Eco-technological Management of Atoll Islands against Sea Level Rise

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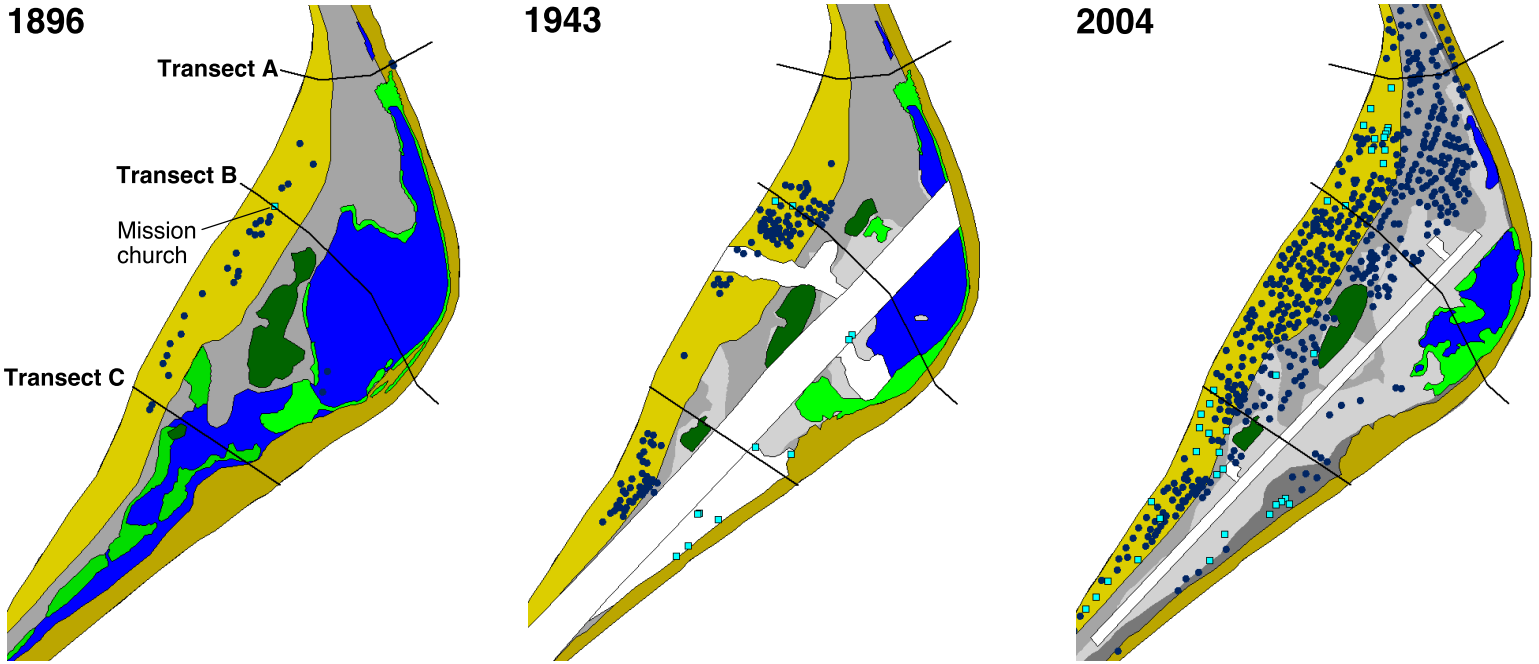
Fongafale Is., Funafuti Atoll, Tuvalu

Sea level rise?

Loss of sandy beach
along Fongafale coast (lagoon side), Funafuti, Tuvalu

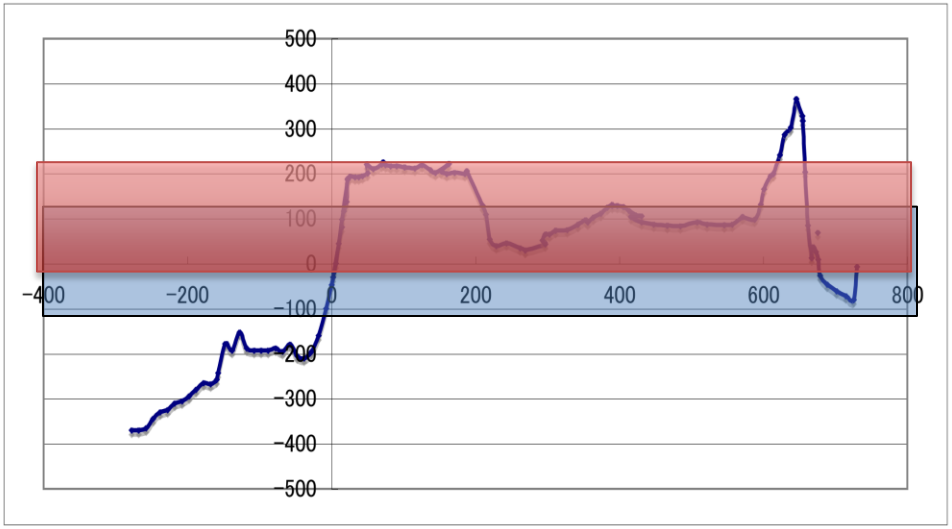
Funafuti MasterPlan, Blue Banana Films

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.

