THE CLIMATE RESILIENT INFRASTRUCTURE REPORT

A FOCUS ON IMPLEMENTATION

International Coalition for Sustainable Infrastructure

RACE TO RESILIENCE

ISSUE 1

ABOUT ICSI

The International Coalition for Sustainable Infrastructure (ICSI) was founded in 2019 by The Resilience Shift, the American Society of Civil Engineers (ASCE) and its ASCE Foundation, the Institution of Civil Engineers (ICE), the Global Covenant of Mayors for Climate & Energy (GCoM), WSP and LA Metro, among others.

We bring together a global coalition of change agents from across the engineering, investment, city and philanthropic communities committed to bold action to solve the systemic problems that exist at the intersection of climate change, ecosystem degradation, ageing infrastructure, and underinvestment.

ICSI is the global movement for engineering action on infrastructure sustainability, resilience and climate change. We place engineers at the forefront of climate action, harnessing their ability to provide solutions and matching it with urgent demand. The solutions we develop and promote will deliver impact on the ground, where it is needed most.

ICSI was created to bring the practical, science-based and solution-oriented perspective for which engineers are known to solve the systems-level problems surrounding infrastructure underinvestment, climate change, and resilience. From its origin, ICSI has been committed to driving action towards instilling sustainability and resilience as the cornerstone of every decision in the infrastructure lifecycle. Built upon a commitment to tangible and collaborative action, ICSI continues to broaden participation across other stakeholder communities to accelerate the innovation, adoption and scaling of people-centred, sustainable and resilient infrastructure solutions that support sustainable development for all.

WITH CONTRIBUTIONS FROM

WITH SUPPORT FROM

FOREWORD

In an already 1.1ºC warmer planet where the climate crisis is putting 3.3 to 3.6 billion highly vulnerable people at risk, a new approach to infrastructure systems is urgently needed. One where communities can be better prepared to stand and recover from the increasing impacts of the climate crisis, where societies prioritize people and nature in the pursuit of resilience – not to survive climate shocks but to thrive despite them.

As part of global efforts to accelerate climate action, the Race to Resilience campaign aims to bring radical collaboration for higher ambition. The International Coalition for Sustainable Infrastructure (ICSI), a partner to the Race to Resilience, has demonstrated exceptional leadership among non-state actors in driving the transition towards a net-zero, resilient world. In this publication, ICSI shares progress on the implementation of climate-resilient infrastructure through inspiring case studies from across the globe.

These case studies demonstrate successful examples of the solutions outlined in the Sharm El-Sheikh Adaptation Agenda, bringing together governments and non-governmental actors to address the impacts of climate change. The Sharm El-Sheikh Adaptation Agenda outlines 30 outcomes that can accelerate adaptation action and finance by 2030 in five impact systems: food and agriculture, water, oceans, human settlements, and infrastructure. ICSI's leadership brings forward the global solutions that can be adopted at a local level to respond to local climate contexts, needs and risks, and to deliver the transformation in critical infrastructure systems required to protect vulnerable communities to the rising climate hazards, such as extreme heat, drought, and flooding.

This publication highlights the remarkable efforts of practitioners, policymakers, and stakeholders in advancing sustainable infrastructure systems. It serves as a source of inspiration to remind us that together, through collective action, we can build a resilient world capable of withstanding the impacts of the climate crisis.

Marcia Toledo Sotillo

Director, Adaptation & Resilience, High-Level Climate Champions

CONTENTS

1. INTRODUCTION

ICSI's Climate Resilient Infrastructure Report is the first in a series of annual publications to report progress on the implementation of climate resilient infrastructure and to showcase curated best-practice case studies and initiatives from around the world that have the potential to deliver change at scale and at pace. The hope is that these can serve as guidance and inspiration for others, emboldening key stakeholders to enact change and serving as a blueprint for climate-compatible, people-centred transformations in infrastructure.

What is climate-resilient infrastructure?

Extreme weather events and climate hazards can cause significant damage to infrastructure systems and disruption to the services they provide. As the climate crisis worsens and these events increase in frequency and severity, the risk to infrastructure, and the communities that depend on it, is heightened. Our infrastructure systems are increasingly more complex and interconnected, increasing the risk of cascading impacts across the wider system. For example, disruption to energy supply can result in disrupted water supply, communications networks, and transport systems, each of which will have their own cascading impacts and can have severe implications on the health, safety and well-being of populations and ecosystems, and the economic stability of entire countries.

Most of the infrastructure in developed countries was built last century and was not designed for the weather extremes that we are experiencing on an increasingly frequent basis; conversely, new infrastructure will be needed in emerging economies to support their growth and prosperity.

We need to work quickly and urgently to retrofit existing infrastructure so that it can better withstand and adapt to the effects of a changing climate, and to ensure that new infrastructure projects embed resilience to climate and other hazards throughout the infrastructure lifecycle, from planning through to end-of-life.

Climate resilient infrastructure should be able to withstand, recover from and adapt to the impacts of climate change so it can continue to provide essential services to the communities it serves.

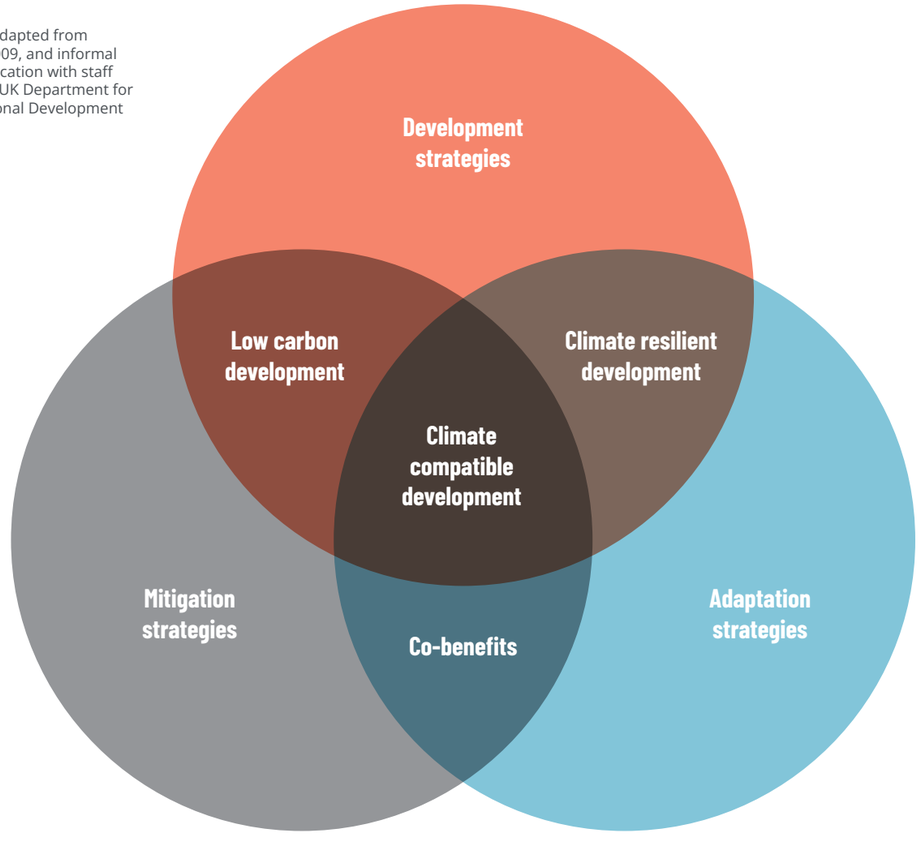
Climate resilience and adaptation as an entry point for climate-compatible development

Climate-compatible development transcends the notions of mitigation, adaptation, and resilience to adopt an approach that transforms development pathways to face the climate problem head on. This approach champions development that minimises the harm caused by climate impacts, while maximising human development opportunities presented by a low-emissions, more resilient future.

Climate resilience and adaptation, and decarbonisation can serve as entry points to develop climate-compatible infrastructure that supports sustainable development. This should become a gold standard and should be prioritised across all sectors and geographies.

Figure 1: Climate compatible development

Source: Adapted from Zadek, 2009, and informal communication with staff from the UK Department for International Development



Who is in the solution space for climate resilient infrastructure?

Inadequate infrastructure is a problem that spans sectors and geographies. Advancing the agenda for resilient infrastructure requires numerous key stakeholders to commit to cross-sector, multilateral and multidisciplinary collaboration and knowledge-sharing. Policy, technology, and investment are all critical to embedding resilience within infrastructure. As UN Secretary General António Guterres said at COP27: "We need all hands on deck for faster, bolder climate action."

Cities

Provide local context, have established mechanisms for community engagement and can drive urban policymaking decisions.

Infrastructure Owners-Operators

Ensure infrastructure delivers reliable service through efficient operation and maintenance during its long lifespan.

Civil Society and Knowledge-based Organisations

Play a key role in advocacy, community engagement and capacity building.

"We need all hands on deck for faster, bolder climate action."

Secretary General António Guterres

Engineering Associations and Industry Bodies

Provide technical guidance and standards, and access to a global pool of experts to support projects.

Engineers and engineering-inclusive firms

Deliver the critical projects that will ensure a more resilient, carbon-neutral future. They hold the real-world technical expertise, invest in innovation and are key to delivering large-scale impact at pace.

Government (all levels)

Establishes the policies and regulatory environment that enable finance, technology, and innovation, as well as provides funding and establishes a project pipeline.

Academia

Provides the latest research and development and can spur innovation in governance, technology, and materials, as well as monitoring and evaluation of progress and impact.

Investors

Can determine the pace and scale of sustainable and resilient infrastructure development through the projects they fund.

© Finn Iispeert

2. ELEVATING THE AGENDA FOR RESILIENCE AND ADAPTATION

The pursuit of climate adaptation and resilience is often separated from the net-zero agenda, but as global efforts leap towards green energy and decarbonisation, there is also an opportunity to embed resilience within infrastructure projects and ensure that adaptation and resilience are on an equal footing with mitigation.

This can be achieved through deep and open cooperation among countries and stakeholders. Knowledge-sharing, technology transfer, and climate and disaster finance are just some mechanisms that will lead to the development of holistic, scalable solutions.

