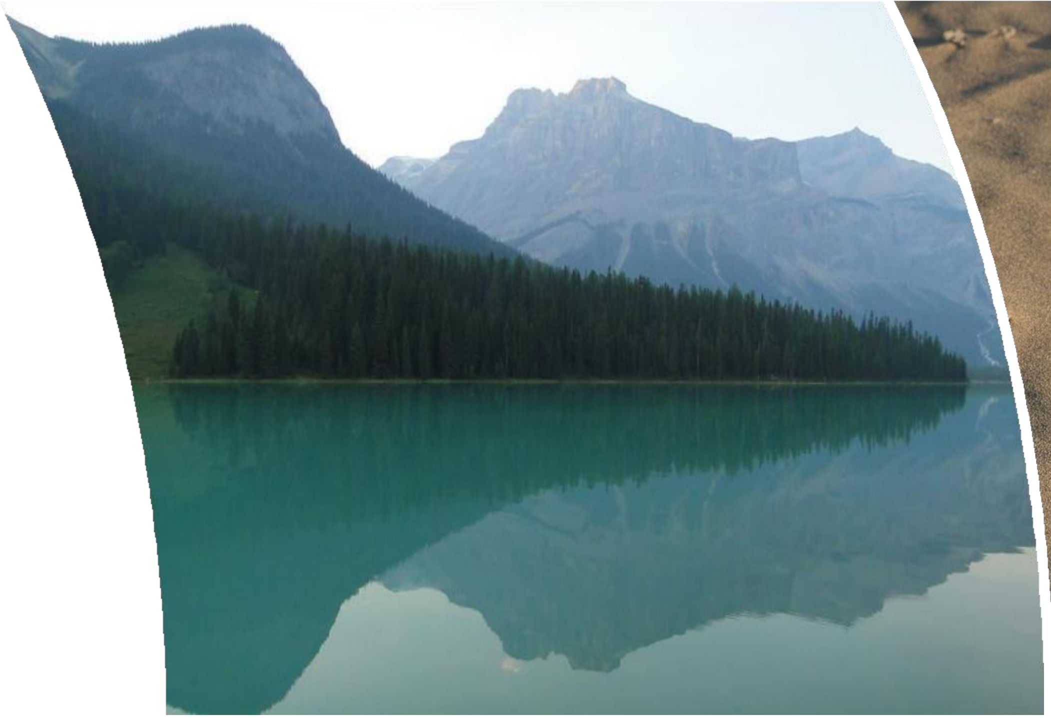
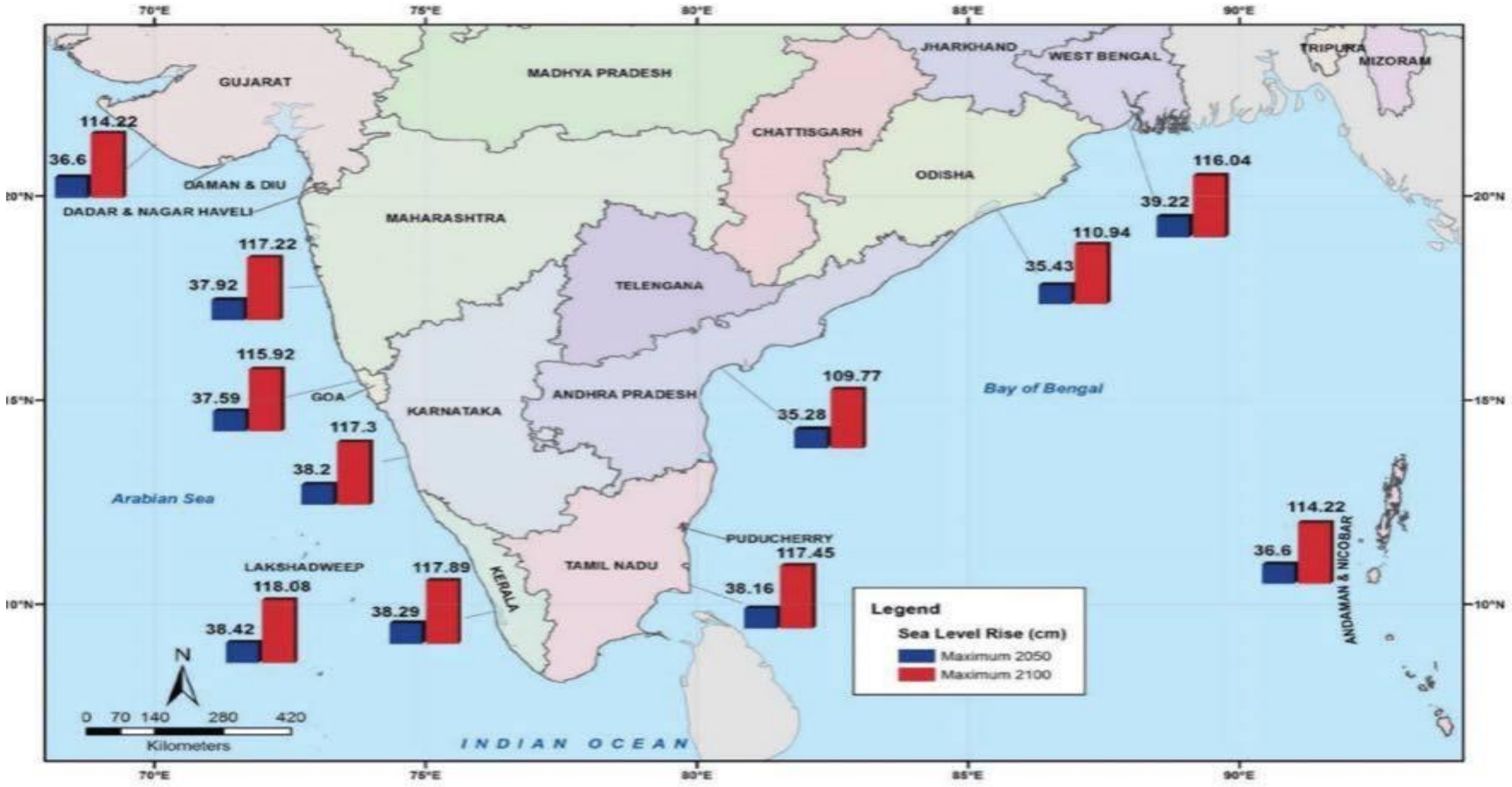
Community-Based Adaptation (CbA) to Climate Change through Nature based solutions (NbS) for coastal zones in India



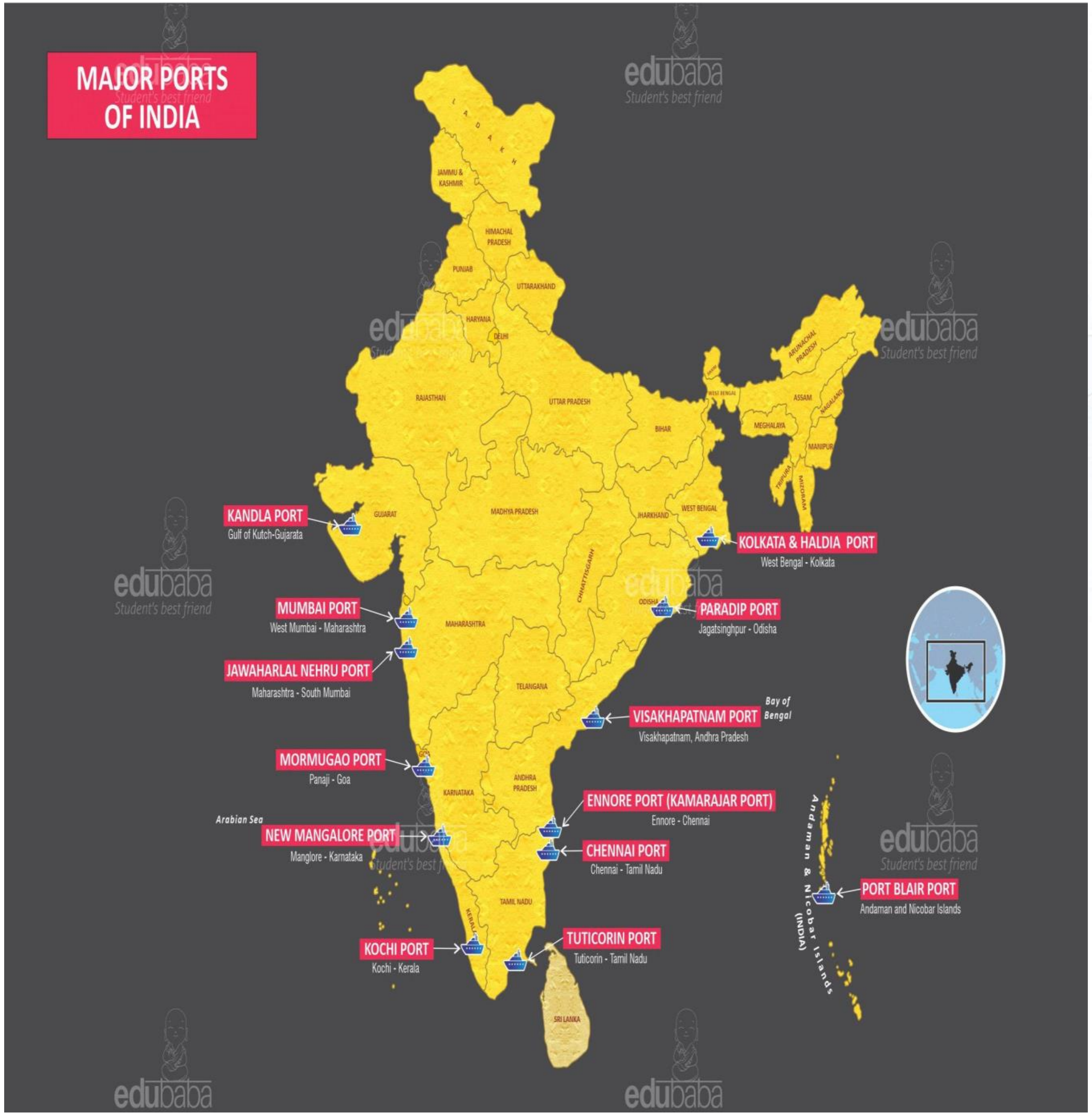
Dr. G.Poyyamoli
Retired Professor
Dept of Ecology & Environmental Sciences, Pondicherry University
Adjunct Faculty- JSS Academy of Higher Education & Research, Mysuru &
Consultant Coastal Ecologist, Taru Leading Edge, New Delhi

- **Why NbS ? Impacts of CC on coastal areas**
- **CbA, EbA, EbM and resilience to CC**
- **Evolution** of **Nature-based Solutions (NbS)**
- IUCN's **concepts & definitions** for NbS
- NbS **principles**
- **IUCN Global standard** for NbS
- **BPCs on** NbS
- NbS-Emerging financing strategies
- **The way forward**

Sea level rise projections (in centimeters) due to climate change for 2050 and 2100 along the Indian coast



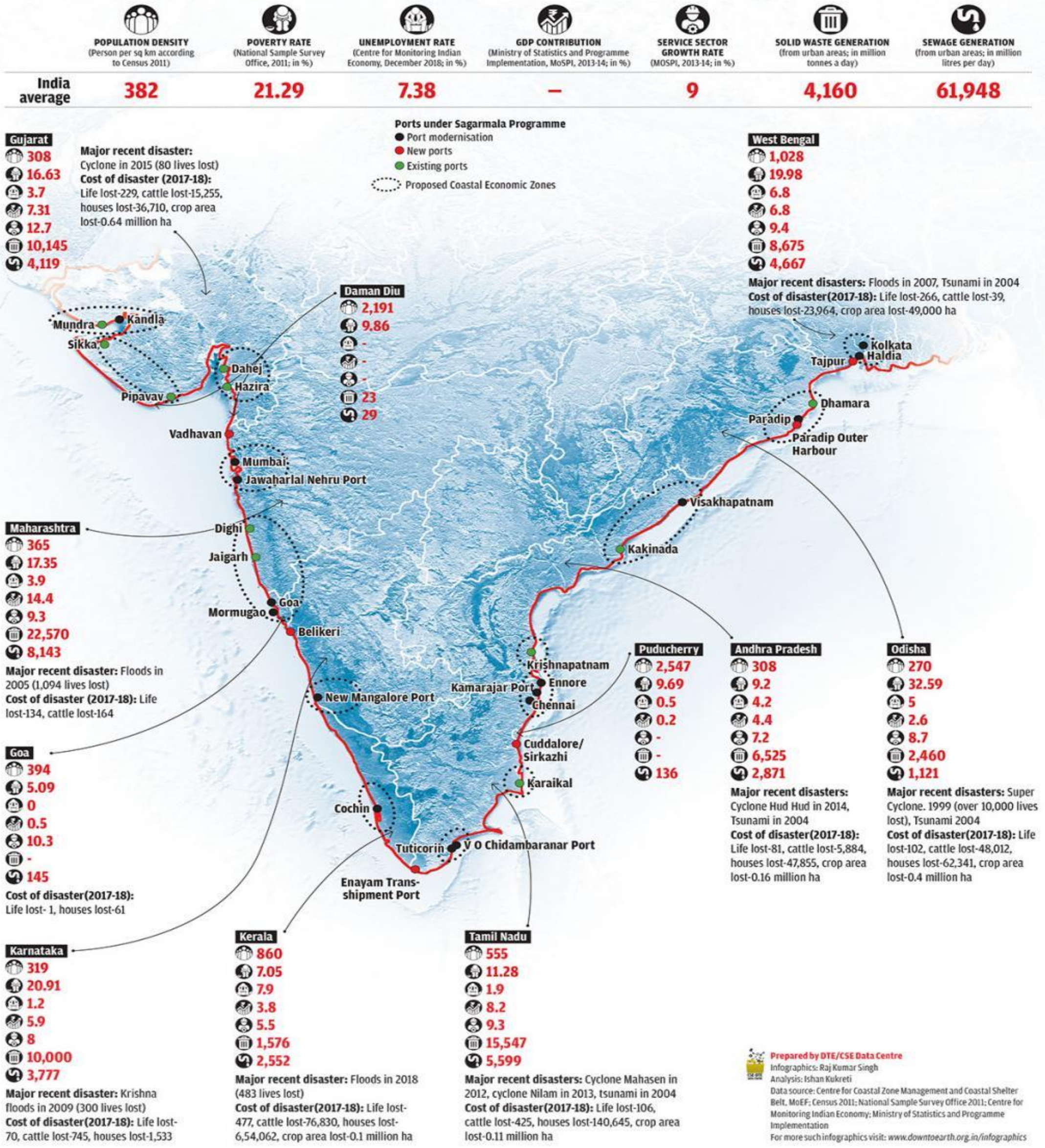
Source: ADB TA-8652 IND: Climate Resilient Coastal Protection and Management Project



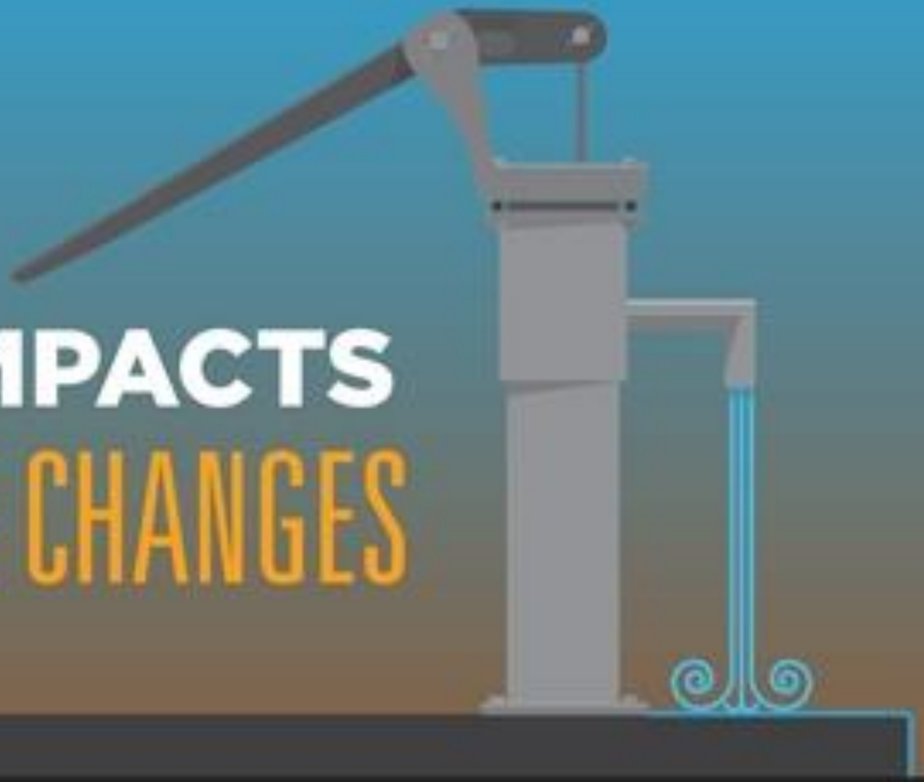
COASTAL REGULATION

Frontier in danger

India's mainland coastline of 6,068 km has been the hub of commercial and tourism activities. Together, the nine coastal states and two union territories contribute over 50 per cent of India's GDP. This has made them vulnerable to exploitation. The Coastal Regulation Zone Notification, 2018 perpetuates this exploitation



GLOBAL IMPACTS
IRREVERSIBLE CHANGES



WEATHER EXTREMES ARE ALREADY AFFECTING LIVES AROUND THE WORLD, DAMAGING CROPS AND COASTLINES, AND PUTTING LIVELIHOODS AT RISK.

EVIDENCE SUGGESTS THE WORLD IS ALREADY LOCKED INTO ABOUT 1.5°C WARMING

1.5°C WARMING

CLIMATE RISKS: 1.5°C VS 2°C GLOBAL WARMING

EXTREME WEATHER

100% increase in flood risk. vs **170%** increase in flood risk.

SPECIES

6% of insects, **8%** of plants and **4%** of vertebrates will be affected. vs **18%** of insects, **16%** of plants and **8%** of vertebrates will be affected.

WATER AVAILABILITY

350 million urban residents exposed to severe drought by 2100. vs **410 million** urban residents exposed to severe drought by 2100.

ARCTIC SEA ICE

Ice-free summers in the Arctic at least once **every 100 years.** vs Ice-free summers in the Arctic at least once **every 10 years.**

PEOPLE

9% of the world's population (700 million people) will be exposed to extreme heat waves at least once every 20 years. vs **28%** of the world's population (2 billion people) will be exposed to extreme heat waves at least once every 20 years.

SEA-LEVEL RISE

46 million people impacted by sea-level rise of 48cm by 2100. vs **49 million people** impacted by sea-level rise of 56cm by 2100.

COSTS

Lower economic growth at 2°C than at 1.5°C for many countries, particularly low-income countries.

OCEANS

Lower risks to marine biodiversity, ecosystems and their ecological functions and services at 1.5°C compared to 2°C.

CORAL BLEACHING

70% of world's coral reefs are lost by 2100. vs Virtually **all coral reefs are lost** by 2100.

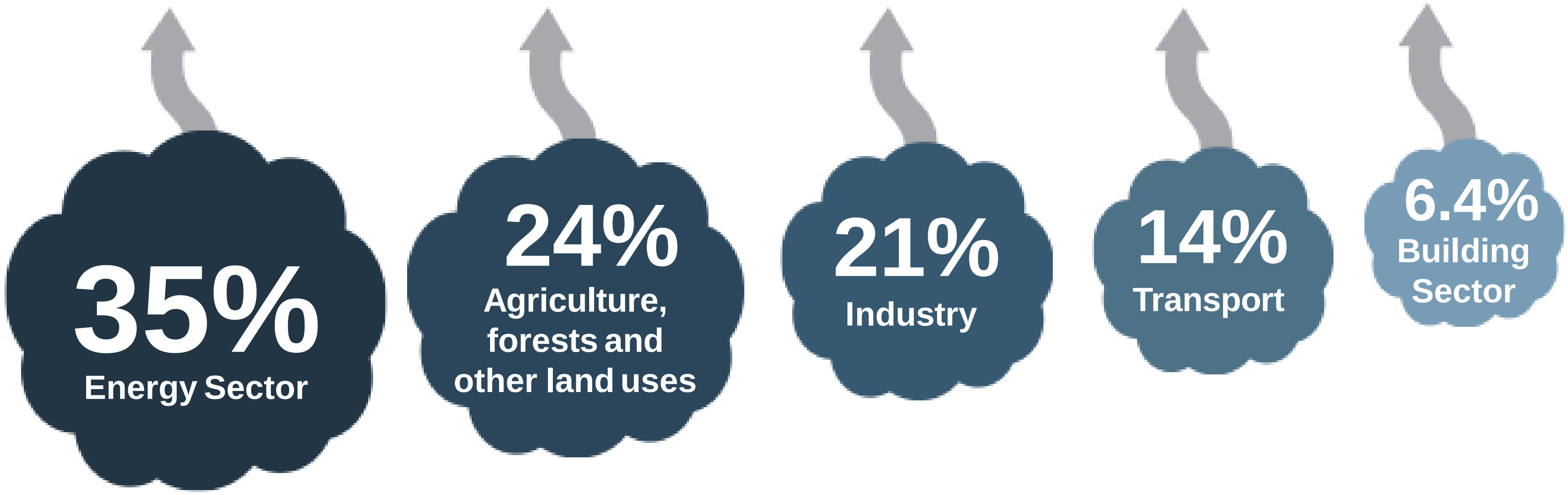
FOOD

Every half degree warming will consistently lead to lower yields and lower nutritional content in tropical regions.

