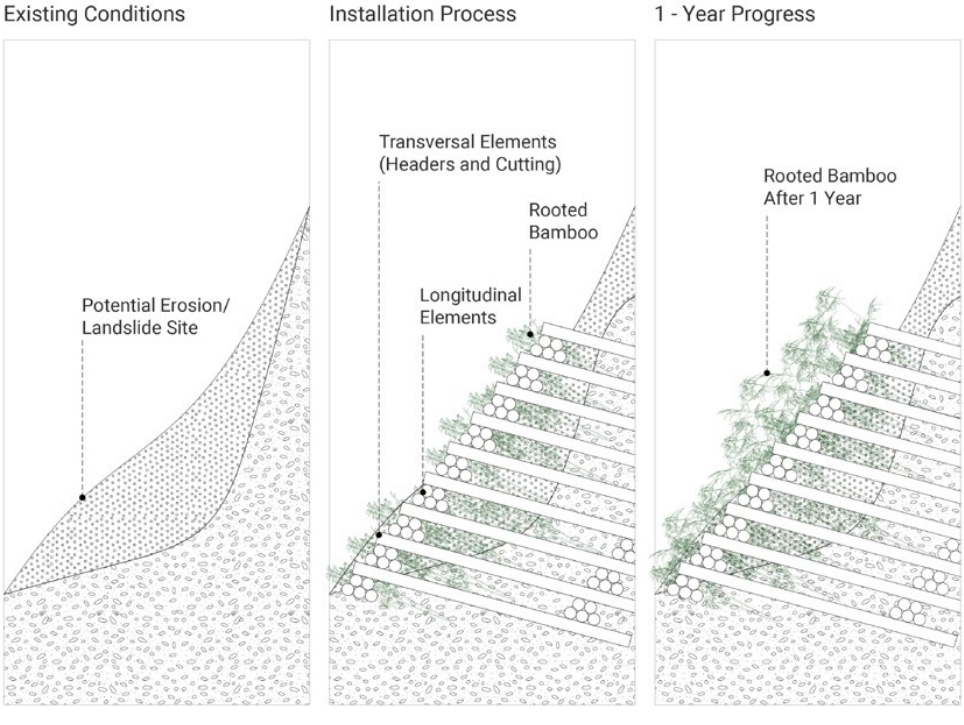
Solution	Carbon
Project	Bamboo Stabilization Initiative
Owner	--
Designer	Tribhuvan Univ., M.S. Acharya
Cost	$20-50k USD for 20 year maint.

Risks of landslides and concern of impact on human lives are increasing as storms, floods, and fires are on the rise. While traditional materials for reinforcement including concrete and steel can be costly and inaccessible to many, low-carbon soil bioengineering methods present an alternative.

One project in Nepal uses a bamboo crib wall to demonstrate improved soil stability and erosion control. This method not only leverages the natural strength and rapid growth of bamboo but also accesses traditional local practices in harmony with modern science to deploy a robust and sustainable solution.

The material choice is strategic, given bamboo's fast growth rate, high strength, and extensive root network, which make it an ideal tool for bioengineering. Bamboo is a multi-purpose material that is utilized for a range of applications, including building materials, which can supplement incomes. Bamboo's multi-purpose nature has the potential to transform environmental stewardship into economic resilience.

Local people are actively involved in every stage, from planting and caring for the bamboo to using it. This strategy ensures the community is not only actively participating in the conservation effort, but also recipients of the benefits. Community ownership and responsibility is critical to the long-term viability of the project which is fostered through meaningful involvement and ensures that the practices continue long after the project is complete.



Carbon Farming

Marin County, California, USA

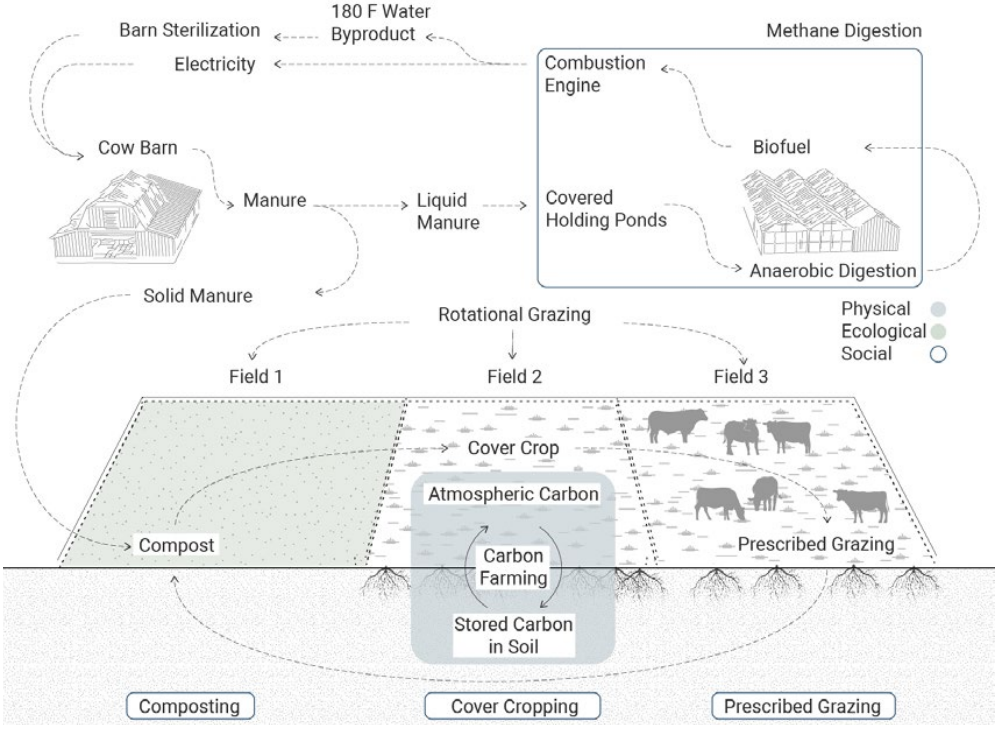
Solution	Carbon
Project	Marin Carbon Project
Owner	Marin County Farmers
Designer	--
Cost	$N/A for 14,000 acres

Carbon Farming is the practice of sequestering atmospheric carbon in soil storage. It improves farm productivity, ecosystem function, and plays an important role in adapting our food systems going forward.