The Race to Resilience and the Sharm El-Sheikh Adaptation Agenda, which was launched at COP27, are two key initiatives that aim to elevate climate resilience and adaptation and drive its implementation.

What is the Race to Resilience?

The High-Level Climate Champions Race to Resilience, the sibling campaign of Race to Zero, was launched at the Climate Adaptation Summit on 25 January, 2021 by Alok Sharma, COP26 President designate, after an opening statement from Ban Ki-moon, 8th Secretary General of the United Nations.

Through a partnership of initiatives, the campaign focuses on helping urban, rural and coastal communities build resilience and adapt to the impacts of climate change, such as extreme heat, drought, flooding and sea level rise.

The Race to Resilience campaign seeks to catalyse action by non-state actors to build the resilience of 4 billion people from vulnerable groups and communities to climate risks by 2030.

The ICSI Race to Resilience

ICSI is an official Partner Initiative of the Race to Resilience global campaign. ICSI's campaign aims to mobilise the engineering community to build and enhance climate resilience of infrastructure through their work. We engage engineering firms, infrastructure owners-operators, individual engineers and enabling organisations (civil society, academia) to achieve our target and contribute to the wider Race to Resilience target.

Through these partnerships, ICSI catalogues infrastructure projects that improve the resilience of the communities they serve, using the Race to Resilience metrics framework. Through building a database of such projects, the ICSI Race to Resilience campaign collects data on best-practice infrastructure projects that directly impact resilience attributes, thereby contributing to the Race to Resilience's overall target.

Delivering impact

ICSI is mobilising the engineering community to build and enhance climate-resilient infrastructure. ICSI's side events at COP27, along with our continued involvement in the UNFCCC-backed Race to Resilience campaign, have allowed us to bring together key stakeholders to accelerate the transformation of our infrastructure for a just, sustainable and resilient future. In 2022, ICSI engaged 89 organisations through events and projects, reaching over 2,200 people across 51 countries. ICSI was delighted to host a number of engaging and collaborative side events at COP27, where we worked to drive the adaptation and resilience agenda.

By 2030, ICSI has pledged to influence and/or deliver 3,780 projects to improve the climate resilience of 567m people through its partnerships and networks.

Why engineers?

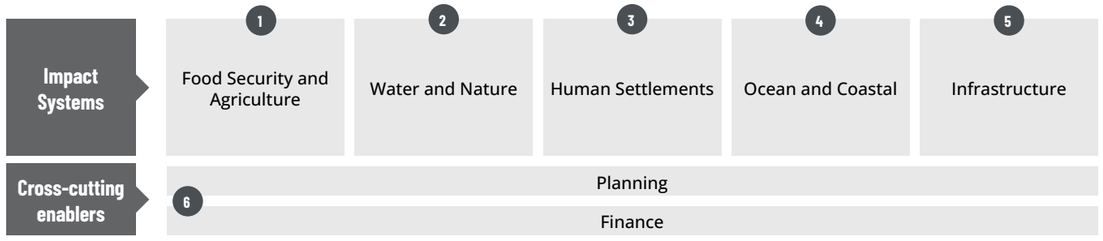
Engineers are the custodians of the built environment and therefore have a crucial role to play in responding to the climate crisis; they hold the technical expertise and credibility needed to drive solutions and implement action. The engineering community is well-positioned to make an impact beyond its own industry, to influence policy and planning, and to become leaders on climate action.

The Sharm El-Sheikh Adaptation Agenda

The Sharm El-Sheikh Adaptation Agenda is a comprehensive, shared agenda launched by the COP27 Presidency to rally global action around 30 adaptation outcomes that are needed to address the adaptation gap and achieve a resilient world by 2030.

Extreme weather events from heatwaves to floods and forest fires have become an everyday reality of our lives. Enhanced global action on adaptation and resilience is an utmost priority, even in a 1.5°C world. In response to the devastating impacts of climate change affecting vulnerable people all over the world, the COP27 Presidency launched the Sharm-El-Sheikh Adaptation Agenda (SAA) in partnership with the High-Level Champions and the Marrakech Partnership in November 2022. The SAA outlines 30 Adaptation Outcomes that are urgently needed to increase the resilience of 4 billion people to accelerate transformations across five impact systems (Figure 2).

Figure 2: Marrakech Partnership Resilience Impact Systems



The SAA underpins and provides the actionable breakthroughs required for the Race to Resilience campaign to accelerate the investment and implementation of adaptation solutions, and to put people and nature first in pursuit of a resilient world.

Collectively, these outcomes represent the first comprehensive global plan to rally both the public and private sectors behind a shared set of adaptation actions that are required by the end of this decade across the five impact systems and including enabling solutions for planning and finance.

Access the agenda here.

Taking action – COP27 Transport Implementation Lab

At COP27, ICSI delivered an Implementation Lab event, *Engineering the vision for climate-resilient transport*, in partnership with Resilience Rising, the Global Covenant of Mayors for Climate and Energy (GCoM), and the Institution of Civil Engineers (ICE). This event highlighted key issues to drive ambition and action to deliver on the Sharm-El-Sheikh Adaptation Agenda, a COP27 presidential initiative outlining 30 Adaptation Outcomes to enhance resilience for 4 billion people living in the most climate vulnerable communities by 2030. In particular, the focus of this event was on the progress and implementation of the resilience and adaptation outcome target, that: 'Transport infrastructure be resilient to climate hazards through the adoption of new technology, design, and materials.'

The session brought together transport experts from the global engineering community, including from the private sector, professional associations, academia, and key transport industry bodies, alongside representatives from the policymaker and investor communities. Participants shared current best practices and available solutions and discussed how to operationalise this resilience and adaptation breakthrough.

The session featured showcases from the rail and road sectors, as well as on guidance, tools, and standards, and showcased over 50 resources, case studies and initiatives across transport modes and with examples from both developed and emerging economies.

Over 20 participants had the opportunity to share current best practices and available solutions from their local context.

Participants were also encouraged to share case studies of climate-resilient transport solutions to accelerate collaboration and knowledge-sharing. These collated case studies can be accessed here.

The COP27 Transport Implementation Lab event initiated a powerful call to action: to mobilise the global engineering community - including key transport industry bodies, the private sector, professional associations, academia, and civil society - to work together with the policymaker and investor communities on developing a target for climate resilient transport systems by COP28.

For a robust target and an associated implementation roadmap to be developed, an all-hands systems approach must be adopted to ensure that this work supports and links into the wider resilience adaptation outcome around equitable access to sustainable transport, as well as the outcomes identified for the other infrastructure systems that are connected to the transport sector, e.g., energy. This will involve engaging all transport modes, embracing radical collaboration, working closely with other Marrakesh Partnership thematic areas and the High-Level Climate Champions, and building on existing partnerships, as well as forging new ones.

Read more about this event here.

3. SPOTLIGHT ON IMPLEMENTATION

This chapter outlines key progress on implementation and spotlights best-practice projects and solutions from around the world. It also showcases resources that enable implementation, and capacity-building initiatives that accelerate it.

These are divided into three categories:

- Projects and Solutions
- Knowledge and Capacity Building
- Collaborative Initiatives

Projects and Solutions

The projects and solutions showcased here serve as best practice examples from across the globe. From exemplary participatory processes to new and innovative ways to harness technology for sustainable development, these case studies each demonstrate ways to deliver solutions for infrastructure that work to uplift nature instead of dominate it, put human wellbeing at their core, and build climate resilience and adaptation.

Contributions to the Race to Resilience target and to the Sharm El-Sheikh Adaptation Agenda outcomes have been highlighted where relevant.

PROJECT LOCATIONS

EAST SIDE COASTAL RESILIENCY PROJECT, NEW YORK CITY, USA

Sector

WATER

Highlights

Community engagement

Coastal Resilience

Project owner
New York City

Project start/completion
2021 - Ongoing

Location
New York City

Community impacted
Urban, Coastal

Climate hazards mitigated
Flooding

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Ocean and Coastal Impact System.

Case study provided by

ARCADIS

Find out more

The East Side Coastal Resiliency (ESCR) Project is a coastal protection initiative, jointly funded by the City of New York and the federal government, aimed at reducing flood risk due to coastal storms and sea level rise on Manhattan's East Side from East 25th Street to Montgomery Street.

ABOUT THE PROJECT

The City of New York has worked hand-in-hand with community partners and residents to identify the best ways to meet the many challenges caused by the climate crisis, including sea level rise and more frequent, intense storms. Community engagement has been a priority for the East Side Coastal Resiliency Project. Through numerous public design workshops, the community reviewed and discussed various approaches using three-dimensional models and drawings of different design options. To better understand community needs, the project design team also analysed earlier plans and projects in the area.

The project area, spanning from Montgomery Street to East 25th Street, is located within the Federal Emergency Management Agency (FEMA) 100-year floodplain and includes a large and diverse residential community of more than 110,000 New Yorkers.

ESCR will create a 2.4 mile flood protection system consisting of floodwalls and floodgates that will be blended into the fabric of the community by integrating with local streets, the elevated East River Park and the new landscape surrounding Corlears Hook Park, Murphy Brothers Playground, Stuyvesant Cove Park, and Asser Levy Playground. The project will also involve significant investments in underground interior drainage improvements that will improve the capacity of the sewer system.

This project is the result of years of planning and collaboration among city, state, federal agencies, elected officials, and the local community, which has been enabled by a $338 million federal grant to fund design and construction, with the remainder of the project's $1.45 billion total cost funded by the City of New York.


© Noah Negishi

The ESCR Project is the first step in the City's plan for a larger coastal protection system in Lower Manhattan. While the project is being designed as a stand-alone 'compartment' to reduce flood risk between East 25th Street and Montgomery Street, it will tie-in with complementary initiatives in Lower Manhattan, including the Lower Manhattan Coastal Resiliency, Resilient Neighborhoods Study, Con Edison Resiliency, Hospital Row Investments, and NYCHA Resiliency.

INTENDED OUTCOMES

In 2012, Hurricane Sandy struck New York City, killing 44 New Yorkers, devastating entire neighbourhoods, and causing approximately $19 billion in damage citywide. The Lower East Side was one of the most impacted communities during the hurricane. In the aftermath of the storm, New York City launched a process to assess climate change vulnerabilities and began advancing an ambitious portfolio of long-term coastal protection projects that will prevent flooding while increasing the vibrancy and accessibility of public waterfront spaces. When completed, the ESCR Project will result in a climate robust and attractive corridor that protects the community from future storm surges.