Sources of emissions

Energy production remains the primary driver of GHG emissions

IPCC AR5 Synthesis Report



2010 GHG emissions

AR5 WGIII SPM

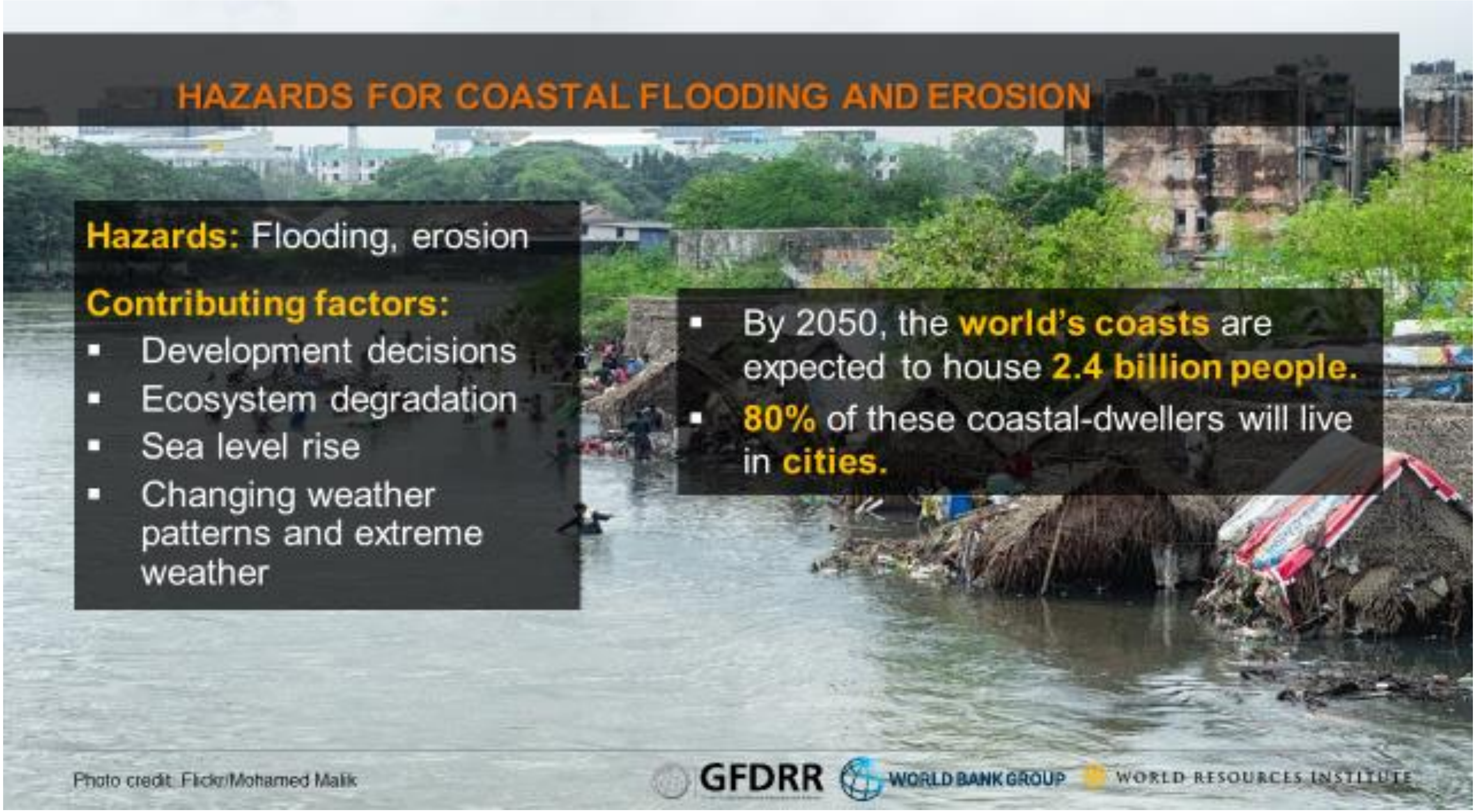
Impacts are already underway

- Tropics to the poles
- On all continents and in the ocean
- Affecting rich and poor countries




AR5 SYR SPM; AR5 WGII SPM

IPCC AR5
Synthesis
Report


HAZARDS FOR COASTAL FLOODING AND EROSION
Hazards: Flooding, erosion
Contributing factors:
Development decisions
Ecosystem degradation
Sea level rise
Changing weather patterns and extreme weather
By 2050, the world's coasts are expected to house 2.4 billion people.
80% of these coastal-dwellers will live in cities.
Photo credit: Flickr/Mohamed Malik
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VULNERABILITY to CC

Vulnerability is considered as the **degree to which** physical structures, people, or natural and economic assets are **exposed to loss**, **injury or damage** caused by the impact of a hazard. This is **similar to 'climate vulnerability'**, but is broken down into three constituents in direct relation to climate hazards,

1) the **degree of exposure** to climate related hazards,
2) the **degree of capacity** available to deal with climate related hazards, and
3) the degree of **sensitivity** to the given climate related hazard.

Hence , differential vulnerability is a key design element for CC adaptation

Adaptive capacity , Resilience & Sensitivity- key elements for Eba& CbA

- **Adaptive capacity -** The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (readiness).

- **Resilience** -The capacity of a system, community or society potentially exposed to hazards to adapt via either **resisting or changing** in order to reach and **maintain an acceptable level of function and structure**. Proactive VS reactive measures to enhance resilience

- **Sensitivity-** The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change

- **Ecosystem-based adaptation (EbA)** to CC provides multiple benefits in terms of poverty alleviation through livelihood opportunities, carbon storage and BD/ES conservation to be **integrated with the Community-based adaptation (CbA) – a Human rights-based approach-**"a **community-led/driven process**, based on communities' priorities, needs, knowledge and capacities, which should empower people to plan for and cope with the impacts of climate change"- context, culture, knowledge, agency, & preferences

Ecosystem-based adaptation

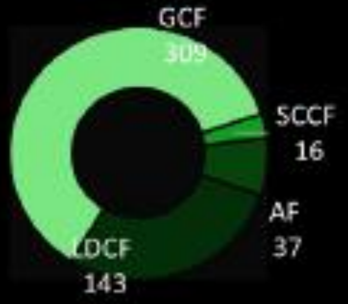
Preserving and restoring natural ecosystems that can provide cost-effective protection against climate change

Portfolio under implementation

$ 504 Million from VF

$ 1.4 Billion Co-financing

39 Projects



31 COUNTRIES **20** LDCs **6** SIDS

Since 2008 and currently under implementation

- 1.3 million ha of mangrove and forests replanted
- 145,800 ha of marine and 2 million ha of land area protected
- 873,771 ha of agricultural land under improved management
- 16,000 km of coastline protected

**The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations or UNDP concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries.*

EBM -STRUCTURAL STRATEGIES

Nature-based Solutions (NBS)		
Built/Grey	**Hybrid**	**Natural/Green**
Hard, gray, engineered structures built to address development objectives	Combination of ecosystem elements and hard engineering interventions to address development objectives	Creation, protection or restoration of only ecosystem elements to address development objectives

Source: World Bank 2017

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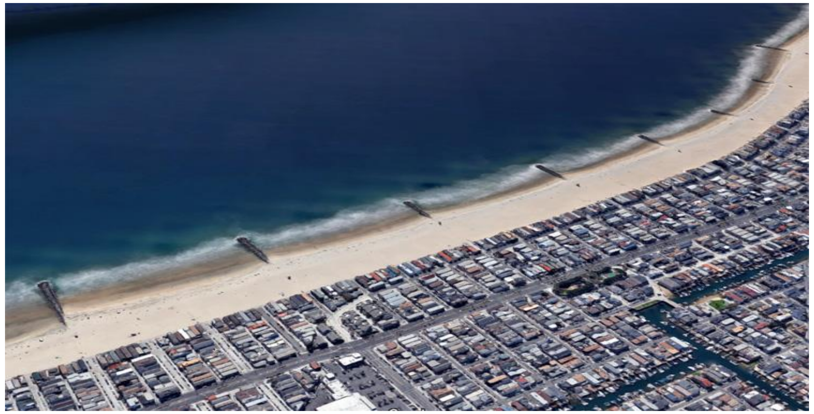
CbA Options for responding to coastal fringe flooding/erosion

Construction of physical barriers/Grey structures Seawalls, breakwaters, groins, gabion, dykes, and sluices (defend) [30,35,41,44,49–54]



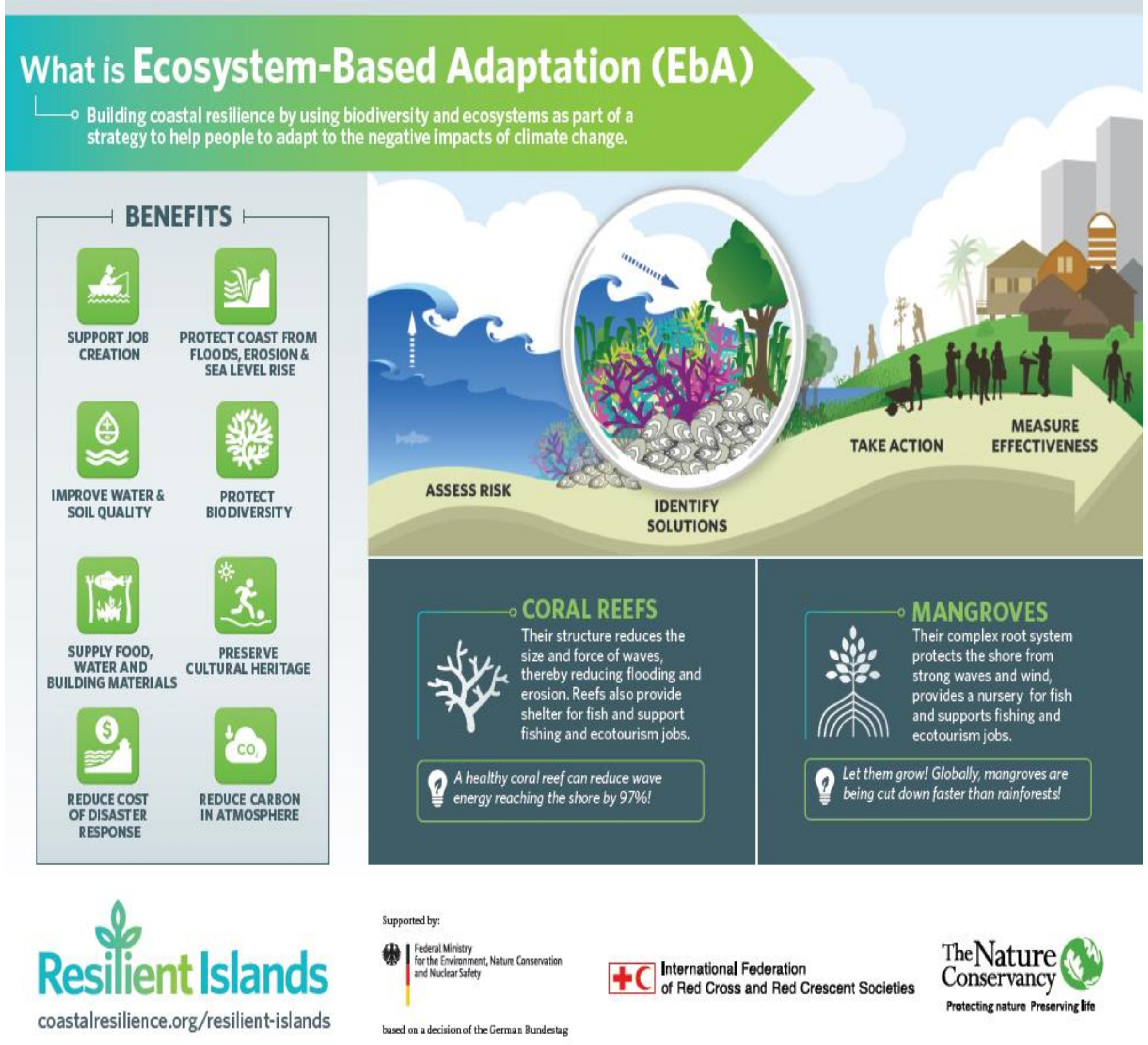
CbA Options for responding to coastal fringe flooding/erosion

EM/NbS/EbA – Protection/Eco restoration of mangrove, wetlands, dunes forests , sea grass beds & coral reefs (defend) [30,38,41,44,50,52,55,56]

Creation of artificial reefs (defend) [57]

Prohibition or control of the removal of beach sediments (defend) [20]

Beach nourishment (defend) [44,50,58]



Adaptation Options for responding to the impacts on farming and food production

Adapt **Agro-ecology** ; Adopt **vertical farms** (co-exist) [64]

Substitute crops with drought and **salt resistant/tolerant** cultivars (defend) [20,41]

Plant an **undercover to crops** (co-exist) ; **Diversify** cropping species (co-exist) [53–55]

Adjust planting and harvest dates for **spreading the risks** (co-exist)

Regulate the use of **agritoxics** that exterminate **pollinizers/beneficial soil biota** (co-exist)

Improve water, environmental and soil management

Improve **irrigation systems** and dig local dams (defend)

Reforestation/revegetation of areas likely to flood (defend) [56]

Improve management to **enrich the soil** with organic matter (defend) [56–61]

Financial and technical assistance to farmers (co-exist) [56–61]

Examples of Green Infrastructure

Green Roof

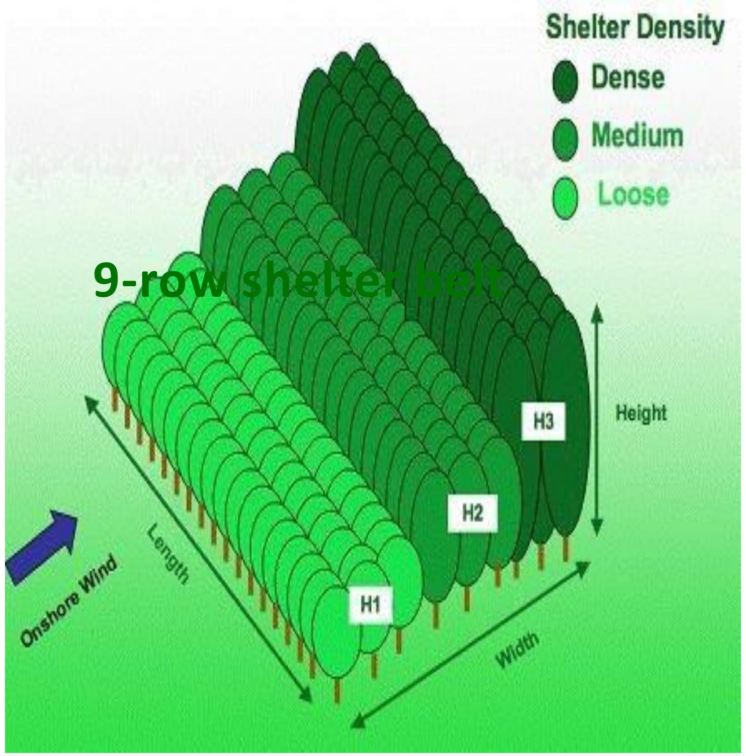
Permeable Pavers

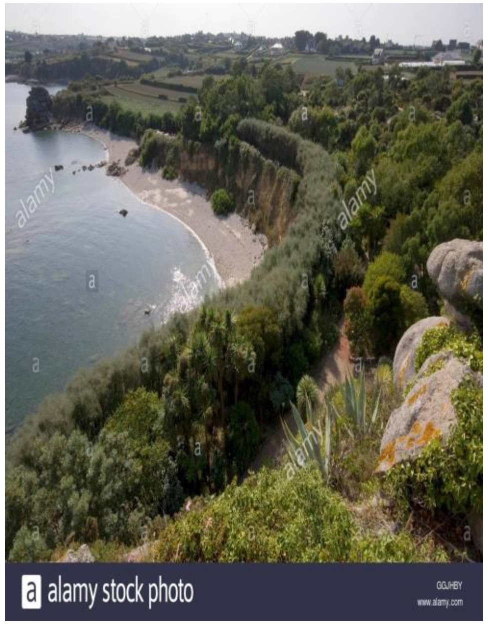
Cisterns/ Rain barrels

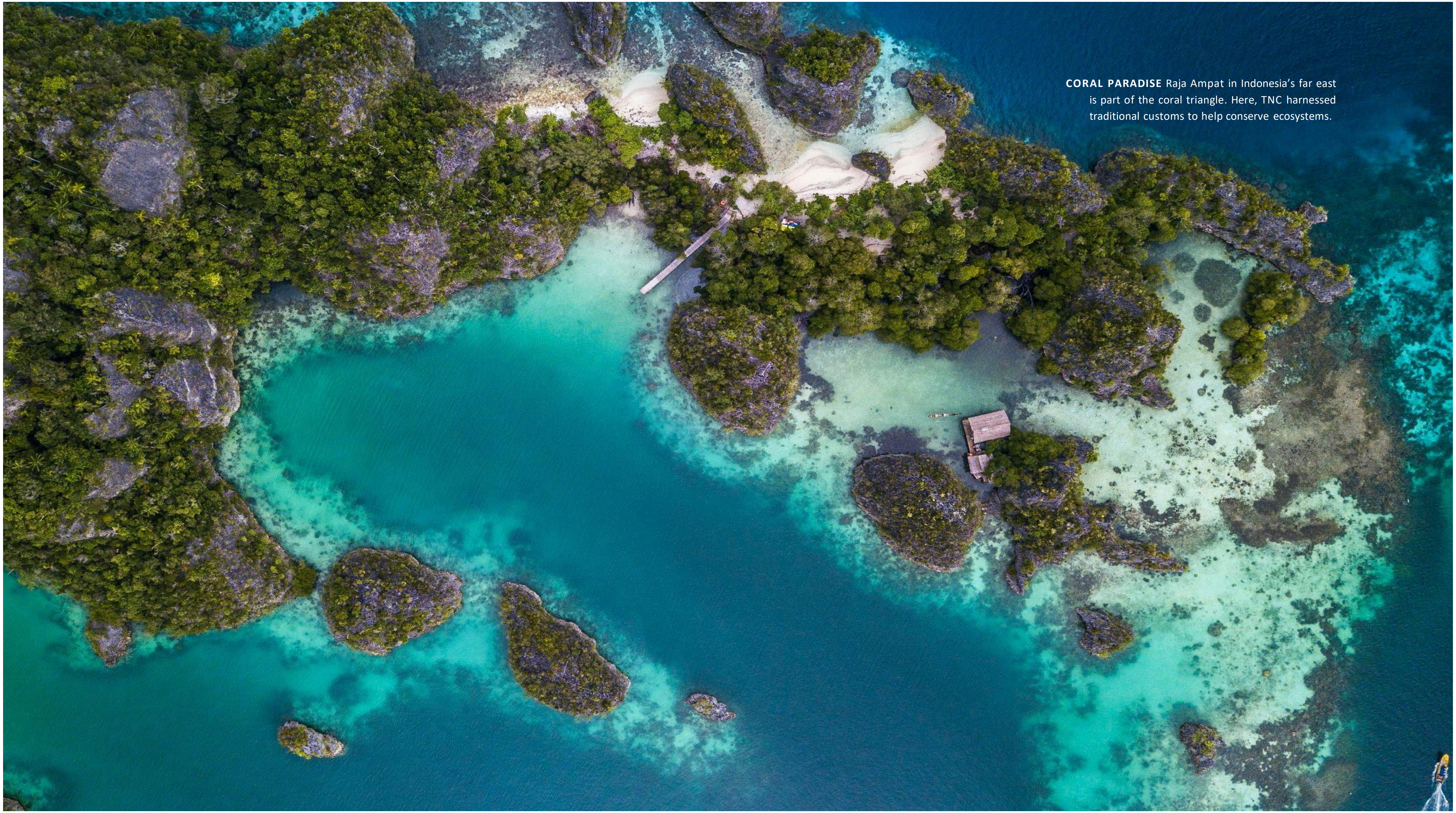
Rain Garden

A well designed **coastal shelter belts** consist of multiple rows of MPTS, with the **seaward (outer)** rows consisting of **bush and shrubs**, the **central** rows of **trees with a medium height**, and the **landward** (inner) rows of **trees with the greatest height.** The protective benefit mainly stems from the redirection of air flows, reducing effective downwind speeds over an area **30-40 times the height of the tallest trees** (Zhu 2008). A **20-m high shelter belt** thus helps **protect an area 600 m in width**, with the protection being greatest close to the shelter belt (where **wind speed** is up to **60% lower** than the initial speed).