Some of the strategies for soil carbon storage include compost application, cover cropping, prescribed grazing, and methane digestion. Soil Organic Carbon (SOC) is the amount of carbon stored in soil. With a 1 percent increase in this amount, one acre (0.4 ha) of land can store 20,000 more gallons of water (76 m^3)–a potentially significant solution to food security concerns in areas of increasing drought.

The Marin Carbon Project is a collaborative initiative between agricultural institutions, working to increase carbon sequestration in rangeland, agricultural, and forest soils within its region. The program works with local farms to help them develop and implement Carbon Farm Plans (CFPs), which inventory the natural resources present on a farm and measures to increase carbon sequestration, from compost planning to carbon mitigation programs.

The program specifically targets the grassy farmlands commonly found in the area, which are often untapped carbon sponges capable of storing a significant amount of atmospheric carbon dioxide. To realize this potential, the project focuses on applying compost to grazed grasslands, proven to both increase carbon sequestration and avoid emissions related to organic waste in landfills.



Straus Family Creamery (right) launched an incentive program in 2023, investing over $250k to help its 13 supplying organic dairies adopt emissions-reducing practices and reach carbon neutrality by 2030. Its founder Albert Straus' Straus Dairy Farm is modeling soil carbon sequestration practices, well over 50% towards the goal.

Scrap

Providence, Rhode Island
USA

Solution	Carbon
Project	The Steel Yard
Owner	The Steel Yard
Designer	Klopfer Martin Design Group +
Cost	$1.2M USD for 3.5 acres

With steel manufacturing as one of the largest industry emitters globally, looking for "scrap" metal to reuse can prove to be an economically viable and visually interesting adaptation material.

Scrap metal can be incorporated into site elements such as retaining walls and railings. Often discarded, uncommon materials like sheet piles, appliances, and car parts can be pulled from industrial sites and be repurposed into prominent site elements.

Once a contaminated steel and iron plant, is now a new space for community artists, industrial arts education, workforce training, small-scale manufacturing, and community events in one of the area's oldest low-income neighborhoods.

The Steel Yard was transformed into a community asset—a creative space that prevents as much as 90 percent of stormwater from entering the city's sewers, stops unhealthy lead contamination from spreading, and provides a measure of environmental justice to an underprivileged area. The redevelopment incorporates the rehabilitation of existing buildings, maintaining gantry cranes, rough brick buildings, and use of recycled materials.

The approach meets strict regulatory requirements and commitments to use sustainable practices within a tight budget. Landforms and variety of materials allow for numerous activities including tractor-trailer deliveries, product fabrication, display, and gathering spaces for events.

Recycled Steel "Bales" Made from Discarded Bicycles and Cars / Courtesy Klopfer Martin Design Group / Christian Phillips Photography

Carbon Counting

Solution	Carbon
Project	Pathfinder App
Owner	Climate Positive Design
Designer	Climate Positive Design +
Cost	Free for Use

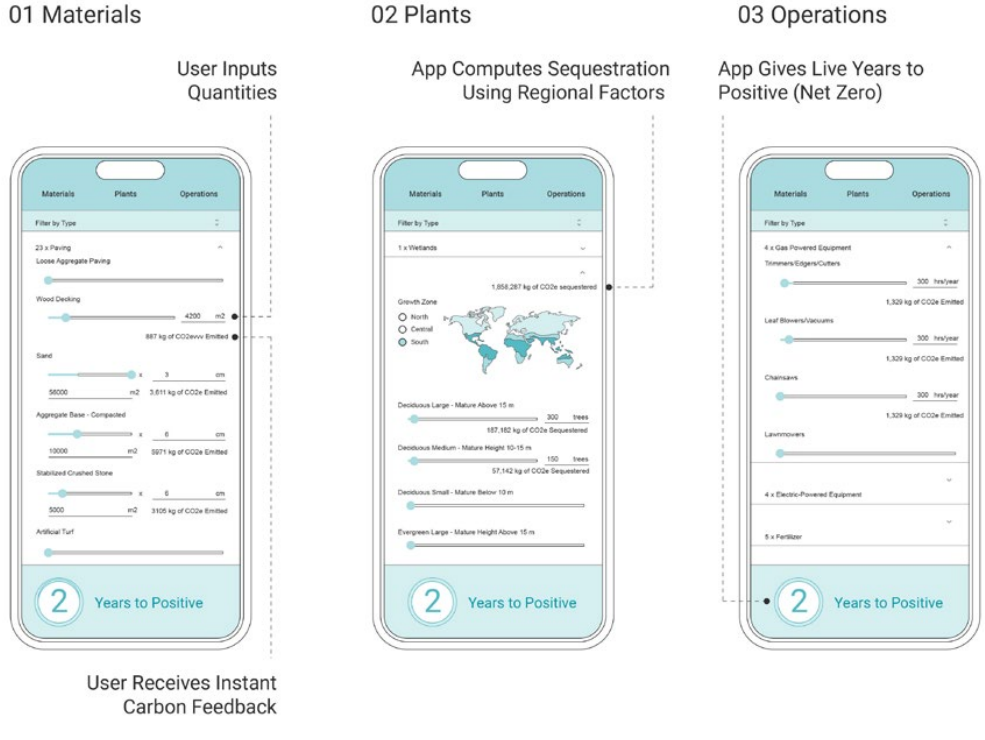
While learning the basics of carbon accounting can be daunting, especially in the face of an adaptation project, the free web-based application called Pathfinder supports quick and easy estimation.

When providing quantity estimates, the app calculates the carbon footprint and time to carbon neutral for site and infrastructure projects based on design and management proposal. The tool also provides design suggestions to help designers improve a project's carbon footprint.

It may be used for projects in the design phase or already completed projects. The only required inputs are project type, site boundaries, however, supplying more information will result in a more accurate estimate.

Users simply enter specifics about their project regarding materials and site features like paving; walls, curbs, and headers; fences and gates; site elements; drainage and irrigation; subsurface elements, and mulch and soil. Adding carbon sinks including restored ecosystems, trees, lawn, and shrubs is also available. Finally, users may enter information on maintenance including gas- and electric-powered equipment and fertilizer and other site operations.

