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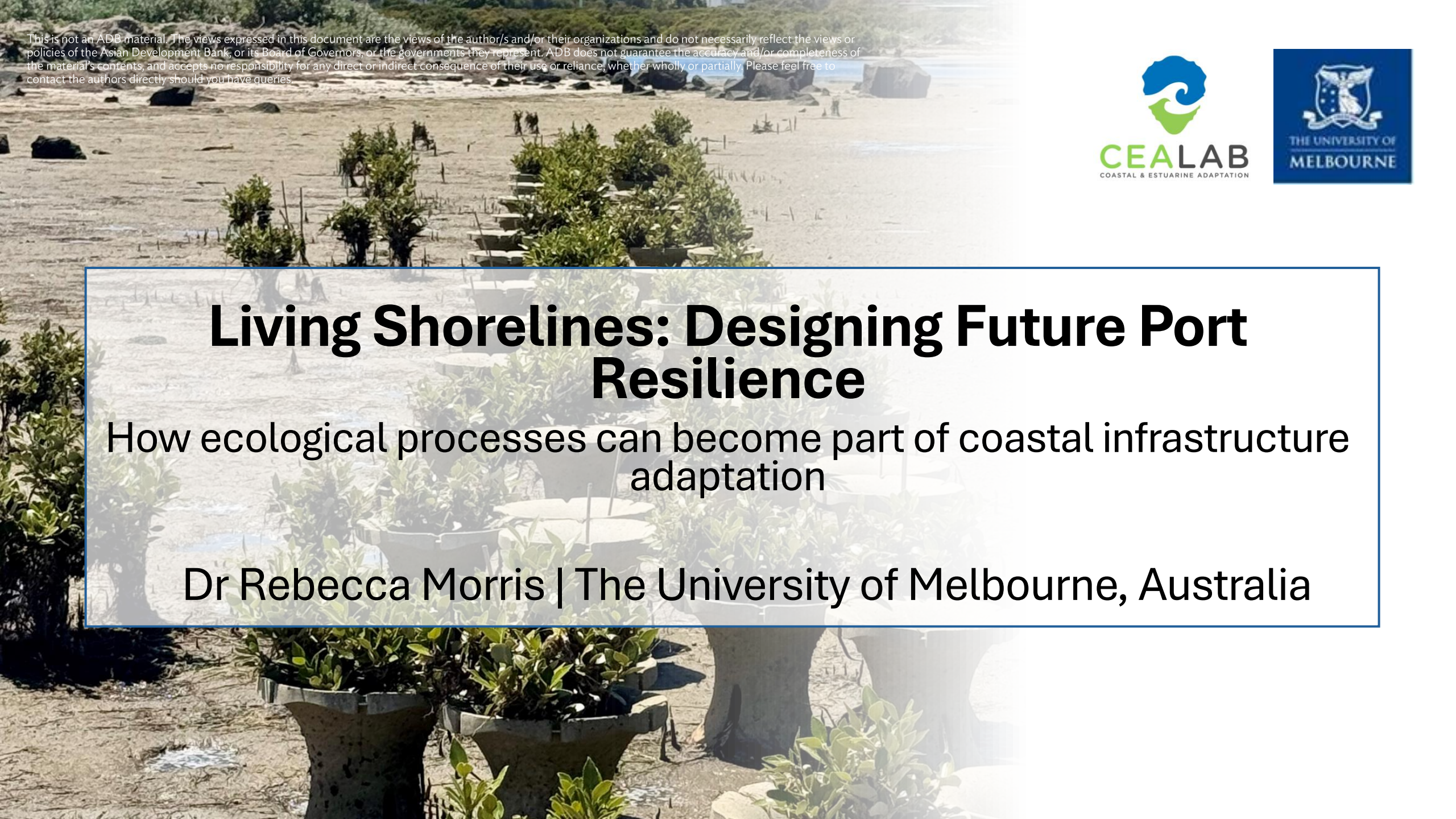
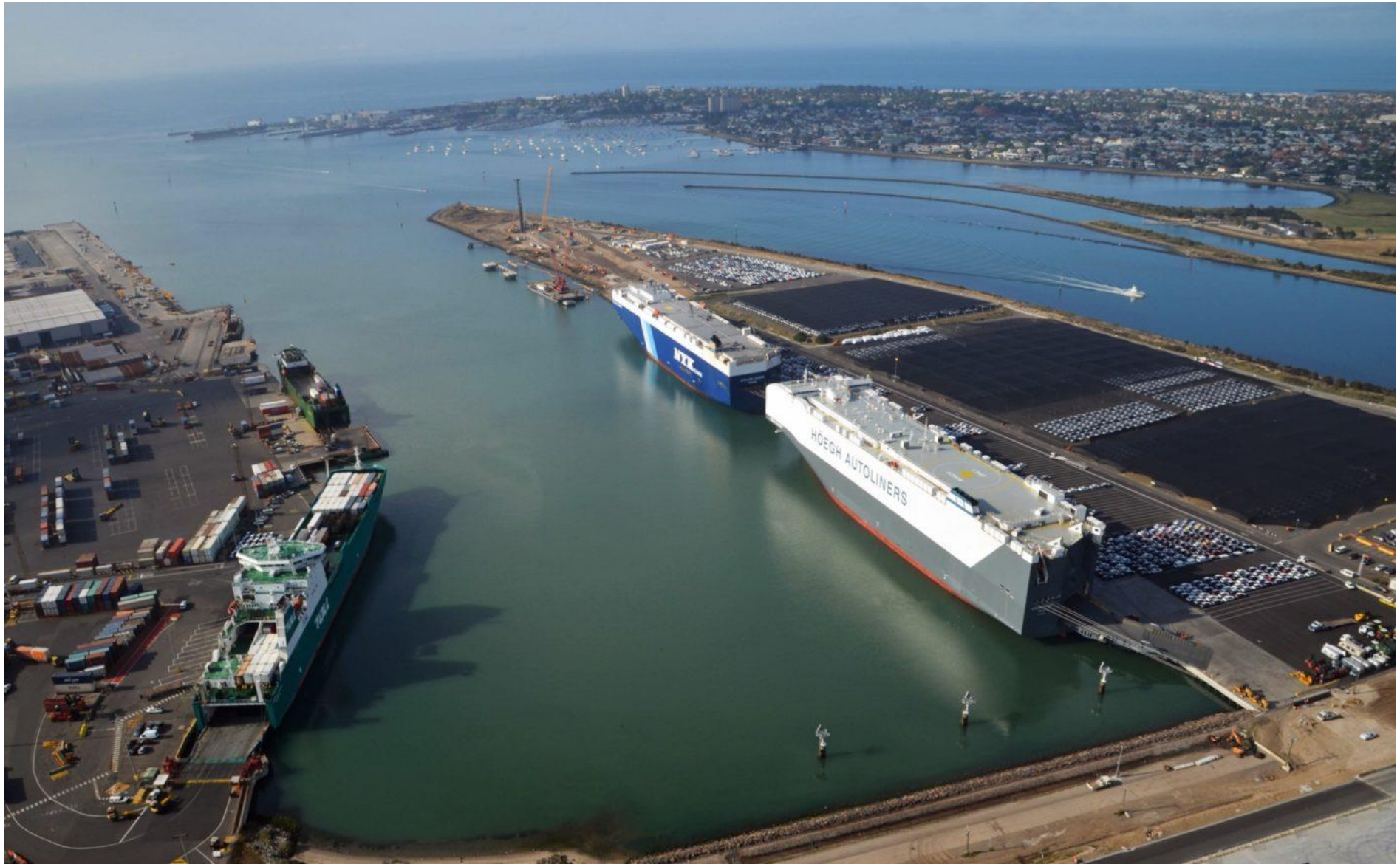


