



# NNBF

International Guidelines on Natural and Nature-Based Features for Flood Risk Management



## Benefits and Costs of NNBF



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# 06



## Benefits and Costs of NNBF

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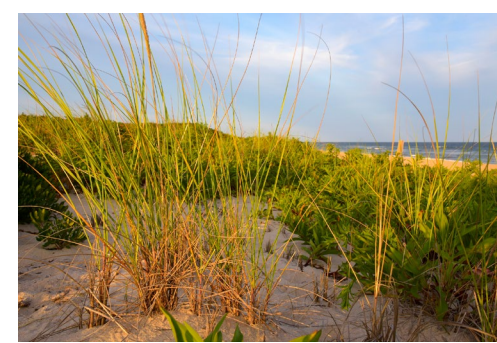
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# Introduction

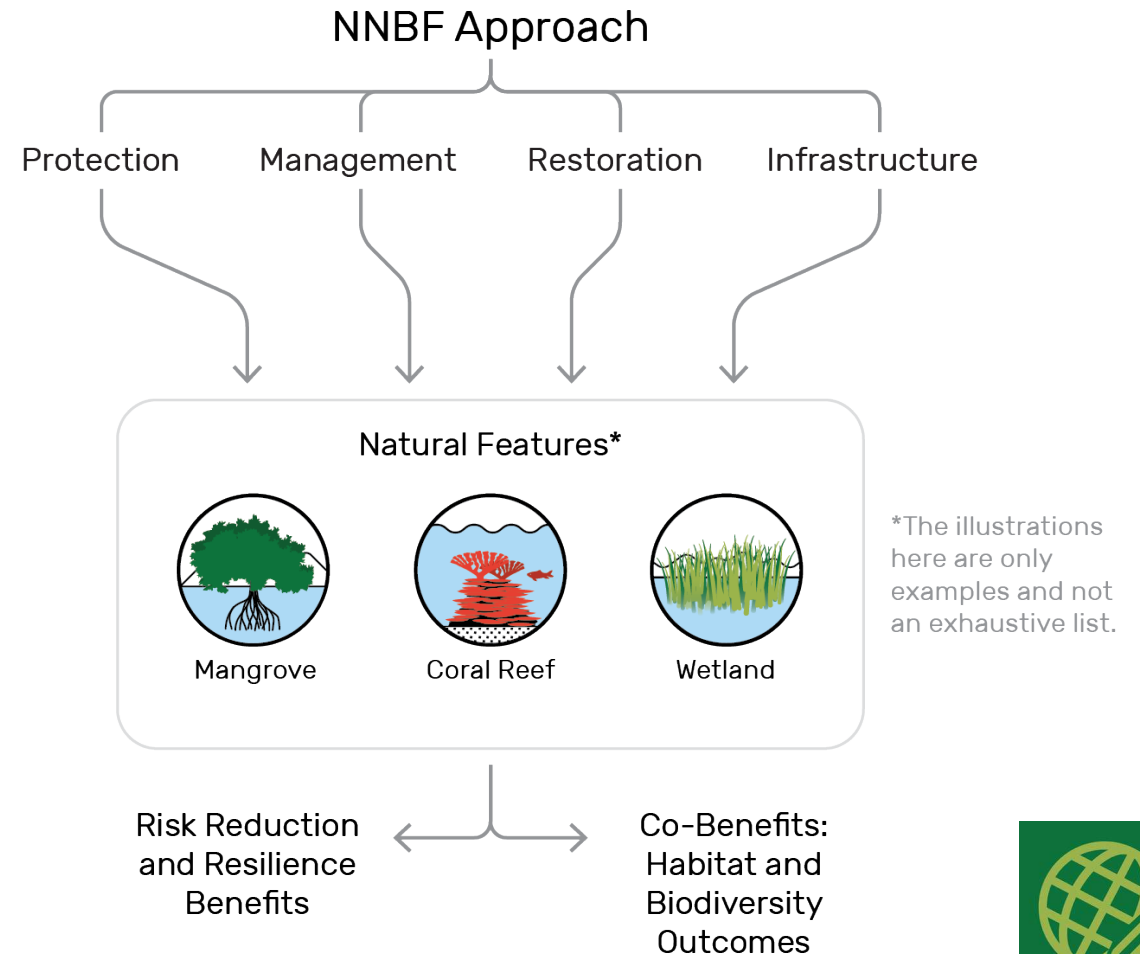


- This chapter provides guidance how to measure benefits and costs as integral part of an NNBF project
- Benefits assessment is critical for communicating the value of NNBF to stakeholders and for identifying financing opportunities
- This chapter distinguishes:
  - *risk reduction benefits* and
  - *co-benefits*