The output is the Climate Positive Design Scorecard, which includes estimated years to carbon neutral for the project, amount of carbon sequestered and net impact over time and based on a 60-year lifespan, and embodied and operational carbon emissions profile.



Pathfinder Helps Designers Improve Carbon Footprints while Supporting Biodiversity, Cooling, Water Conservation, and Equity


9:41
4 years until my project will be climate positive.
The sooner you offset your project's carbon footprint, the more positive impact it has.
carbon sequestered
2023
time

Low Carbon Hollow Blocks

Solution	Carbon
Project	LC3 Low Carbon Hollow Blocks
Owner	EPFL, Dr. Alice Titus Bakera
Designer	LC3, Lab of Const. Materials +
Cost	N/A

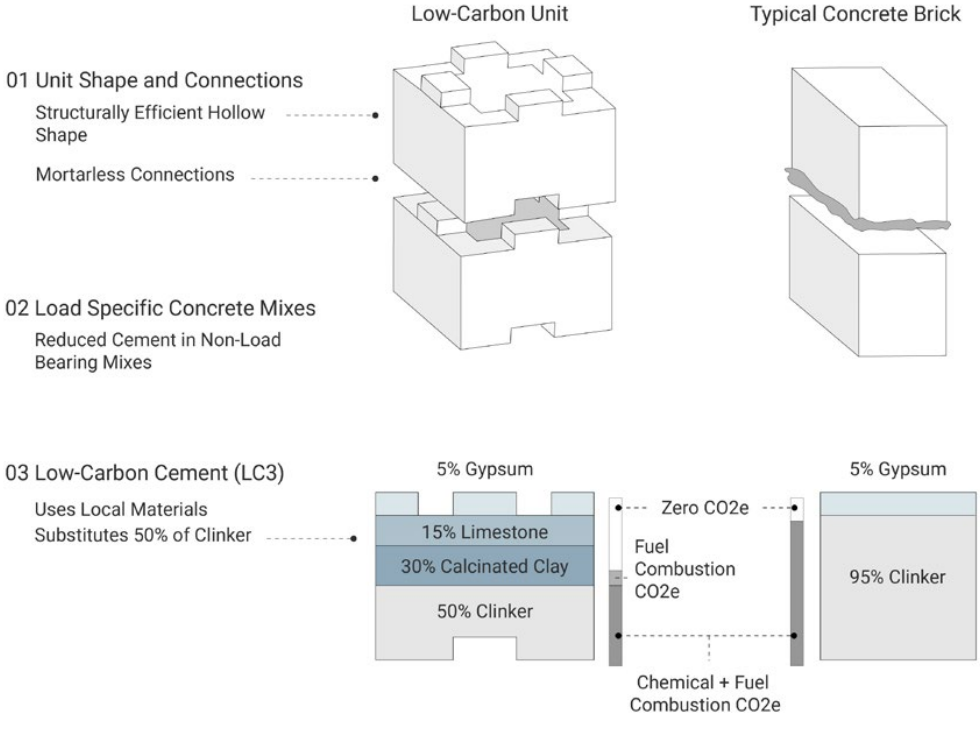
Based on East Africa's projected population growth, related emissions, informal settlements, and climate risks there is a need for properly adapted housing and infrastructure to support the country's well being. One solution is sustainable construction methods and the use of local and eco-friendly materials.

Concrete blocks make up 20 percent of the most common construction materials but are the most efficient in terms of embodied carbon and energy consumption. Most of the cement produced in Tanzania is used for concrete block manufacturing. This cement is Ordinary Portland Cement, which contributes significant energy and carbon dioxide emissions.

Decarbonizing the industry can firstly be addressed by adopting new block designs, such as shifting from solid mortar blocks to hollow ones, which reduce cement consumption through introducing the void. Adopting interlocking blocks eliminates joint mortar and allows easy assembling and reassembling of structures.

Second is to design concrete mixes according to the application, for instance, reducing cement content in the non-load-bearing unit and adopting packing density for load-bearing units.

The third is the use of low-carbon and low-cost cement like LC3 that reduces up to 50 percent clinker content without altering performance. This promotes locally available material because LC3 resources are abundant in Tanzania.



Low Carbon Hollow Blocks Support Adaptation in Africa / Drawing Modified from Alice Bakera, EPFL.

Experimental Re-Use

Philadelphia,
Pennsylvania, USA

Solution	Carbon
Project	Urban Outfitters HQ
Owner	URBN Inc.
Designer	D.I.R.T. Studio +
Cost	$N/A for 9 acres

As the world consumes natural resources at an unsustainable rate, it is time to get creative with what we have. Experimental re-use of materials can support the need for adaptation and offer resources at a fraction of the costs and emissions.

One exceptional but replicable example exists at the Urban Outfitters Headquarters campus. Not only did the textile manufacturing company reclaim a decommissioned U.S. Naval Shipyard, but they also salvaged tons of materials for reuse on site that would otherwise have been shipped to landfills.

These recycled materials served as the primary building blocks for the new campus, while increasing the overall permeability of the site and rainwater infiltration into the aquifer below. Emissions were also saved from avoiding distance driven to the landfill.

The "circular" palette of reused materials for reconstructing the landscape included asphalt, concrete, brick, and rusted metal. No imported materials were utilized, and a salvation strategy was documented. Creating full-scale mock-ups ensured the approach remained cost effective. Nearly a thousand cubic yards (765 m^3) of waste was reused and site perviousness increased by approximately 800 percent.