Local tree species , in addition to protection can also offer numerous economic benefits (e.g. increase of yields, multiple products, ES) & often used in agroforestry.







CORAL PARADISE Raja Ampat in Indonesia's far east is part of the coral triangle. Here, TNC harnessed traditional customs to help conserve ecosystems.


What is a Rain Garden?
Nature's Water Filter: Rain gardens are shallow landscaped depressions that capture, clean and absorb stormwater runoff from roofs, parking lots and roads.
Runoff is collected from paved and other hard surfaces and directed into the garden.
Native plants do not require fertilizer and help filter pollutants.
Native plants provide food and habitat for birds, butterflies and other pollinators.
A depression in the earth is filled with a mixture of sand, topsoil and compost that filters water.
A typical rain garden is between six and nine inches deep.

Credit: TNC

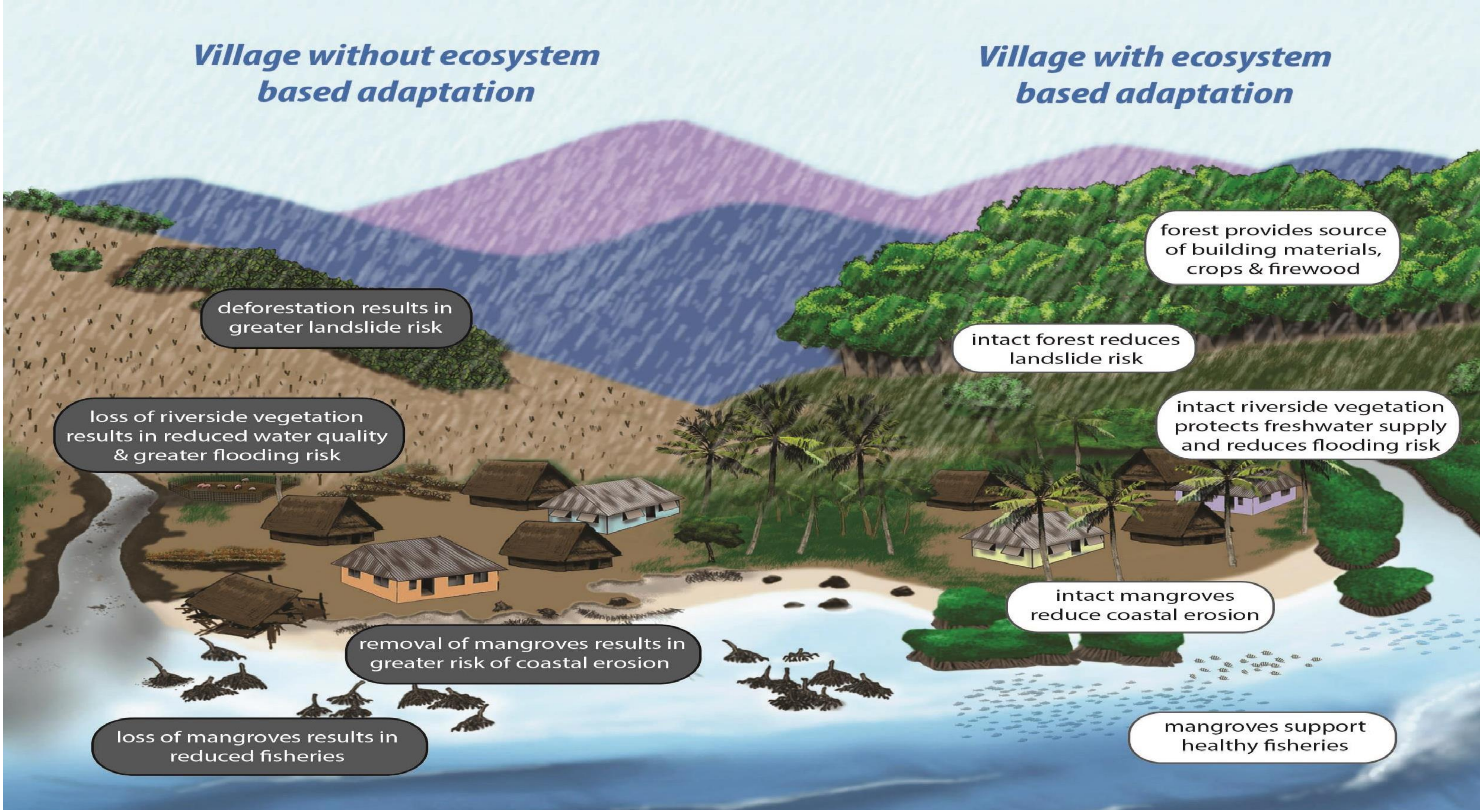
ECOSYSTEM-BASED MANAGEMENT

The geographic scope of EBM can collectively cover that of all five of the main management strategies: 1) the coastal lands and nearshore environment of ICZM; 2) the marine environment of MSP; 3) the rivers and drainage basins in watersheds that drain into the sea; 4) the waters supporting exploited fish stocks; and 5) the coastal and marine environments encompassed by MPAs.

Core Elements of EBM

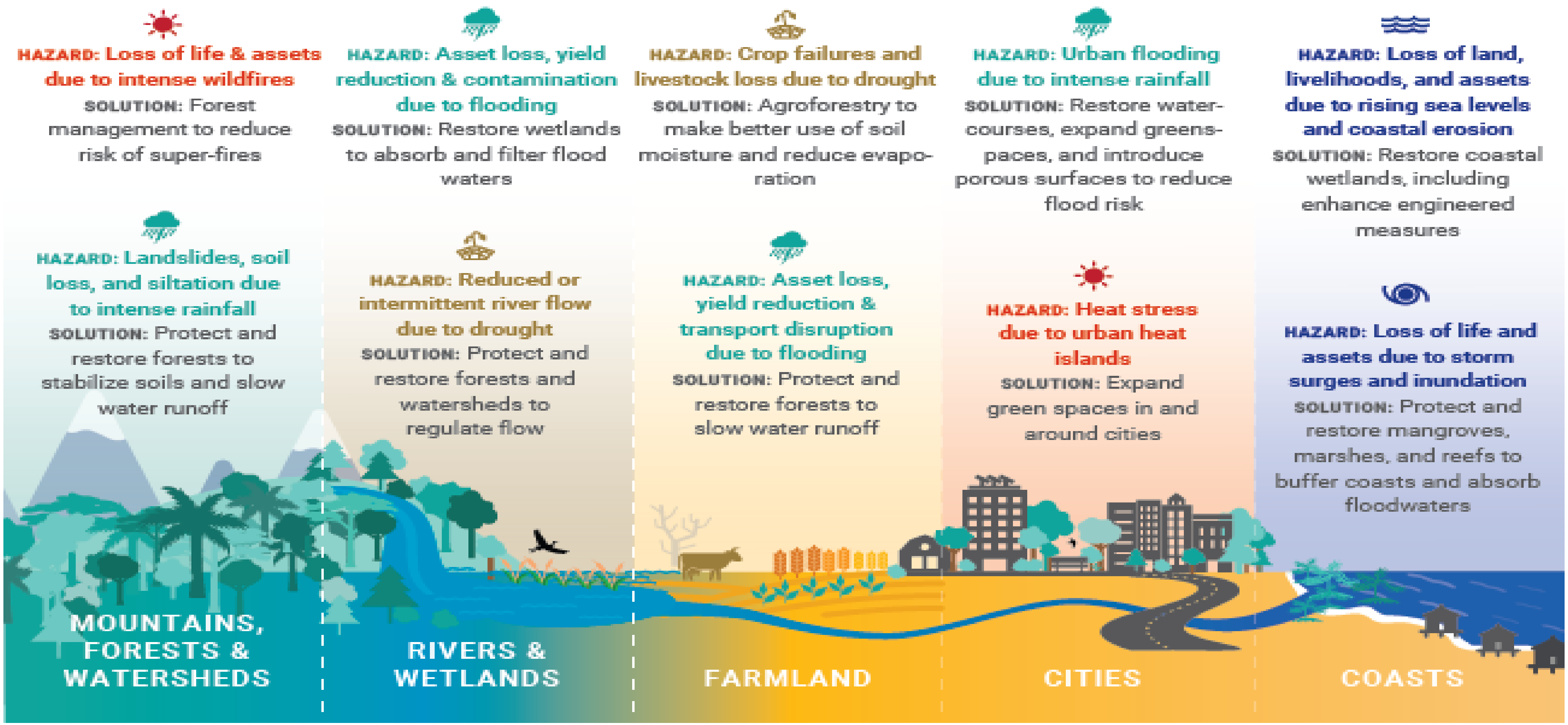
- Recognizing **connections** among the **local/regional SES** - marine, coastal, and terrestrial systems, as well as between ecosystems and human societies.
- Using an **ES perspective**, where ecosystems are valued not only for the **basic goods** they generate (such as food or raw materials) but also for the important **services** they provide (such as clean water, pollination, and protection from extreme weather).
- Addressing the **cumulative impacts** of various activities affecting an ecosystem
- Managing for and **balancing multiple and sometimes conflicting objectives** that are related to different benefits and ecosystem services.
- **Embracing change, learning from experience, and adapting policies** throughout the management process.

Thus, EBM builds on existing knowledge and management structures and develops these further. It is not about throwing out what we have and replacing it with something else.



Village without ecosystem based adaptation
Village with ecosystem based adaptation
deforestation results in greater landslide risk
loss of riverside vegetation results in reduced water quality & greater flooding risk
removal of mangroves results in greater risk of coastal erosion
loss of mangroves results in reduced fisheries
forest provides source of building materials, crops & firewood
intact forest reduces landslide risk
intact riverside vegetation protects freshwater supply and reduces flooding risk
intact mangroves reduce coastal erosion
mangroves support healthy fisheries

Nature-Based Solutions Can Build Resilience to Multiple Climate Hazards



Source: Global Commission on Adaptation, *Adapt Now* report, 2019.

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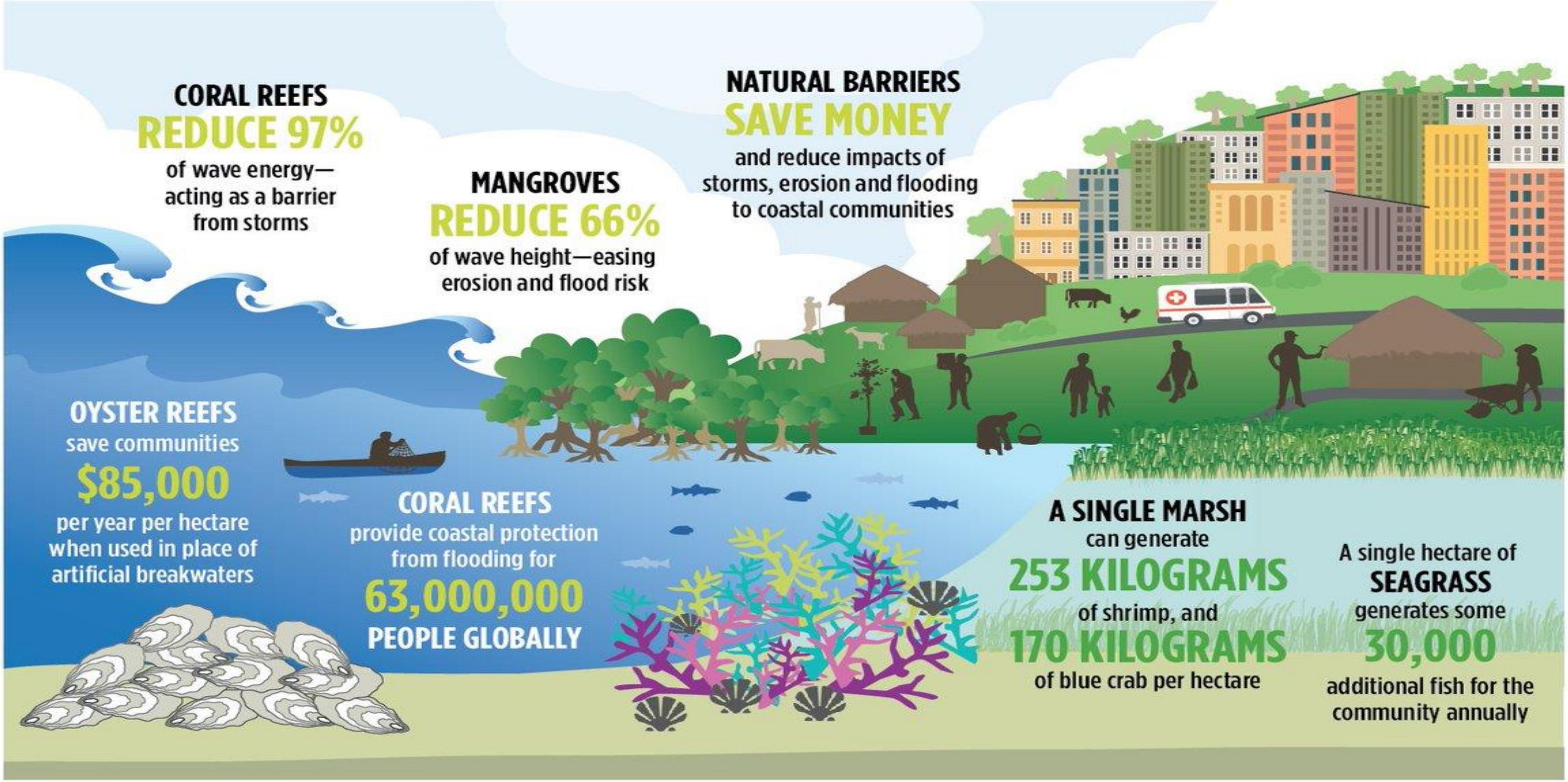
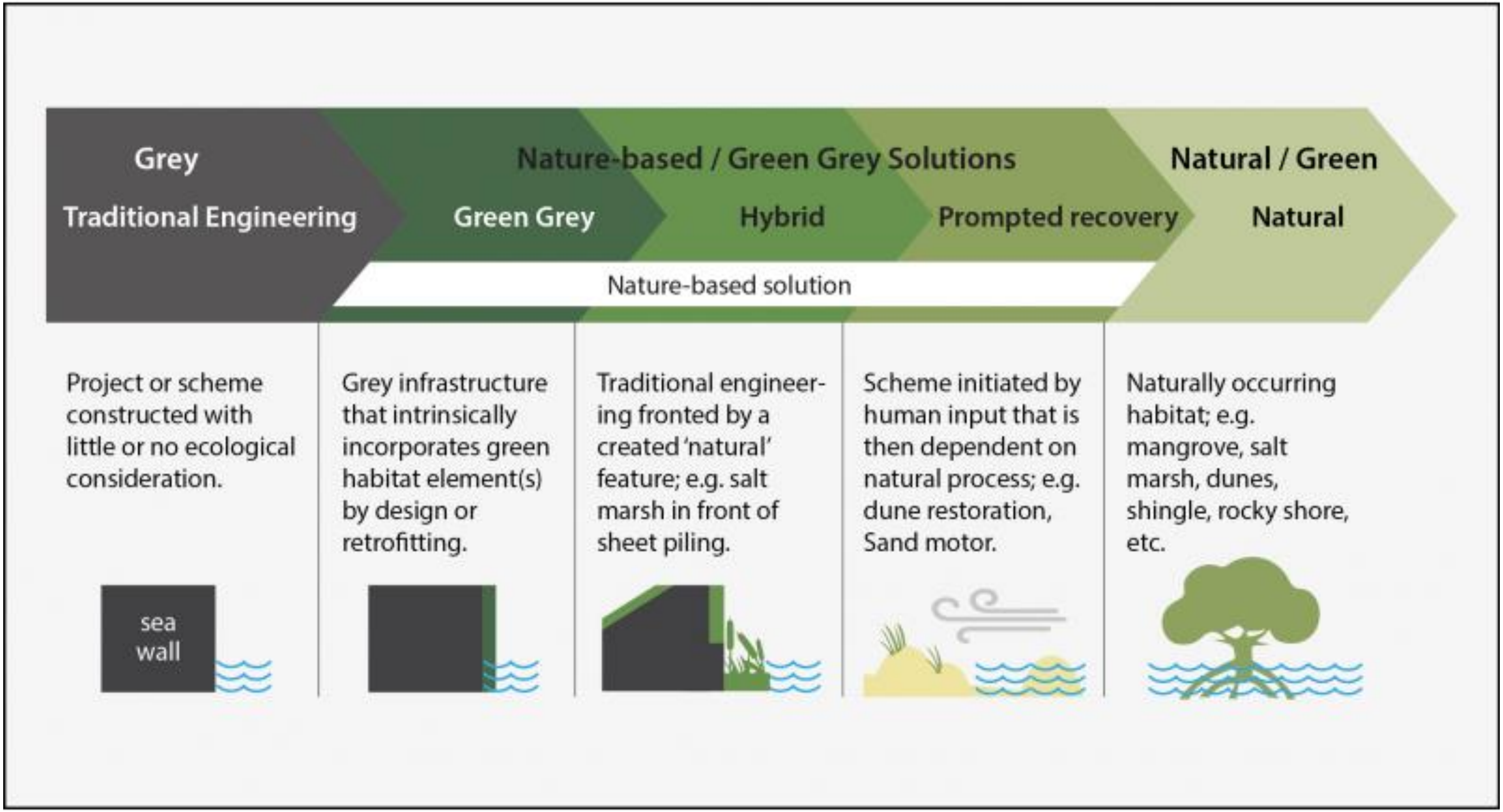
NATURE PROTECTS PEOPLE



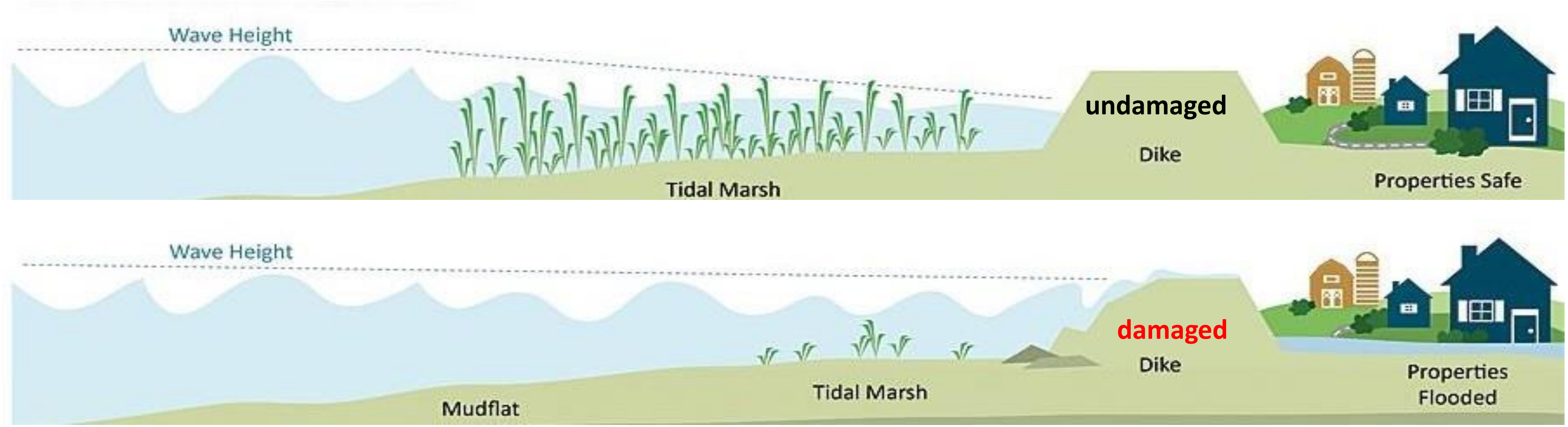


Grey
Traditional Engineering
Nature-based / Green Grey Solutions
Green Grey
Hybrid
Prompted recovery
Natural / Green
Natural
Nature-based solution
Project or scheme constructed with little or no ecological consideration.
Grey infrastructure that intrinsically incorporates green habitat element(s) by design or retrofitting.
Traditional engineering fronted by a created 'natural' feature; e.g. salt marsh in front of sheet piling.
Scheme initiated by human input that is then dependent on natural process; e.g. dune restoration, Sand motor.
Naturally occurring habitat; e.g. mangrove, salt marsh, dunes, shingle, rocky shore, etc.
sea wall