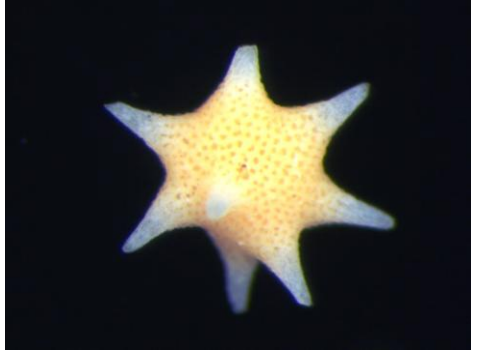
Yamano et al. (2007)



How have atoll islands formed?

Coral gravels

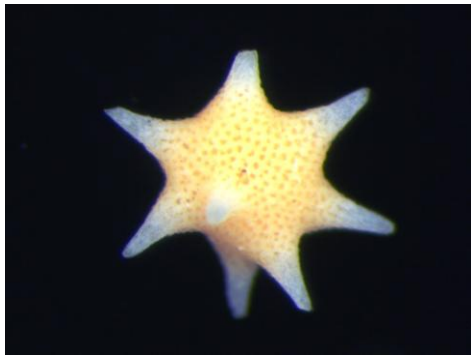
Coral reef

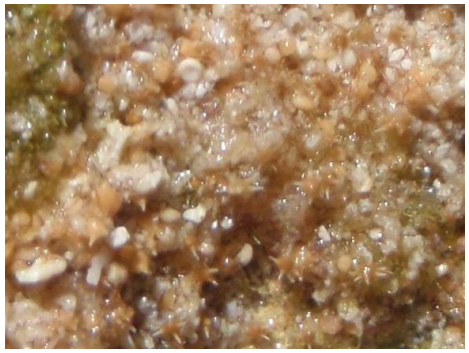


Foram sand

Corals and forams have formed the island

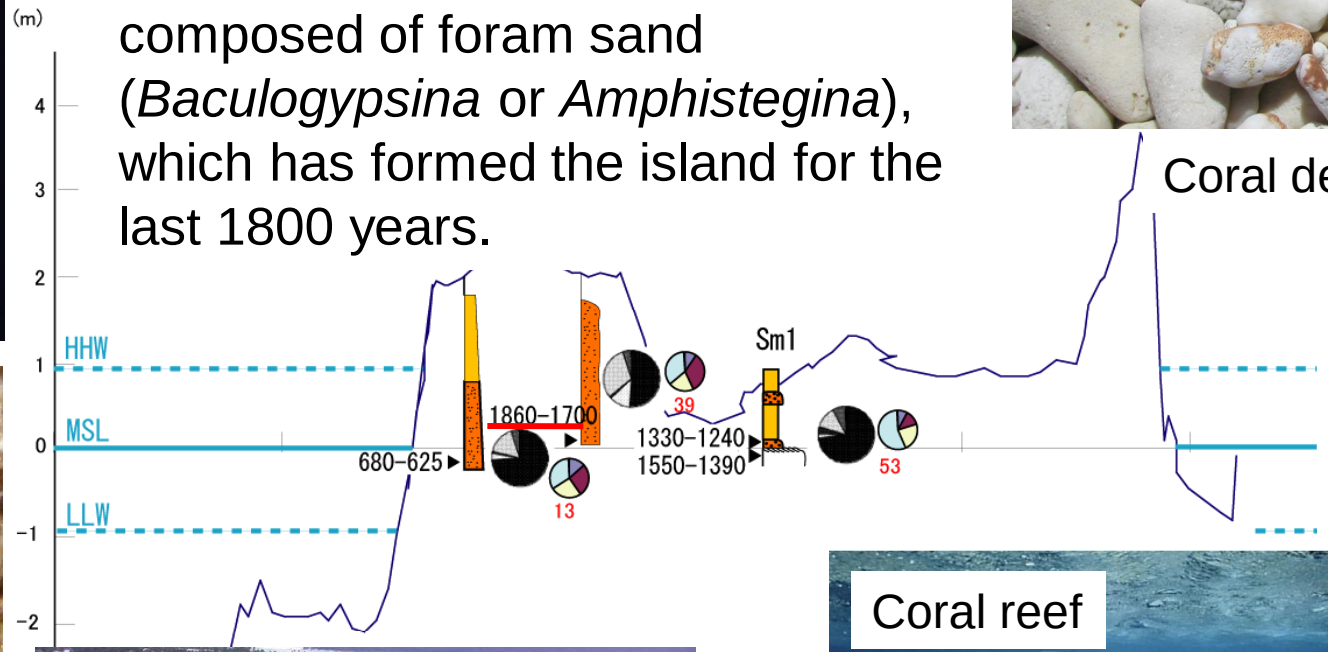
1/2 to 3/4 of the island sediment is composed of foram sand (*Baculogypsina* or *Amphistegina*), which has formed the island for the last 1800 years.