ESCR is a one-of-a-kind, forward-thinking resiliency project being constructed in a dense urban environment with complex below and above-ground infrastructure. This project is intended to build physical, social, and economic resiliency, strengthening the city's coastline while improving waterfront open space and accessibility.

The project design integrates flood protection into the community fabric, improving waterfront open spaces and access, rather than walling off the neighbourhood. ESCR will also offer protection to critical infrastructure—including a major pump station and an electrical substation that powers much of Lower Manhattan—as well as numerous local schools and libraries.

Desired outcomes include:

- **Flood Risk Reduction** from future storm surge and sea level rise;
- **Improved Access** with expanded connections between local communities and the waterfront, and designing to meet universal access standards;
- **Enhanced Public Spaces** with resilient design, updated recreation facilities, increased multi-use spaces, new furnishings, and ecologically diverse landscaping.

Number of vulnerable people made more resilient:

110,000

COMMUNITY-BASED WATER STEWARDSHIP, CHINA

Sector

WATER

Highlights

Community engagement | Capacity building | Nature-based solution | Biodiversity

Project owner
Conservation International

Project start/completion
2019 - Dec 2021

Location
Guangdong Province, China

Community impacted
Rural

Vulnerable groups impacted
Rural residents in key water source areas

Climate hazards mitigated
Water stress

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Water and Nature Impact System.

Case study provided by

CONSERVATION INTERNATIONAL

Find out more

The pilot communities currently have no wastewater treatment facilities, resulting in the direct discharge of sewage to nearby streams and a water supply reservoir, which negatively impacts human and ecosystem health. An innovative community-based participatory approach to designing, building, and maintaining wastewater treatment wetlands is being applied to improve sustainability and freshwater conservation.

ABOUT THE PROJECT

The Dongjiang River in southern China provides drinking water for 40 million people, from city dwellers in Hong Kong to rural residents.

But this critical freshwater ecosystem is being pushed to its limits. With limited effective wastewater treatment facilities in the countryside, sewage often seeps into the freshwater resources that people depend on — and local officials are struggling to combat the pollution degrading the Dongjiang River.

Using the results of Conservation International's Freshwater Health Index (FHI) — a tool to help local decision-makers create healthier watersheds — people in the villages of Xiadong and Lixi, in the Dongjiang River Basin, embarked on a project to improve community-based water stewardship. With funding from Conservation International, they led the design and construction of nature-inspired water treatment systems that mimic wetlands' ability to purify water contaminated by chemicals and waste.

Community members and stakeholders were engaged in the entire project process beginning at site selection and investigation, and the drafting of a project implementation plan that establishes a core project implementing team and a water environment management team. The core project implementing team is composed of members from Conservation International and local partners, and includes experts in water treatment, community and capacity building, nature education, and project management. The water environment management team, composed entirely of community members, co-designs the treatment system and is responsible for building and maintaining the new wastewater treatment wetlands in their communities. Treatment wetlands use a combination of ecosystem and conventional treatment approaches to clean the water, improving ecosystem health and freshwater supplies.

These 'constructed wetlands' work by facilitating the flow of contaminated water through traditional infrastructure, such as shallow septic tanks, into natural ecosystems such as marshes, plants and soil that absorb pollutants and filter the water. Every year, the engineered wetlands treat up to 9,000 tons of sewage in the two villages before returning the water to the river.

ACHIEVED OUTCOMES

As part of the programme, Conservation International helped train a group of villagers as guides to showcase the wetlands, offering educational tours of the apiaries where beekeepers harvest honey, the native herb and bamboo forests, and orange orchards. A portion of the revenue from the tours goes to a community water fund, which was set up to support the wetlands' maintenance.

"We villagers now actively take part in testing water quality monthly, patrolling along the river twice a week, and cleaning leaves and branches from it," said Yanghui Dai from Xiadong Village. "The project is not only about constructing a wetland, but more about the actual changes to local people's lives by bringing in economic benefits and an improved environment that attracts more and more visitors."

Along with treating wastewater, these natural systems are providing habitat for native waterfowl, fish, frogs, insects and other species.

"Since the project began, we have seen a rise in the amount of wildlife in the area. With clean water, the animals can thrive at the same time that we are creating freshwater infrastructure to help people."

Weiling Wu, Conservation International

How has carbon mitigation been integrated?

Compared with traditional grey infrastructure for sewage treatment, the constructed wetland system does not consume electricity for operation. It made use of topographic relief to direct water flows and semi-natural wetland ecosystem to degrade pollutants. This helps save considerable amount of energy and reduce carbon release in the long run. Furthermore, growth of aquatic plants has certain carbon sequestration effects.

Number of vulnerable people made more resilient:

200

OHIO CREEK WATERSHED PROJECT, VIRGINIA, USA

Sector

WATER

Highlights

- Community engagement
- Coastal resilience
- Nature-based solution
- Ecological uplift
- Green-grey infrastructure

Project owner
City of Norfolk, Virginia

Project start/completion
2016 - December 2022

Location
Norfolk, VA

Community impacted
Urban, Coastal

Climate hazards mitigated
Flooding

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Ocean and Coastal Impact System.

Case study provided by

ARCADIS

Find out more

In the Ohio Creek Watershed project, the city is employing a multi-layered approach to mitigating current and future flooding concerns. The $122-million project aims to help mitigate both regular nuisance flooding and storm-surge flooding in the historic Chesterfield Heights neighbourhood. The strategies deployed will offer city officials valuable insight for future planning while creating best practices that other flood-threatened urban centres can follow.

ABOUT THE PROJECT

In Chesterfield Heights, rainstorms regularly cause nuisance flooding on neighborhood streets because ageing infrastructure is unable to handle stormwater effectively. Flooding also raises safety concerns. The neighborhood, which is partly cut off from the rest of the city by Interstate 264, can only be accessed by two streets. During flooding events, those roads may be impassable.

In 2017, the state was able to secure a $112-million resiliency grant through the Dept. of Housing and Urban Development's National Disaster Resilience Competition. As part of conceptual design, the city and designers worked with the community to devise a strategy that would not only address flooding concerns and make the neighbourhood more resilient, but also provide other improvements for the community.

The final design concept called for a mix of hard infrastructure and natural solutions. Near the shoreline, crews would construct more than 1,000 linear ft of floodwall, along with more than 2,000 linear ft of living shoreline. Based on National Oceanic and Atmospheric Administration sea level rise projections, an earth berm was built to an elevation of 12 ft. It extends from the floodwall, across the shoreline and into the neighbourhood. The combination of floodwall and berm create a continuous coastal defence system for the entire community.

At the foot of the berm along Ohio Creek, the team designed a living shoreline to provide a natural buffer against wave action and surge; the design was largely based on studies of wave energy. Along the side closest to the Elizabeth River, a hardened approach was used, incorporating large areas of rip-rap stone to armour the shore. In areas subject to less wave action, vegetated shoreline was installed. Oyster reefs were also created in some areas with rip-rap fill, providing small breakwaters just offshore. Although the living shoreline is located on the other side of the berm from the neighborhood, the community can walk along the berm or gain access to a new fishing pier to better experience the new shoreline.

Designers added a tide gate to the floodwall that can be operated by city staff, as needed, in the event of a storm. As part of that project, VHB also enhanced an existing marsh on the neighborhood side of the gate, where water will be able to move in and out as needed. Numerous solutions were also designed to help alleviate flooding, including two large pump stations. Stormwater systems were also improved in the neighborhoods, with new large-diameter drainpipes installed along streets that are already prone to nuisance flooding. Planted bioswales and permeable pavers were also added to help convey stormwater.

To address access issues, roadways that regularly flood were raised. Because the neighborhood had limited access to begin with, existing roads needed to be kept open while construction crews built raised roadways on new alignments, including a new 30 ft span precast concrete bridge. Sidewalks and paths were also added to expand transportation options, helping to improve access to a light rail station located just outside the neighborhood.

Green space was converted to 'stormwater parks', which also help capture runoff and lessen flooding. The strategy provides a public amenity, too. The largest of the parks is an area adjacent to a school, which has been converted to play fields once the area was graded to alleviate standing water and help better direct runoff.

ACHIEVED OUTCOMES

The Ohio Creek integrated plan results from the Dutch Dialogues planning process and Norfolk's participation as a 100 Resilient City member. The extensive participatory effort acknowledged the regional economic, watershed and infrastructure context, resulting in a multifaceted and multidisciplinary project scope.

As determined by the needs of the residents, the watershed project had three goals:

- Design a coastal community capable of dealing with the increased risk of flooding
- Create economic opportunity by promoting the growth of existing and new industry sectors
- Advance initiatives to connect communities, alleviate poverty, and strengthen neighbourhoods.

The Ohio Creek community is better protected to withstand impacts of weather events such as extreme precipitation and storm surge as well as more intense future weather events. The constructed solutions serve multiple purposes, supporting the community and local ecology. A variety of community amenities have been embedded, including innovative features such as permeable roads which have water quality benefits and a positive effect on water storage capacity, and bioswales which store large volumes of water and form green elements in the community. The natural waterfront edge enhances ecological value over time.

Number of vulnerable people made more resilient:

2,000

“During our dialogue with the community, we toured around the neighborhood and you felt how deep their connection with the water goes. That’s not something you want to take away with a big wall. We wanted them to stay connected.”

Edgar Westerhof, North America Climate Adaptation Director, Arcadis

UNLOCKING PROSPERITY IN THE HORN OF AFRICA

Sector

TRANSPORT

Highlights

Economic development

Poverty reduction

Project owner
UK Aid, implemented by TradeMark Africa

Project start/completion
Nov 2020 - Ongoing

Location
Somaliland

Community impacted
Urban

Vulnerable groups impacted
Women and girls, Youth, Elderly people, Indigenous and traditional communities, Internally displaced people

Climate hazards mitigated
Water stress, Extreme wind

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Infrastructure Impact System.