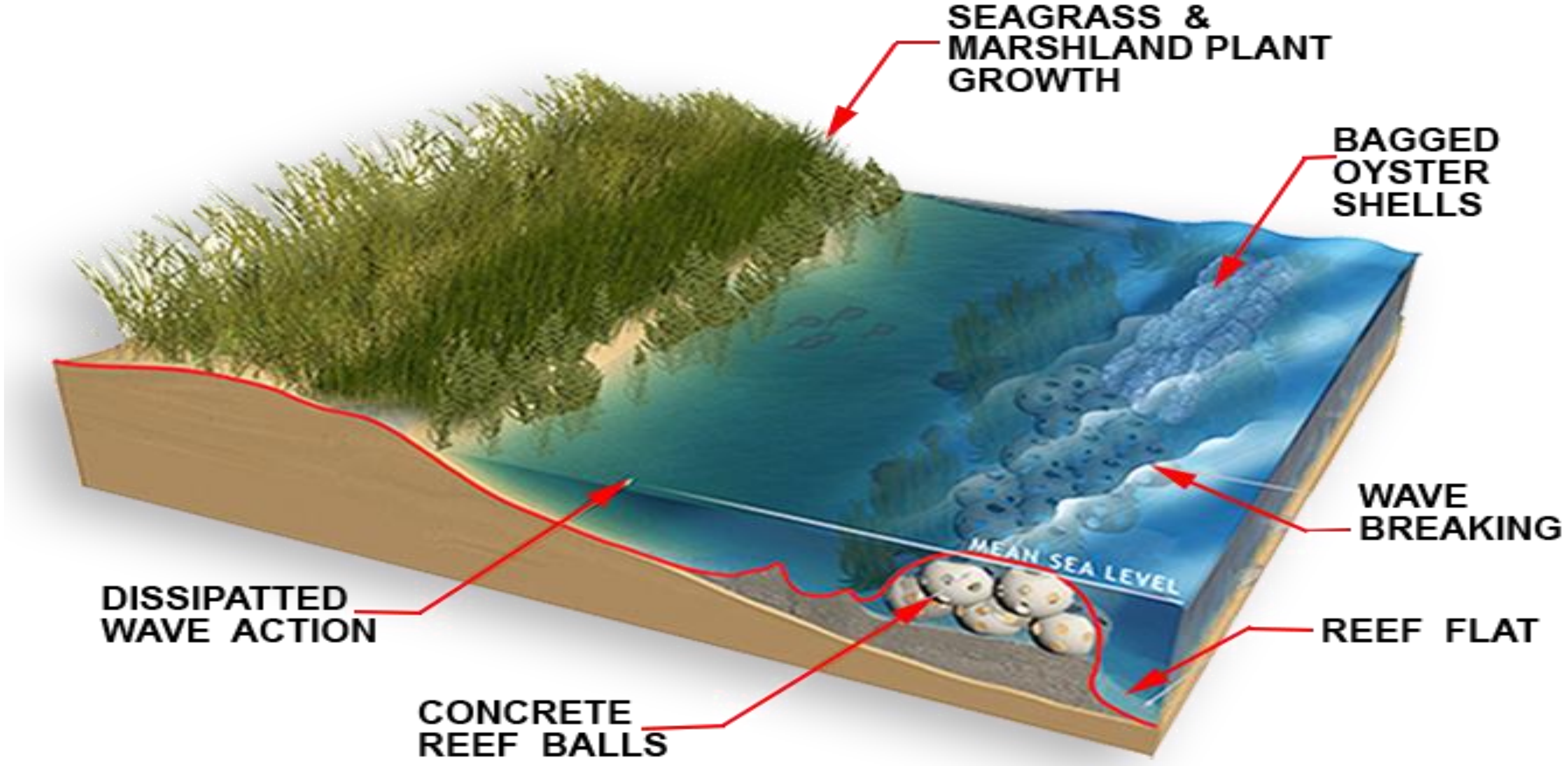
NbS: 'HYBRID' INFRASTRUCTURE

- Nature-based solutions alone are **often insufficient** to meet all needs
- **'Hybrid'** solutions **integrate and enhance** the benefits of natural and built solutions

- **Examples:** permeable pavements, constructed wetlands, removable sea walls, green roofs

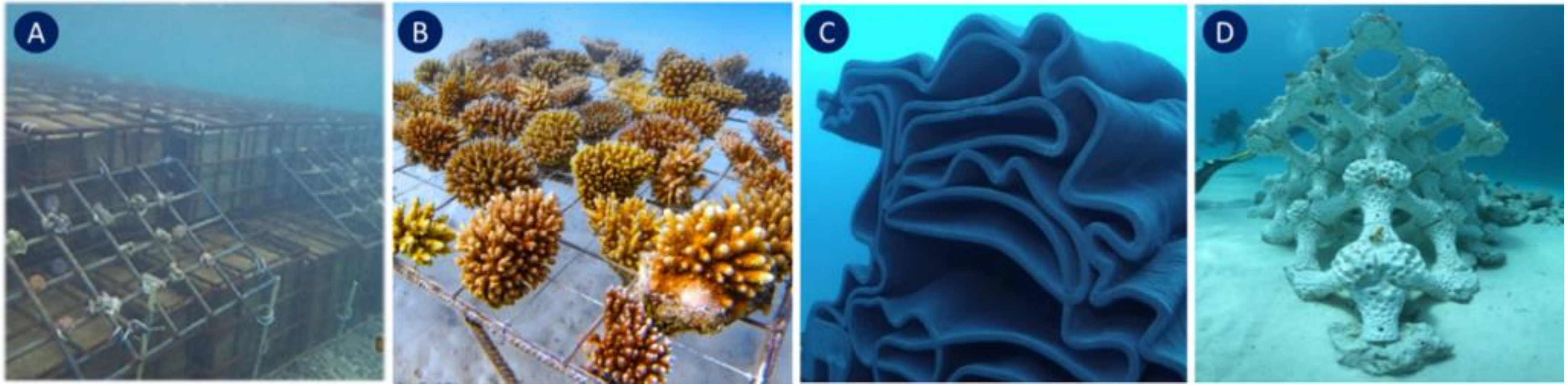


Graphic: Ferdana et al. 2014


SEAGRASS & MARSHLAND PLANT GROWTH
BAGGED OYSTER SHELLS
WAVE BREAKING
MEAN SEA LEVEL
REEF FLAT
DISSIPATTED WAVE ACTION
CONCRETE REEF BALLS

Blue barriers" can build coastal resilience for small islands

The Govt. of **Seychelles** & the **WB** are exploring the potential of innovative hybrid solutions -"blue barriers." …consist of reef structures enhanced with coral restoration-designed to induce wave breaking, to reduce or redirect destructive erosional currents-involve the construction of a **submerged structure using natural non-toxic materials** that can serve as a **stable and hard substrate for coral colonization**; can offer **multiple benefits** and can build a **coalition** of **key stake holders-** government, civil society and the private sector: can **simultaneously** provide coastal **resilience**, support the **recovery of corals** and **marine BD**, & contribute to **tourism** and regenerating **fish stocks** esp for **small islands**.



(A) Pilot unit made with gabion baskets and rocks in Grenade (Reguero et al., 2018); (B) Metal structure using mineral accretion technology in Maldives (Coralive); (C) 3D-printed concrete artificial reef in the Calanques National Park, France (Seaboost and XtreeE); (D) MARS project: 3D-printed artificial module in Maldives (Alex Goad-MARS).

CONVENTIONAL: ‘BUILT’ INFRASTRUCTURE

- **Controlled disruption** of ecosystem by building man-made structures
- **Examples:** pipes, levees, dams, flood walls, gutters

Photo credit: Flickr/darkday

NBS: 'NATURAL' INFRASTRUCTURE

- Nature-based solutions include **regenerating, protecting** and **creating ecosystems that can decrease wave height & energy**
- Newer and **not as well-tested** as built infrastructure, but can be more **cost-effective** in some cases- resilient ES
- **Examples:** mangroves, SGBs, coral/ oyster reefs, wetlands, floodplains, upland forests, dunes

Photo credit: Flickr/Ed Hunsinger


NBS FOR COASTAL FLOODING AND EROSION
The solutions:
▪ Mangrove forests
▪ Coral reefs
▪ Oyster reefs
▪ Sandy beaches and dunes
▪ Salt marshes
▪ Seagrass
Photo credit: Flickr/Anh Dinh
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Figure 1.3 | Green Corridors Prevent Diffuse Pollution from Agriculture

Image: World Bank.

Table 1.1 | From the Frontlines: Green Infrastructure Case Studies Tackling Multisector Water and Disaster Risk Challenges

SERVICE	EXAMPLE OF GREEN INFRASTRUCTURE	FEATURED CASE STUDIES
Water supply and hydropower	Watersheds: Forestland and riparian areas surrounding water sources can naturally filter biological and chemical impurities, as well as trap sediment, reducing erosion and associated reservoir sedimentation.	**Costa Rica:** Payments for Ecosystem Services to Support Hydropower Operations **Brazil:** Targeted Green Infrastructure for Source Water Protection*
Coastal flood management and erosion control	Natural coastal barriers: Reefs (coral or oyster), coastal wetlands, and mangroves protect coastal assets against flooding and erosion by dissipating wave energy, while dunes serve as a barrier to protect developed areas from waves and storm surges.	**The Netherlands:** Piloting Mega Sand Nourishment for Coastal Flood Management **Vietnam:** Using Mangroves and Sea Dikes as First Line of Coastal Defense*
River flood management	Floodplains: Natural components of riverine systems (such as floodplains, riparian areas, river meanders) dissipate flood energy and serve as storage reservoirs that attenuate flood flows, and allow water to slowly infiltrate and replenish soil and ground water. Upstream forest cover intercepts and slows floodwater.	**United States:** Integrating Green and Gray Infrastructure for River Flood Management **Poland:** Combining Green and Gray Infrastructure for Flood Risk Management at the River Basin Scale*
Stormwater management	Urban retention and infiltration: Complementing gray infrastructure with pervious surfaces (such as green roofs, porous pavements) and green, open spaces (such as wetlands, bioswales, rain gardens) allows precipitation to slowly infiltrate the ground, instead of quickly running off impervious surfaces or overflowing gray infrastructure.	**United States:** Innovative Financing for Urban Green Infrastructure **Sri Lanka:** Conserving Wetlands to Enhance Urban Flood Control Systems*
Drought management	Aquifers and wetlands: Groundwater can be enhanced by maintaining natural recharge areas, such as floodplains or engineered percolation ponds. Forests, wetlands, and floodplains can also improve surface water availability by increasing storage capacity, improving base flows, and enhancing water quality. These approaches can be used to augment water supplies during dry periods.	**Ecuador:** User-financed Ecosystem Conservation for Water Security **Somalia:** Recharging Aquifers to Combat Drought*
Irrigation and drainage	Soils: The more water the soil layer can hold, the more water is available to support crops and reduce irrigation demands. Soil water levels can be augmented by reducing evaporation through techniques such as furrow diking, reducing tillage, and maintaining mulch cover. The soil's water holding capacity can also be increased by improving its organic content and minimizing compaction.	**India:** Community-led Watershed Restoration **China:** Active Soil Management for Water Conservation*

MULTI-LAYER VEGETATION
CURB NOTCHES
BIO-RETENTION SWALE
MULCH
BIO-RETENTION SOIL
GRAVEL BASE
PERFORATED PIPE

MANY TERMS FOR "NATURE-BASED SOLUTIONS"

Source: Cohen-Shacham et al. 2016; UNEP et al. 2014; EC 2015; Lo 2016; WWF 2017; USACE n.d.; EcoShape 2018; WBCSD 2017

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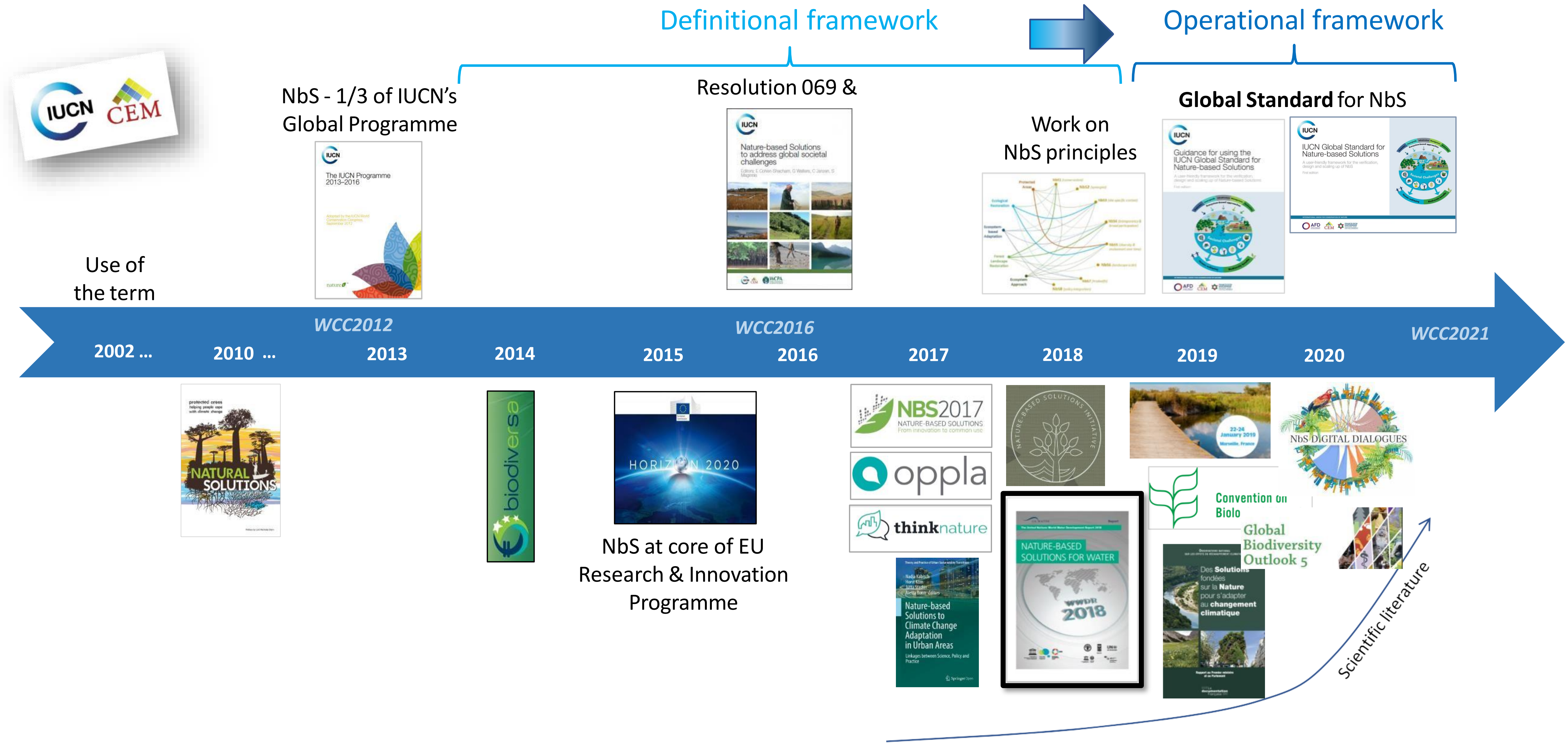
Evolution of Nature-based Solutions



IUCN Resolution 069 – Defining Nature-based Solutions

Nature-based Solutions Definition:

"**Actions** to **protect, manage and restore natural or modified ecosystems**, which **address societal challenges**, **effectively and adaptively**, providing **human well-being** and **biodiversity benefits**".

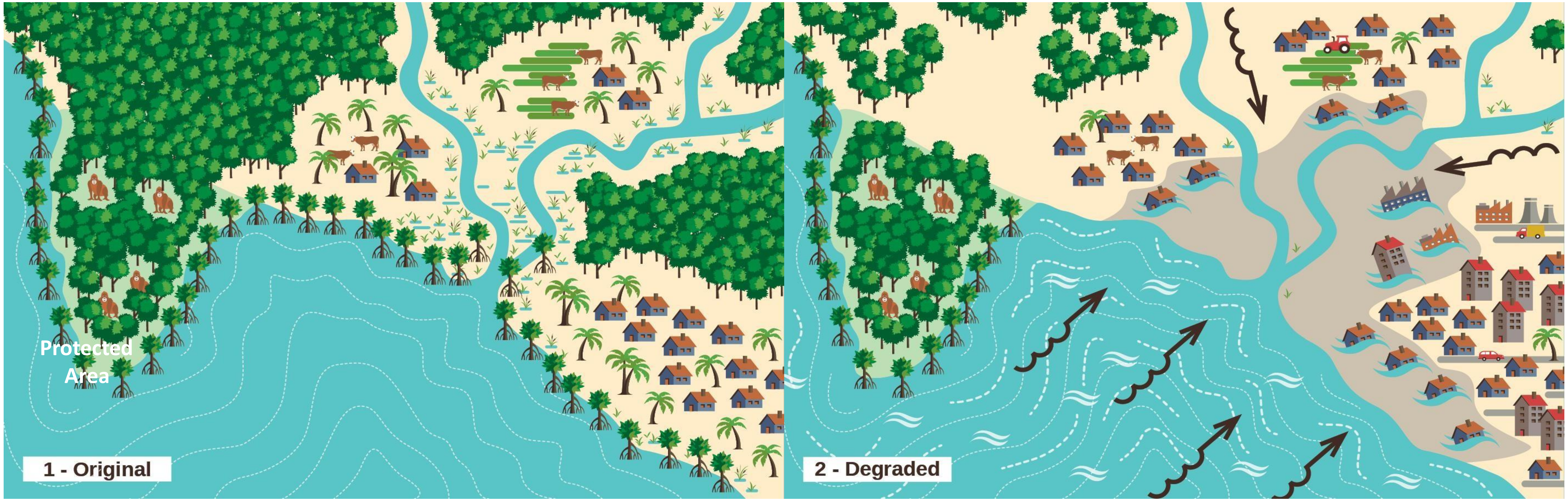
**Societal challenges: climate change, natural disasters, social and economic development, human health, food security, water security, ecosystem degradation and biodiversity loss.*

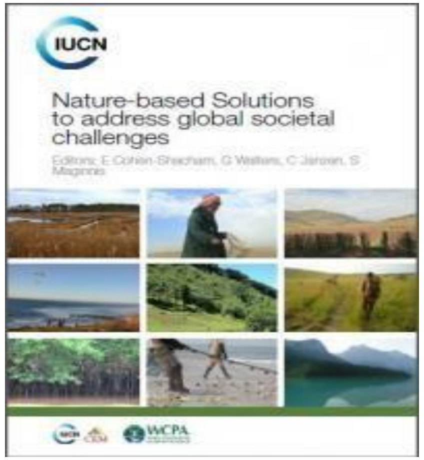
IUCN Resolution 069 – Principles for NbS