Due to the removal of paving, bioswales now filter and support plantings that provide shade, reclaiming a new biologically and culturally fertile ground that celebrates circularity.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Fossil Free Steel

Solution	Carbon
Project	TELLUS Bench
Owner	Vestre
Designer	Emma Olbers Design
Cost	From $2,380 USD for 1 bench

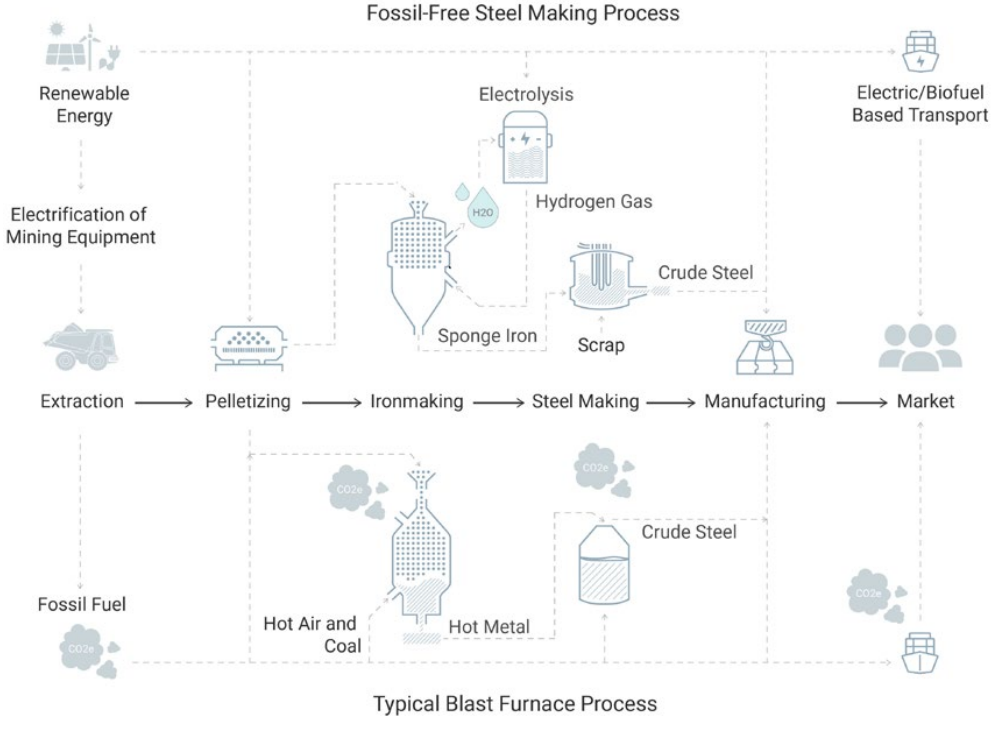
Thousands of miles (km) of shoreline and countless structures will need to be adapted in the future regardless of which emissions reduction scenario our global community accomplishes. While using bio-based materials will contribute the least emissions, they may not always meet requirements. Because of this, it is good to know that fossil-free steel is on the way.

Swedish steelmaker SSAB is forging steel from its converted blast furnace, which uses green hydrogen instead of coal for heat, and so emits no carbon dioxide. The process is called Hydrogen Breakthrough Ironmaking Technology (HYBRIT) and creates the same properties of traditional steel but helps reduce the 5 percent of global emissions it creates.

Through the electrolysis of water, which splits water molecules into hydrogen and oxygen, green hydrogen is obtained and emits no greenhouse gasses. SSAB is planning to convert all its factories in Sweden, Finland and the USA to HYBRIT and phase out its other steel products by 2045.

While much of this steel is currently in use for car manufacturing, a portion is being utilized by street furniture brand Vestre. In collaboration with designer Emma Olbers they have produced furniture using fossil-free steel made without creating carbon emissions.

Even though the alloy is forged without coal, remaining carbon emissions from mining and transport will need to be minimized by using biofuels and electric equipment.



Bridging with Bamboo

Huizhou, Guangdong Province, China

Solution	Carbon
Project	Crosswaters Ecolodge
Owner	L. Mt. Nankun Z. Eco. Dev. Co.
Designer	EDSA Inc. / Hitesh Mehta +
Cost	$ N/A for 6,177 acres

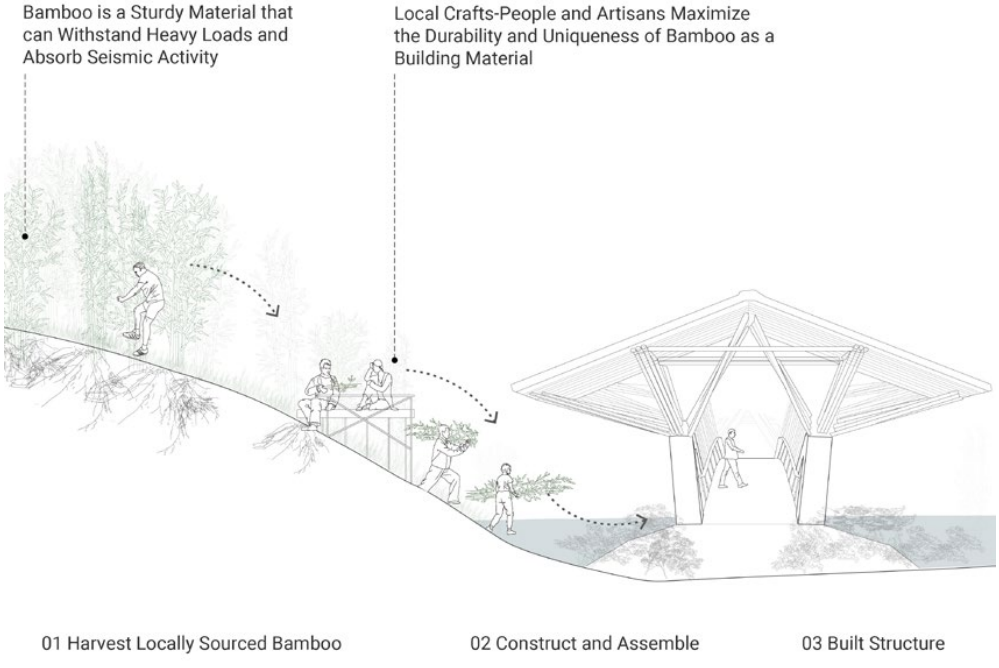
As rising waters and increased storms require elevating or reconstructing infrastructure to higher levels, bamboo is a low-carbon material to consider. Bamboo is a fast-growing renewable resource that can sequester carbon faster than typical trees. In addition, it has the tensile strength of steel and compressive strength of concrete.

Throughout China, rapid industrialization is causing millions to migrate from the countryside. The consumptive pattern of urban sprawl development is causing widespread environmental devastation and social disruption as natural resources are depleted.

The Nankun Mountain Reserve was created in 1984 to preserve 260-square kilometers (100 mi^2) of native evergreen forest. More than 5,000 native Keija people live within the reserve. During the planning process, landscape architects consulted the community to learn the history of the land and native culture. Residents offered insights which helped increase the community's sense of ownership and appreciation for the preservation effort.