Living Shorelines: Designing Future Port Resilience

How ecological processes can become part of coastal infrastructure adaptation

Dr Rebecca Morris | The University of Melbourne, Australia

People and assets are increasingly vulnerable to coastal hazards



Nature-based Solutions in ports

Working with Coastal Systems

NBS measures within this NBS family:

Port siting and layout

Restoring riverine ecosystems

Sustainable sediment management

General scale of family:

System scale

Example:

Sandbar Breakwaters of Lekki Port, Nigeria and Lome Port, Togo

Wave and Coastal Dynamics Attenuation

NBS measures within this NBS family:

Sandy foreshores

Ecological breakwaters

Mangroves

Salt Marshes

Reefs

General scale of family:

Port scale

Example:

Mangroves Against Wave Overtopping on Breakwaters in Jakarta Fishing Port

Beneficial Reuse of Dredged Sediment

NBS measures within this NBS family:

Foreshore and land reclamation from dredged sediments

Construction material

Creation of habitats

General scale of family:

Port scale

Example:

Horseshoe Bend Island in the Channel of Lower Atchafalaya River, United States

Enhanced Hard Structures

NBS measures within this NBS family:

Enhanced quay walls

Hanging and floating structures

Habitat creation units

General scale of family:

Local scale

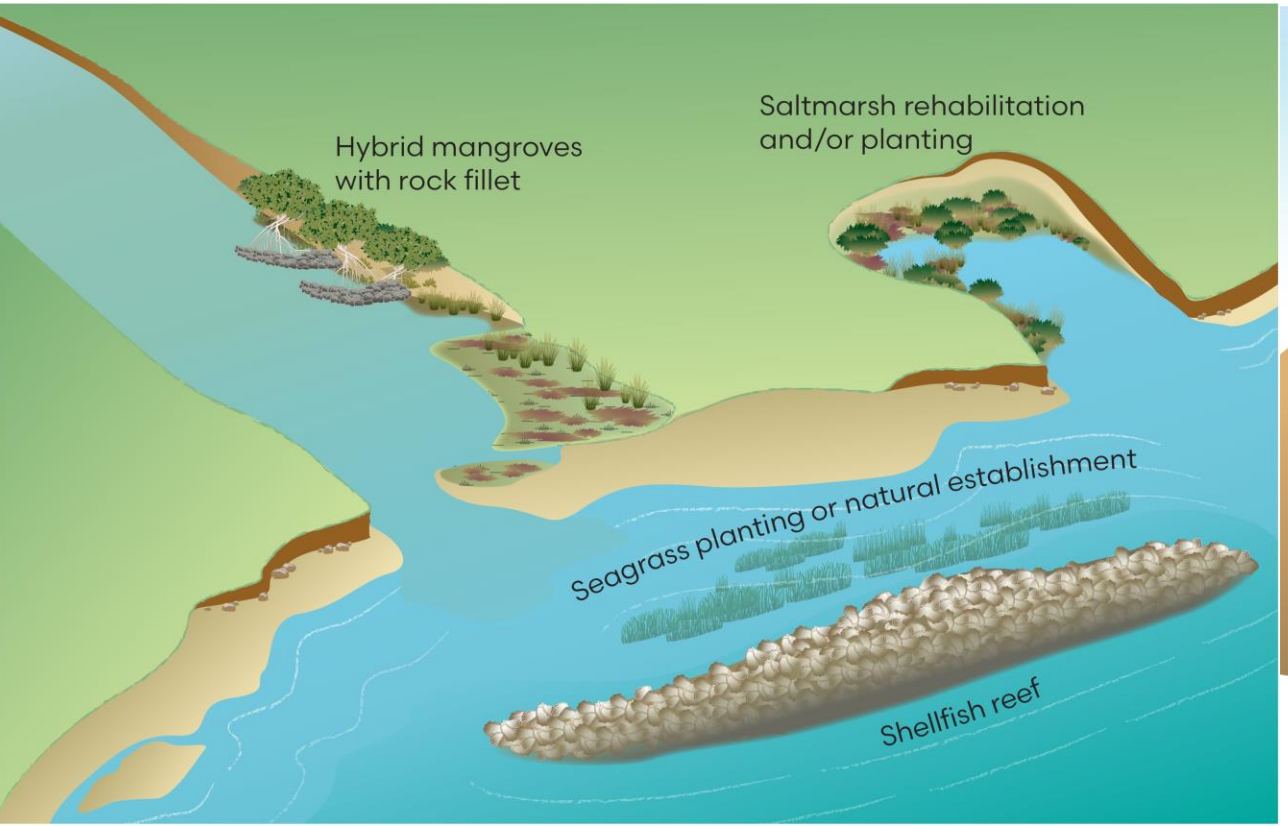
Example:

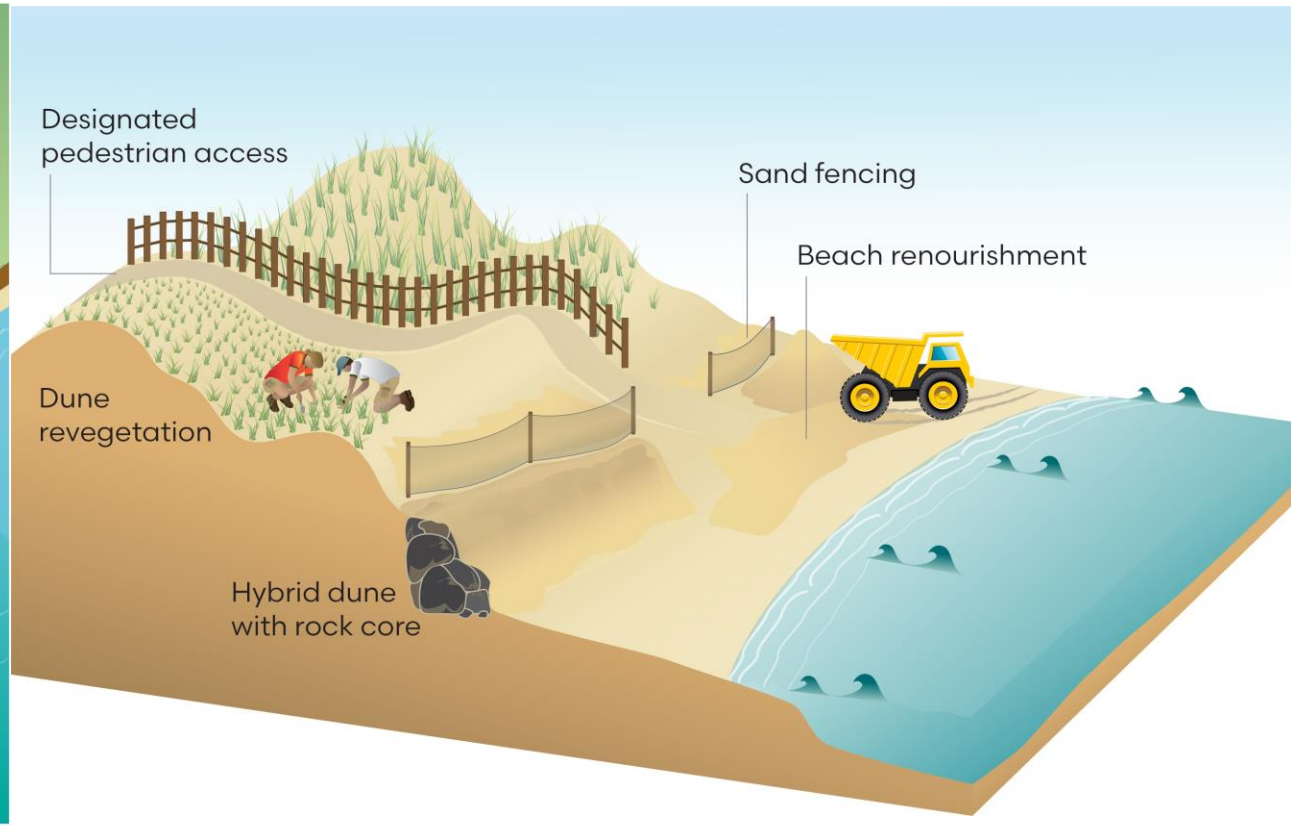
Adding Complexity for Life on Hard Quay Wall Structures, in Vigo Port, Spain

World Bank (2025)

What are living shorelines?

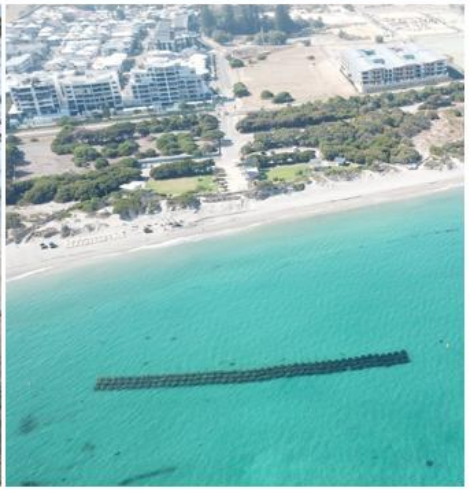
Nature-based Solutions that use habitats such as oyster reefs, mangroves, saltmarshes and seagrasses to protect coasts.