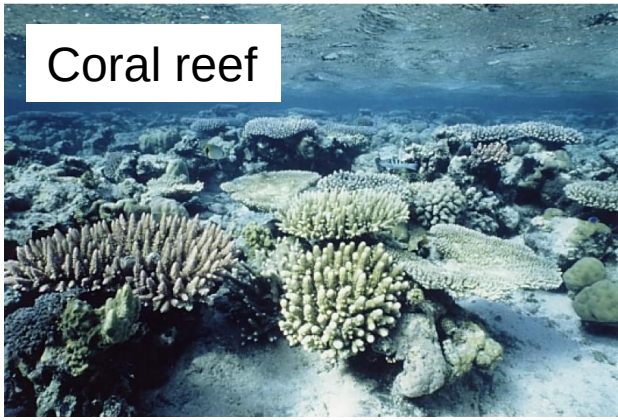




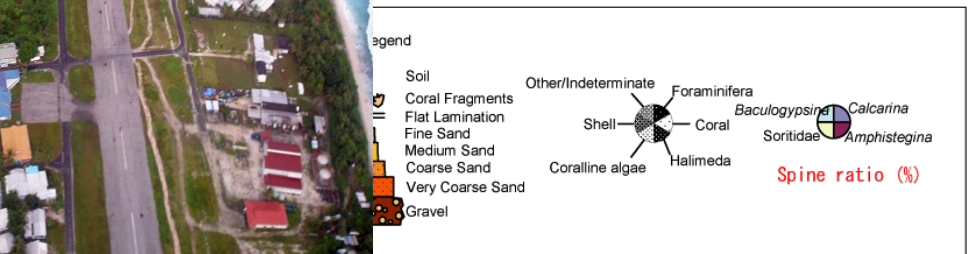
Foraminifera sand

Coral debris

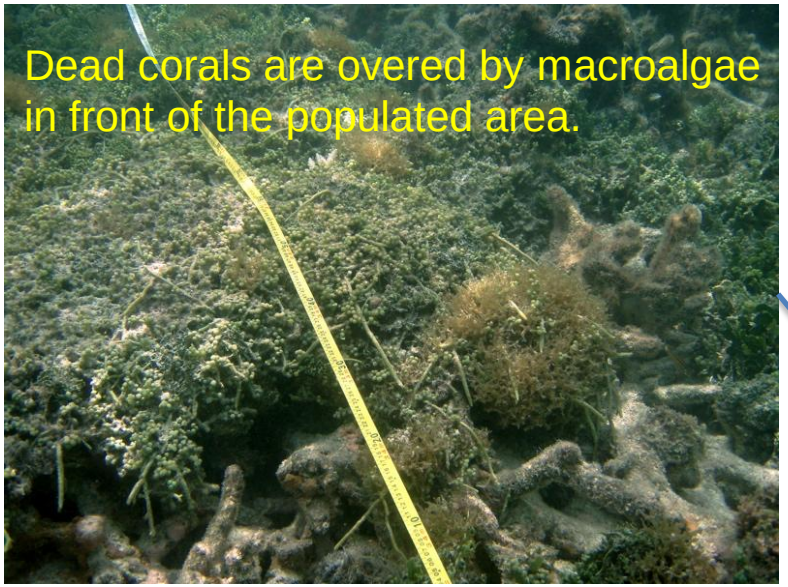


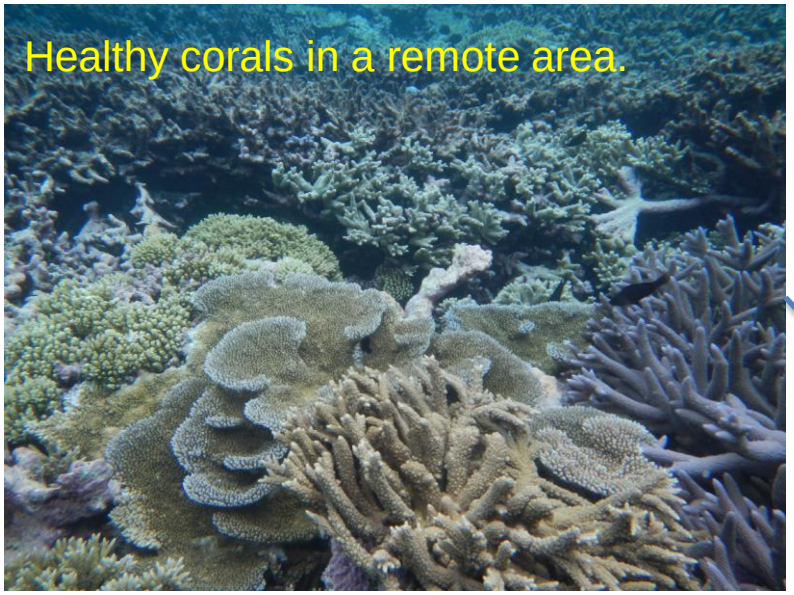


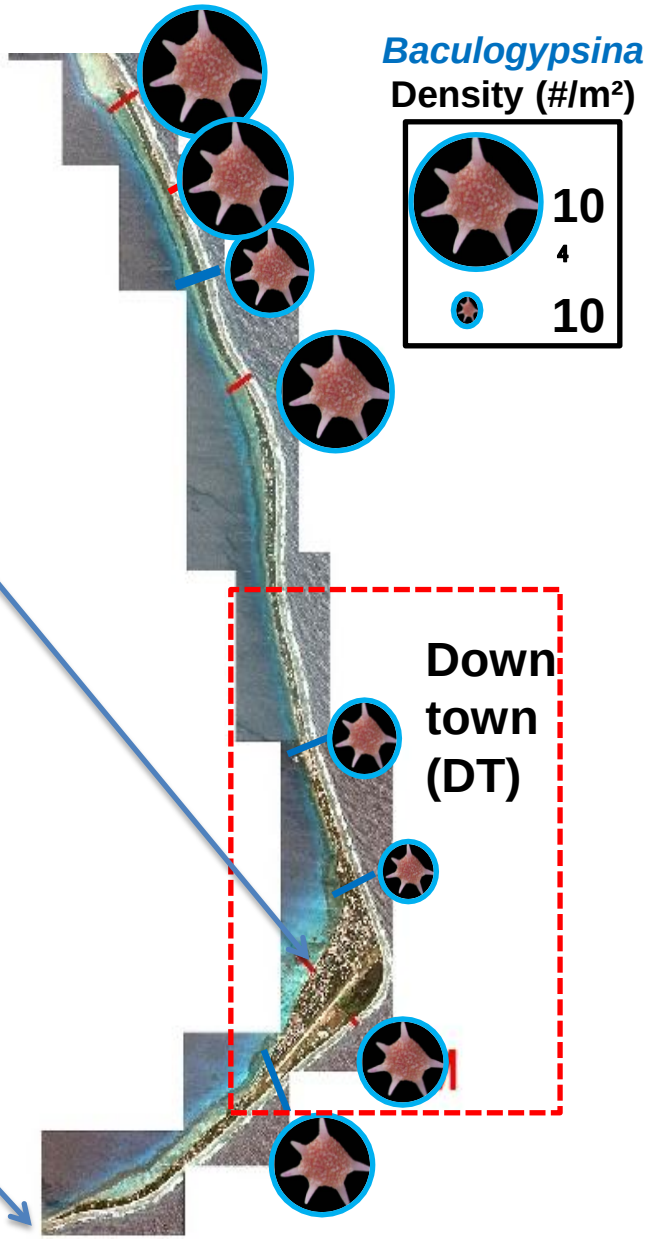