- Valuation approaches for measuring risk reduction benefits, co-benefits and the costs of NNBF are described and linked to phases in the project cycle



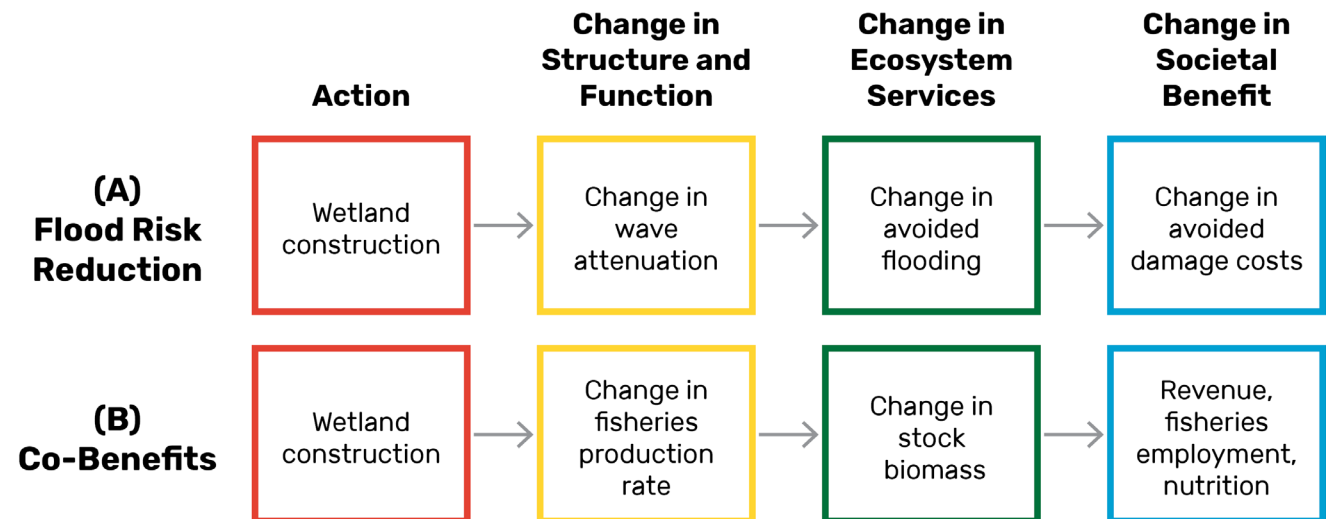
# NNBF not only provide risk reduction benefits but also co-benefits that are highly valued by society

- Approaches, such as protection, management and restoration can be applied to a variety of natural and nature-based features
- These approaches will provide flood risk reduction & resilience benefits as well as a variety of co-benefits, including habitat and biodiversity outcomes



# Valuation approaches and metrics can be used to assess benefits and social vulnerability outcomes

- An ecosystem services assessment framework helps to understand the link between an NNBf approach and its benefits



Adapted from: Beck and Lange (2016), Arkema et al. (2017), and Olander et al. (2018)