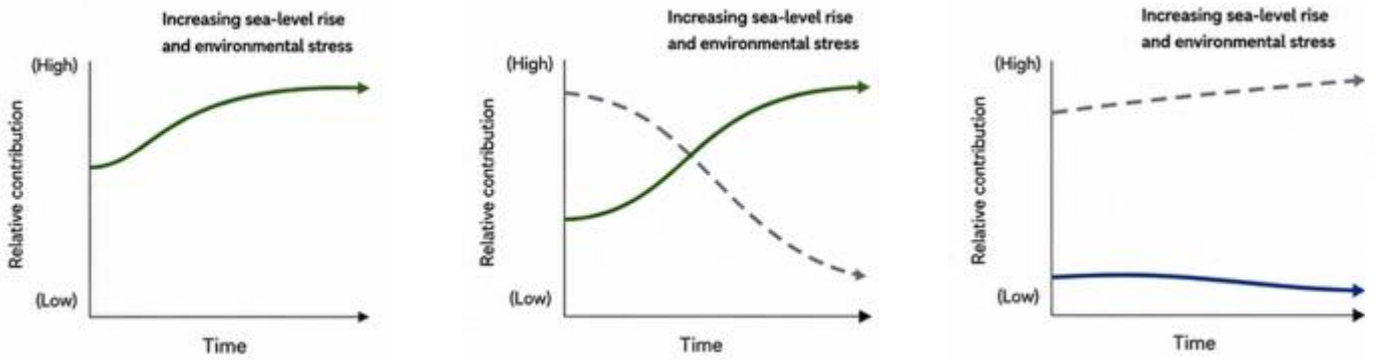




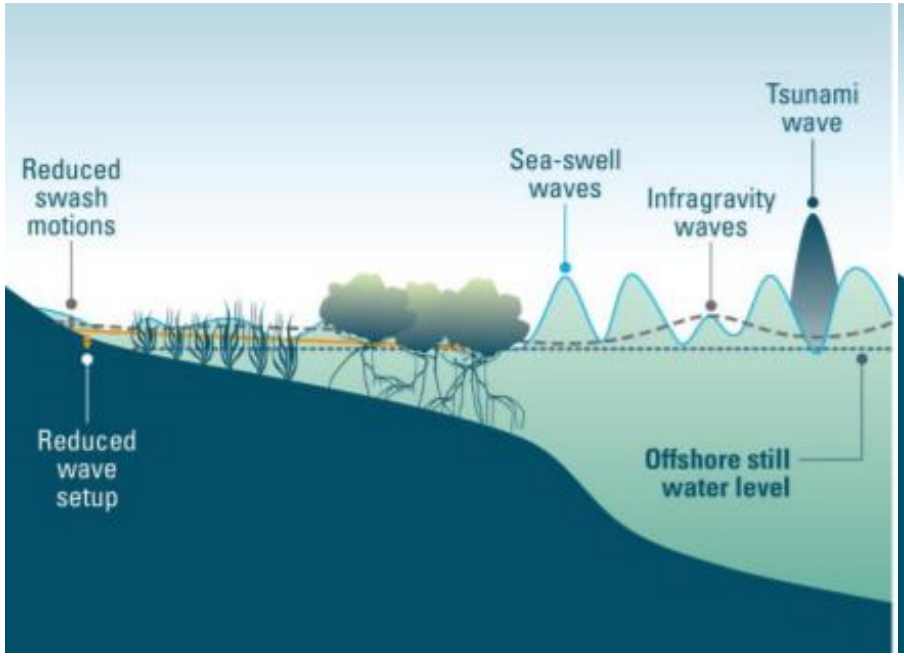
What are living shorelines?

