Eco-technological Management of Atoll Islands against Sea Level Rise

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Fongafale Is., Funafuti Atoll, Tuvalu
Coastal erosion

Sea level rise?

Inland inundation
Loss of sandy beach along Fongafale coast (lagoon side), Funafuti, Tuvalu
Change in land-use pattern in Fongafale Is.

Over the central depression area, 1896: Swamp and mangrove extended, 1943: An air strip was constructed, 2004: Residential area has been extended since 1980s.

Yamano et al. (2007)
How have atoll islands formed?
Atoll islands are formed by corals and forams.
Corals and forams have formed the island

1/2 to 3/4 of the island sediment is composed of foram sand (*Baculogypsina* or *Amphistegina*), which has formed the island for the last 1800 years.
But corals and forams are dying…

Dead corals are covered by macroalgae in front of the populated area.

Healthy corals in a remote area.
**Ecosystem deterioration by bad water quality**

Loss of coral is crucial for Tuvalu as it forms a foundation and natural breakwater.

*Daily utilization by local people*

*Reduced layer 2-3cm below the sand surface!*

*During ebb tide, e-coli of 25,000 MPN/100mL, 25 times higher than Japan environmental criteria.*
Sand transportation is blocked by jetties, and escaped to the deep lagoon via dredges.

Causeway between islands blocks sand transportation from ocean reef flat to lagoon.
sedimentation

Vertical seawalls induced erosion at their foot.

Original landscape

Loss of coastal vegetation
Ecosystem rehabilitation
Increasing sand production and reef formation.

Removal of obstacles for sand transportation (causeway, jetties, dredges)

Beach nourishment
Coastal vegetation

Countermeasure plans to regenerate sandy beach

Production

Transportation

Sedimentation

Monitoring for evaluation
Production

Improvement of coastal environment is required before or in parallel with any ecosystem rehabilitation challenges.

Then

Foram culture

Tuvalu

Coral culture and transplantation

Okinotorishima
transportation

72 m³/year

Optimum width: 20 m
Optimum depth: reef flat

Open-cut the causeway

Removal of jetties
Backfill dredges

sedimentation

beach nourishment
Challenge level

High

- Coral and foram culture
- Open-cut the causeway
- Beach nourishment
- Replanting coastal vegetation
- Environment improvement
- Ecosystem rehabilitation
- Removal of jetties
- Backfill dredges
- Waste management
- Sewage treatment

Low

Time scale

Short-term

- Present status

Long-term

Ultimate goal

Rehabilitation of ecosystem = land

Regeneration of sandy beach
We have learned that only artificial construction can never save lives.
A hope...
Distribution of atolls in the world

Mahe, Maldives

Funafuti, Tuvalu

Majuro, Marshall Islands
Sea level is rising and will rise by the end of this century.