Case study provided by
Foreign Commonwealth and Development Office

Find out more

The UK is supporting development of the 'Berbera Corridor,' between Berbera Port in Somaliland to the Ethiopian border at Tog Wajaale. The Unlocking Prosperity in the Horn of Africa programme aims to improve transport infrastructure, trade efficiency, local economic development and increase market access. When fully operational, a competitive Berbera Corridor will support prosperity and poverty reduction in Somaliland, Ethiopia and the wider Horn of Africa region.

ABOUT THE PROJECT

Upgrading critical road infrastructure along the Berbera Corridor is a catalyst for economic transformation in the Horn of Africa. This programme supports construction of the 22.5km climate-resilient Hargeisa Bypass, a critical component of the Berbera Corridor, aiming to decongest traffic through Somaliland's capital city and reduce transportation time and costs.

Road assets are vulnerable to climate stressors such as higher temperatures, increased precipitation, or flooding. This programme took a systemic approach to embedding climate resilience through 1) 'zooming in' on the bypass road infrastructure future climate risks and vulnerabilities; and 2) 'zooming out' on the ecosystem and communities living along the Berbera Corridor future climate risks and vulnerabilities. A climate risk and resilience matrix, the first of its kind for regional infrastructure in the Horn, provided the following infrastructure recommendations, which were implemented during construction:

- Flood estimates uplifted by 20% for bridge and culverts
- Changes in design and location of 210m Wadi bridge to address vulnerabilities identified
- Increase in number of culverts from 12 to 24
- 80% of workforce from Somaliland.

Longer-term resilience recommendations along the corridor included enhancing food storage trade for perishable products, improving access to water points and veterinary services for livestock trade, and improving storage and distribution for the fisheries sector.

ACHIEVED OUTCOMES

When construction is completed, this programme will have delivered the longest bridge in Somaliland, facilitated faster movement of emergency humanitarian goods to vulnerable communities in the region and reduced time and cost of freight along the Berbera Corridor. Stimulating business growth and connectivity encourages regional prosperity, stability and poverty reduction.

Improvements in transport infrastructure, trade arrangements and linkages with local economies will produce a more efficient, investable, and inclusive Berbera corridor with positive long-term impacts on economic growth, stability and poverty reduction.

Number of vulnerable people made more resilient:

~1,200,000

Hargeisa Bypass. Source: FCDO

UPGRADE OF THE SECTION 1 OF THE A380 ROUTE, UZBEKISTAN

Sector

TRANSPORT

Highlights

Innovative technology

Smart materials

Artificial Intelligence

Project owner
Uzbekistan Government

Project start/completion
June 2023 - Ongoing

Location
Uzbekistan

Community impacted
Rural

Climate hazards mitigated
Extreme heat

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Infrastructure Impact System.

Case study provided by

ORIS

Find out more

ORIS, the first digital materials platform for sustainable roads, worked with the Asian Development Bank to perform an expert due diligence on the A380 route upgrade project in Uzbekistan. This road project is among the Asian Development Bank's strategic investments with the route being one of the major trade routes in Central Asia and part of the road networks connecting the Caucasian region to Eastern Asia. The A380 also connects the Southern and Western part of Uzbekistan to its neighbouring country, Kazakhstan.

ABOUT THE PROJECT

The upgrade of section 1 of the highway A380 in Uzbekistan is a 25 km section running from Turtkul towards Nukus and is to be widened from one lane per way to two lanes per way, with a separated carriageway.

The upgrade of the section aims to reduce the travel time by 15%, and increase the daily traffic by 54% to reach 5.1m vehicles per year while reducing fatalities by 10% along the section, and improve resilience to climate change. Multi-criteria simulations were performed on the ORIS platform to find an optimum design on costs, carbon emissions, and resource consumption. A safety due diligence on designs and alignments was performed to provide recommendations on road safety. In addition, an assessment of risks linked to climate change over 40 years was performed to anticipate resilience to climate change.

Supported by Artificial Intelligence and its unique algorithms, ORIS assesses the impact of linear infrastructure designs in a multidimensional view. The platform allows users to compute parameters and data such as materials properties, geolocation, expected traffic and weather conditions for an effective and sustainable construction efficiency.

Based on this data-driven analysis, users make informed decisions for smart materials consumption.

With the support of ORIS, users are able to assess multiple pavement design solutions according to different criteria, including: costs, carbon footprint with a whole lifecycle analysis using international standards, reduction of primary resources usage thanks to circular solutions, road safety using the iRAP methodology and resilience to climate change based on risks and climate scenario.

ACHIEVED OUTCOMES

This due diligence was carried out in Spring 2022. The platform modelled over 40 years how climate change would impact the project. The analysis showed that the A380 section 1 is at high risk of heat rise, heavy cycle of frost/thaw, increase of water run-off and silting. For each risk, a set of countermeasures was identified to mitigate those risks. Overall, the analysis identified a $19.4m investment on adaptation and mitigation measures to limit damages and avoid early repair needs.

"Thanks to all innovations embedded and the quick and numerous digital iterations performed through ORIS, the A380 project is shaped to align with our climate ambitions. We have discovered a new capacity to comply with the highest climate requirements of ADB in terms of the project's resilience, its carbon emission, mitigation and adaptation measures".

Pawan Karki, Asian Development Bank.

GREEN-GREY INFRASTRUCTURE IN CONCEPCIÓN, PHILIPPINES

Sector

TRANSPORT

Highlights

Coastal resilience | Community engagement | Supporting livelihoods | Capacity building | Nature-based solution | Biodiversity | Green-grey infrastructure

Project owner
Bagongon Fisherfolk Association

Project start/completion
2015 - 2021

Location
Bagongon, Concepción, Iloilo, Philippines

Community impacted
Rural, Coastal

Vulnerable groups impacted
Coastal communities, fishing communities

Climate hazards mitigated
Flooding

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Ocean and Coastal Impact System.

Case study provided by

CONSERVATION INTERNATIONAL

Find out more

In Bagongon island, the Green-Gray Community of Practice has focused on three key objectives:

- **Rebuild coastal sediment by replanting mangroves;**
- **Halt the ongoing beach erosion, and;**
- **Reduce the effects of extreme weather events on residents living in the Bagongon cove.**

ABOUT THE PROJECT

Because of mangrove deforestation, an approximately 200m width of coastline in Bagongon eroded. Most of the population (489 households) is densely concentrated in a cove, where the storm surge and wind wave potential are high. The green-grey project includes mangrove planting within sediments accumulated behind sediment-trapping fences and new rock breakwaters for wave attenuation. The goal of the sediment-trapping fences and wave attenuation structures is to promote beach growth where mangrove seedlings can be planted. The wave attenuation structures at Bagongon were placed on the 'surf side' of the sediment trapping fences to reduce the effects of wind waves and storm surge on the communities until the mangrove rehabilitation occurred. Construction materials were locally sourced and included bamboo poles, bamboo mats, coconut coir mats, twine, sand, and rock. Once the restored mangrove ecosystem is established, the sediment trap and wave attenuation structure materials can be reused in other locations to support similar beach growth and mangrove rehabilitation efforts. Off-shore, marine protected areas conserve coral reef ecosystems, that provide additional risk reduction benefits. The community was engaged throughout the design development process and members of the Fisherfolk Association were hired to construct the project features.

ACHIEVED OUTCOMES

So far, a total of 110,363 seedlings of native species have been planted covering an area of 11 hectares of mangrove rehabilitation and establishing a 769.7 hectare community-based marine protected area (CB-MPA), which included capacity building and training. The mangrove and coral reef restoration aids with flood regulation and protection from storm surge.

The community has been directly engaged in the restoration and implementation of the project. As part of the effort to incentivise community participation, two livelihood projects were included: the production of coconut-based products and the production of virgin coconut oil (VCO) as liniment and ointment. This supports the community which is heavily reliant on fishing to diversify their income, and increases resilience during typhoons, monsoons and other extreme weather events that affect fishing.

The project also supported the community in establishing a Barangay Emergency Response Center and emergency response plans.

The project goal was to increase the resilience and security of small island communities and ecosystems to climate change and disaster risk by:

- Increasing environmental and community capacity to avoid and/or withstand impacts of extreme events like typhoons
- Reducing fatalities and damage to livelihoods and structures during extreme climate-related events and disasters
- Reducing dependence on relief and development programmes from the government, NGOs, humanitarian groups and official development assistance from other countries
- Restoring important natural resources and elements of the unique biodiversity of the Philippines to bolster food security
- Diversifying livelihood activities to bolster profitability and sustainability of the long-term economic development of partner communities (e.g. increased income, better access to social services such as health and education, improved wellbeing)
- Integrating green-grey engineering concepts and related-strategies into planning, implementation and evaluation processes from the local to national level, leading to relevant policies, national priorities, and gaining broad-scale support from the national government agencies (e.g. faster processing of requests, financial and technical assistance) in the process
- Scaling up green-grey approaches across the Philippines and other countries made possible as the project provides effective examples of a demonstrable and replicable strategy for climate change resilience, integrating green approaches with traditional engineering to increase resilience in a highly vulnerable key biodiversity area in a developing country where there are very limited resources.

Number of vulnerable people made more resilient:

1,300

“We did not have an appropriate system [Emergency Response Plan] like this before, as we were not actively engaged as a community, but we were able to achieve this now through the participation of our members and community (...) Now we believe we are more prepared to face the challenges of Climate change.”

Vivian Amasan, Community Leader, Bagongon Fisherfolks Association

Community engagement meeting. Source: Conservation International

Volunteers help with planting. Source: Conservation International

LA GOGUE DAM, SEYCHELLES

Sector

WATER

Highlights

Community engagement | Capacity building | Gender equality | Supporting livelihoods

Project owner
Public Utilities Corporation (PUC)

Project supporter
African Development Bank

Project start/completion
2018 - Ongoing

Location
North Mahé, Seychelles

Community impacted
Urban, Rural, Coastal

Climate hazards mitigated
Drought

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Water and Nature Impact System.

Case study provided by

Public Utilities Corporation

The raising of La Gogue Dam is one of the major civil engineering projects being undertaken by the Public Utilities Corporation (PUC), a state-owned company that operates and manages the dam.