# Valuing Risk Reduction Benefits and Costs *Avoided Damages*



Step 1

Estimate coastal or fluvial hydrodynamics

Step 2

Estimate effects of NNBF on hydrodynamics

Step 3

Estimate flooding and erosion with and without NNBF

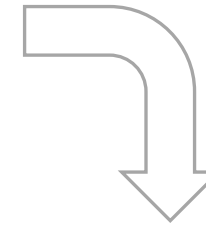
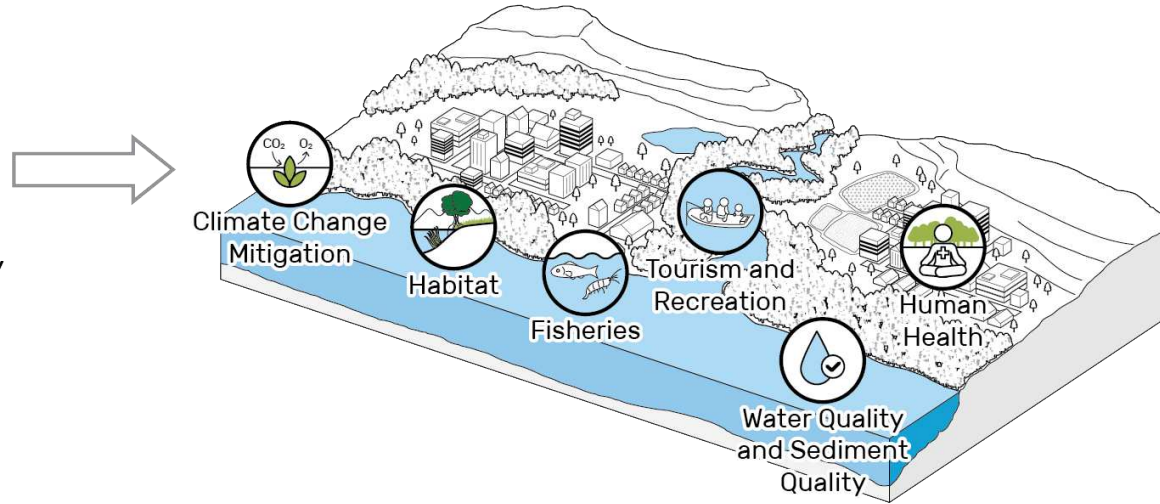
Step 4