Coral reef



But corals and forams are dying…



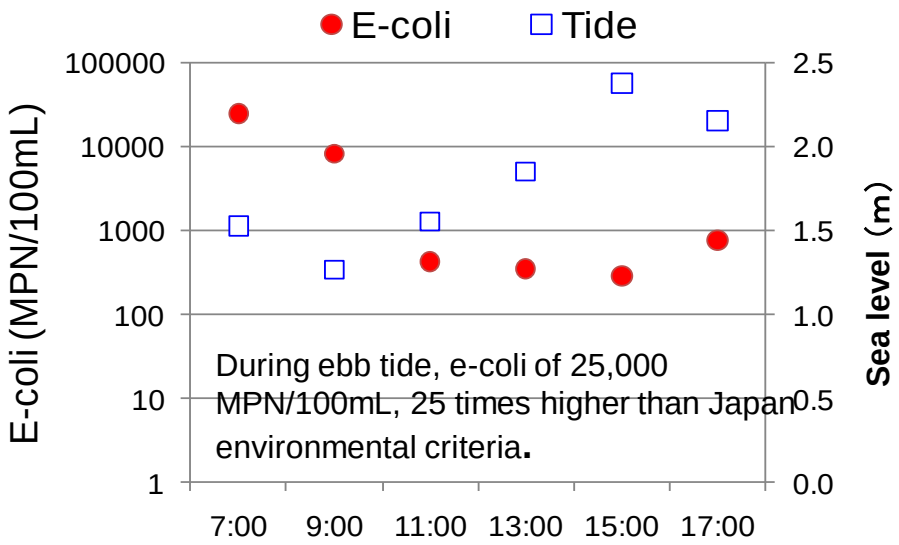




Production

Ecosystem deterioration by bad water quality

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