Local Keija craftsmen and artisans were employed in the construction, even complex structures like this bamboo bridge, which spans the Ganken River. Local workers were mentored by expert craftsmen to learn new construction techniques, gaining skills that can be applied on future projects.

The area contains 53 structures constructed with locally sourced materials like bamboo.



Democratic Green Rezoning

Sunset Park, Brooklyn,
New York, USA

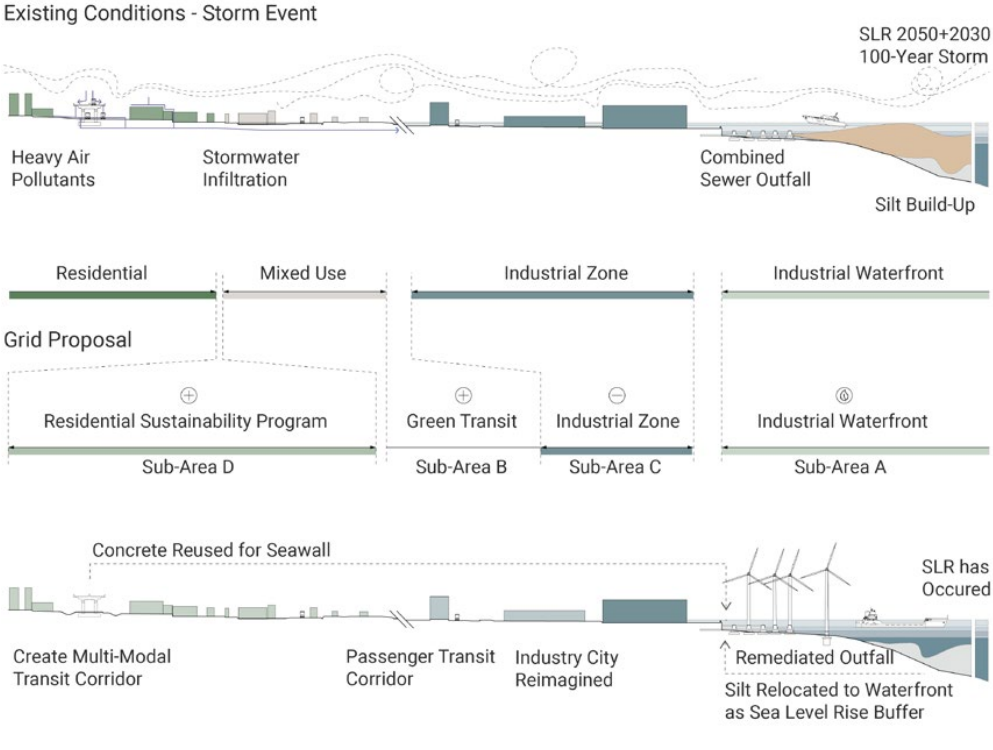
Solution	Carbon
Project	Sunset Park GRID
Owner	City of Brooklyn
Designer	UPROSE +
Cost	N/A

While at times physical adaptations are the first course of action, some situations require policy or zoning changes prior to supporting future changes in an inclusive way. A democratic green rezoning process is one that provides communities with choice and voice in adapting to low-carbon resilience.

In New York, UPROSE created the Green Resilient Industrial District Plan (GRID) — a multi-point strategy for revamping the industrial waterfront, making use of its existing infrastructure, and bringing green jobs to Sunset Park. The neighborhood's rail and maritime activities have historically propelled the area's industrial core. Rezoning of the climate vulnerable area was proposed in 2017, but residents weren't convinced as recent nearby redevelopments of industrial neighborhoods dramatically changed, rents soared, and diversity decreased.

Many opponents see Sunset Park as a hub for clean, green energy with blue-collar jobs for current residents which eventually led to support of the community proposed plan.

The GRID is divided into four areas with different goals, based on their existing zoning and land use. Sub-Area A, preserves and expands green industrial uses. Sub-Area B, connects industry, waterfront, transportation and renewable energy production. Sub-Area C encourages sustainable manufacturing and resiliency by preserving existing zoning and limiting retail, commercial, and entertainment uses. Sub-Area D will mainly focus on residential energy efficiency, waste reduction, and renewable energy.



Wind Sighting

Fairfield, Norway, and
Little Falls, New York, USA

Solution	Carbon
Project	Hardscrabble Wind Power Project
Owner	Iberdrola Renewables, Avangrid
Designer	Environmental Design & Research +
Cost	$200M USD for 6,540 acres

For the successful adaptation of renewables, support from the local community and a thorough understanding of environmental impacts is essential. If sited poorly, wind farms can significantly alter the visual landscape, negatively impact local flora and fauna and have detrimental effects on local environmental systems. Using visual impact assessments, the project landscape architects created scenarios showing how the wind farm will interact with the landscape to protect significant natural and cultural viewsheds.

At the Hardscrabble Wind Power Project the majority of the wind turbines are situated on agricultural land since the area is predominantly rural. Wetland restoration, invasive species control, and the utilization of pre-existing roadways and drainage systems were among the design and construction methods employed to reduce disturbances to the streams, wetlands, and vegetation.

A first-of-its-kind animated simulation was made to accurately represent the visual impact of the turbine blades in motion, and 3-D models were utilized to replicate multiple crucial points of view. The final count of turbines was lowered thanks to technological advancements, resulting in a low to moderate visual impact on high-value landscape viewsheds in the area.

This wind farm project is one of the first significant deployments of the 100-meter (328-ft) turbines in North America. The turbine facility generates enough electricity to annually power over 33,000 average New York homes.