Preliminary principles for Nature-based Solutions

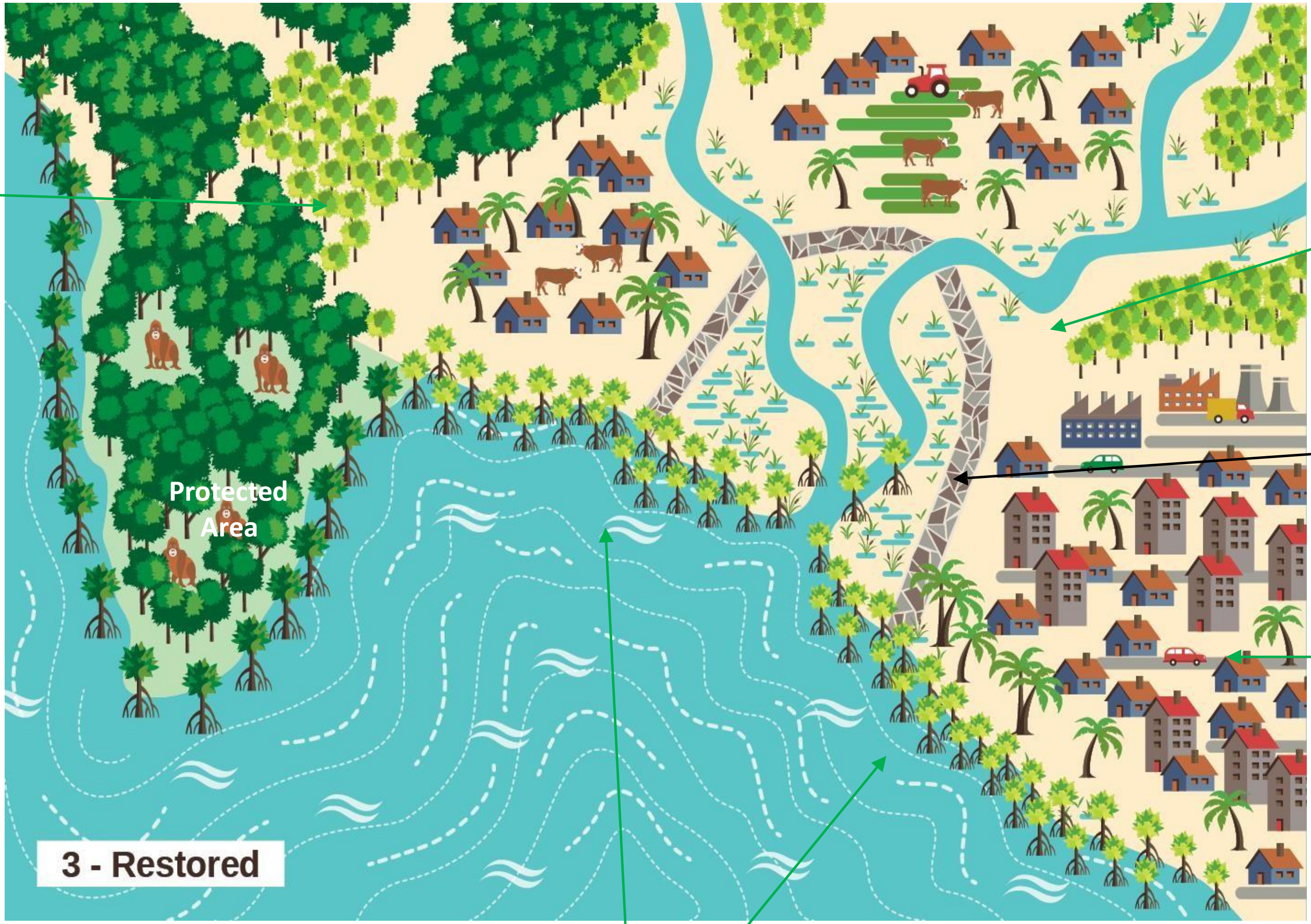
1. **Embrace nature conservation-Sustaining/diversifying livelihoods**
2. Can be implemented with **other solutions to societal challenges- C sequestration**
3. Are determined by **site-specific natural & cultural contexts**
4. Produce **societal benefits** in a fair & equitable way-Improving food/water/nutritional security
5. Maintain **habitat, biological & cultural diversity- ES**
6. Are applied at a **landscape/sescape scale**
7. Recognise & address the **trade-offs between immediate economic benefits** for development & future production of ES
8. Are an **integral part of the overall design**

NbS complementary with other types of actions: infrastructure development & protected area conservation





NbS complementary with other types of actions: infrastructure development & PA conservation



NbS as umbrella for different types concepts

1. Ecosystem protection approaches

AbC

2. Issue-specific ecosystem-related approaches

EbA EbM Eco-DRR

3. Infrastructure-related approaches

GI NI

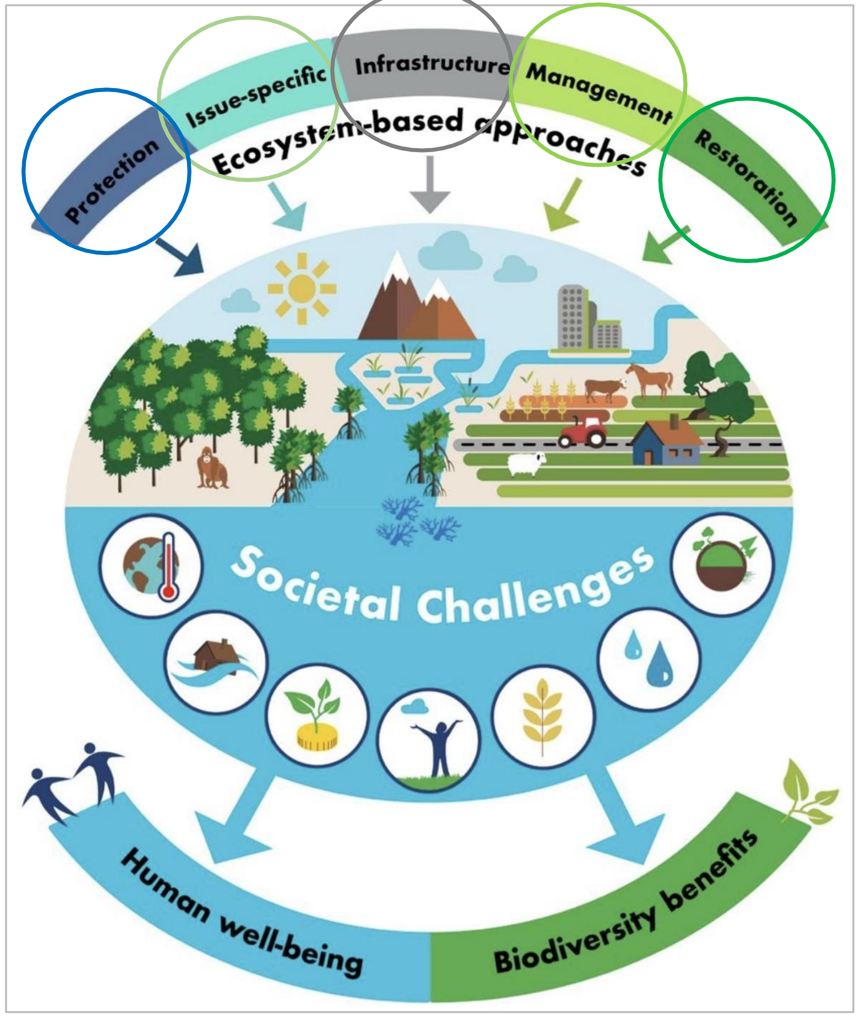
4. Ecosystem-based management approaches

EbMgt

5. Ecosystem restoration approaches

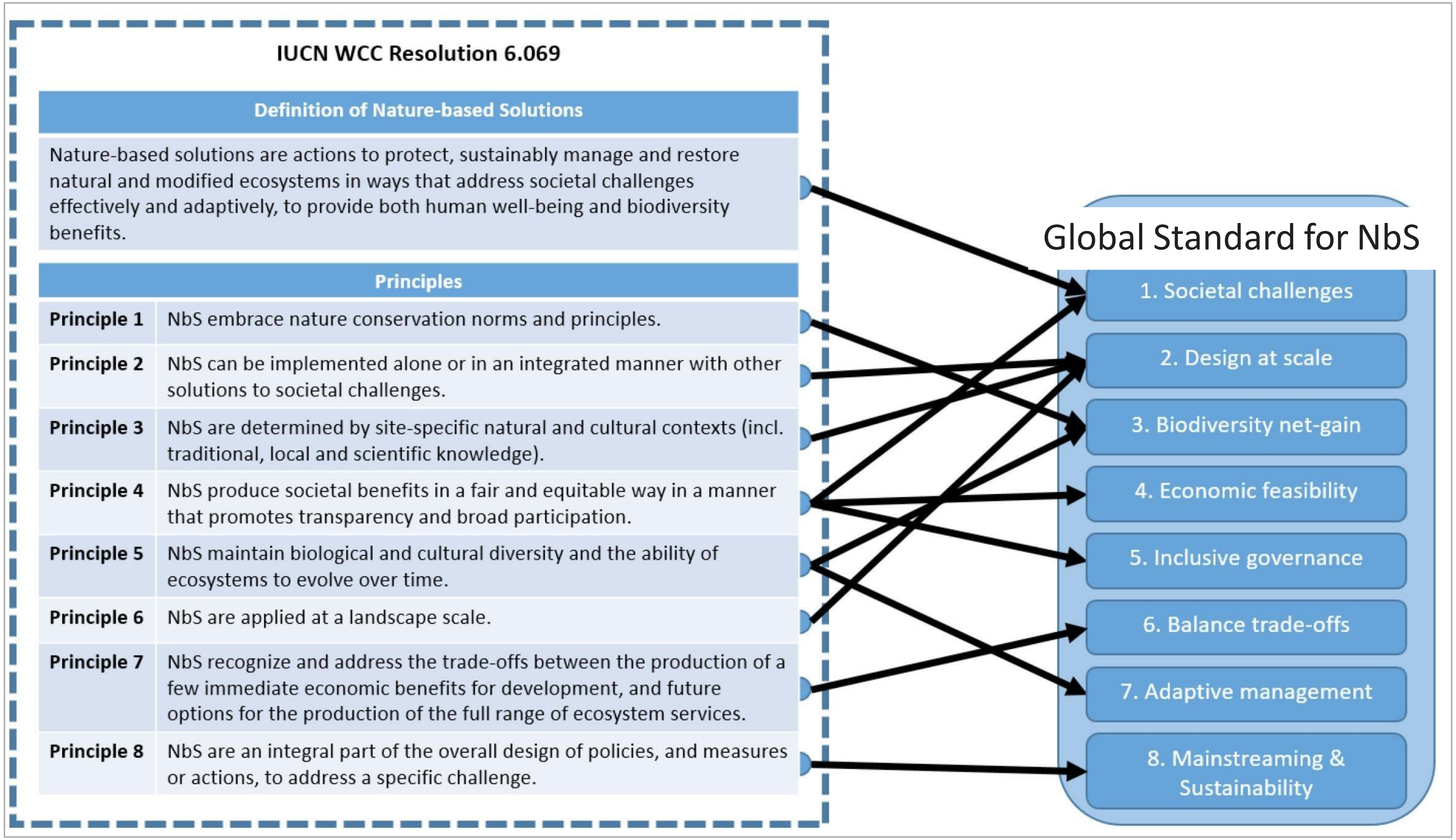
ER EE FLR

Cohen-Shacham et al., 2016



ABC- Area based Conservation **; FLR**-Forest Landscape Restoration

From NbS definitional framework to operational framework



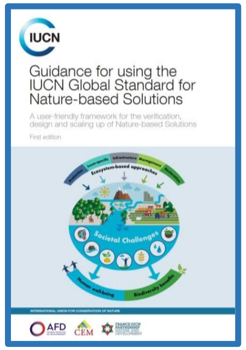
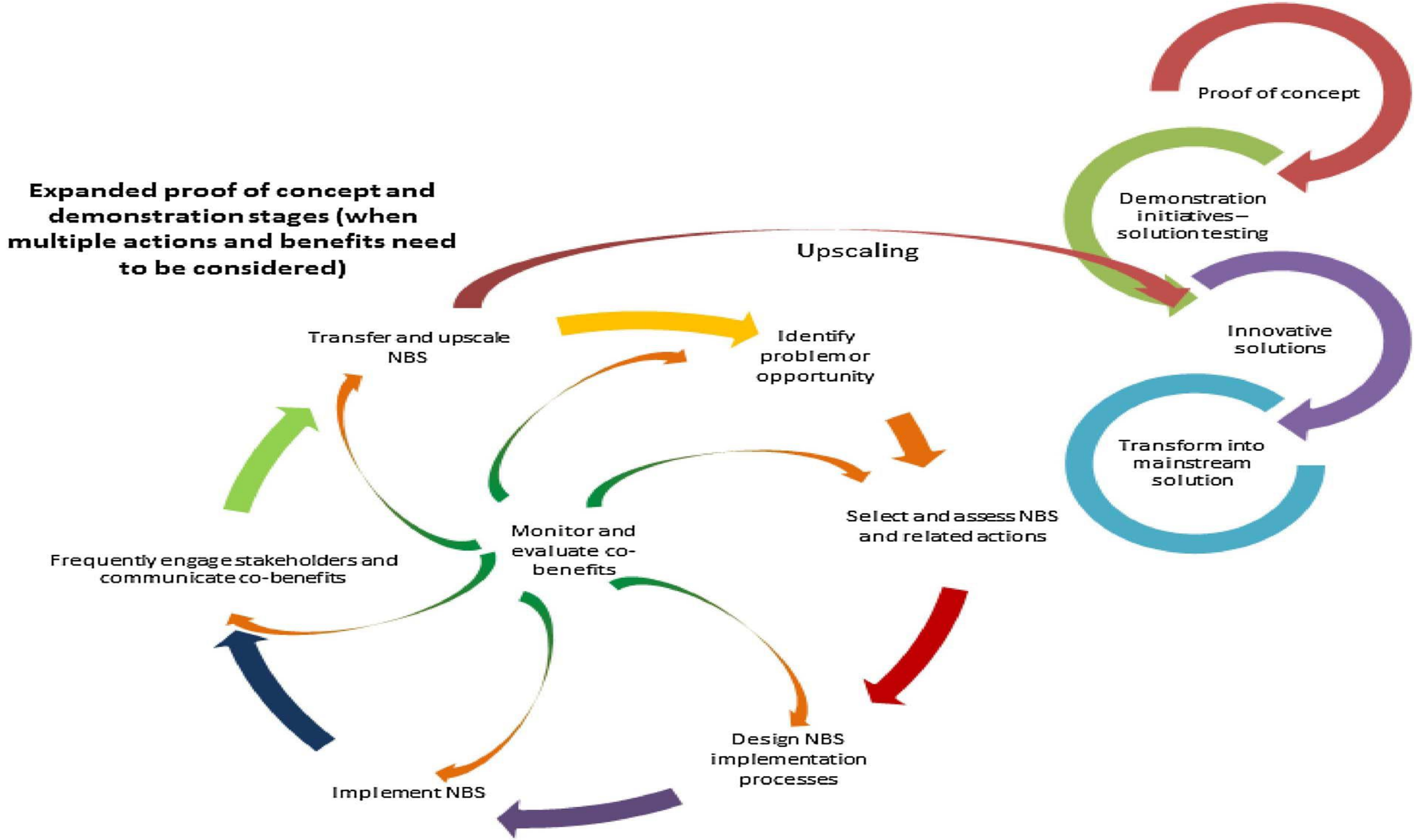


Figure: IUCN, 2020


Proof of concept
Demonstration initiatives – solution testing
Innovative solutions
Transform into mainstream solution
Expanded proof of concept and demonstration stages (when multiple actions and benefits need to be considered)
Upscaling
Transfer and upscale NBS
Identify problem or opportunity
Select and assess NBS and related actions
Monitor and evaluate co-benefits
Frequently engage stakeholders and communicate co-benefits
Design NBS implementation processes
Implement NBS

NbS Global Standard - Use and target audience

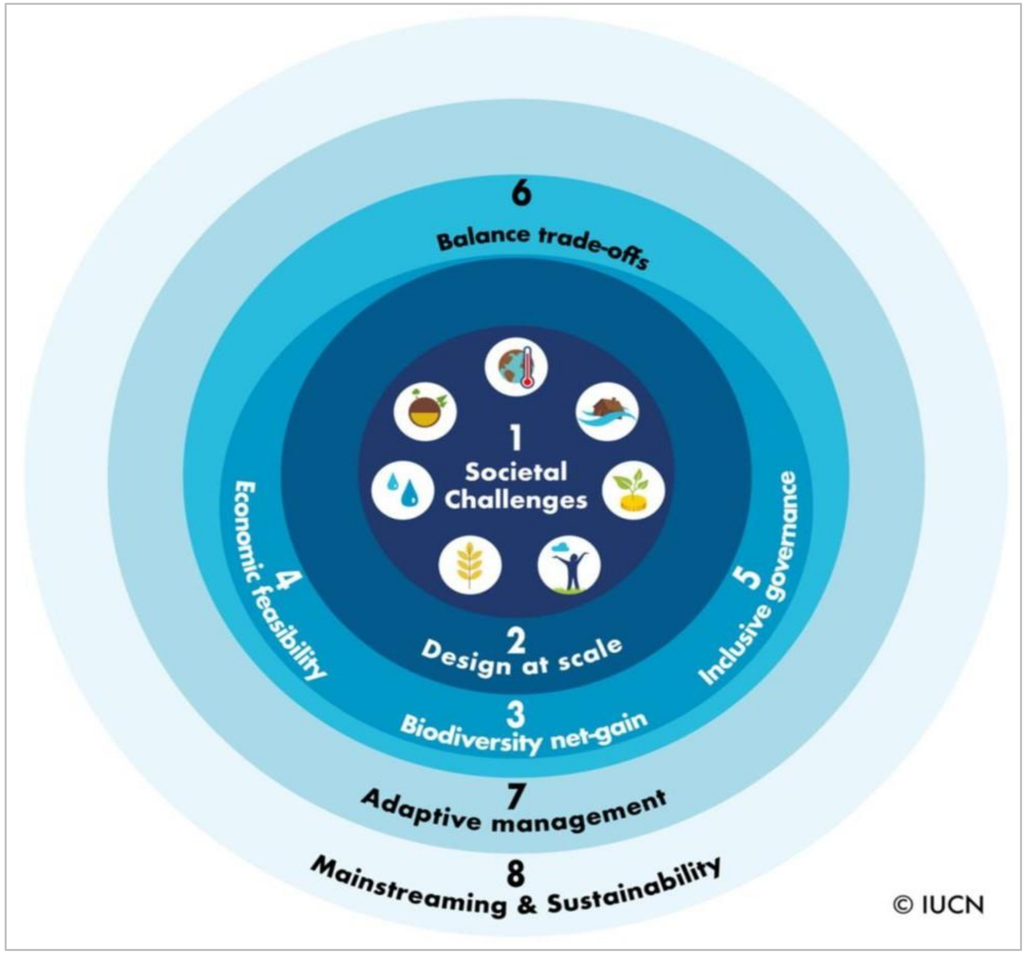
Purpose: Set a common basis of understanding for NbS and provide a robust framework, to **design, implement, assess, adapt and improve NbS.**

→ **Contribute to transformational change**

→ **Support NbS-related policy**

Audience: project managers, landscape planners, development practitioners, conservationists, policy makers, finance sector representatives (donors and investors), governments and planners.

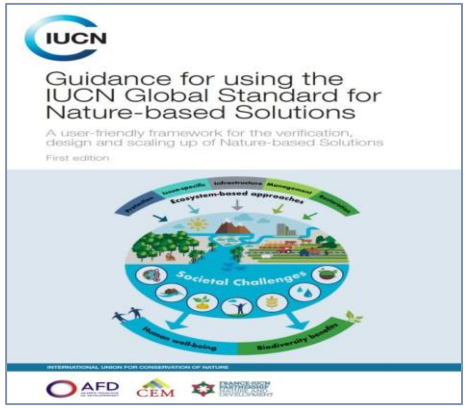
8 Criteria, 28 Indicators



Global Standard for NbS – Available products

Part I:
NbS Standard

Part II:
Guidance



Part III:
Self-Assessment

Indicator 3.1 NbS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss

To develop a solution using nature, one must have a well-founded understanding of the current state of the ecosystems concerned. The baseline assessment needs to be broad enough to characterise ecological state, drivers for ecosystem loss and options for net improvements, making use of both local knowledge and scientific understanding where possible.