ABOUT THE PROJECT

The main aim of the project is to increase the storage capacity of La Gogue dam by 60% (from 1Mm^3 to 1.6Mm^3) as part of a nationwide effort to improve raw water storage systems and thus improve climate resiliency. This will lead to a reduction in the need for water-rationing during dry seasons due to insufficient supply to match the increasing demand. It will also support the tourism industry (the country's main economic driver) and manufacturing/industries e.g. fisheries/beverages. Access to clean water supply throughout the year will also be a contributing factor to the maintenance of high social development indicators, such as gender equality or quality of life.

The dam is the largest of two in the country and is the main water store for the island which houses the majority of the country's population (about 100,000 people). The raising of the dam includes the following main components:

- Raising of the dam's embankment by 6m; the full storage capacity will be increased by 600,000 m^3
- Seepage control measures for the natural north and south saddles
- The construction of a new spillway on the right embankment
- The raising of the intake tower by 6m
- Replacement of all ductile iron pipelines, valves, and fittings that are housed in the intake tunnel
- Construction of temporary and permanent roads.

INTENDED OUTCOMES

Environmental

The increased storage capacity will improve water supply services during dry periods and will also lead to a reduction in energy costs from the operation of desalination plants (though these will still act as back-up). The increased water production capacity will help to reduce the dependency of households on bottled water during dry periods. The establishment of a catchment and buffer zone (no-development zone) around the dam will also help to ensure the dam's security from contamination.

Social

This project has helped to create job opportunities during the implementation stage, and will continue to do so through the operation and maintenance of the dam. Gender equality has been prioritised throughout the consultation process by targeting women engineers for on-job training and offering project management and dam construction training for both men and women.

The project will also lead to improvements in sanitation facilities in schools (in addition to water tanks) and a reduced need for additional efforts in getting water for households.

Economic

The increased water supply of the dam will support growth in the tourism industry, which is a main contributor to the country's economy, as well as other industries reliant on water.

"The dam is being raised by 6m, determined as the maximum feasible height. This is expected to have a major impact on the country's resilience to climate change as it addresses water supply constraints to the central and northern regions of Mahé during extended dry periods."

Erna Victor, Public Utilities Corporation (PUC)

Lessons learnt from project financing

The project is being financed under a loan from the African Development Bank (AfDB) through the Government of Seychelles. Prior to financing approval, the AfDB conducted an in-depth assessment of the expected outcomes, particularly their feasibility and performance indicators.

Lessons learnt include ensuring that the implementation of highly technical projects is supported through capacity building within the implementing agency due to a lack of expertise in dam construction projects. Therefore, project management training, technical assistance, and an experienced technical firm were included in the project's implementation.

Number of vulnerable people made more resilient:

100,000

Involving the community in decision-making

Consultations and meetings with relevant stakeholders took place during the appraisal mission (prior to signature of financing agreement) as well as during the preparation of the Environmental and Social Impact Assessment (ESIA). The stakeholders involved were the residents of Anse Etoile and Glacis districts, who would be directly affected by the impacts of the project, as well as the two districts councils, represented by members of the National Assembly.

Issues raised during consultations and meetings were:

- Close consultations should be continued with PUC during implementation
- Propose disaster-preparedness emergency plan and train experts in handling emergencies, and
- Door-to-door communication with households close to the dam.

The design of the project has accommodated these three areas of intervention. The consultation process was continued through regional public meetings on Mahé, detailing the relevant works under the project prior to commencement. This was further supplemented by door-to-door visits with households within a close vicinity of the dam as raised in previous consultations.

La Gogue dam - before raising. Source: PUC

La Gogue dam - under construction. Source: PUC

GRAVITY SMART CAMPUS

Sector

TRANSPORT

Highlights

Biodiversity | Innovative technology | Supporting livelihoods | Capacity building | Green-blue infrastructure

Project owner
Gravity

Project start/completion
Aug 2019 - Oct 2021

Location
Bridgwater, Somerset, England, UK

Community impacted
Urban, Rural, Coastal

Vulnerable groups impacted
Economically deprived communities

Climate hazards mitigated
Water stress, Flooding

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Infrastructure Impact System.

Case study provided by

Stantec

Find out more

Facilitating clean growth is key to building resilience to climate change, both through directly reducing carbon and building a strong local economy where people can afford to choose lower carbon goods and services and which can fund climate adaption.

ABOUT THE PROJECT

Gravity is a smart campus led by a clean and inclusive growth strategy, proposed to house 1.1 million m^2 of advanced manufacturing and associated uses and 750 residential dwellings. Gravity is positioned to attract international investment to facilitate a gigafactory to accelerate progress on transport decarbonisation in the UK through the advanced manufacturing of battery technology for electric vehicles. To facilitate access up to the development, which is on a former Royal Ordnance Factory (now fully remediated), a new link road has been constructed and recently completed connecting the site directly to the main highway infrastructure so that development traffic avoids travelling through the local villages. This has been delivered with a surface water and biodiversity strategy to deliver climate resilience and provide net gain. The UNSDGs have been considered throughout the lifecycle of the link road and the project as a whole. Innovations include the implementation of a prefabricated green bridge, a solar powered site compound, solar powered lighting for permanent road signage and solar powered bollards. The reuse of site-won material significantly reduced the carbon impact of the project and the green/blue infrastructure has delivered water sustainability and biodiversity.

The link road included integrated ducting for the provision of dark fibre for communications to provide gigabit telecoms, and for Western Power Distribution to run twin 33KV electricity cables. The project worked with the Hinkley Point C new nuclear build connection project to purchase the material released from the haul road they built to install the new power lines past the Gravity site. This was reused in the road construction, minimising the transport of new materials to the site.

ACHIEVED OUTCOMES

The project has been designed to deliver transformational economic growth in the South West of England, benefiting local communities and areas of deprivation through a Business and Skills Charters, creating new opportunities to transition from the Hinkley Point C nuclear new build project to sustain economic activity, whilst ensuring resilience against climate change.

Key outcomes included:

- A design for the supporting drainage system that significantly exceeds the current minimum requirements for water attenuation, allowing for critical storm events and climate change
- A design that reduces flooding due to surface water run-off on local roads in critical storm events, benefiting local communities
- A design that can better return water to the soil locally through attenuation, addressing rapid loss of water to rivers following heavy rain or after a very dry spell, which will become more frequent with climate change
- A net enhancement of biodiversity, developing resilience of local wildlife populations to climate change, through providing better habitat than was provided on site or in the agricultural fields.

The transport link will enable the site to come forward with jobs for around 7,500 people. Training the local population for new advanced manufacturing jobs will have a direct benefit on the local economy with jobs that will be of direct benefit to the more deprived areas in this area of the South West of England. Delivering high-quality, high-value jobs in Somerset will also reduce out-commuting, reducing car use and carbon impacts. There will also be benefits to the local populations of the villages adjacent to the site, Puriton and Woolavington (c.4500), who will benefit from new walking and cycling infrastructure between the villages and the removal of traffic from the villages.

How has carbon mitigation been integrated?

Various link road options were appraised to consider the impact on the environment and maximise carbon reduction. The least carbon intensive option was carried forward. Material was re-used from both the nearby M5 J25 works and the Gravity main site, significantly reducing GHG and carbon emissions. No material was exported from site. Recycled plastic crates were used to construct an attenuation tank.

Enhancing resilience of natural systems

The road has been designed using Sustainable Urban Drainage System principles. Four large catchment attenuation features have been constructed, three of which have high biodiversity quality with a permanent cold-water store with planting for biodiversity. The surface water run off attenuation is the top 200mm of each pond. By attenuating water, high rainfall can be diverted into dry soil following drought conditions when it would normally quickly run off.

The proposed development landscaping will deliver over 5,000 trees, 2,600m of hedgerows and 5.68KA of meadow grassland providing both biodiversity and carbon sequestration. The species used in the planning will be a mix of native species to support biodiversity. By increasing biodiversity with carefully chosen species, we will be increasing our resilience to climate change.

In addition, the scheme includes a green bridge designed to reduce the severance impacts of the new road and allow safe crossing, away from traffic and environmental impacts, for humans and biodiversity.

APALACHICOLA BAY LIVING SHORELINE

Sector

WATER

Highlights

Coastal resilience | Nature-based solution | Ecological uplift | Carbon sequestration | Supporting livelihoods

Project owner
Apalachee Regional Planning Council

Project start/completion
Jul 2020 - Ongoing

Location
Franklin County, Florida, USA

Community impacted
Coastal

Vulnerable groups impacted
Youth, Low-income communities

Climate hazards mitigated
Flooding, Hurricanes/Cyclones

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Ocean and Coastal Impact System.

Case study provided by

Find out more

This nature-based solution involves creating up to 20 acres of engineered oyster reefs and up to 30 acres of salt marshes to attenuate wave action and help protect the vulnerable coastline and critical infrastructure from erosion. The project also provides ecological uplift through oyster repopulation, habitat enhancement and improved water quality.

ABOUT THE PROJECT

A 6-mile segment of Highway 98 that traverses Apalachicola Bay on the Florida panhandle lies directly beside the water's edge. Wave energy, rising tides and severe storms make this stretch of shoreline, and the adjacent roadway infrastructure, particularly vulnerable to chronic erosion.

Due to the importance of this highway as a designated hurricane evacuation route, millions of dollars have been spent trying to protect the roadway. Over the years, efforts have been undertaken to stabilise the shoreline using various types of armouring, including vertical concrete seawalls, rock rip-rap, concrete rubble and articulated-concrete block mats. However, the shoreline and critical waterfront asset have continued to sustain damage.

Unlike natural habitats, such as oyster reefs and salt marshes, man-made armouring is unable to repair itself after being damaged by waves. Taking this into account, the Apalachee Regional Planning Council (ARPC) partnered with WSP USA to explore a different approach involving design and implementation of a living shoreline project.

The nature-based solution involves establishing an intertidal marsh through the introduction of oyster reefs to attenuate wave energy. As one of the largest oyster fisheries in the United States, the economy and ecology of Apalachicola Bay have always been closely intertwined — the oyster fishery has suffered significant decline in recent decades and nearly total collapse in 2012. The project will enhance ecological functions of the coastal habitats and help to restore the hard-hit oyster fishery, while also building the resilience of the shoreline and infrastructure, and enhancing recreation opportunities in the area.