Ecological autonomy ⟷ **Structural dependence**

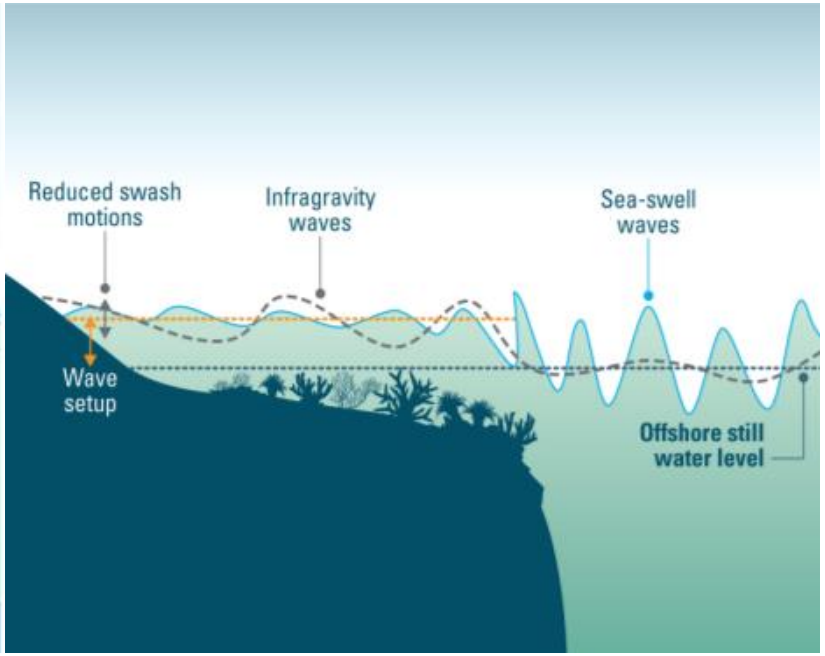
SOFT LIVING SHORELINE	HYBRID LIVING SHORELINE	HYBRID ENGINEERING
		
Self-organizing ecosystems maintain structure and function under prevailing conditions without engineered support.	Structures support establishment or enhance resilience, but ecosystems can persist without them under prevailing conditions.	Structures are necessary to maintain ecological presence and functions under prevailing conditions.



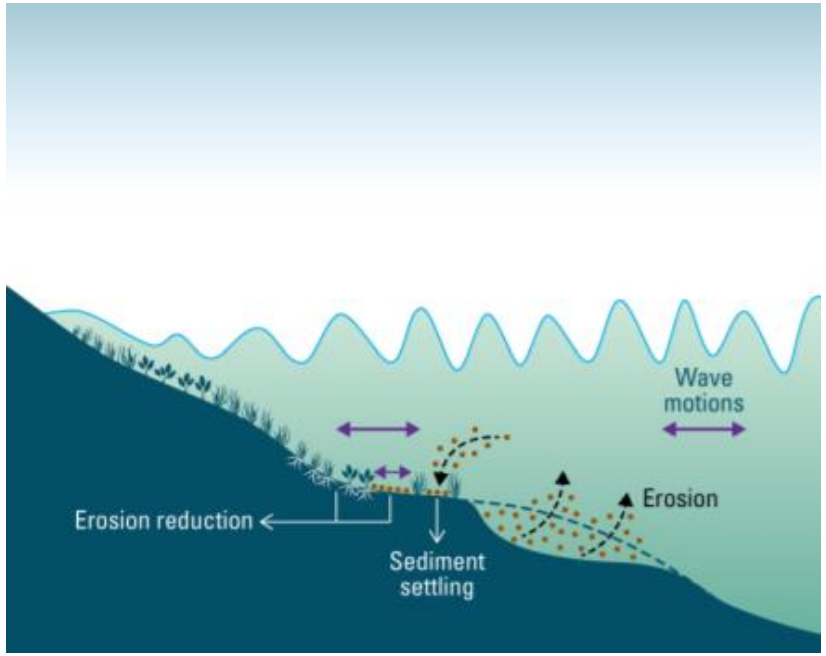
How do living shorelines work?