Strong	Adequate	Partial	Insufficient
Yes. An updated assessment of the current status of ecosystems at the appropriate spatial and temporal scales is in place. The assessment includes information about the drivers of change and biodiversity loss. The assessment includes field verification and local knowledge.	There is information available about the current state of the ecosystems using secondary data and reference maps, not older than 10 years. The information of the ecosystem has been verified in general terms through field visits, with general inputs from local communities and traditional knowledge, where possible.	General information about existing land cover and land use is used for assessing the status of the ecosystems, at more general scales and not older than ten years. There is not validation at field level and data coming from communities or traditional knowledge.	No. There is no information available about general conditions of the status of the ecosystems at any relevant spatial or temporal scale.

NbS Criteria

Criterion 1: NbS effectively address societal challenges

Criterion 2: Design of NbS is informed by scale

Criterion 3: NbS result in a net gain to biodiversity and ecosystem integrity.

Criterion 4: NbS are economically viable

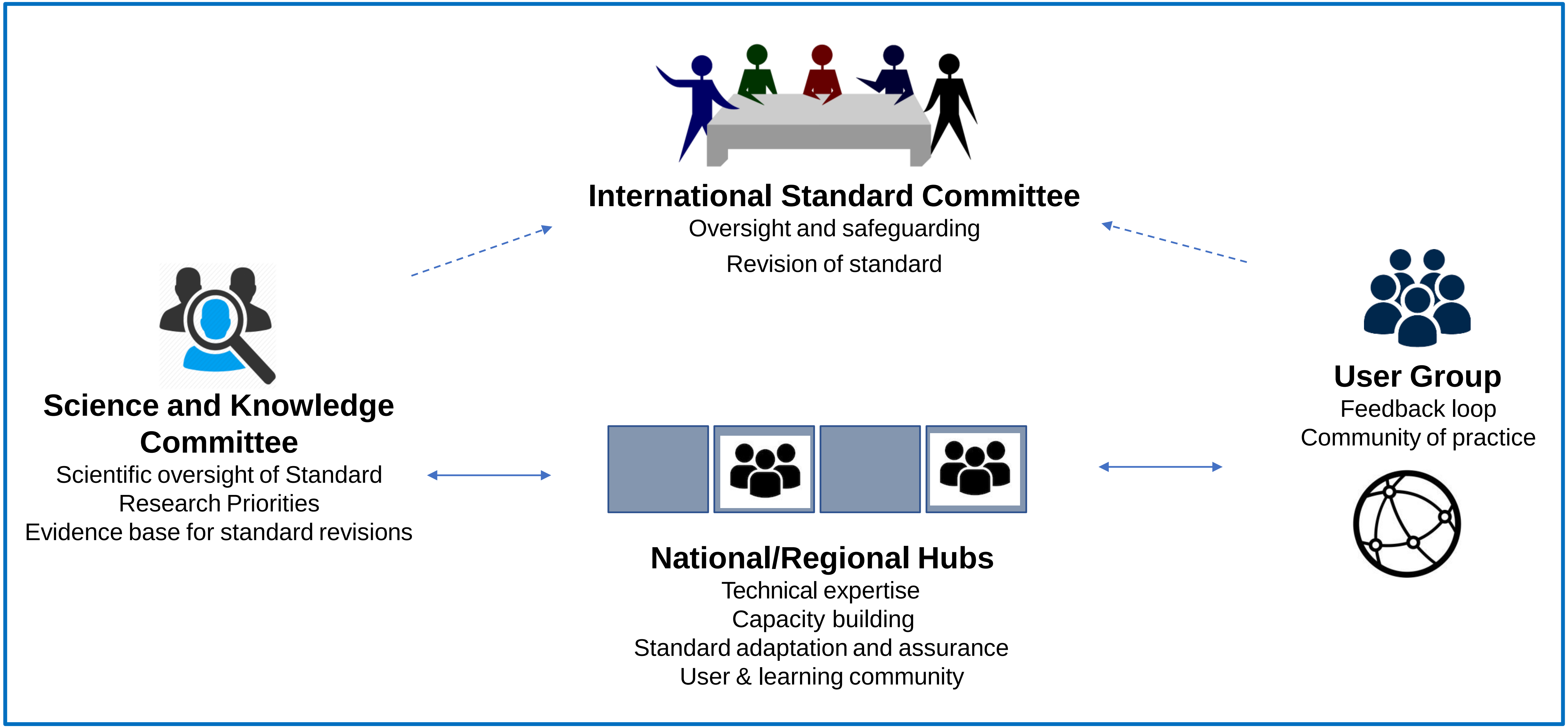
Criterion 5: NbS are based on inclusive, transparent and empowering governance processes

Criterion 6: NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits in SE systems

Criterion 7: NbS are managed adaptively, based on evidence

Criterion 8: NbS are sustainable and mainstreamed within an appropriate jurisdictional context- CC, BD, SDGs…

Global Standard for NbS – Governance Structure



RISK REDUCTION AND ADDITIONAL BENEFITS:
COASTAL FLOODING AND EROSION

Mangrove forests

- Reduce wave energy; stabilize shoreline; elevate soil

Additional benefits

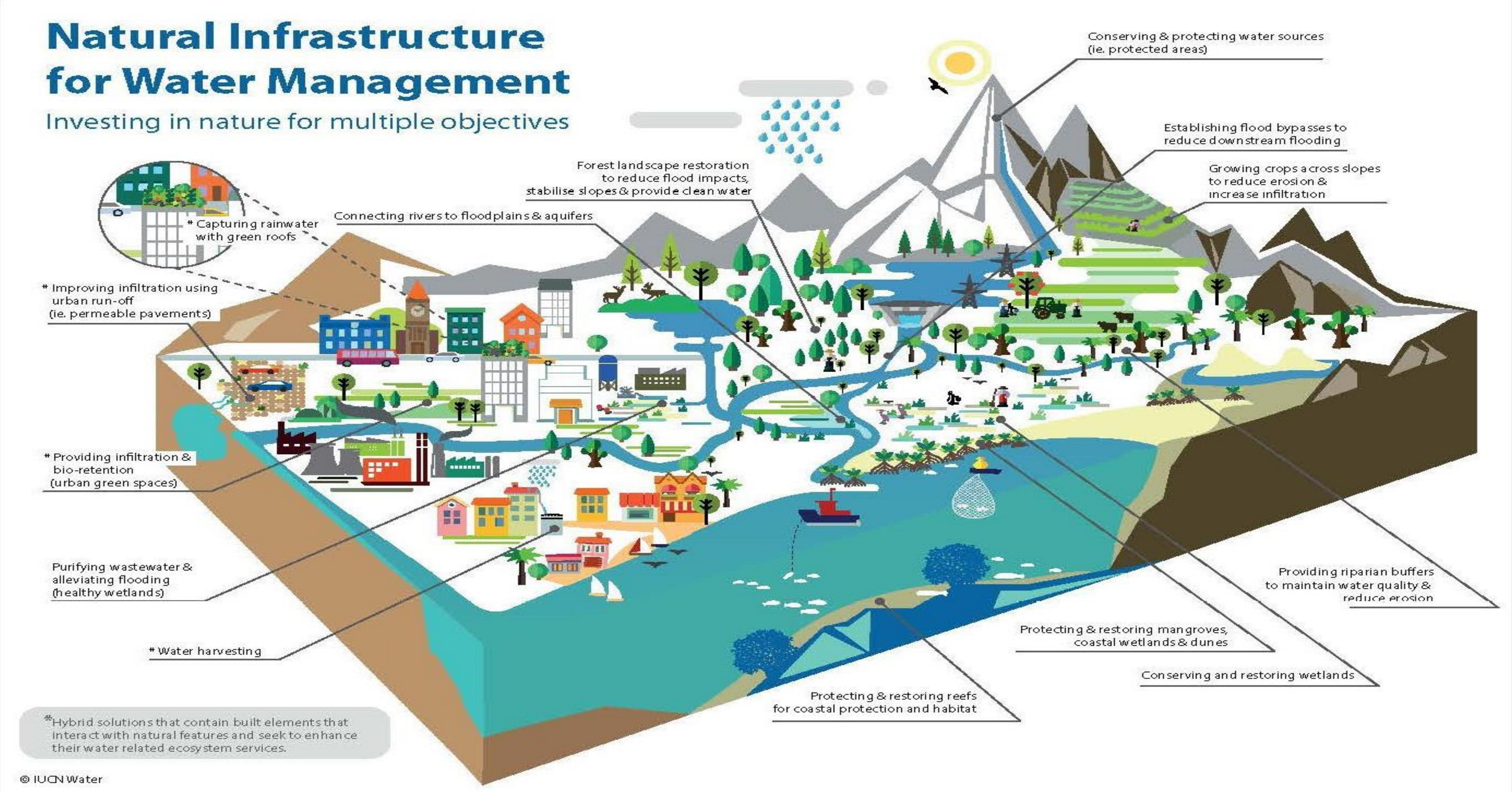
- Forest products; biodiversity; long-term carbon sequestration; tourism and recreation

Oyster reefs

- Reduce wave energy; stabilize and raise shoreline; protect adjacent habitats

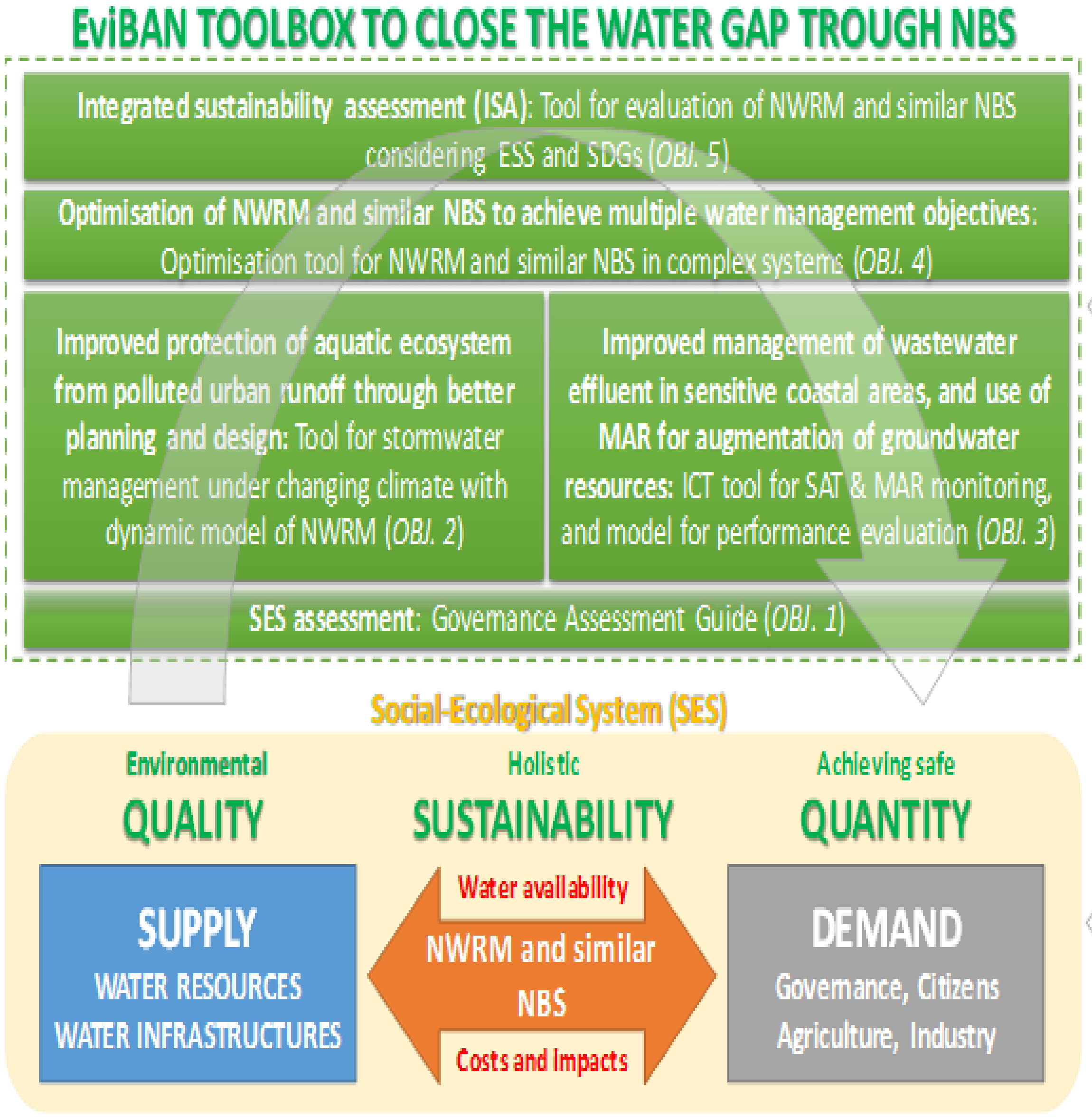
Additional benefits

- Habitat for fisheries; water filtration; food supply and livelihoods



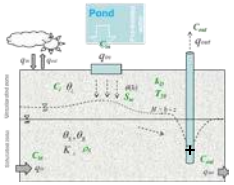
Source: IUCN (as part of 'WISE-UP to Climate' project). See http://www.iucn.org/theme/water/our-work/wise-climate

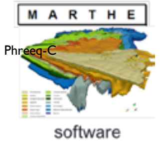
Best practice case studies (12) on NbS in coastal zones around the world



Managed Aquifer Recharge **(MAR)**
Natural Water Retention Measures **(NWRM)**
Soil Aquifer Treatment **(SAT)**
Evidence based assessment of NWRM **(EviBAN)**

- Tools to be developed together with local stakeholders
- Interaction between tool development and demonstration
- Dissemination through existing platforms and project web site



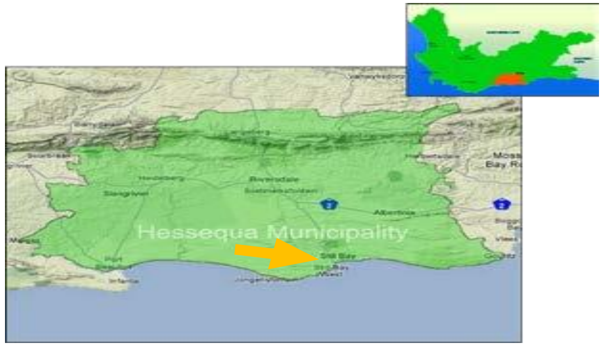


Agon , Normandy, France:

Description: Tertiary treatment of secondary WWTP effluent (33 500 inh. eq./ BOD5= 2120 kg /day) by reed bed and a sand dune filter. The MAR/SAT system has been chosen to protect the sensitive shellfish production zone on the surrounding estuary. Since 2016, the ImaGeau Subsurface Monitoring System is implemented for real time monitoring of saline intrusion. Water quality and quantity are analysed to develop an ICT tool (BRGM/Géo-Hyd) to assess efficiency of SAT in context of saline intrusion.

Hessequa Municipal area , Western Cape, South Africa:

Description: Water stressed areas relying partly on groundwater for water supply. Pressures on water resources due to drought. Artificial aquifer recharge (AR) in the Goukou River, using flushed water during high rain periods, is a potential water resource. Potential impacts of the AR- on biodiversity and estuarine health will be key indicators. Optimisation of best combination of water sources and NWRM to use- to be customised for use by local municipal officials.



<u>KLIMA 2050 - Høvringen, Vikaune Fabrikker - Sveberg and Storm Aqua – Sandnes, Norway</u>: Eco-engineered grey-green solutions for rooftops and engineered pervious surface materials for runoff management with respect to quality and quantity. Høvringen consists of 3 large-scale test fields, whereas Sveberg consists of 4 large-scale test fields. One site focuses on infiltration and the other on treatment.

<u>Stormwater NBS test sites , Espoo and Vantaa, Finland:</u>

Description: Biofilters and similar NBS to capture and treat stormwater runoff from roads prior to infiltration or discharge to receiving surface waterbodies. Site monitoring and acquisition of data for hydrologic, hydraulic and geochemical performance assessment.

www.waterjpi.eu

RESTORING OYSTER REEFS IN THE GULF OF MEXICO

Problem:
Need for storm and ecosystem protection
(85% loss of oyster reefs globally)

Solution: **5.9 km of restored oyster reefs** in Mobile Bay, Alabama

- **Reduces wave height/energy:** by 76-99% for top 10% of waves
- **Produces marine food supply:** 3,460 kg of oyster harvest/yr
- **Purifies water:** 1,888 kg of nitrogen/yr removed nearshore

Photo credit: Galveston Bay Foundation; Cesar Harada

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URBAN FLOODING AND STORMWATER HAZARDS

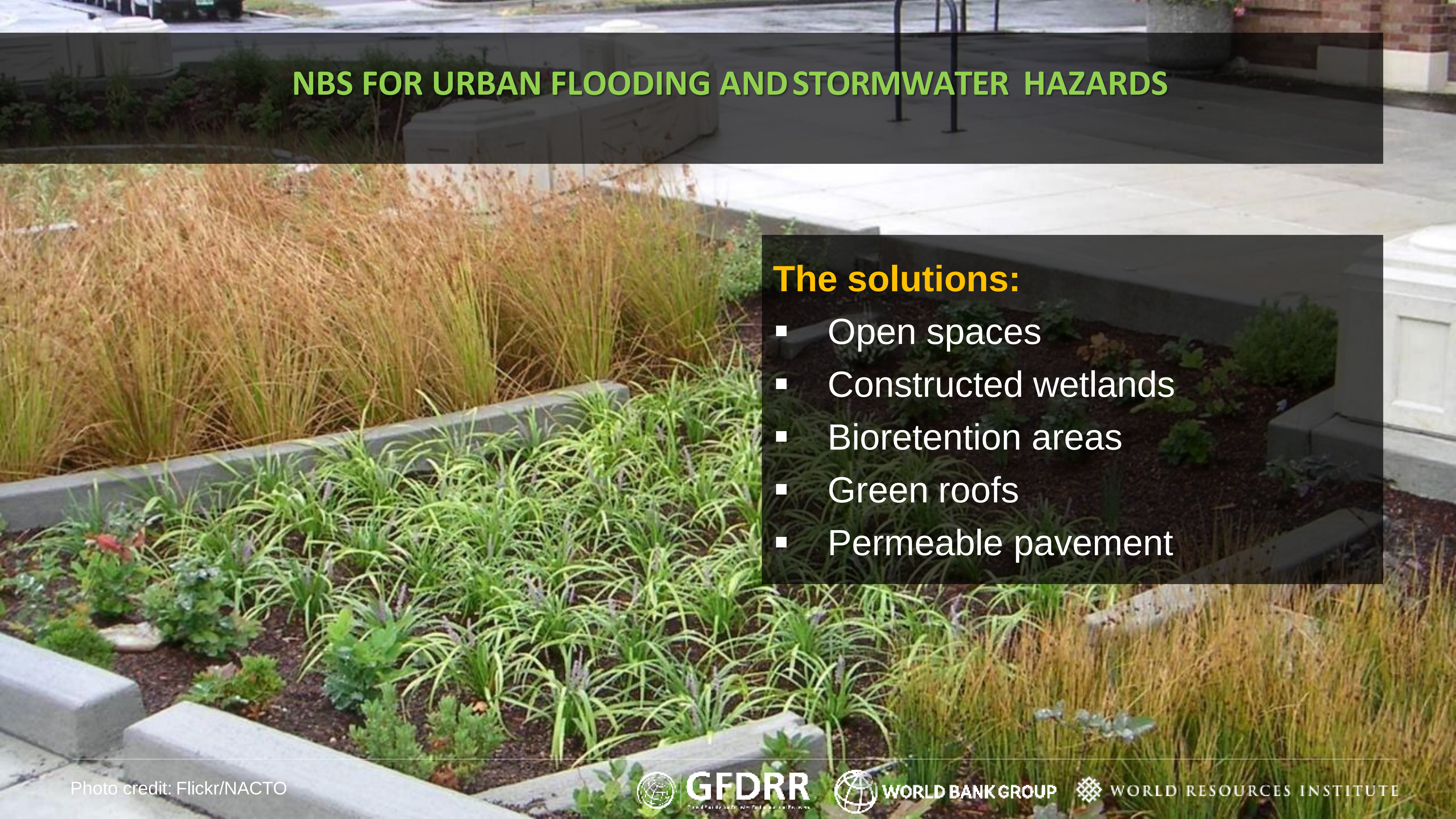
Hazards: Flooding, stormwater pollution, landslides

Contributing factors:

- Urbanization
- Lack of drainage
- Insufficient water infrastructure
- Climate change

- Urban flooding occurs when water flows faster than it can be absorbed or transported away
- **By 2030, global urban population** will increase by another **1 billion**.