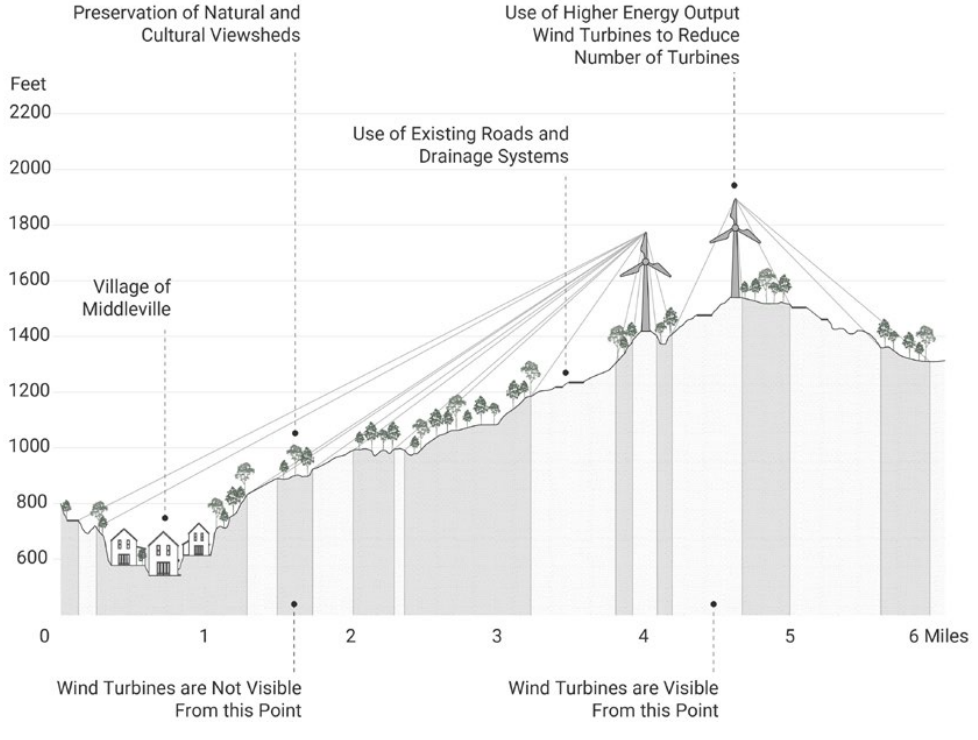


Illustration of Wind Farm Sighting to Preserve Cultural Views / Drawing Modified from EDR

Rammed Earth

Pilbara Region, North
Western Australia

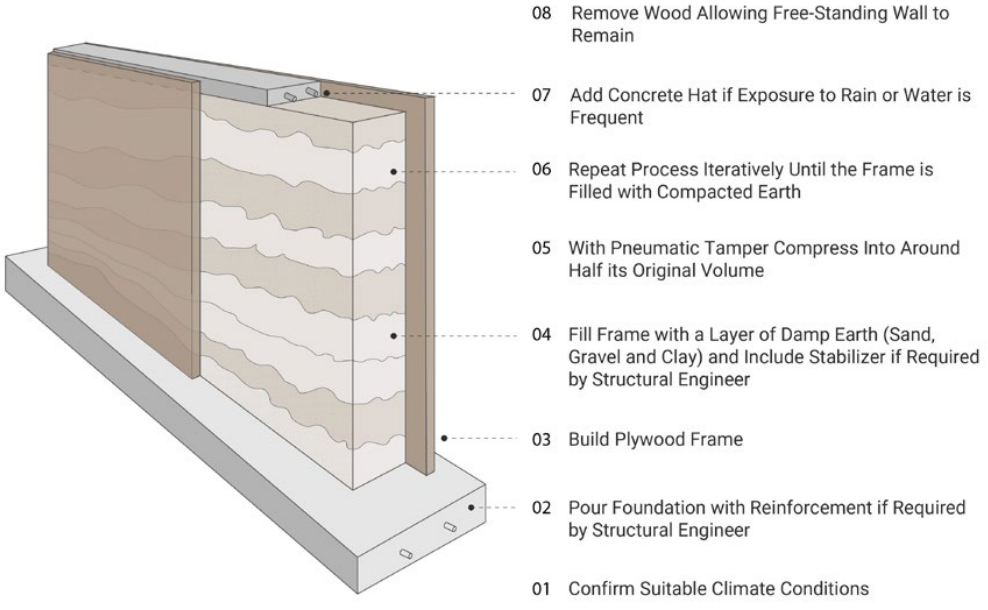
Solution	Carbon
Project	The Great Wall of WA
Owner	N/A
Designer	Luigi Rosselli Architects /
	Luigi Rosselli Pty Ltd, Sydney Aus. +

One approach to reduce the emissions associated with adaptation construction, especially in isolated areas, is to use the resources around you. Rammed earth walls utilize soil as a primary element for creating structural land or building elements which reduces emissions from transport and creation of the material itself, and avoidance of higher emitting materials like conventional concrete and metals.

The Alhambra in Spain, the Great Wall of China and various Japanese temples have all been constructed using this lower embodied carbon alternative.

When planning to create a rammed earth wall it is essential to have a thorough understanding of the surrounding environment as well as building codes or regulations. This method is often most effective in regions with high humidity and moderate temperatures as they require more insulation in colder climates and more rain protection strategies in locations with higher precipitation.

With a goal of creating shelter for local shepherds, the Great Wall of WA team created a homestead that naturally blends into the surrounding topography including the longest rammed earth wall in the country, at 250 yards (229 m). The iron rich, sandy clay available on site is combined with gravel and water from the nearby river to form the rammed earth wall. The wall's placement provides the best thermal mass possible, which helps to stay naturally cool in the heat while the roof covered in soil and planting provides year-round insulation.



Rammed Earth Wall Construction Assembly / Drawing Modified from Endeavour Centre

Depave

Shanghai Shi,
P.R. China

Solution	Carbon
Project	Xuhui Runway Park
Owner	Shanghai Xuhui Riverfront Dev.Co.
Designer	Sasaki +
Cost	$28.5M USD for 36 acres

When adapting communities to become more resilient, sometimes the most effective strategy is to do more with less. By choosing the cost-effective "depave" approach, removing underutilized pervious surfaces supports urban cooling, increased infiltration and biodiversity, in a low-carbon way.

Located on a former industrial site and runway, Xuhui Runway Park was created to serve the surrounding residents. This adaptive reuse project provides much-needed recreational space while promoting green transportation and biodiversity.

Approximately 50,000 square feet (4,645 m^2) of the historic runway was protected in place and restored to serve as the main pedestrian thoroughfare. Nearly 30,000 square feet (2,787 m^2) of demolished concrete was salvaged and repurposed for secondary paths and as well as a turf-jointed flagstone-style pedestrian path. Other low-carbon techniques include using regionally available fused bamboo lumber in benches, boardwalks, and riverfront overlooks.

