REEF RESTORATION IN SINGAPORE'S URBANIZING ENVIRONMENT

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- Restore degraded reefs.
- Create new reef habitats.
- Innovative techniques.

COASTAL URBANISATION IMPACTS ON CORAL REEFS

Compressed coral growth zone
Slope depth limit reduced -
Inshore, sheltered reefs (8-12m to 3-5m).
Offshore, exposed reefs (12-15m to 5-8m).

Unstable substrate
Reef substrate degraded with increased unconsolidated rubble and silt.

Reef area decline
Intertidal **61%,** subtidal **89%** lost since 1953.

ENHANCING REEF BIODIVERSITY OF URBAN COASTS

- Visibility reduced from 10m (1960s) to 2-3m now.
- Sedimentation load 45 mg/cm^2/day in 1990s.

UNDER SUCH CONDITIONS,

1. *IS PROTECTION NECESSARY?*
2. *IS RESTORATION RELEVANT?*

YES, because despite urbanization impacts

- high biodiversity maintained (>180 hard coral spp, > 100 reef fish spp).
- reefs withstood 3 major mass bleaching events (1998, 2010, 2016).
- annual mass spawning occurs during April full moon.
- reefs are self-recruiting.

REEF RESTORATION – WHAT WORKS?

Circumvent challenges of:

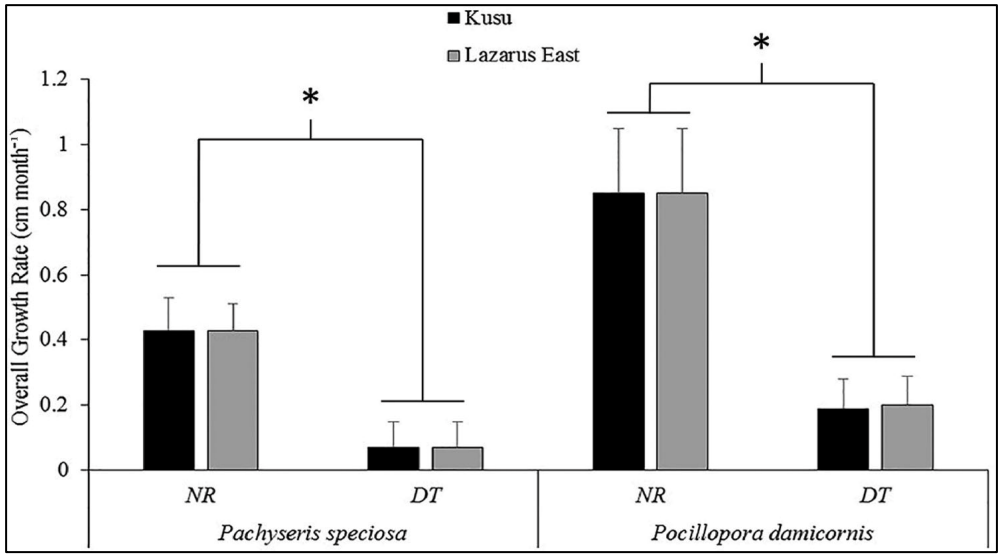
- high sedimentation
- substrate instability

In-situ coral nurseries useful in high sediment conditions

- provide stability for coral growth
- reduce impacts of sedimentation

Mesh nets minimize sediment accumulation and provide secure platforms for coral attachment.

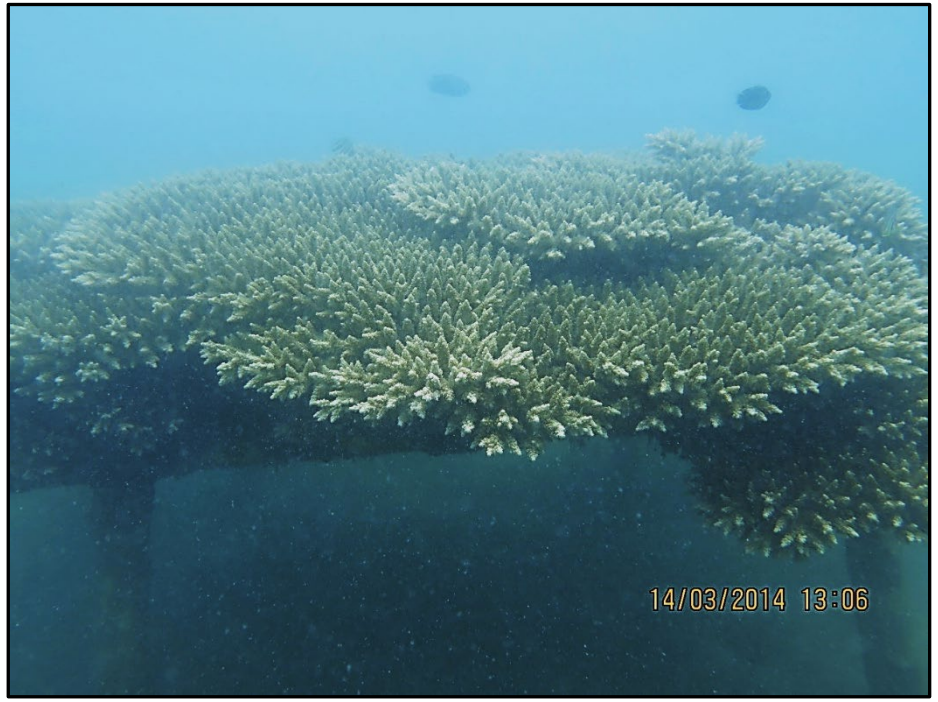
Improves post-transplantation survival and growth