Photo credit: Flickr/Oxfam International



NBS FOR URBAN FLOODING AND STORMWATER HAZARDS

The solutions:

- Open spaces
- Constructed wetlands
- Bioretention areas
- Green roofs
- Permeable pavement

Photo credit: Flickr/NACTO

RISK REDUCTION AND ADDITIONAL BENEFITS:
URBAN FLOODING AND STORMWATER HAZARDS

Constructed wetland

- Filters pollutants; captures sediments; reduces stormwater runoff that can damage built infrastructure

Additional benefits

- BD & ES; SL; fresh water storage; recreation, tourism, and education

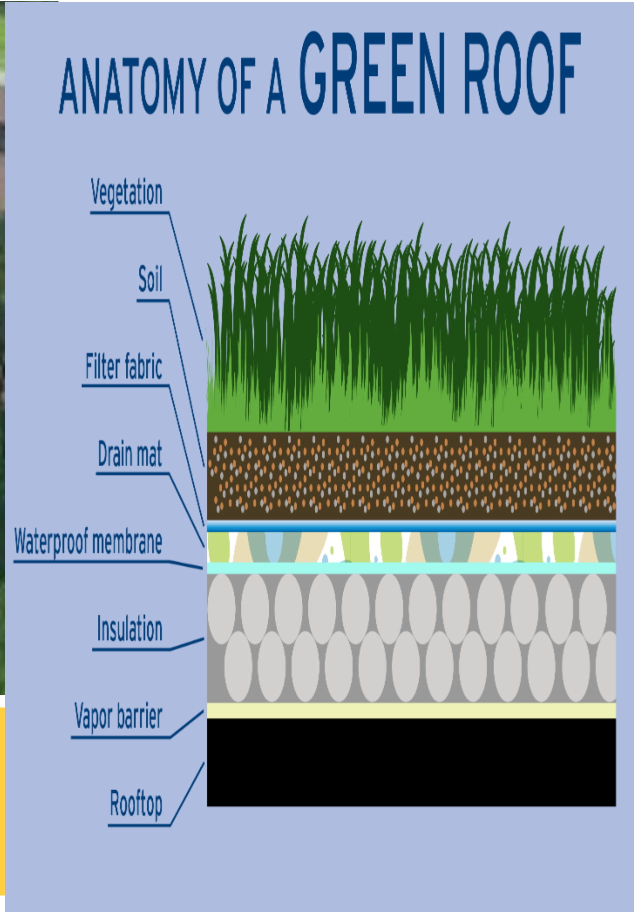
Bioretention areas

- Reduce runoff of sediments and pollutants into river; increase groundwater recharge

Additional benefits

- Protect streamside properties; recreation and tourism

Photo credit: Flickr/Ed Dunens



URBAN FLOOD MANAGEMENT WITH GREEN ROOFS IN SHANGHAI, CHINA

- Problem: **Poor wastewater management**
- Solution: Small-scale, decentralized **wetland system** for pollutant removal
- Lesson: **Community support essential** for low cost construction and maintenance
- Only **$290/year** to treat **wastewater for 80 HHs**

Photo credit: Flickr/kafka4prez

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HAZARDS OF RIVERINE FLOODING

Riverine flood hazards: infrastructure and property damage, ecosystem disruption, water contamination

Contributing factors:

- Agricultural activity
- Residential encroachment
- Weak water infrastructure
- Climate change

- **Floodplains** are relatively flat lands adjacent to rivers or streams that are prone to flooding
- Floodplains are home to some **9.6 million households** in the US

Photo credit: Flickr/US Army Corps of Engineers

NBS FOR RIVERINE FLOODING

The solutions:

- Floodplains and bypasses
- Inland wetlands
- River beds and banks
- Upland forests

Photo credit: Flickr/Amir Jina

RISK REDUCTION AND ADDITIONAL BENEFITS:
RIVERINE FLOODING

Floodplains and bypasses

- Significant water storage; flood risk reduction; water quality maintenance

Additional benefits

- Productive agriculture and fisheries; groundwater recharge; biodiversity

River beds and banks

- Long-term flood risk reduction by restoring natural riverine processes (meandering, sedimentation, etc.)

Additional benefits

- Erosion control; fisheries; recreation and tourism

Photo credit: Flickr/South Florida Water Management District

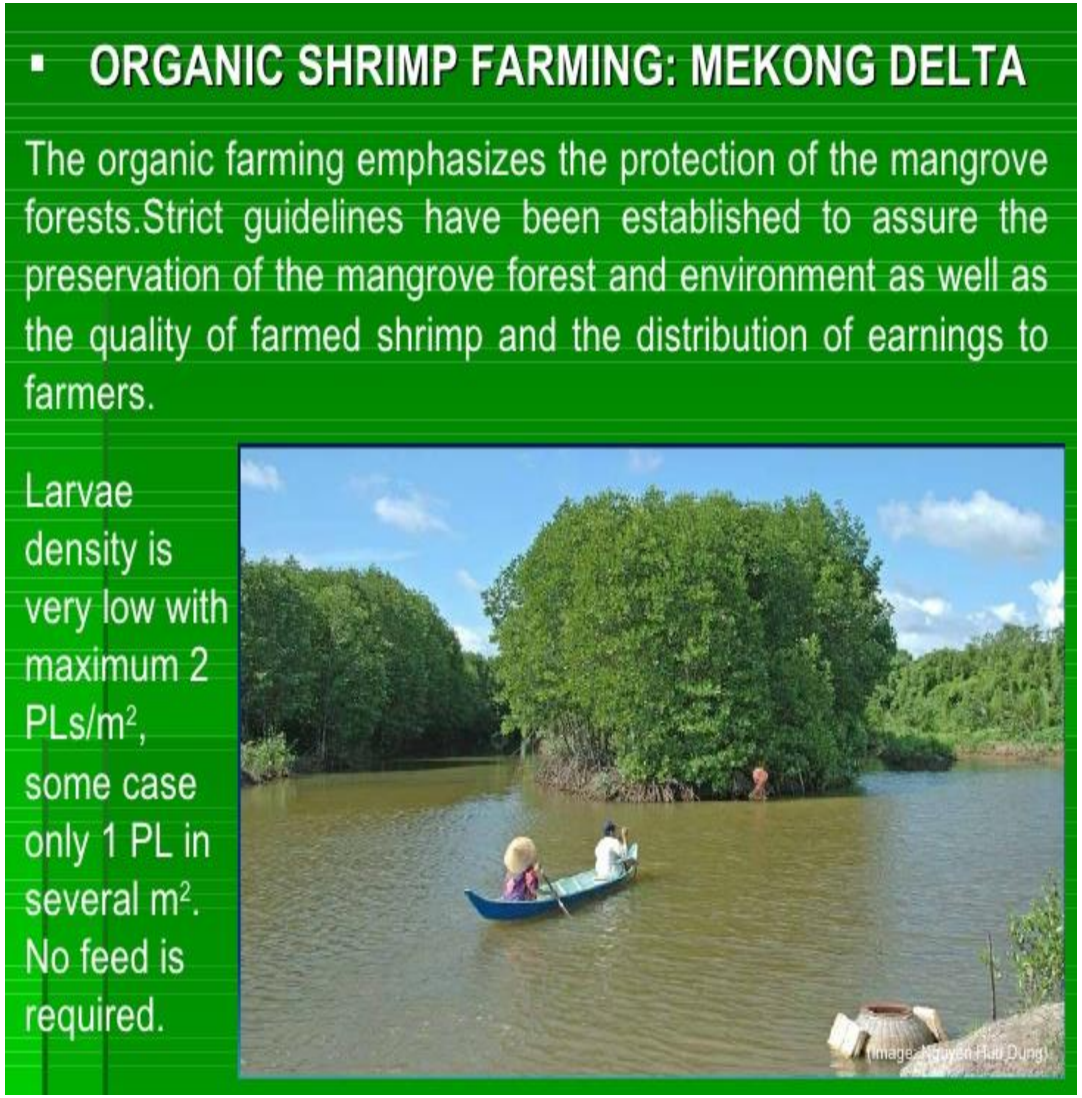
Incentivizing shrimp farmers to modify their practices: lessons from Vietnam

Successful implementation of green infrastructure projects require farmers to adopt **AE** & requires an extensive outreach program E.G. The **Vietnam Mekong Delta Climate Resiliency and Sustainable Livelihood Project.**

In Vietnam, coastal shrimp farmers are encouraged to **shift from intensive shrimp farming**—a risky business, given the potential for shrimp diseases and storms that disrupt operations—to a **Sylvo fisheries.**

The reconstruction of a mangrove belt can help reduce the impacts of storm surges and flooding along the coast; creates opportunities for farmers to become internationally **certified** as a **sustainable seafood operation**, and **revenue generation**. A shift into certified organic mangroves was estimated to generate an annual net benefit of **$992 /Ha/yr.**

PLS- Pure live seeds



Various Schemes of Community Based Management (CBM) of Mangrove Ecosystems

Scheme II
CBM of Mangrove Ecosystem for Fishery

Sylvofishery System	Sylvo-Fishery-Pastoral System	Agro-Sylvo-Fishery-Pastoral System
		
Fish (milk fish, etc), crab, prawn, and firewood, etc.	Fish (milk fish, etc), crab, prawn, milk, meat, eggs, and firewood.	Fish (milk fish, etc), crab, prawn, milk, meat, eggs, agricultural crops, and firewood.
Coastal northern part of Java	**Subang, West Java**	**Deli Serdang, North Sumatera**

Demonstration of Shore Protection Measures

- The Pondicherry coast experiences severe erosion. Environmentally friendly shoreline stabilization measures were demonstrated.
  - ➢ Beach nourishment and construction of an artificial reef were implemented. Gain of beach width to an extent of 60 m was observed.
  - ➢ The efforts made by ESSO-NIOT was appreciated by Punduchery Government.

Applying NBS to build Kochi's Climate Resilience

Applying NBS to build Kochi's Climate Resilience

- Decentralized waste water management system on a community level scale
- Phytoremediation of water bodies
- Ward level composting of wet waste and linking this with the urban farming initiatives
- Permeable pavements using grid pavers
- Rain gardens
- Recycling and reuse of water in public buildings

- **Well rejuvenation**
- **Mapping of urban heat islands**
- **Development of an action plan for Vembanad Lake**
- **Development of butterfly gardens in schools**
- **Restoration of Thevara canal**
- **Study on ES provided by mangrove and a mapping of mangroves within the city**

DISASTER RISK MANAGEMENT IN CURITIBA, BRAZIL RECLAIMING THE IGUAZU FLOODPLAIN

- **Problem:** Urbanization and poor infrastructure led to a **six-fold increase in flooding**
- **Solution:** Integrated **floodplain reconnection and wetland restoration** into flood management systems

Benefits:

- **Mitigate flood damages**
- **Improve water quality**
- **Enhance public recreation**

Photo credit: Wikipedia/Francisco Anzola; Wikipedia/Ricardo Freitas

ROOM FOR THE RIVER, THE NETHERLANDS

- **Problem**: Higher dikes no longer sufficient due to **climate change**
- **Solution:** New island and **river park**
- **US$ 460 million** to push dikes 350 m inland
- **Local participation and compensation** – essential to move forward with house demolitions

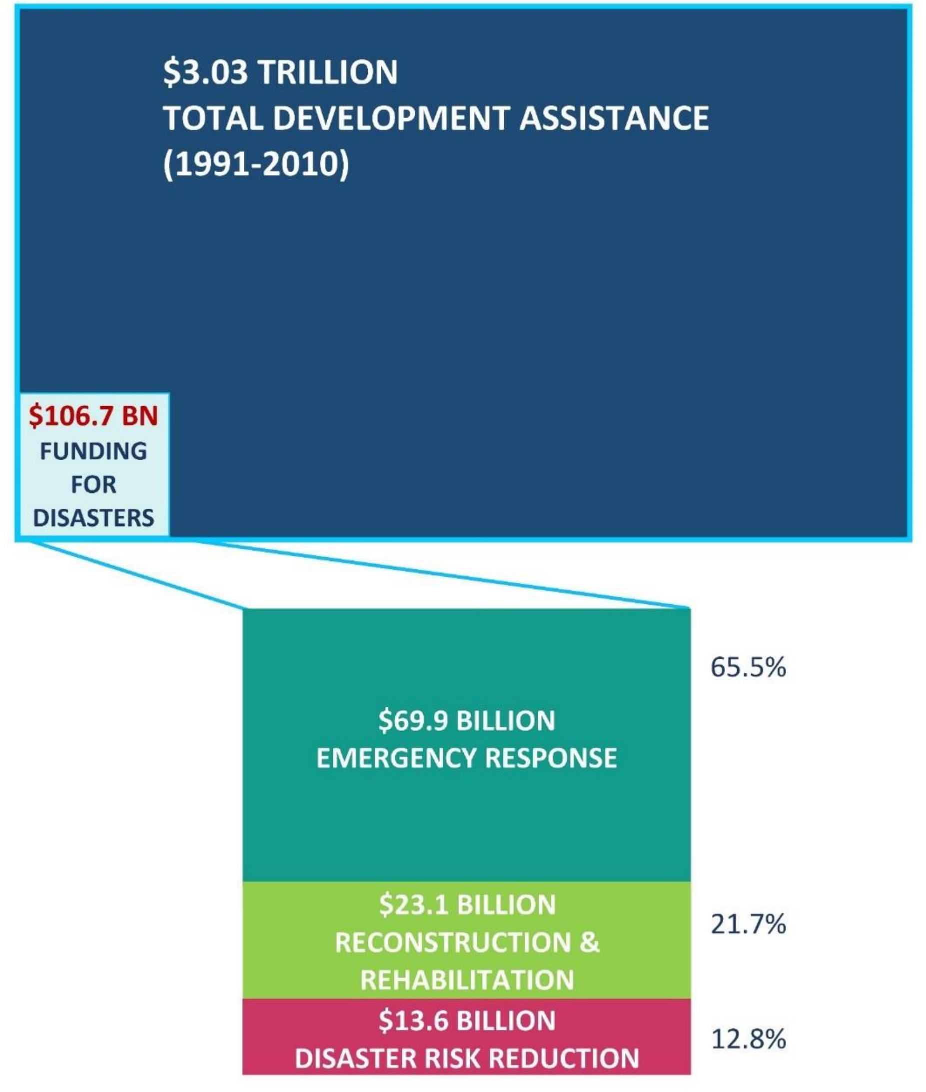
Photo credit: YouTube/GroeneSteden; Wikipedia/Roger Veringmeier

SOURCES OF FUNDING FOR NBS

Majority of funds from **public sources** (governments, international development agencies, etc.)

Philanthropic funds are important for shorter-term seed funding to support pilot projects that help promote NBS

NBS can **attract diverse base of investors** interested in different project benefits



TRADITIONAL FINANCING STRATEGIES- now only $82 billion- 0.008% of global GDP vs desirable $140 billion/year

Public sector sources:

- Taxes

Policy to raise funds for NBS:

- Water use fees
- Municipal bonds
- Environmental compensation funds (PES, etc.)

Philanthropic sources:

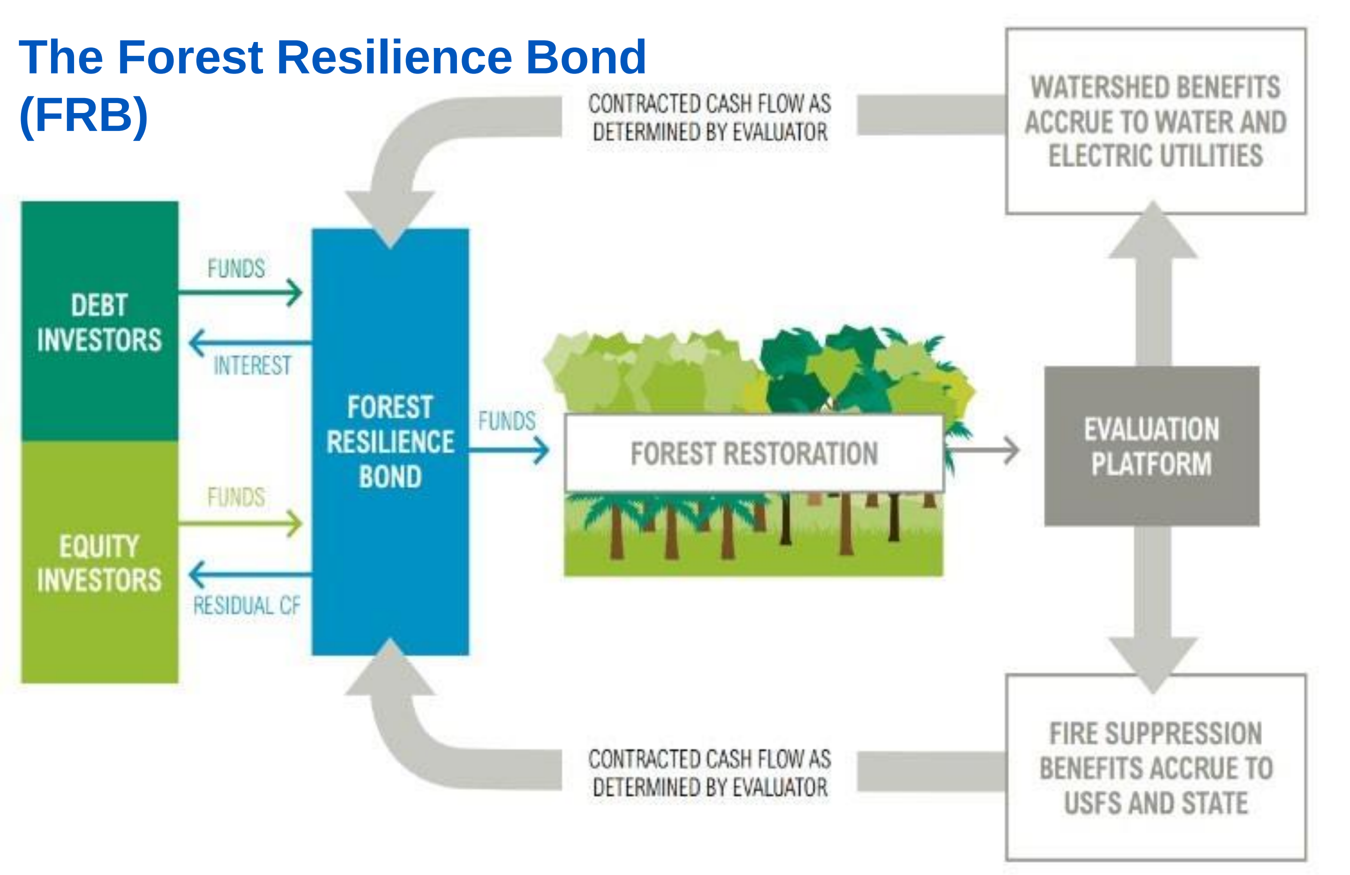
- Grants and donations
- Program-related investments

Photo credit: Flickr/S.L.

EMERGING FINANCING STRATEGIES

- Green bonds
- Pay-for-success
- Corporate stewardship
- Water Fund
- Insurance for risk reduction
- Public-private partnerships

Ex. Forest Resilience Bond
Investors pay upfront restoration costs for forest fire mitigation and water benefits. Beneficiaries pay FRB based on verified metrics.