transportation

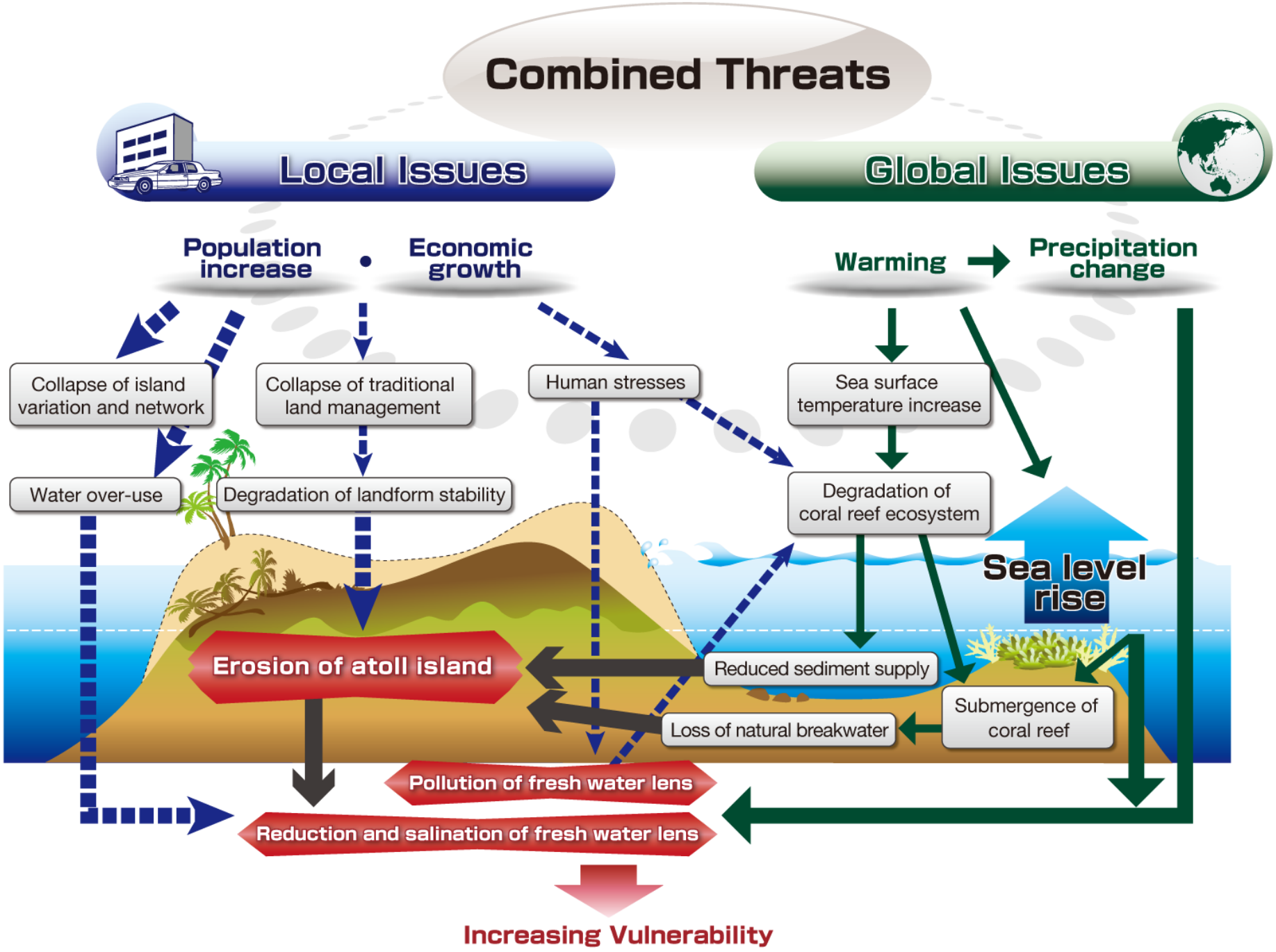
Causeway between islands blocks sand transportation from ocean reef flat to lagoon

Sand transportation is blocked by jetties, and escaped to the deep lagoon via dredges.