Source: WSP

Initially, WSP assisted ARPC in developing the project concept and prepared grant applications. ARPC was awarded funding for the project through National Fish and Wildlife Foundation's Emergency Coastal Resilience Fund and Gulf Environmental Benefit Fund programmes. WSP then completed an initial Coastal Conditions Analysis and gathered field data needed to support the design including ecological surveys, geotechnical data, and elevation surveys, and are providing design, construction support and monitoring through 2024.

INTENDED OUTCOMES

The project provides added protection to Highway 98, a critical disaster evacuation route, as well as the primary access to education, jobs and services for area residents, and for emergency services vehicles to reach residents. Environmental benefits are numerous; the establishment of the saltmarsh habitat supports carbon sequestration. Saltmarshes absorb and store large quantities of carbon dioxide that contribute to the effects of climate change. According to the National Oceanic and Atmospheric Administration, "mangroves and salt marshes remove carbon from the atmosphere at a rate 10 times greater than tropical forests" and "store three to five times more carbon per acre than tropical forests." Additionally, the engineered oyster reef system establishes a foundation for the oyster population to proliferate and build resilience to wave action and storm surge. The oysters also clean the water and serve as a food source, while the salt marshes provide habitat for birds, fish, crabs and other species.

Local communities will benefit from increased resilience of the shoreline and adjacent critical infrastructure, ecological uplift provided by the improved marine habitat, environmental co-benefits of improved water quality and biodiversity, and economic benefits of a restored oyster fishery.

Number of vulnerable people made more resilient:

>12,500

CLIMATE RESILIENCE OF WATERSHEDS, NEPAL

Sector

WATER

Highlights

Community engagement | Capacity building | Gender equality | Supporting livelihoods

Project owner
Government of Nepal's Department of Forests and Soil Conservation (DFSC)

Project start/completion
Jan 2014 - Feb 2021

Location
Nepal

Community impacted
Rural

Vulnerable groups impacted
Women and disadvantaged groups, indigenous people

Climate hazards mitigated
Water stress

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Water and Nature Impact System.

Case study provided by:
Asian Development Bank

Find out more

The BCRWME project aimed to ensure a reliable water supply for domestic and agricultural use for about 45,000 households. At completion, the project improved water management and storage practices and works to protect the areas around water sources to increase the volume of clean water in 1,251 settlements benefitting over 51,000 households. This included interventions to protect springs and augment groundwater recharge within their watersheds, building water collection ponds, plantations, erosion protection, and educating communities on water conservation practices.

ABOUT THE PROJECT

The BCRWME project was implemented in the watersheds of Nepal's lower basins of the West Seti and Budi Ganga rivers (tributaries of the Karnali river basin) in 108 former village development committees of six districts of Sudurpashchim Province.[1]

The project intended to improve climate resilience in Nepal's mountain communities through improved access to more reliable water resources for communities in selected climate-vulnerable mountain watersheds.[2] The project had four outputs: (i) Participating communities have improved catchment management and new or improved water storage infrastructure; (ii) Communities and government manage water and land in an integrated and inclusive manner within watersheds; (iii) Knowledge-based approaches for integrated water and land management and improved water reliability and accessibility in the wake of climate change adopted by government; and (iv) Project management support provided.

The major investment was for the implementation of 108 subprojects consisting of small civil works and catchment restoration works. The civil works consisted of construction of domestic and irrigation water supply and storage infrastructures, including spring protection works. Catchment restoration works included plantations, slope and landslide stabilisation works, and capacity building for effective watershed management.

The subprojects were identified in a highly participatory approach through extensive engagement with various development committees and community groups. The proximity with the local levels insured overlap with other similar interventions were avoided, while complementary support could be planned.

ACHIEVED OUTCOMES

Social

The project sought to target disadvantaged communities, which have fewer reliable water sources, and to reduce the time spent by women collecting drinking water.[3] In response, the project (i) ensured that the voice of women, Dalit, and disadvantaged groups would be heard in public meetings on subproject selection; (ii) reduced women's and children's time for collecting water through improved domestic water and irrigation infrastructure; (iii) ensured representation of women and disadvantaged groups in the committees responsible for planning and implementing subprojects; (iv) improved the capacity of communities to conserve soil and water, equity in domestic water sharing, and irrigation through capacity building; and (v) included women, Dalit, and disadvantaged youth in technical and vocational training programmes.

At completion, 51,278 households had access to improved domestic and irrigation water sources, exceeding the initial target. Similarly, availability of irrigation water during the dry season was assessed to increase to 0.75 litres per second per hectare in the project area. Domestic water collected during the dry season increased by 50% from the baseline on average, and the time spent by women and children collecting domestic water was reduced by 73% (by 0.75–4.8 hours per day) during the dry season on average.

The project supported both the communities and the government to manage water and land in an integrated and inclusive manner within watersheds. All participating communities were involved in a phased cycle of training and capacity building so that the knowledge they develop in integrated and inclusive watershed management could be used to apply best practice. To strengthen the public sector's capacity to manage watersheds more effectively, the project invested in tertiary education that benefitted 54 people in the project area, developed a watershed management planning system, and delivered various training on watershed management which benefitted 711 government participants. Similarly, a total of 5,168 community-level participants benefitted from the project-sponsored training on watershed management.

Environmental

The environmental management plans included catchment restoration and plantation on about 2,300 hectares, bioengineering works, and construction of gabion walls for control of soil erosion; social fencing was implemented as planned.

The project has led to several environmental benefits that could not be quantified. The construction of recharge ponds and reforestation activities may have controlled surface run-off leading to better percolation and groundwater recharge, retained fertile topsoil, and stabilised slopes and gullies from erosion and landslides.

Economic

The project supports the livelihoods of the project beneficiaries through gains in agricultural outputs, increase in cropping intensity, and time saved on fetching drinking water and fodder collection to feed cattle. The households usually collect fodder daily from the forest; the project supported fodder species plantations near beneficiary households to reduce time spent on fodder collection. In one of the settlements supported by the project, farmers from 28 households in Ganeshpur village development committee (currently Ganyabdhura rural municipality) sold 36 tons of cauliflower, 36 tons of bell pepper, 5 tons of cabbage, and 1 ton each of chili and soyabean in 2021, and they reported additional annual incomes of NRs300,000–NRs700,000 (around $3,000 - $7,000) as a result of the irrigation pond built by the project.

Number of vulnerable people made more resilient:

318,208

Enhancing the resilience of natural systems

The project contributed to enhancing the resilience of watersheds through direct interventions such as plantations, bioengineering, contruction of check dams and gabion walls to control landslides, and also through capacity building interventions. New plantations were done on more than 2,300 hectares. Brush layering covered 2.5 km, and live fencing covered almost 12.0 km.[4] To improve groundwater percolation, 11,230 recharge pits and 157 recharge ponds were constructed. Landslide protection measures included the construction of 6,357 gabion walls. On the capacity building side, more than 5,100 local community members (44%) participated in the project-sponsored watershed management training, which focused on water conservation and soil management.

Similarly, the project promoted the concept of 'community fencing' where villagers imposed bans on grazing in vulnerable slopes and around their spring source. The project also provided training to government officials involved in watershed management, and developed a geographical information system based on a watershed management planning system.

(1) In 2015, Nepal adopted a new constitution and transitioned to a federalised system. The former village development committees—the lowest administrative units—were reorganised into rural municipalities and municipalities. In the project area, the 108 village development committees are now within 8 municipalities and 16 rural municipalities.

(2) ADB. 2013. Report and Recommendation of the President to the Board of Directors: Proposed Administration of Grants Nepal: Building Climate Resilience of Watersheds in Mountain Eco Regions. Manila.

(3) ibid.

(4) Government of Nepal, Ministry of Forest and Environment. 2020. Project Completion Report for Building Climate Resilience of Watersheds in Mountain Eco-Regions Project. Kathmandu.

COASTAL RESILIENCE IN MONROE COUNTY, FLORIDA, USA

Sector

WATER

TRANSPORT

Highlights

Coastal resilience | Property protection

Project owner
Monroe County

Project start/completion
May 2019 - Ongoing

Locations
Key Largo and Big Pine Key, Monroe County, Florida

Community impacted
Coastal

Vulnerable groups impacted
Women and girls, youth, elderly people

Climate hazards mitigated
Flooding, Hurricanes/cyclones

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Ocean and Coastal, and Infrastructure Impact Systems.

Case study provided by

wsp

Find out more

To enhance the resilience of its low-lying infrastructure to frequent flooding from sea level rise and storm surge, Monroe County instituted a pilot project in two communities, which involve elevating approximately 6,400 feet of specified roads and installing 2,000 feet of pre-treated and pressurised closed stormwater management systems.

ABOUT THE PROJECT

Projections from the Southeast Florida Regional Climate Change Compact indicate that areas of the Florida Keys may experience sea level rise of 12 inches by 2030, and more than 30 inches by 2060. To communities that populate these islands, that level of increase poses a significant threat of inundation.

To enhance the resilience of its infrastructure, Monroe County instituted a pilot project in two communities—Twin Lakes in Key Largo and the Big Pine Key community of Sands—where streets are bordered by wetlands and canals, and are already subject to frequent flooding during king tides and intense storms, and precipitation events.

As a partner to the county, WSP performed a pilot study to assess the 20-year tidal record and 2015 event and determine a target elevation for roadways and required drainage improvements to adapt to the new conditions. The study outcomes informed the project solution, which includes elevating approximately 6,400 feet of specified roads and installing 2,000 feet of pre-treated and pressurised closed stormwater management systems.

The drainage design consists of a gravity collection system with a pump station discharging into multiple injection wells. All runoff will be routed to the pump stations, one for the Key largo Project and the other for Big Pine Key, using trunk lines along the main roads. The system includes numerous inlets and manholes, above ground electrical pump station control and distribution panel and components, generator, underground valve box, wet well, pollution treatment unit structure and a solids storage sump. The design storms for this system are the 10-year Soil Conservation Service (SCS) Type II storms with durations of 24 and 72 hours correspondingly, and proposed improvements take into consideration the Sea Level Rise projections for year 2050.