Compared to the prior use, this park increased green space, added permeable paving strategies and planted thousands of native tree, shrub and groundcover species. Many areas are designed and dedicated to provide both food and shelter for birds and pollinators, such as a butterfly grove and a bird watching garden. Additionally, the riparian edge along with the floating wetland provides aquatic habitat while reducing flood risk.

Photo of Construction Prior to Runway Transformation / Sasaki

Green Link

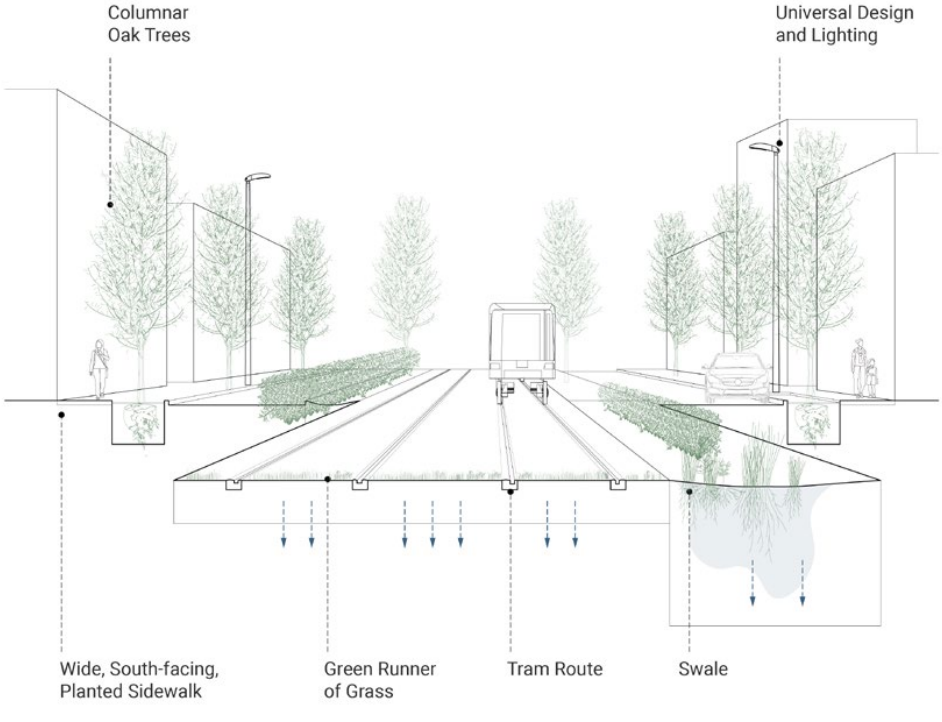
Bjørvika, Oslo, Norway

Solution	Carbon
Project	Queen Eufemia's Gate
Owner	Norwegian Public Roads Admin.
Designer	Dronninga
Cost	$N/A for 30 acres

Adapting the urban environment to welcome lower emitting transit is sometimes a frustrating and fruitless endeavor. Finding available space within a city, both above and below ground, to squeeze in trees and plantings that sequester carbon and emit less than paving isn't an easy task, but the rewards are great when it does succeed.

Queen Eufemia's Gate is a prime example of this hard work paying off. Located in downtown Oslo, this street was designed with an asymmetrical section to make room for a wide, planted sidewalk on the sunnier side of the street along with light reflective granite curbs and paving. The tram is placed asymmetrically in a swale profile at the bottom of the street, supporting treatment of urban runoff and aquifer recharge. Universal design and lighting were prioritized to create a safe environment for all and comply with the latest standards. The tram runs along a linear grass panel which would typically be paved with an impermeable material, flanked by trees on either side. Wooden safety barriers and planting strips form a safety buffer between the tram route and the roadway.

The selection of tree varieties in this "botanical street" complies with and exceeds Oslo's strict street tree requirements for street conditions and climate considerations. Street trees are labeled for easy identification and have been intentionally located based on canopy size to provide shade during the summer months.

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Compressed Earth Block

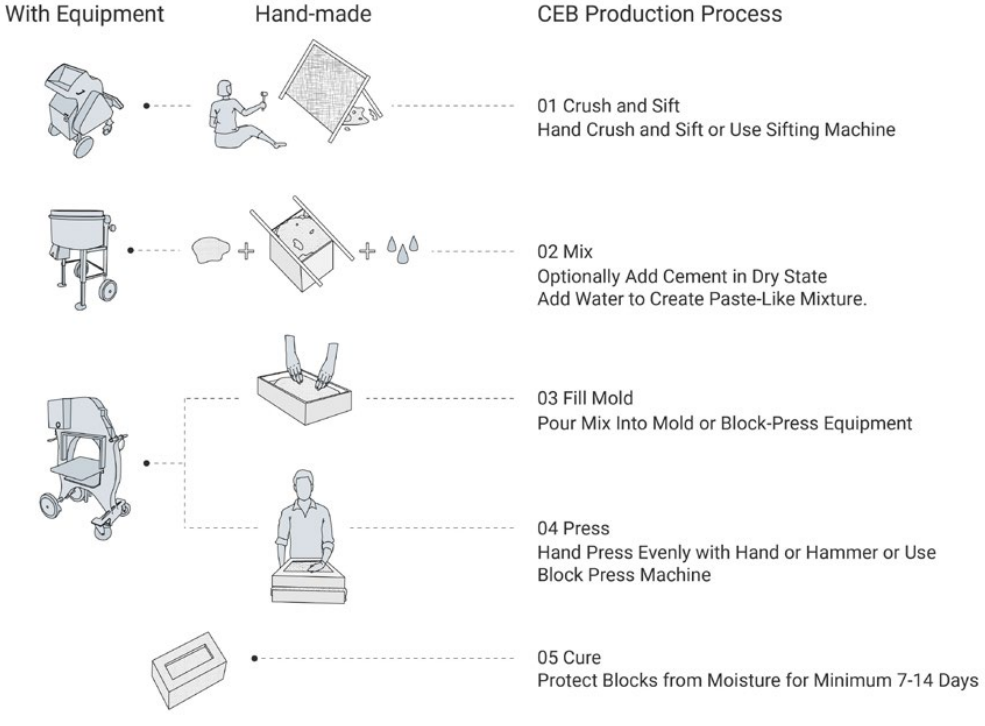
Pemba Island, Tanzania, Africa

Solution	Carbon
Project	ISCEB
Owner	Local Community Members
Designer	Community Forests International
Cost	N/A

In some locations and communities, acquiring suitable and low-carbon construction materials for adaptation is difficult and cost-prohibitive. Mobile brick-making machines allow residents to create building materials for their homes onsite using local materials. Compressed earth block (CEB) is a low cost and low carbon alternative to traditional building materials such as concrete, baked brick or even adobe. Compared to rammed earth, using CEBs allows for more modular and adaptive construction techniques because large formwork is not required.