Wave attenuation due to roughness



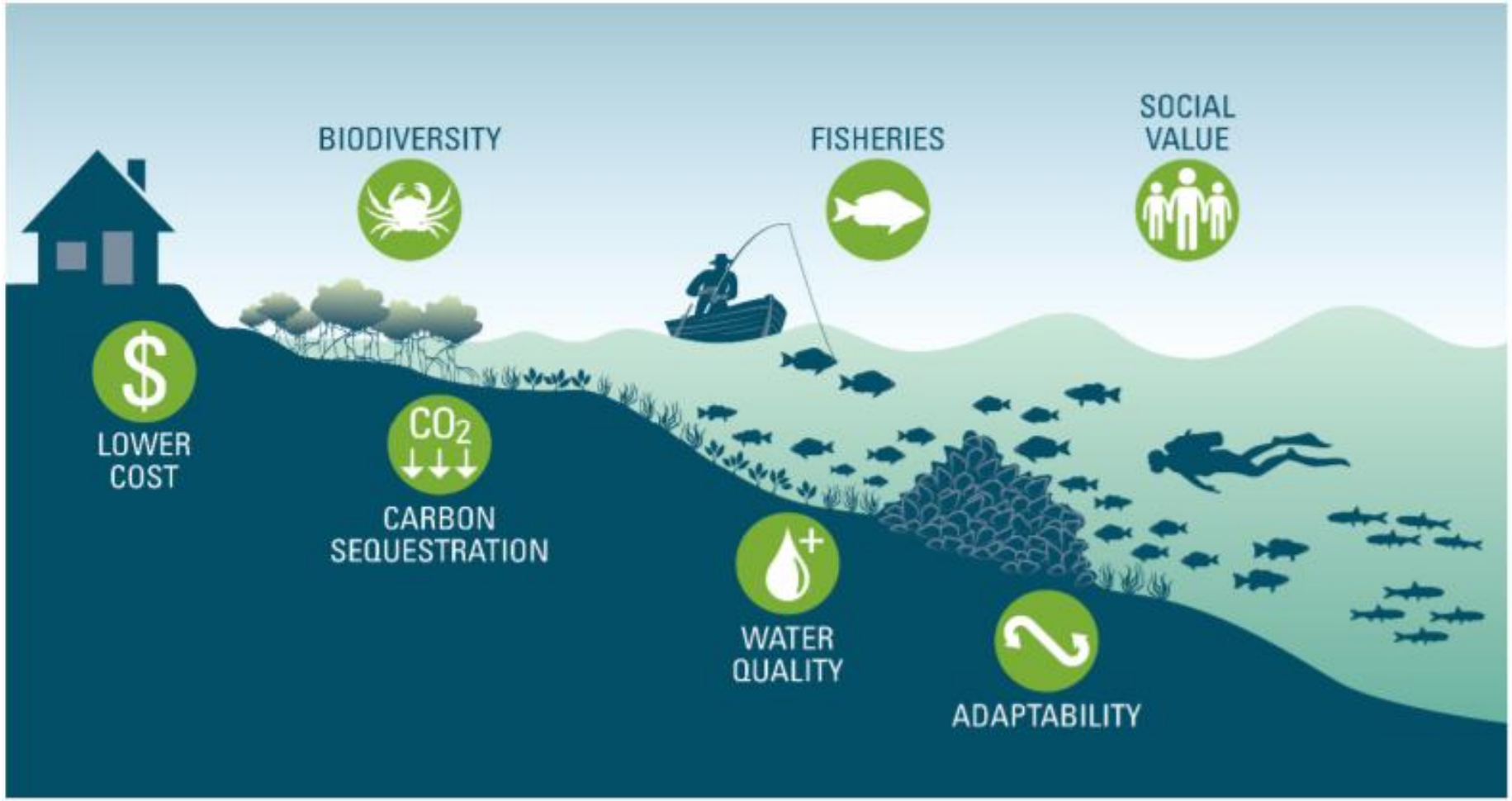
Wave attenuation by depth-induced breaking