Additionally, the project involves reconstructing and resurfacing the pavement, signing and marking, and conducting property surveys to harmonise the elevated roads with adjacent properties. A retaining wall has also been proposed along the road, to provide safety for drivers and surge protection.

The roadway and drainage design required close coordination with the Florida Keys Aqueduct Authority's water mains and vacuum sewer lines. The design adheres to Monroe County's adopted methodology for adapting infrastructure for sea level rise.

INTENDED OUTCOMES

This project is designed to protect a major access road to a low-lying, low-income subdivision that is subject to frequent and persistent flooding due to storms, tides, and sea-level rise. It will maintain access to 190 homes in a low-income residential neighborhood of which 115 homes sustained substantial damage due to Hurricane Irma, and it will help to sustain property value.

Number of vulnerable people made more resilient:

~4,000

Source: WSP

REBUILDING INFRASTRUCTURE IN PERU

Sector

WATER

TELECOMMUNICATIONS

Highlights

Collaboration | Early Warning System | Healthcare | Education | Carbon sequestration | Ecological uplift

Project owner
Authority for Reconstruction with Changes (ARCC)

Project start/completion
July 2020 - Ongoing

Location
Peru

Community impacted
Rural, Coastal

Vulnerable groups impacted
Women and girls, Youth, Elderly people, People of color, Indigenous and traditional communities, Internally displaced people (IDPs)

Climate hazards mitigated
Water stress, Hurricanes/cyclones, Extreme wind

Sharm El-Sheikh Adaptation Agenda
This project addresses outcomes from the Sharm El-Sheikh Adaptation Agenda within the Marrakech Partnership Human Settlements Impact System.

Case study provided by

ARUP

Find out more

In 2017, the El Niño climate cycle hit Peru, causing the loss of lives and more than a billion dollars of damage to homes, businesses, public facilities and critical infrastructure. In 2018-19 the Peru Government established the Autoridad Para la Reconstrucción Con Cambios (ARCC, Authority for the Reconstruction with Changes) to rebuild destroyed or damaged infrastructure and increase national resilience, while transforming the way the country delivers major capital programmes.

ABOUT THE PROJECT

Peru sought international support to deliver an integrated reconstruction 'with changes' programme and the UK was appointed as preferred partner. The UK and Peru Governments then formed a two-year Government-to-Government agreement, through which the ARCC appointed Arup, Mace, and Gleeds as a joint UK Delivery Team (UKDT) embedded within the ARCC to accelerate and assure the delivery of critical infrastructure totalling 119 projects, which were valued at £1.7 billion across 13 regions of Peru. The agreement is in the process of being extended to the end of 2023.

Starting in July 2020, the UKDT was tasked with putting systems, processes and practices in place to accelerate the delivery of 74 schools and 15 healthcare facilities in the areas hardest hit, as well as flood protection on 17 river basins and 5 gullies, and drainage systems for 7 cities. Additionally, following a UKDT review, the ARCC is set to invest in a national integrated Early Warning System that will better equip and prepare 16 million people living in high-risk areas to respond to natural disasters. The system will also include new emergency command centres, new telecommunications infrastructure and a new siren system.

The task required a systemic change in Peru's public sector through the proactive transfer of specialist knowledge, establishing a transferable portfolio management office function and assuring the design, delivery and operation of resilient facilities and infrastructure to international standards.

INTENDED OUTCOMES

The project has been founded on the principles of community benefit. The infrastructure provided will be resilient for current and future generations and will empower communities to adapt to the impacts of climate change. The Early Warning System is an integrated communication system to help communities prepare for hazardous climate-related events.

Additionally:

- 74 schools are being built or retrofitted
- 47,000 school places will be available in the first tranche of schools
- 8 regions will benefit from schools
- 15 healthcare facilities will provide services to nearly 1.5 million residents of Peru
- There will be flood defence improvements to 17 river basins, 5 gullies and 7 city drainages supported by a national Early Warning System

Number of vulnerable people made more resilient:

16 million

How has carbon mitigation been integrated?

The planting of 56 million trees and seedlings as part of natural flood defences will capture an estimated 220,000 tonnes of carbon per year. This carbon capture will amount to 0.12% of Peru's national target emissions in 2030 while improving community resilience to floods and creating accessible green spaces for farming, the public and wildlife.

Enhancing resilience of natural systems

Millions of trees will be planted and a variety of terracing, earthworks and soil conservation techniques will cover 51,000 hectares to reduce the risk of flooding across 17 river basins. This ecological approach will avoid expensive construction while capturing carbon and creating new green and biodiverse spaces for improved agricultural practices and increased community resilience to climate change.

Knowledge for Action and Capacity Building

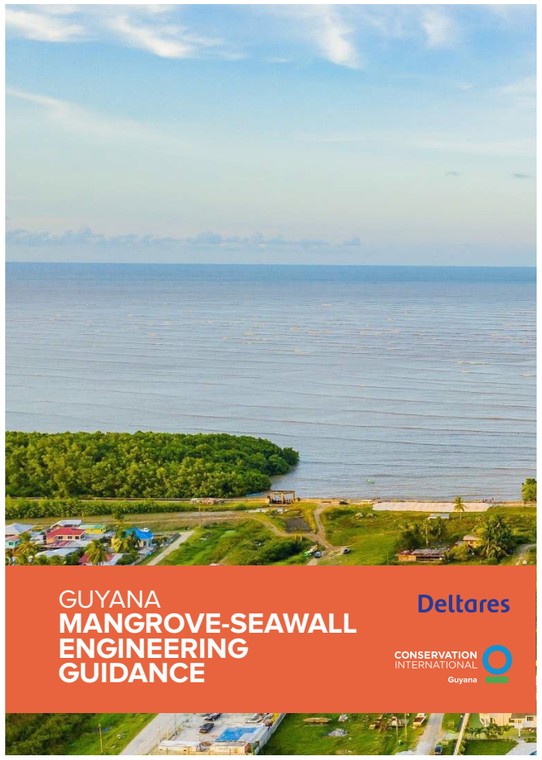
Through knowledge-sharing and capacity-building activities, we can accelerate the uptake of tools, resources, and skills for advancing sustainable and resilient infrastructure in communities across the world. The following are examples of tools, resources and knowledge-transfer initiatives that can empower practitioners and local communities to work towards climate resilient, sustainable solutions for infrastructure.

GUYANA MANGROVE-SEAWALL ENGINEERING GUIDANCE

Guyana is among the countries most profoundly threatened by climate change induced sea level rise, with 90% of the population and 75% of agricultural production situated on the low-lying coastal plain. To mount a response to this existential threat, Guyana needs to harness the same natural processes that created the North Brazil Shelf's coastal plain – from the Amazon river to the Orinoco river. The coastal plain was created over tens of thousands of years by a flux of Amazonian soil particles transported along the coast and captured in the roots of mangroves. By taking a 'design with nature' approach to study and model mudbank dynamics, we can optimally time the application of green-grey technologies to speed up this natural process and reclaim/regrow our coast.

The Guyana Mangrove-Seawall Engineering Guidance report by Conservation International provides recommendations for practical Engineering Guidelines for the assessment, development and implementation of green-grey solutions along Guyana's coast, and a technical resources document providing the theoretical background for the guidelines.

Find out more



CONSERVATION INTERNATIONAL

RESPONS, NORWAY

The RESPONS project improves preparedness for managing natural hazards on the road network. Started in 2019 by the Norwegian Public Roads Administration, it reduces the risk for road users from landslides, avalanches, or flooding by closely monitoring weather conditions and relating them to previous events and mapped vulnerabilities. Although it is focused on current climate, it is a good and important basis for adaptation to future climate.

RESPONS is a web-based mapping solution that combines static information from natural hazard mapping with dynamic data on weather, avalanche hazard and other events. It is designed both for professionals who work with natural hazards and for contractors responsible for road operation.

Hazard assessment

Landslide personnel in the Norwegian Public Road Administration carry out daily assessments of landslide and flood hazards on roads. The results of the assessment are presented on a map and are also sent out by email to professionals in the road authority and partners. RESPONS is also used for local assessment of known landslide locations or road sections exposed to adverse weather.

Emergency events on the road

In the case of flooding or landslide events on the road, RESPONS acts as a support tool, both table-top and in-field, for relating to previously documented relevant incidents, estimating hazard from neighbouring avalanches and assessment of possibilities for reopening the road.

Operation, maintenance and protection of the road network exposed to natural hazards

RESPONS shows information about natural hazards, of various origin, relevant for roads. This includes hazard zone maps from other agencies, events registered by the operating contractor, and geotechnical reports and notes. The official database for storing road data is the National Road Data Bank (NVDB).

When all available information is gathered in one place, it will always be possible to produce an updated digital natural hazard map, which is useful both for the daily operation of the road network, and for work on protection against natural hazards.