Graphic: BFC 2017; Photo credit: Flickr/Alex Blanck

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CHANGING POLICY TO SUPPORT NBS in the Coastal Zones
▪ Implement **environmental monitoring** & **ICZM - PLA**
▪ Engage **all stakeholders - CBCOM**
▪ Facilitate **cross-sectoral coordination**
▪ Applied Behavioral change through **knowledge sharing/ dissemination**
▪ Encourage **supportive policy signals-EPI**
Photo credit: Flickr/WRI
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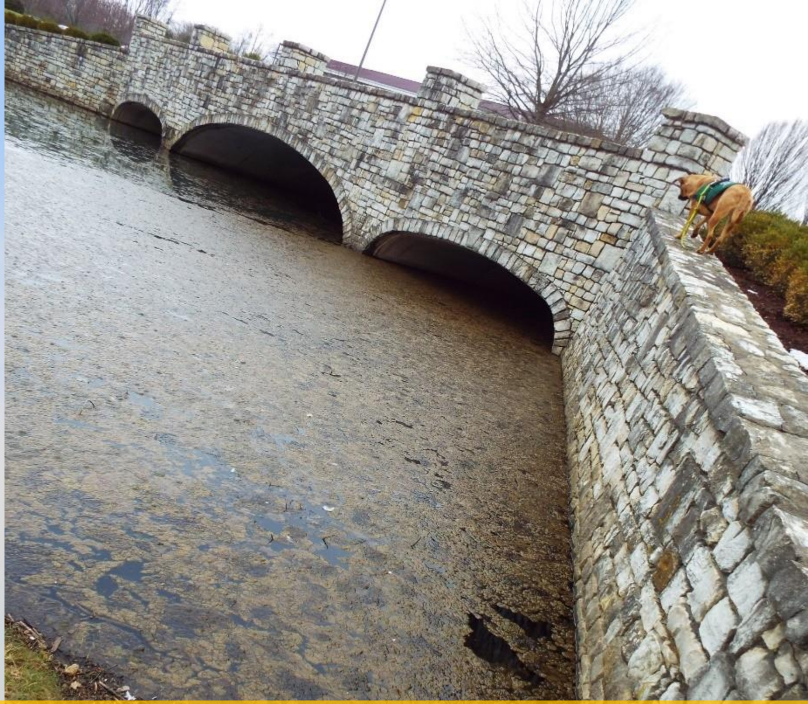

WASHINGTON, D.C., USA FINANCING URBAN GREEN INFRASTRUCTURE

- Problem: **2 billion gallons of sewage and stormwater** discharged into local waterways annually.
- One-third of DC's wastewater runs through a **single-pipe system built over 100 yrs ago**.
- Solution: **US$100 million** invested in bioretention areas, rain gardens, permeable pavement, and downspout reconnection.
- Financed by **environmental impact bond** (tax-exempt municipal bond) with **"pay for success"** payment model.

Photo credit: Flickr/Kghopkin; Flickr/Y Nakanishi; Flickr/EX22218 - ON/OFF

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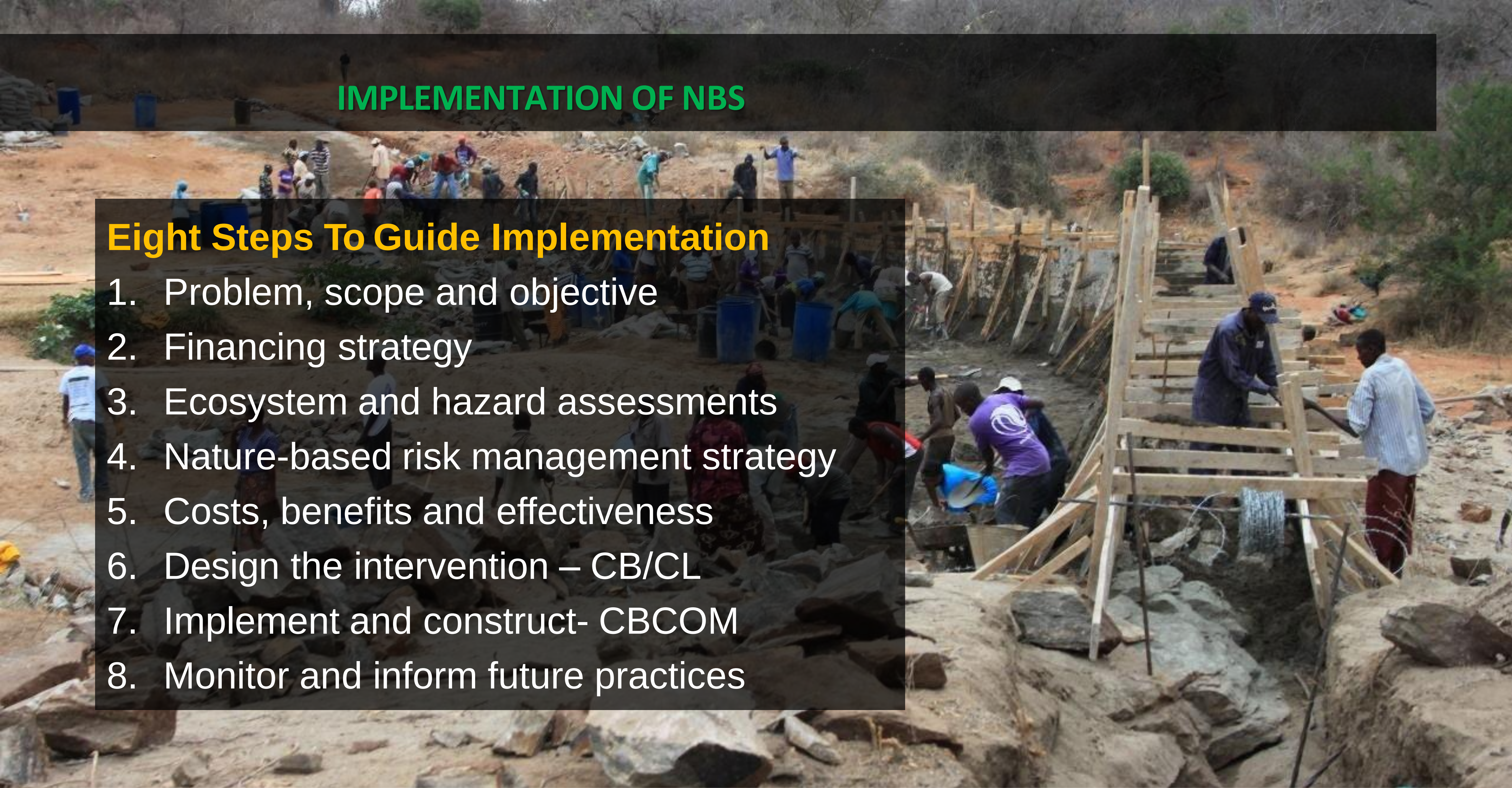
The restoration of the natural dynamics of a Danube floodplain to the east of Vienna was aimed at protecting riverine habitats and species but also at moderating floods and droughts. Photos show the floodplain before and after the hydrological restoration, which included the removal of all artificial elements to generate a natural river bank structure

IMPLEMENTATION OF NBS



Eight Steps To Guide Implementation

1. Problem, scope and objective
2. Financing strategy
3. Ecosystem and hazard assessments
4. Nature-based risk management strategy
5. Costs, benefits and effectiveness
6. Design the intervention – CB/CL
7. Implement and construct- CBCOM
8. Monitor and inform future practices

Photo credit: Flickr/thisisexcellent

NBS IMPLEMENTATION CHALLENGES

Need to better understand:

- Risk reduction performance of NBS
- DRM-related benefits from local community to national levels
- Technical guidelines for NBS evaluation
- Integration of NBS with gray solutions
- Cost-benefit analysis

Photo credit: Wikipedia/Biplob Rahman-BD

The way forward

Understand local site context

- Biophysical traits and compatibility with hazard reduction target
- Social, policy, & financial conditions / commitment–CB CoM options
- Potential for co-benefits
- Variability in levels of performance

TO SUCCESSFULLY

- **Leverage regenerative and adaptive traits of NBS** for resilience in the post COVID recovery context
- **Understand spatial and time scales** to maximize benefits-cross-sectoral partnerships
- **Integrate** with current and future built infrastructure
- **Inform** implementation, management, and evaluation plans- CCESD, Skill based T/CB, ICZM based on EPI

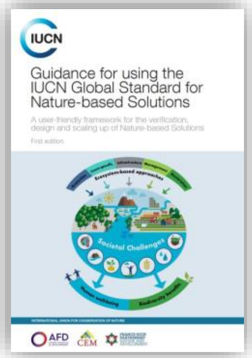
Photo credit: Flickr/PNUD Panama

Useful references and resources

Websites: https://www.iucn.org/commissions/commission-ecosystem- management/our-work/nature-based-solutions; https://www.iucn.org/theme/nature-based-solutions; https://www.gfdrr.org/en/nbs; https://wwf.panda.org/discover/our_focus/climate_and_energy_practice/what_we_do/nature_based_solutions_for_climate/?

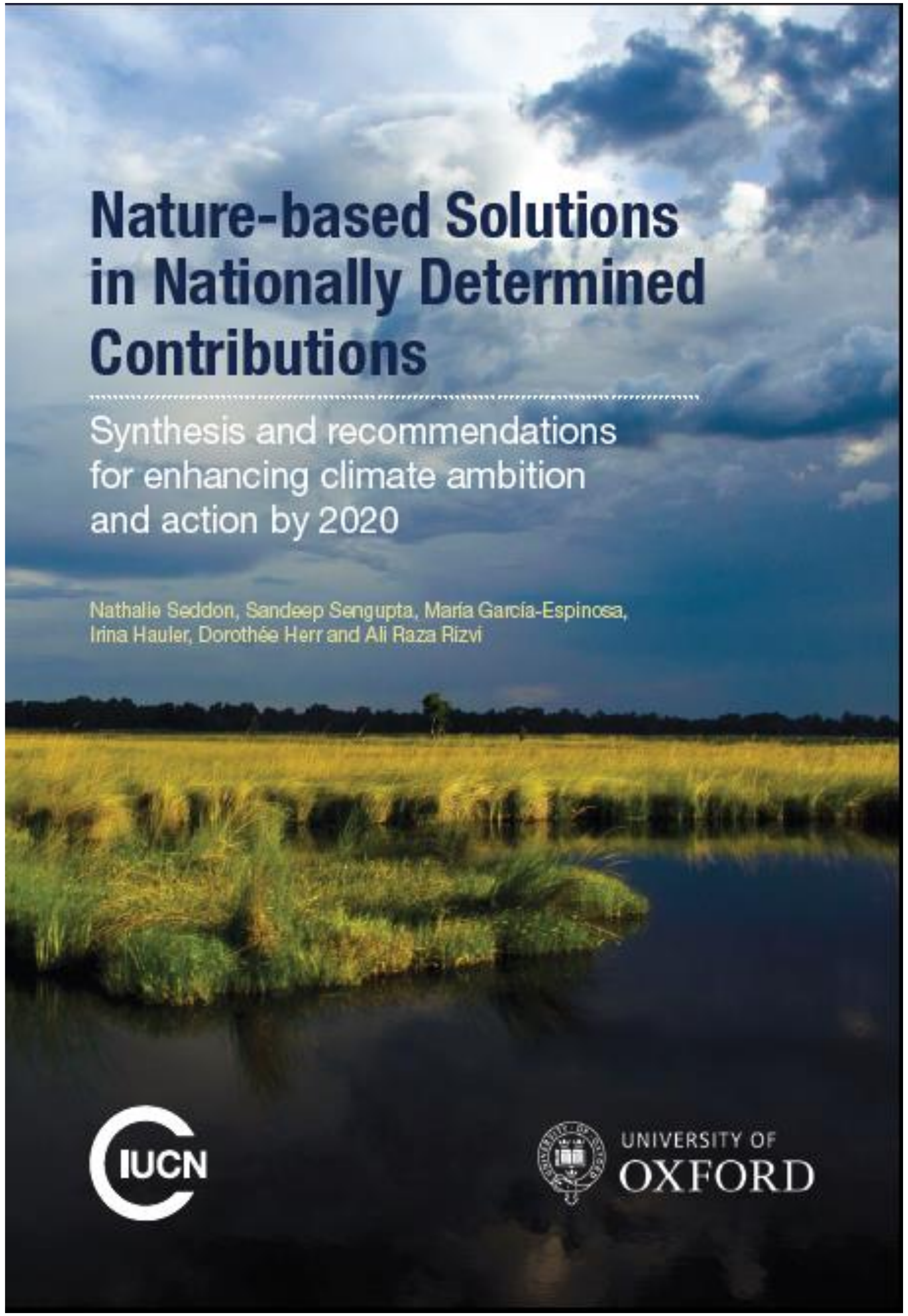
Cohen-Shacham E, Walters G, Janzen C, Maginnis S. (eds.). 2016. **Nature-based Solutions to address global societal challenges**. Gland, Switzerland: IUCN. https://portals.iucn.org/library/node/46191

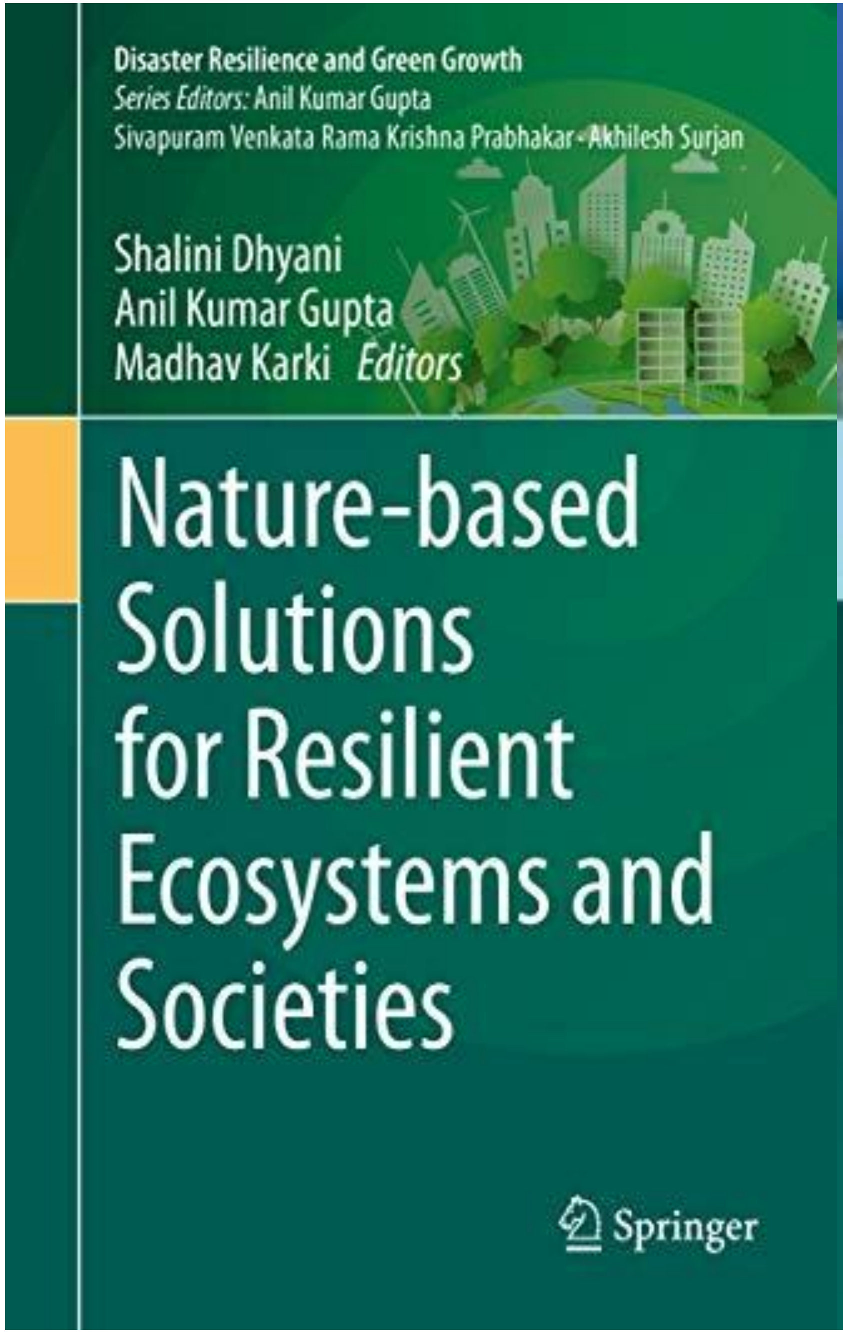
Cohen-Shacham E, Andrade A, Dalton J, Dudley N, Jones M, Kumar C, Maginnis S, Maynard S, Nelson C, Renaud F, Welling R, Walters G. 2019. **Core principles for successfully implementing and upscaling Nature-based Solutions**. Environmental Science and Policy 98: 20-29.

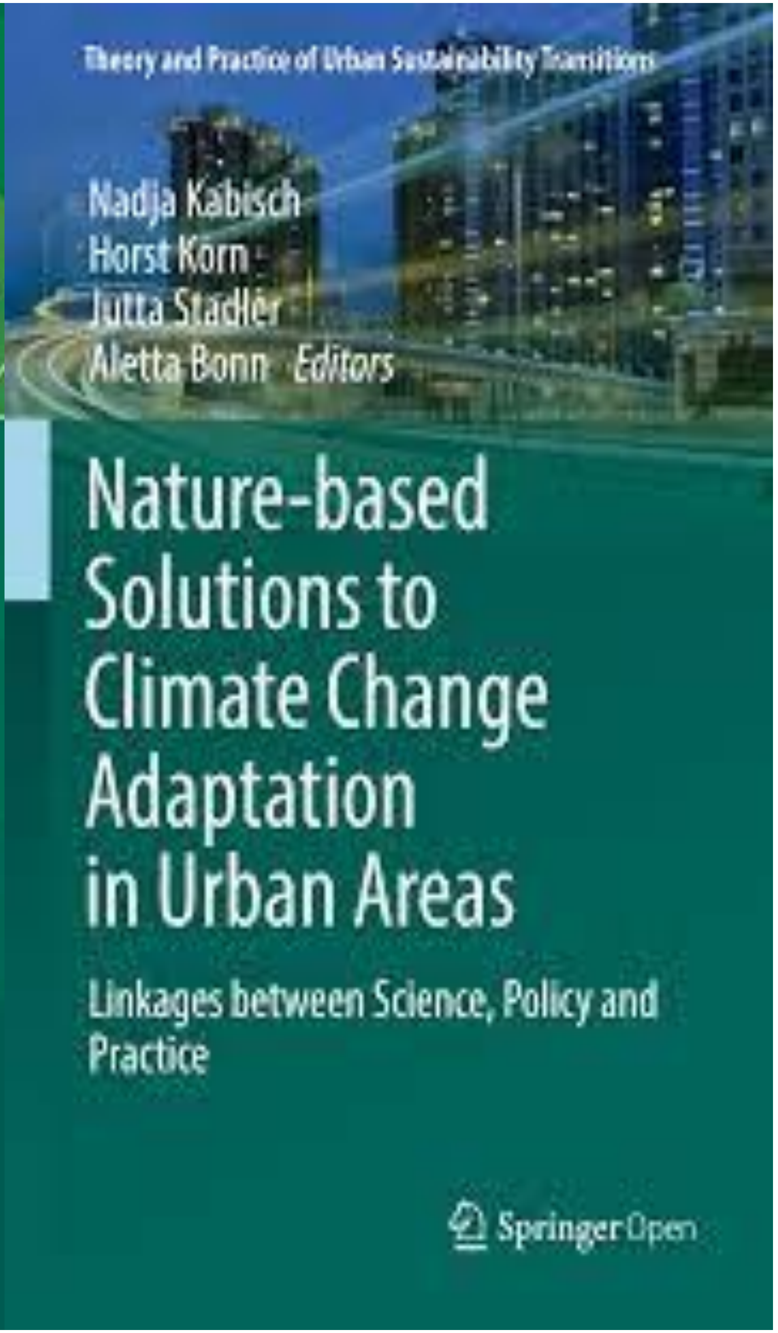


IUCN. 2020. **Global Standard for Nature-based Solutions**. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN. *Available online (En/Fr/Sp):* https://portals.iucn.org/library/node/49070

*IUCN. 2020. **Guidance for using the IUCN Global Standard for Nature-based Solutions**.* A user-friendly framework for the verification, design and scaling up of Nature-based Solutions. First edition. Gland, Switzerland: IUCN. Available online (En/Fr/Sp): https://portals.iucn.org/library/node/49071


Nature-based Solutions in Nationally Determined Contributions
Synthesis and recommendations for enhancing climate ambition and action by 2020
Nathalie Seddon, Sandeep Sengupta, María García-Espinosa, Irina Hauler, Dorothée Herr and Ali Raza Rizvi
IUCN
UNIVERSITY OF OXFORD


Disaster Resilience and Green Growth
Series Editors: Anil Kumar Gupta
Sivapuram Venkata Rama Krishna Prabhakar · Akhilesh Surjan
Shalini Dhyani
Anil Kumar Gupta
Madhav Karki Editors
Nature-based Solutions for Resilient Ecosystems and Societies
Springer


Theory and Practice of Urban Sustainability Transitions
Nadja Kabisch
Horst Korn
Jutta Stadler
Aletta Bonn Editors
Nature-based Solutions to Climate Change Adaptation in Urban Areas
Linkages between Science, Policy and Practice
SpringerOpen

THANK YOU, Any ???

Photo credit: Flickr/Stefan

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