Assess expected damages with and without NNBF



# Valuing Co-Benefits

  
Stakeholder  
identifying key  
co-benefits



## Valuation method

## Co-benefit measurement examples

Production function approach

Fishing opportunities; water quality

Travel cost method

Recreational and tourism opportunities

Hedonic analysis

Aesthetic landscape quality; tourism opportunities

Benefit transfer

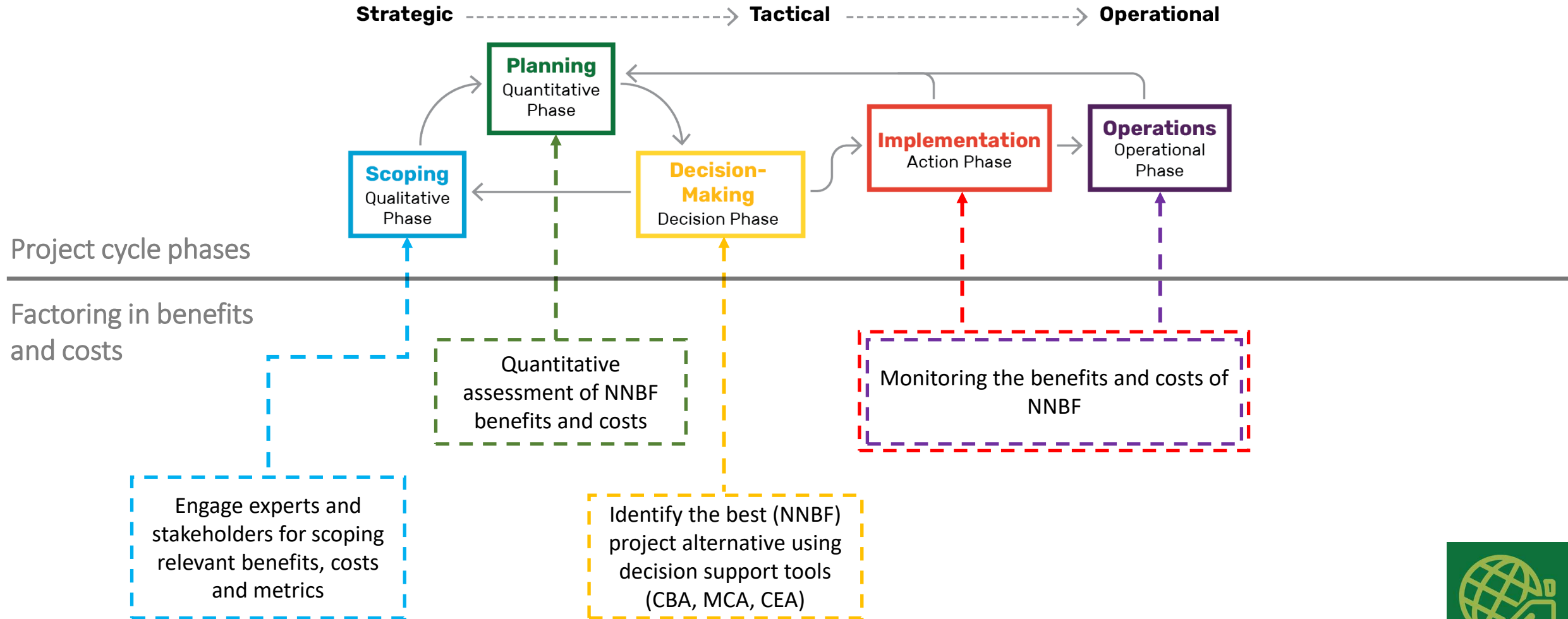
All benefits

Index-based approaches

All benefits



# Benefits assessment inform different phases of a project





## COASTAL ASSETS FACING INCREASING RISKS IN SEYCHELLES

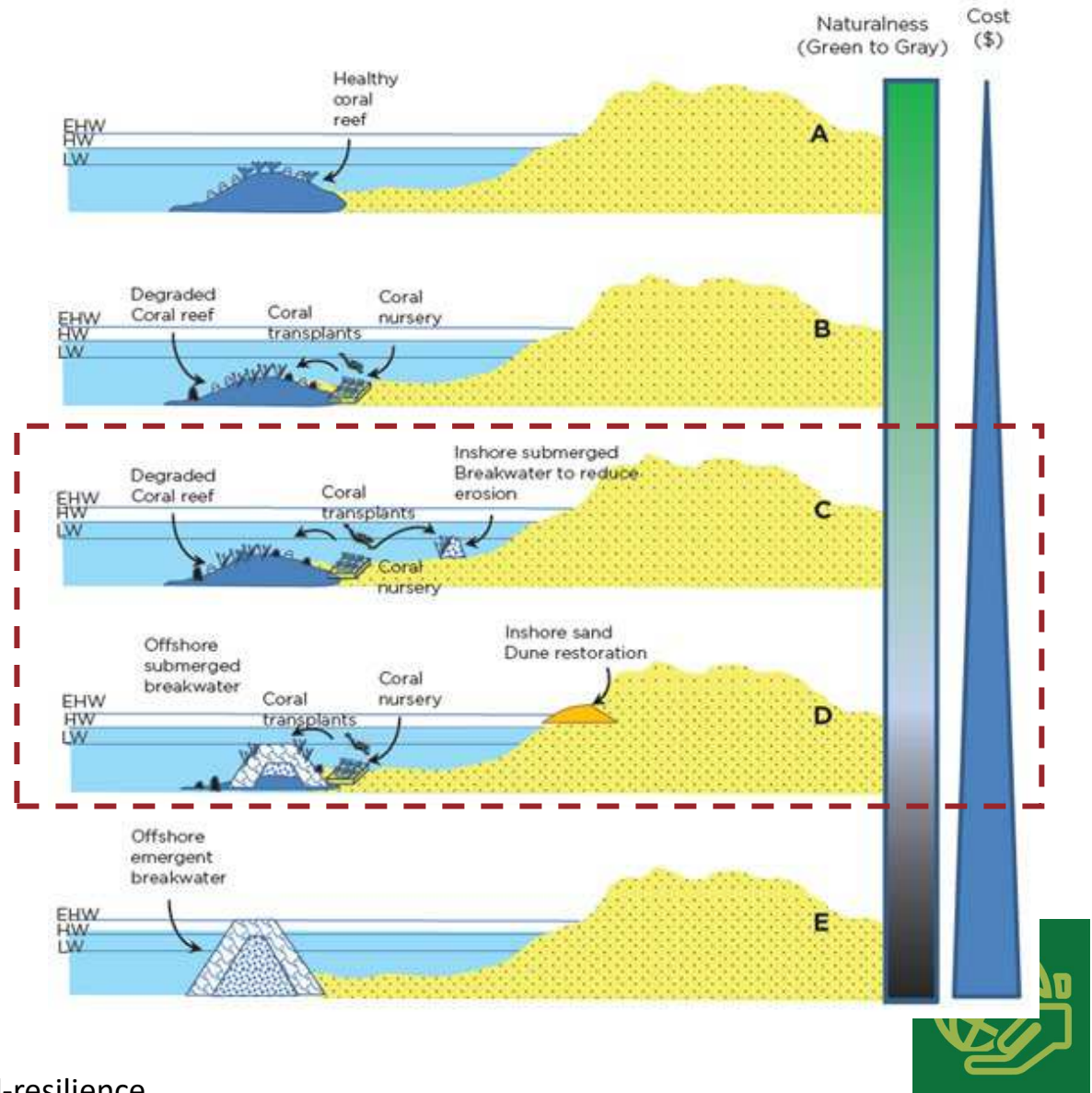
- Severe **erosion** affecting beach use
- Ongoing **coastal flooding** events damaging businesses and private properties
- Higher **preventive costs** (protective measures and insurance premiums)
- Higher **recovery costs** after damage
- **Aesthetic** impact



# The Blue Barrier Concept

A **multifunctional approach** combining an artificial structure to deliver effective coastal protection and coral rehabilitation to maximize the ecosystem recovery:

1. Construction of a submerged-detached breakwater to **reduce erosional currents and coastal flooding** events protecting the beach, waterfront properties and public infrastructures.