© Lars Olve Hesjedal, Statens vegvesen

INFRASTRUCTURE PATHWAYS: NATURE-BASED SOLUTIONS ACROSS THE LIFECYCLE

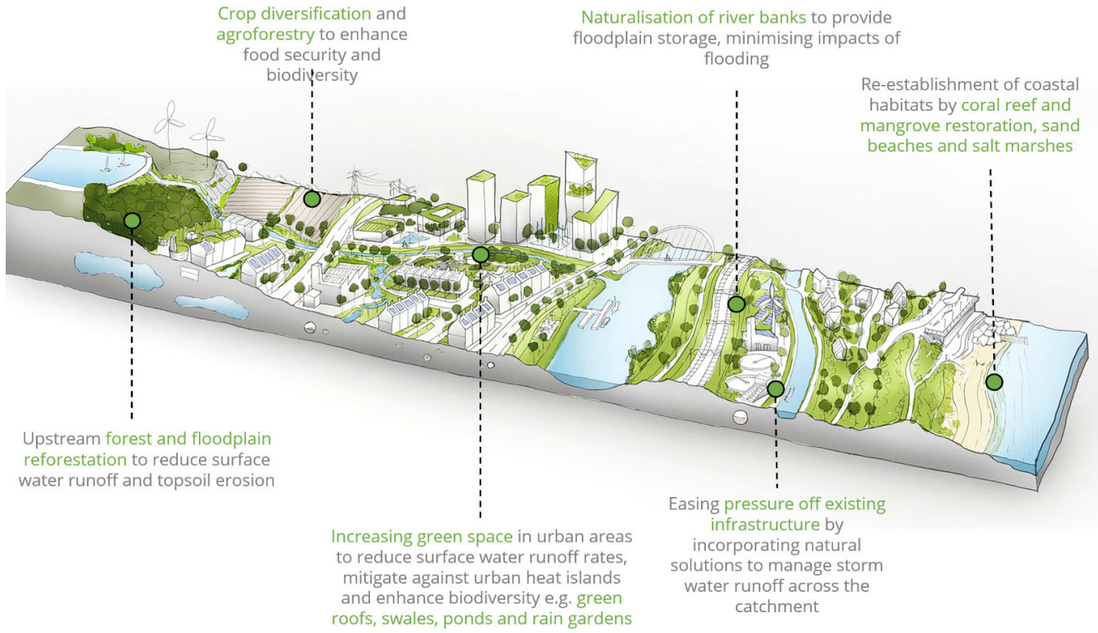
Nature-based solutions (NbS) involve working with nature to address societal challenges, providing benefits for both human wellbeing and biodiversity. Actions of NbS include protecting, sustainably managing and restoring natural and semi-natural (or modified) ecosystems in such a way that provides environmental benefits and tackles societal challenges. This topic has gained traction in recent years due to evidence showing that NbS have the capacity to reduce greenhouse gas emissions, (i.e. provide climate change mitigation benefits) as well as reduce the impact of climate-related shocks and stresses such as flooding and drought (i.e. climate change adaptation benefits).

The topic of Nature-based Solutions (NbS) was selected as the first Use Case Pathway for Infrastructure Pathways, a resource for practitioners in search of clear, easy-to-navigate guidance on climate-resilient infrastructure, compiled from hundreds of leading resources, and organised by lifecycle phase.

While Nature-based Solutions are as old as nature itself, they have only recently been viewed as a tool for enhancing the resilience of the built environment and as an alternative to traditional 'grey' infrastructure. As such, there is a need to integrate emerging research, policy, technical design guidance and implementation learnings on this topic across the infrastructure lifecycle to allow for a more coordinated approach to implementing Nature-based Solutions.

The Use Case Pathway builds on the foundational guidance provided in the main lifecycle phases of Infrastructure Pathways to highlight key actions that need to be taken at each stage of the infrastructure lifecycle, and is organised by four main phases of the infrastructure lifecycle as described here. It also provides links to the most relevant resources and tools as well as case studies to support practitioners in implementing NbS.

Find out more



Infrastructure Pathways: Nature-based Solutions Use Case Pathway

SUSTAINABLE INFRASTRUCTURE COMMUNITY OF LEARNERS

The Sustainable Infrastructure Community of Learners (SI-CoL) was established in 2020 in the wake of the COVID-19 pandemic. The SI-CoL was formed as a response to the urgent need for economic recovery and the desire to 'build back better' by embedding sustainable infrastructure (SI) considerations in projects.

Convened by the Sustainable Infrastructure Partnership and powered by a core group of partners – the UN Environmental Programme (UNEP), Duke University, ICSI, and Conservation International - the SI-CoL is a learning community among SI capacity resource providers (those developing and delivering SI capacity resources like courses, tools, standards, or frameworks) and SI capacity resource clients (those that utilise these resources to create sustainable infrastructure). The mission of the group is 'to share information, experiences, and resources globally... to improve approaches, outcomes, and uptake of Sustainable Infrastructure capacity development.'

In 2021, SI-CoL piloted a year-long webinar series, entitled Sustainable Infrastructure: Putting Principles into Practice, which explored UNEP's 10 International Good Practice Principles for Sustainable Infrastructure through presentations and discussions of technical tools and case study examples, followed by informal discussions in smaller groups.

The series brought together over 650 engineers, architects, scientists, economists and students from around the world to discuss topics such as strategic planning, environmental assessments, climate resilience, participatory decision-making, equity, circularity, and systems planning.

Participant feedback revealed strong support for the SI-CoL programme and use of the ECHO model, an interactive, case-based learning approach developed by Project ECHO that can be translated to meet the needs of sustainable infrastructure practitioners.

The pilot series provided a proof of concept for rapidly and effectively building a virtual community of practice that can disseminate state-of-the-art knowledge and resources, share best practices through case-based learning, build a support system to exchange knowledge, and address concerns and challenges within and across stakeholder groups.

Find out more

"We hope that the SI-CoL will serve to bring into focus the urgent need to quickly scale up capacity building and good practice adoption. With the tsunami of new infrastructure investments just over the horizon, we have little time to ensure that those financing, regulating, planning, and building are equipped to make the most appropriate and sustainable decisions. The pathways they pick will affect us for decades to come."

Elizabeth Losos, Executive in Residence, Nicholas Institute for Energy, Environment & Sustainability, Duke University

Collaborative Initiatives

Systemic problems require systemic solutions; the collective challenge of climate change demands a radical, collaborative approach to problem-solving that spans sectors, geographies, and disciplines. This kind of approach will help to bridge divides between practitioners, communities, and governments, and catalyse key actors into moving forward on adaptation and mitigation measures. Allowing for diverse contributions to problem solving will result in solutions that are holistic, transferable, and inclusive at their core.

RESILIENCE4PORTS

The Maritime Resilience Breakthroughs Lab: Resilience4Ports is the first Innovation Lab launched by Resilience Rising, tapping into its global, multi-sector consortium of policymakers, engineers, businesses, financiers, and infrastructure owners and operators, and supporting the UN Climate Change High Level Champions' 2030 Maritime Resilience Breakthroughs.

The programme aims to mobilise a critical mass to create the scale and momentum necessary to break through the industry's barriers to resilience.

Find out more


© Shunya Koide

COALITION FOR DISASTER RESILIENT INFRASTRUCTURE (CDRI)

The Coalition for Disaster Resilient Infrastructure (CDRI) is a global partnership of national governments, UN agencies, multilateral development banks, the private sector, and knowledge institutions that aims to promote the resilience of new and existing infrastructure systems to climate and disaster risks in support of sustainable development. CDRI has a mandate to provide technical assistance, capacity development and knowledge curation. Examples of initiatives include DRI Connect (knowledge and capacity development platform), GIRI (global platform providing risk information in the public domain), and IRIS (program to support resilience in Small Island Developing States).

Find out more

CLOSING REMARKS

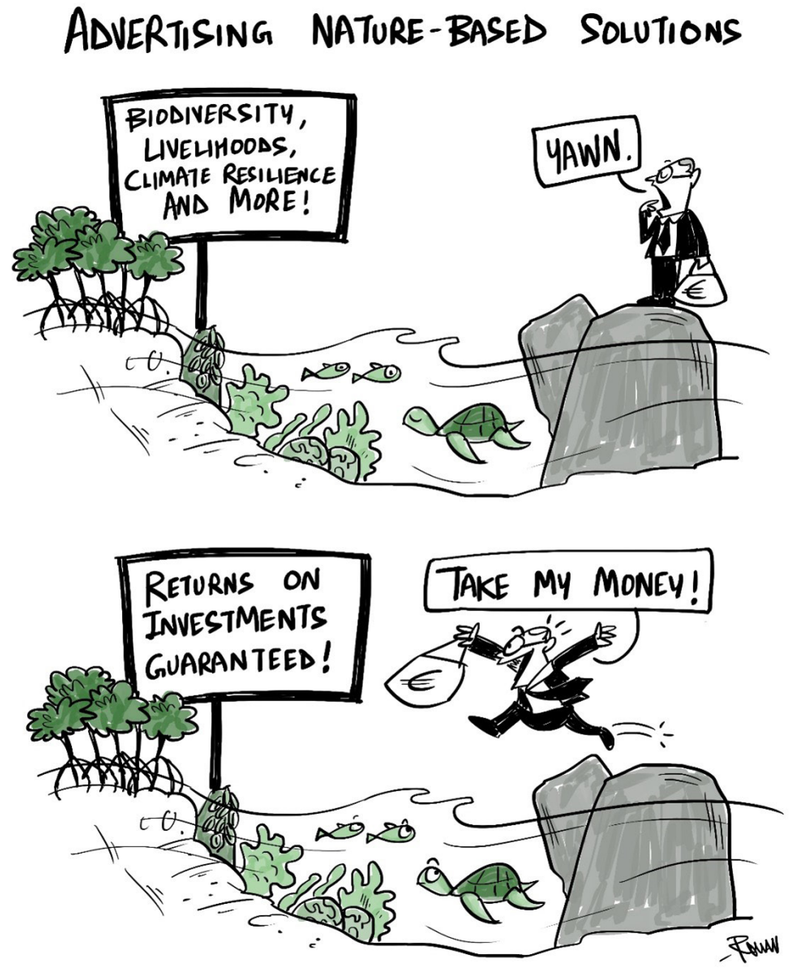
This paper presents just a small portion of the infrastructure projects around the world that are centring sustainability and resilience in their approach and achieving positive outcomes for people and planet. These case studies exemplify the salience of sustainability and resilience in the built environment and serve as a beacon of hope that we are steadily and collectively steering the industry in the right direction.

As the timeframe for taking meaningful climate action shrinks, it is critical to take this people- and planet-centred approach with every project that breaks ground. The engineering community is bursting with the talent and technical skill needed to green our world's infrastructure and to make it resilient enough to withstand and recover from climate impacts. Harnessing this talent is crucial to achieving the environmental, social and political outcomes that initiatives such as the Race to Resilience and the Sharm El-Sheikh Adaptation Agenda strive for.

We now need to encourage creativity and ambition in the profession in order to deliver the transformation needed in our critical infrastructure systems. Our hope is that by showcasing and championing the projects at the helm of this shift, others will be inspired to act similarly in their approach to building infrastructure that is sustainable, resilient and rooted in inclusivity.

Savina Carluccio

Executive Director, International Coalition for Sustainable Infrastructure



Cartoon developed by Rohan Chakravarty for the ICSI-hosted session on Nature Based Solutions at the COP27 Resilience Hub. www.greenhumour.com.

International Coalition for Sustainable Infrastructure

www.sustainability-coalition.org