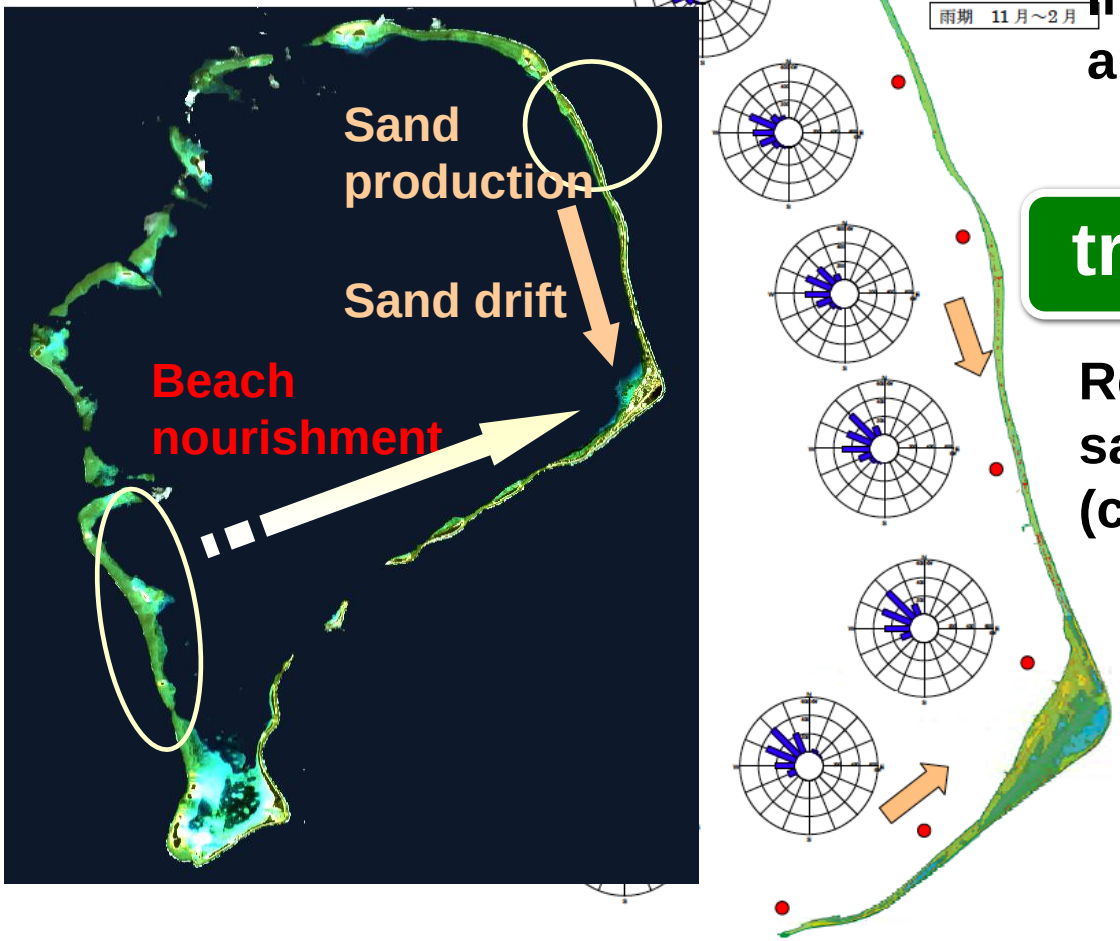
sedimentation

Vertical seawalls induced erosion at their foot.

Loss of coastal vegetation


Combined Threats
Local Issues
Global Issues
Population increase
Economic growth
Warming
Precipitation change
Collapse of island variation and network
Collapse of traditional land management
Human stresses
Sea surface temperature increase
Water over-use
Degradation of landform stability
Degradation of coral reef ecosystem
Sea level rise
Erosion of atoll island
Reduced sediment supply
Submergence of coral reef
Loss of natural breakwater
Pollution of fresh water lens
Reduction and salination of fresh water lens
Increasing Vulnerability

Countermeasure plans to regenerate sandy beach



Production

Ecosystem rehabilitation

Increasing sand production and reef foramation.

transportation

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

sedimentation

Beach nourishment

Coastal vegetation

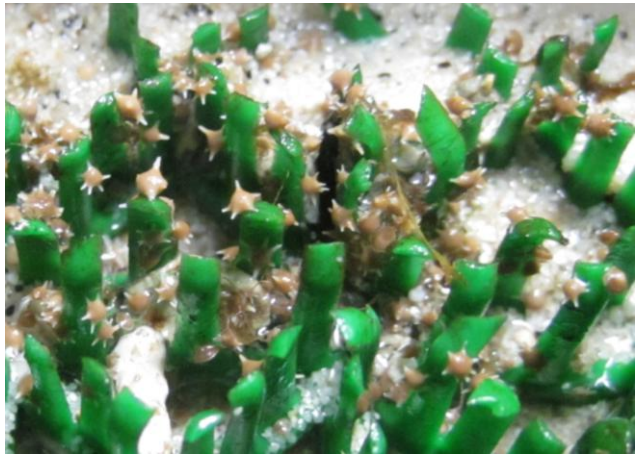
Monitoring for evaluation

Production

Improvement of coastal eivironment is required bofore or in parallel with any ecosystem rehabilitation challenges.