2. Development of a living coral reef on top of/around the barrier **providing biodiversity benefits** and new recreational opportunities.



## BENEFITS

# Benefits and Beneficiaries



### TOURISM BENEFITS

Reducing erosion, the need of protective infrastructure and offering new recreation opportunities:  
**+ VISITATIONS / - COSTS FOR HOTELS**

### AVOIDED INFRASTRUCTURE COSTS

Reducing cost of new protective measures:  
**+ PROTECTION / - PUBLIC COSTS**

### COMMUNITY BENEFITS

Recreation, use and cultural values for local population and increase protection of private properties.

### BIODIVERSITY BENEFITS

Providing shelter, food and other necessary elements for biodiversity and a productive ocean (potential fishing benefits).





## SCOPING PHASE

# Identification of Suitable Areas

### COASTAL VULNERABILITY



Proven **high coastal vulnerability**:

- Hydrodynamic processes of near shore and current dynamics
- Risks and frequency of flooding events
- Erosion effects and causes
- Accessibility of the site

### ECOLOGICAL REQUIREMENTS



Suitability for the **establishment and long-term survival** of a coral community:

- Understand degradation causes
- Good water quality
- Adequate light for photosynthesis
- Sufficient water movement

### SOCIO-ECONOMIC IMPACT POTENTIAL



Potential to **deliver benefits** for the local community:

- Exposure level of the site
- Economic value of the beach and nearby coral reefs (tourism, recreation, fisheries, etc.)
- Cultural value of the site
- Educational activities and research opportunities



## EXAMPLES

# Coral Rehabilitation with the Blue Barrier



(A) Pilot unit made with gabion baskets and rocks in Grenada ([Reguero et al., 2018](#));

(B) Coral restoration project using mineral accretion technology in Maldives ([Coralive](#));

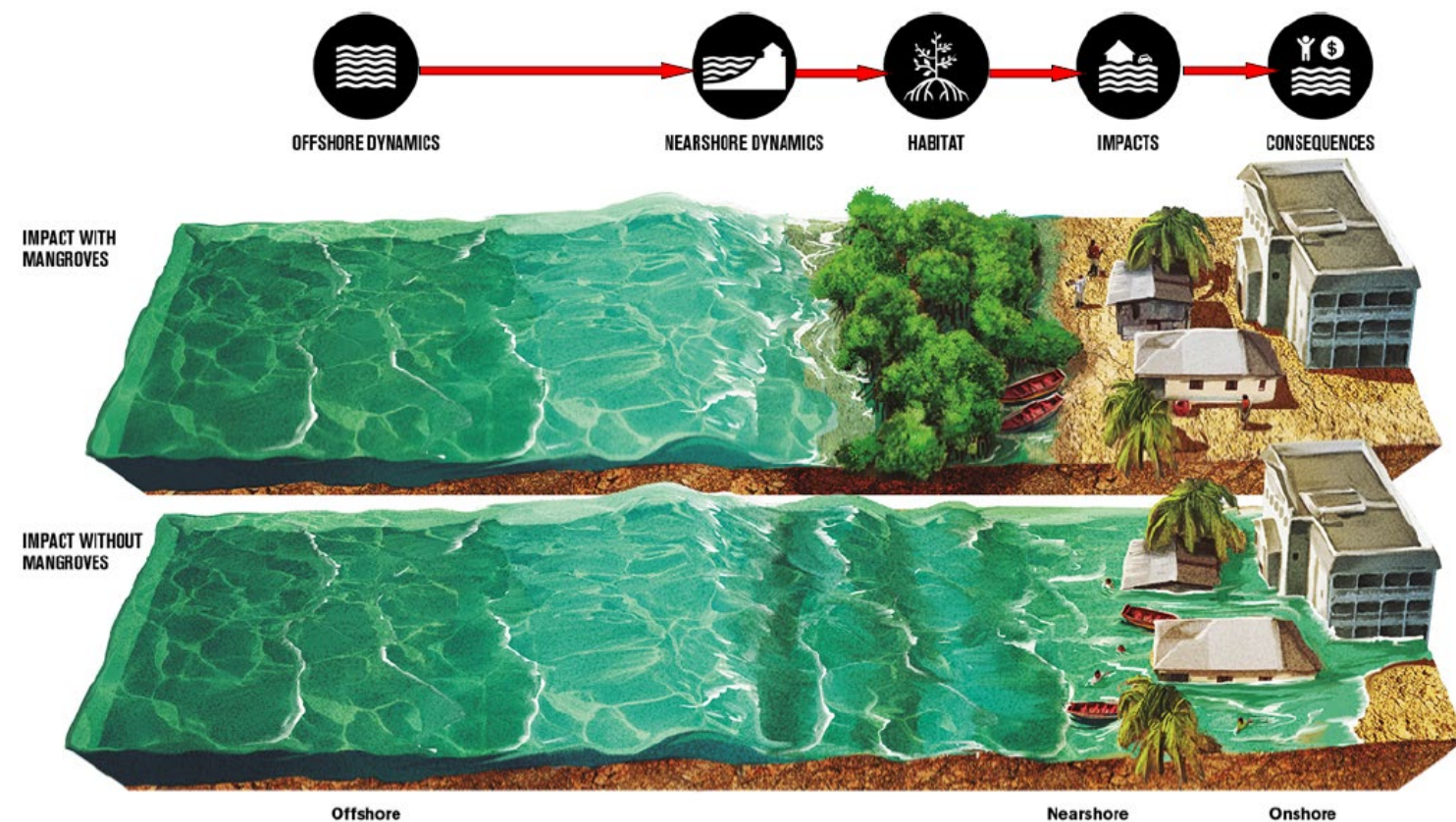
(C) 3D-printed concrete artificial reef in the Calanques National Park ([Seabioost and XtreeE](#));

(D) MARS project: 3D-printed artificial barrier in Maldives ([Alex Goad-MARS](#)).