CEBs are made by compressing a mixture of non-expansive clay, sand aggregate and dry inorganic subsoil into a formed and structurally sound building material. The compression process reduces the original material by about 50 percent under approximately 3,000 psi (21 MPa) of pressure. If a stabilizing agent, such as Portland Cement, is added to the mixture then the blocks become compressed stabilized earth block (CSEB) or stabilized earth block (SEB). Compressed earth blocks are stronger than traditional mud bricks due to the materials used and block compression versus brick drying technique.

Building standards for CEBs have been developed to ensure the construction of safe and long-lasting homes and other structures using standard bricklaying and masonry techniques. Mortar, made from either a simple slurry made of the same soil/clay mix without aggregate or even a cement mix, is spread thinly between the blocks for bonding.



CEB Process Drawing Modified from Haque, Md. Obidul & Munzarin, B & Saikia, Samujjal. (2021)

Closing: A Climate and Nature Positive Future for All

Pamela Conrad

As you've just experienced through the success of so many great projects, there are a multitude of ways that we can *WORK* with nature and adapt to climate change without contributing to the problem. While preserving existing natural landscapes is essential, we must also design with nature to create a more sustainable future.

Nature-based Solutions, reported to cost over 50 percent less than traditional engineered solutions, offer an effective path forward. Unfortunately these strategies are under funded and face implementation challenges but we cannot afford to continue a "business-as-usual" approach for the sake of humanity as we know it. Working *WITH* nature and embracing Indigenous knowledge are both crucial for our global community to change course.

When designed and implemented thoughtfully, Nature-based Solutions can also draw down carbon, potentially accounting for up to 30 percent of required reductions by 2030. While all construction adds associated greenhouse emissions, we know that within exterior environments those "embodied carbon" emissions are largely from specific material selections, construction activities, and transportation. *WORKS With Nature* outlines several strategies for adopting low carbon, circular construction techniques that can be implemented anywhere in the world. Addressing operational energy use and thoughtfully incorporating renewables into landscapes will also provide many associated benefits including food security and habitat creation.

Beyond exacerbating the climate crisis, we can *WORK* with nature to meet the challenge of rising water levels and increasing storm severity and frequency. By incorporating strategies such as living shorelines and breakwaters, restoring blue carbon ecosystems, and infiltrating water through green infrastructure, communities can adapt to survive unforeseen events in ways that emit less and sequester more carbon while supporting a wide array of additional benefits. Millions of people and thousands of miles of shoreline will be impacted — but bringing participatory design processes into communities fosters self-determination, leadership and stewardship in those invested in their own future.

These interventions support biodiversity which is essential to achieve the minimum 10 percent global gain. Beyond restoration efforts, we must protect existing ecosystems and support the 30 percent preservation by 2030 global goal just to sustain life on this planet. As the climate changes, it is imperative that we allow nature to expand and adapt to support species migration for survival. Reconnecting habitat corridors through land bridges and creating moments for humans to responsibly experience these ecosystems is critical to increasing awareness and empowering future advocates for nature.

Rising global temperatures will not only force animal species to migrate and adapt but will require humans to do the same. By making cities and their adjacencies more connected, walkable and bikeable, we can preserve the outlying wilds by increasing population density. Creating green corridors with healthy street trees and multi-layered native plantings can *WORK* with nature's cooling effects and support community health and resilience. Structures built with natural materials support cooling where water is scarce. Endemic and native plants use less water and resources, are more resilient in arid regions and minimize the spread of wildfires.

With 75 percent of global infrastructure required for 2050 yet to be built, we have an obligation and responsibility to design with green, not gray. We must work *WITH* nature to ensure life will continue to thrive on this planet that we know, love, and call home.

The solutions and techniques in this guide are just the beginning. As you've read, many inspiring nature-based projects exist around the world, yet countless more remain to be discovered and invented by *YOU*. I hope you let this guide serve as a catalyst to reimagine, innovate and inspire others in their efforts to build a better future.

Our climate and biodiversity crises are a global challenge that demands a global response. Let's work together and change the world.

Pamela Conrad, ASLA, PLA, LEED AP
Pamela is a licensed landscape architect whose upbringing on a farm in the rural United States inspires reconnecting with nature to solve the climate and biodiversity crises.

She is the founder of Climate Positive Design, faculty at Harvard's Graduate School of Design, and the American Society of Landscape Architect's (ASLA) inaugural Biodiversity and Climate Fellow. She was the chair and lead author of ASLA's Climate Action Plan, 2019 Landscape Architecture Foundation Fellow, 2023 Harvard Loeb Fellow and currently serves as the International Federation of Landscape Architects Climate and Biodiversity Working Group Vice-Chair, World Economic Forum's Nature-Positive Cities Task Force Expert, Carbon Leadership Forum ECHO Steering Committee, and is an Architecture 2030 Senior Fellow.

Kotchakorn Voraakhom
Kotchakorn Voraakhom is a landscape architect from Thailand who works on building productive green public space that tackles climate change in dense urban areas and climate-vulnerable communities.

She is the founder of LANDPROCESS and chief executive officer of Porous City Network, a social enterprise that looks to increase urban resilience in Southeast Asia. Voraakhom is Chairwoman of the Climate Change Working Group of the International Federation of Landscape Architects (IFLA World), TED Fellows, Echoing Green Climate Fellow, Atlantic Fellow, and Futurity Fellow from BMW Foundation.

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WORKS with Nature: Low Carbon Adaptation Techniques for a Changing World

Pamela Conrad, Kotchakorn Voraakhom

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