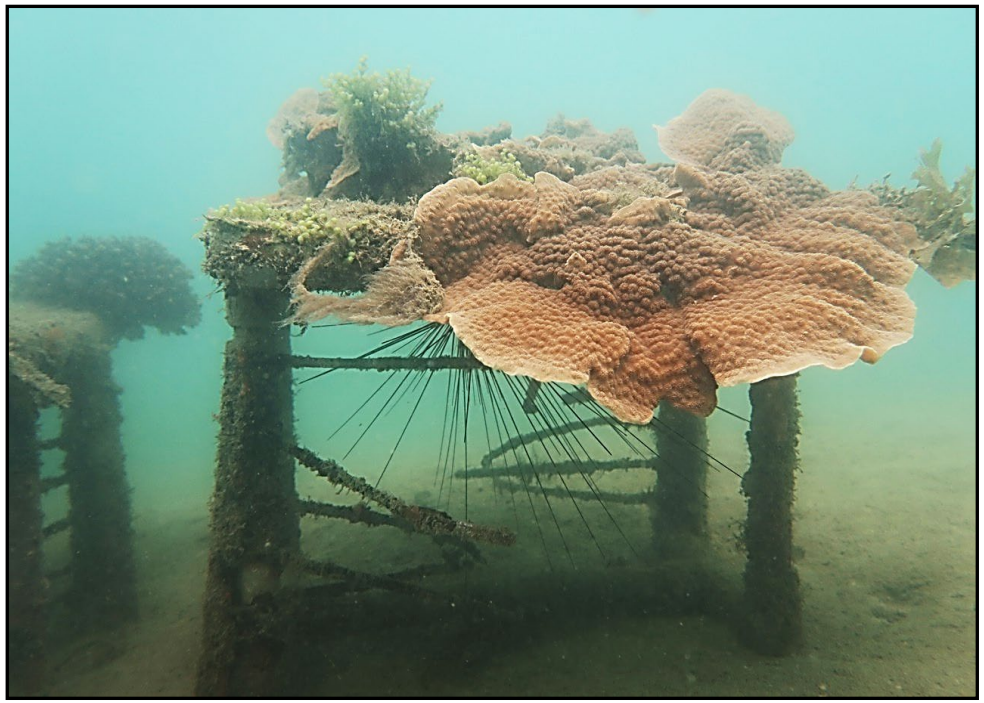
(Afiq-Rosli *et al* 2017)

Addressing unstable substrate using Reef Enhancement Units (REUs)

CREATING REEF COMMUNITIES IN NON-REEF AREAS



Acropora fragments (10cm)
on nursery table after 3.5 years



Nursery frames (1m x1m).
Echinopora lamellosa fragments
March 2015 - 5cm diameter,
March 2018 - 1m diameter.
20x size increase in 3 years.


COASTAL DEFENCE AND REEF BIODIVERSITY ENHANCEMENT


More marine biodiversity settlement opportunities with terraced sea wall


Large intertidal pools provide better opportunity for coral and marine biodiversity development.

URBANISATION AND REEF BIODIVERSITY

- Human-modified coastal environment cannot adequately match ecosystem service levels of natural habitats
- However, they can be enhanced to support/sustain diverse biological communities.
- The urbanised coast can serve both, development and biodiversity functions.
- Restoration is necessary to enhance biodiversity of degraded habitats as well as create new habitats - helps mitigate urbanization and climate change impacts.