# Valuing the risk reduction benefits of Jamaica's mangroves



## National Flood Risk and Mangrove Benefits Model

The ADCIRC Model

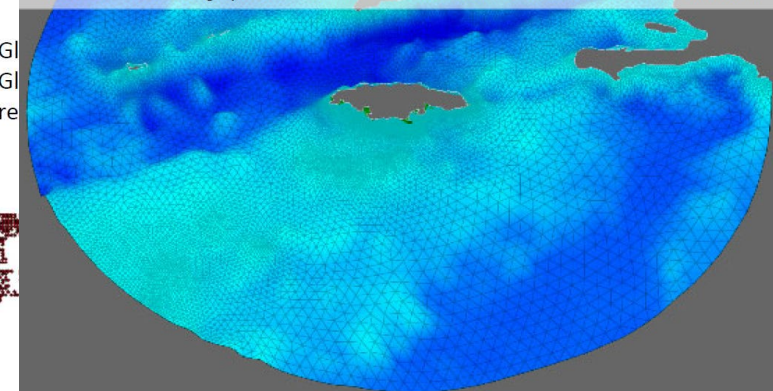
- Built to assess coastal and estuarine flooding from storms and high sea levels
- State of art model that provides flood extent and height information
- Used for forecasting cyclone hazards and risk assessments for critical infrastructure

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# Valuing the risk reduction benefits of Jamaica's mangroves