Then

Foram culture



Tuvalu

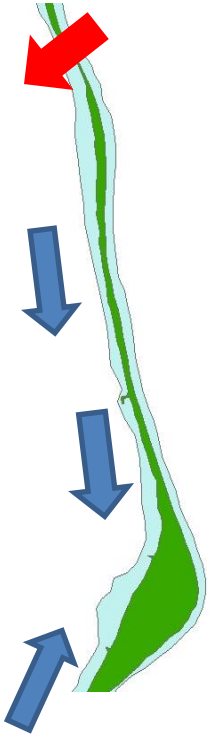
Coral culture and transplantation

Okinotorishima

transportation

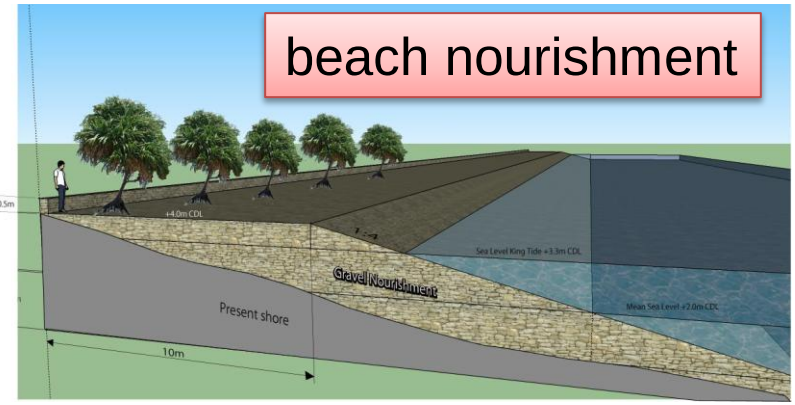
Optimum width: 20 m
Optimum depth: reef flat