Erosion mitigation within ecosystem

Morris et al. 2021. *ESCC Hub Report*

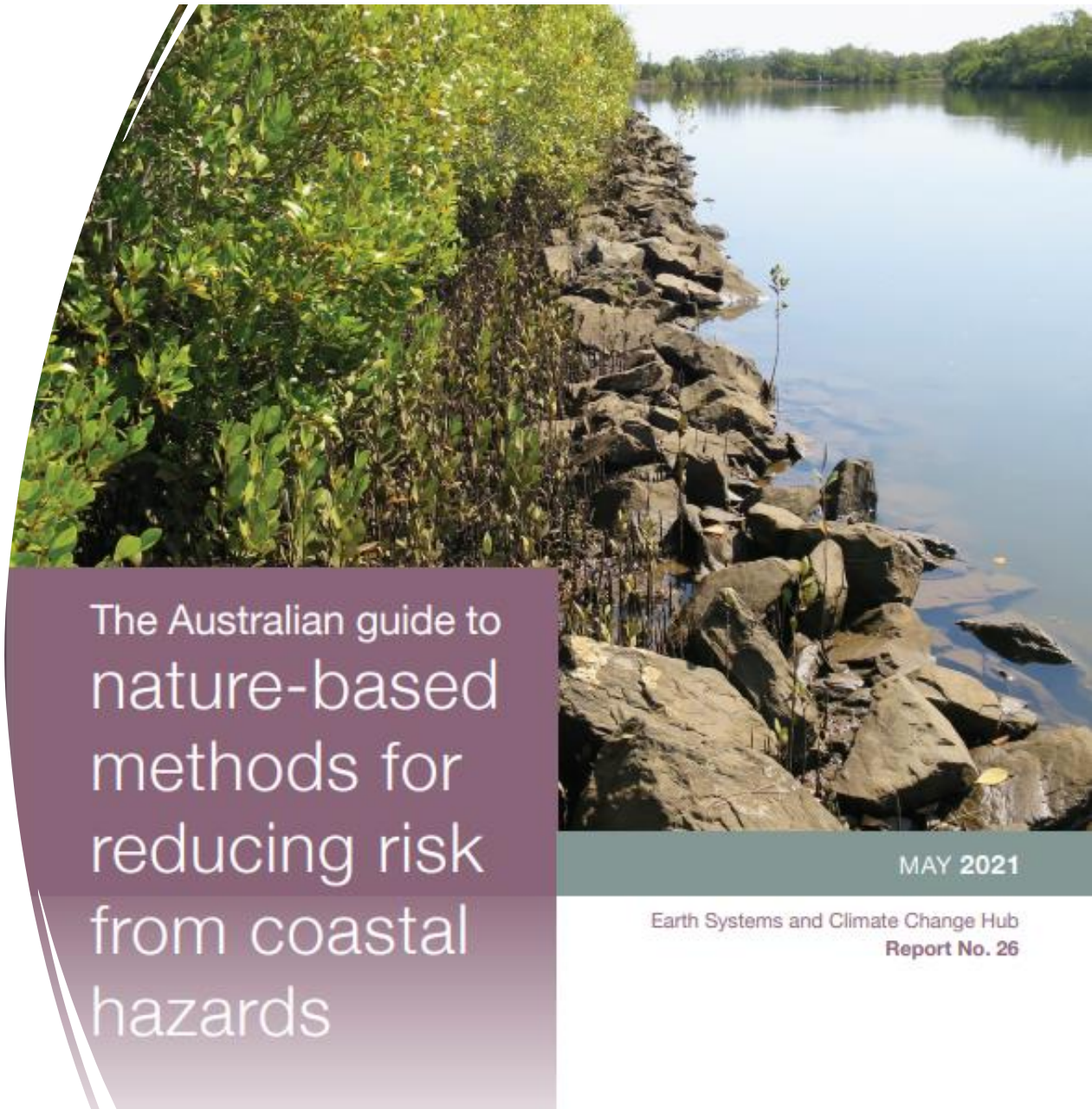
What are potential benefits?



Morris et al. 2021. *ESCC Hub Report*

Considerations for the use of living shorelines

- Physical: waves, tides, depth, sediment
- Ecological: recruitment, species tolerance, connectivity
- Infrastructure: navigation, safety, assets
- Governance: approvals, monitoring, stewardship
- Socio-cultural: values, social license



Morris et al. 2021. *ESCC Hub Report*

Examples relevant to ports: mangroves

Examples relevant to ports: mangroves

Natural

20 years

1 year

Eroding

Morris et al. 2023. *Journal of Environmental Management*
Chan, Swearer and Morris. 2024. Estuaries and Coasts

Examples relevant to ports: mangroves

World Bank: Jakarta fishing port

Examples relevant to ports: reef-based

Morris et al. 2026. *PNAS*

Tyndall Airforce Base, Florida

Examples relevant to ports: reef-based

Examples relevant to ports: reef-based

Loxahatchee River District

Port of Rotterdam

The future port shoreline

Designing ports using a spectrum of approaches where nature becomes part of the infrastructure system

Conceptual image placeholder

The future port shoreline

Designing ports using a spectrum of approaches where nature becomes part of the infrastructure system

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