## Mangrove Loss Increases Flood Risk Old Harbour Bay 2005 to 2013

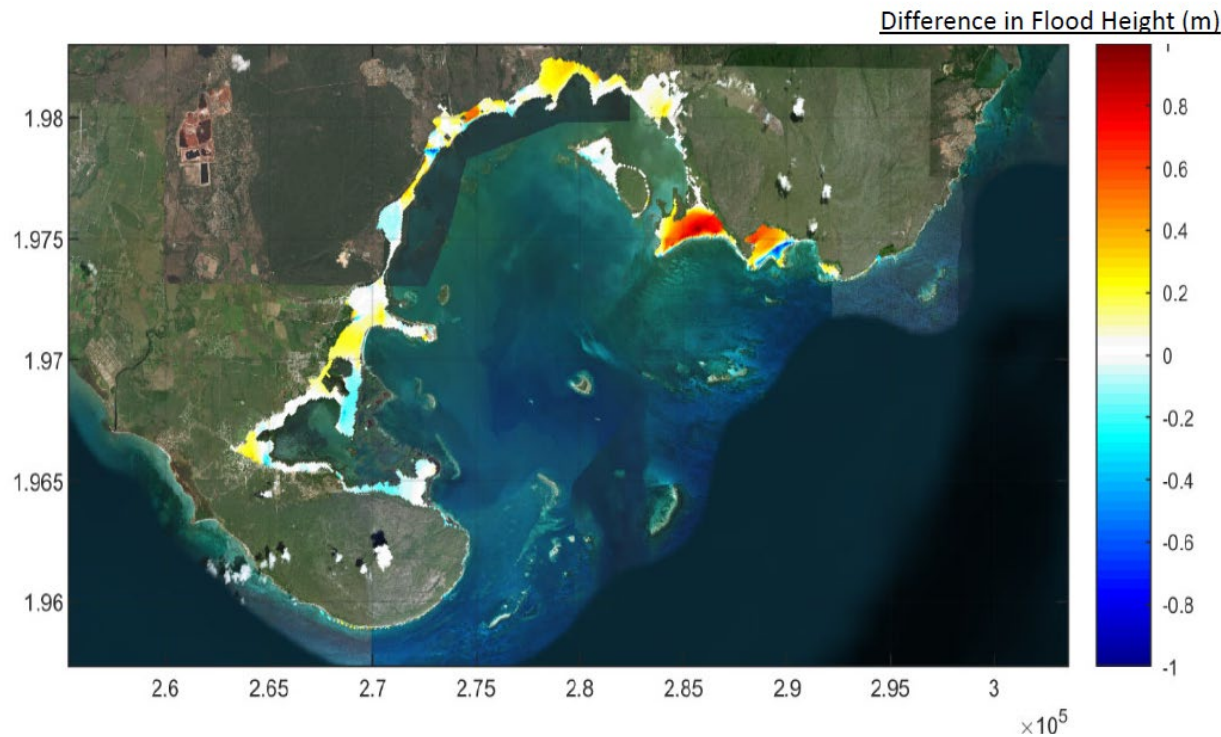


FIGURE 13

Mangrove benefits are most apparent for higher intensity storm events.

Source: UCSC-IHC-TNC.

More than **US\$2,500** per hectare protected annually.



**US\$2.4 billion** in assets protected

**US\$386 million** in assets protected

1 in 100-year event

1 in 500-year event

**22,000** people protected

**770,000** people protected



# Marine Conservation and Climate Adaptation Project

## Belize

In the Caribbean, the project worked to restore coral reef, protect mangrove forest with policy and regulation support, and increased the number of marine protected areas (MPAs).

Coral reef and mangrove were found to have a **high per-acre base annual benefit (see below)**. The cost-benefit analysis focused on shoreline protection determined that preserving **reefs and mangroves is cost-effective at provided shoreline protection**, even if they offer lower shoreline protection offered by levees (which are often expensive).

Category	Corozal Bay Wildlife Sanctuary	South Water Caye Marine Reserve	Turneffe Atoll
Tourism			
Coral Reef	\$16,800	\$5,271,000	\$25,597,846
Mangrove	\$1,545,462	\$640,202	\$11,376,820
Shoreline Protection			
Coral Reef	\$18,360	\$5,760,450	\$16,820,820
Mangrove	\$4,265,475	\$1,766,958	\$17,743,367

Table 7.2: Present Value of Costs, Selected Benefits, Net Selected Benefits (USD) - 10-year Horizon

	Discount Rate		
Selected Benefits	10%	12%	4%
Corozal Bay			
Coral Reef	\$3,804	\$3,367	\$5,620
Mangrove	\$46,527	\$41,168	\$68,861
South Water Caye			
Coral Reef	\$1,193,404	\$1,056,512	\$1,763,325
Mangrove	\$307,067	\$271,767	\$454,103
Turneffe Atoll			
Coral Reef	\$9,052,239	\$8,015,749	\$13,365,837
Mangrove	\$46,527	\$37,519	\$62,761
Combined			
Coral Reef	\$10,249,447	\$9,075,629	\$15,134,782
Mangrove	\$395,998	\$350,453	\$585,726
Total Selected Benefits	\$10,645,445	\$9,426,082	\$15,720,508
Total Costs	\$8,203,097	\$7,660,983	\$10,310,531
Net Selected Benefits	\$2,442,348	\$1,765,099	\$5,409,977

# In Summary

- This chapter aims to provide technical experts, policy makers, project developers and researchers involved in NNBF projects with the right tools and approaches to successfully consider the full range of risk reduction, co-benefits and costs across project cycles.
- It consolidates advances in NNBF benefits research, which has advanced to bridge the gap between environmental economics, hydrology and hydrodynamic modeling, and

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# Questions?

EngineeringWithNature.org



## Download

- Executive Summary (70 pages)
- International Guidelines on NNBF for Flood Risk Management (1,000 pages)