Open-cut the causeway



Removal of jetties
Backfill dredges

sedimentation

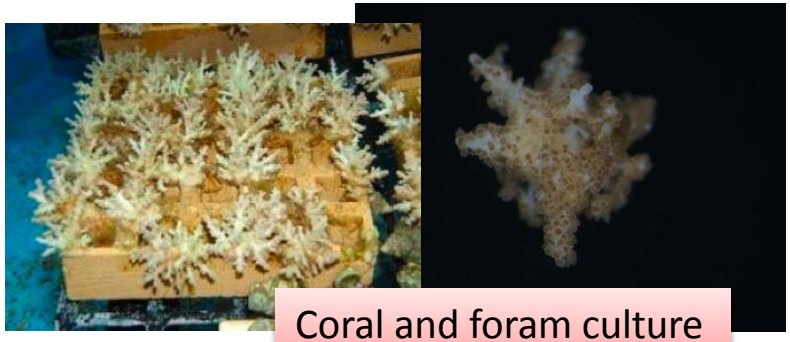


Rehabilitation of ecosystem = land

High

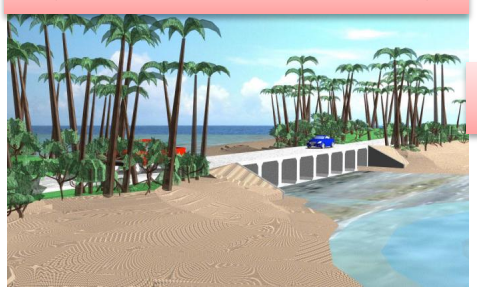
Challenge level

Low



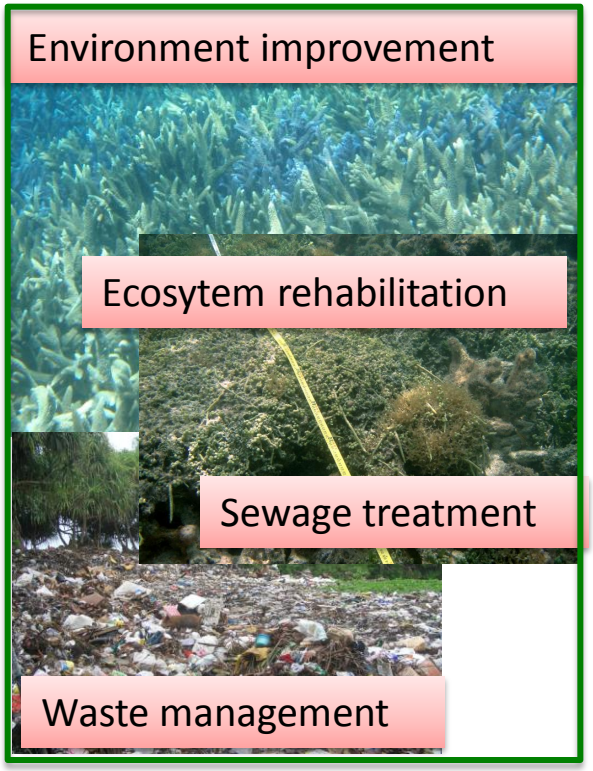
Coral and foram culture

Open-cut the causeway

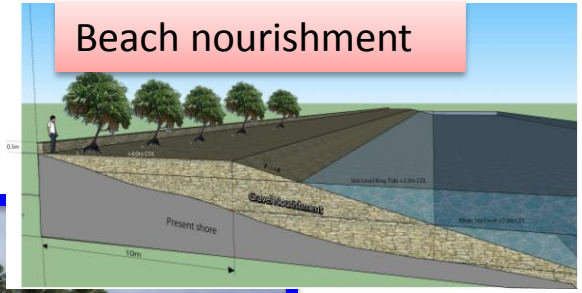


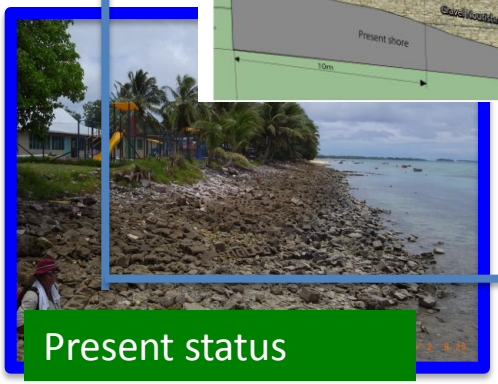
Replanting coastal vegetation

Removal of jetties
Backfill dredges



Beach nourishment





Present status

Short-term

Time scale

Long-term

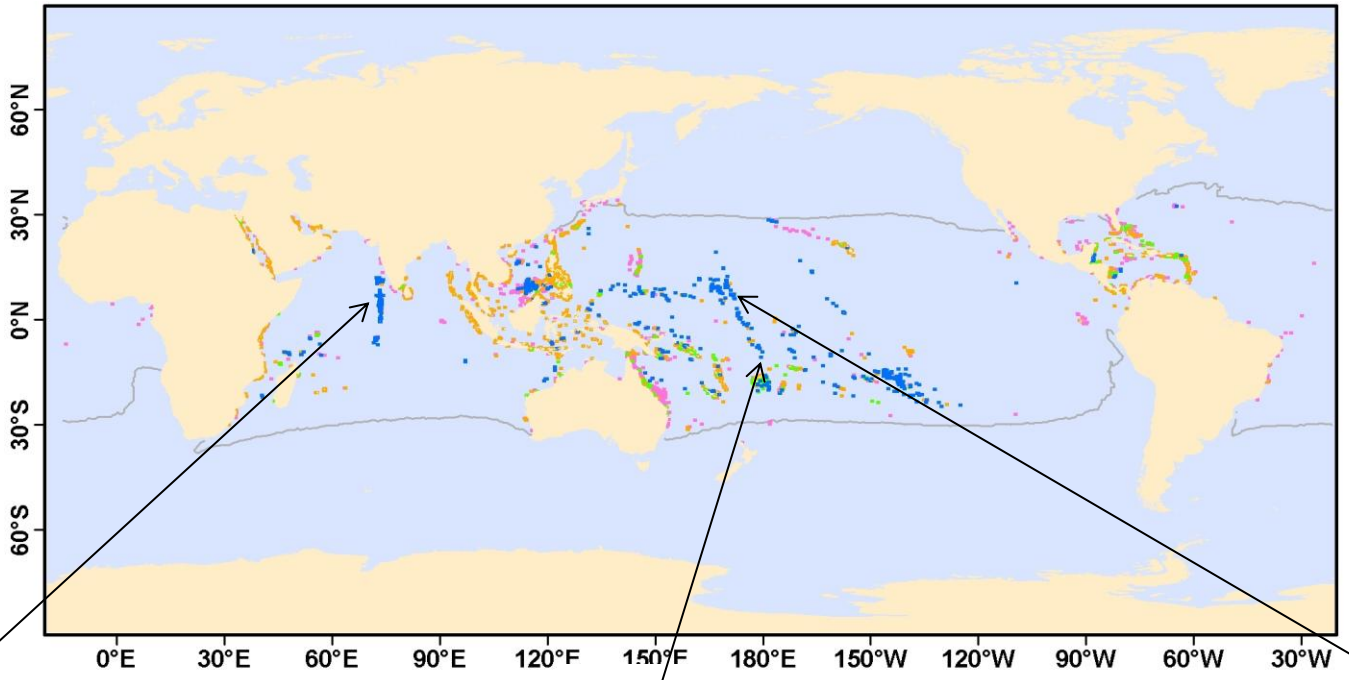
Before 2011.3.11

2011.3.11

We have learned that only artificial consruction can never save lives.

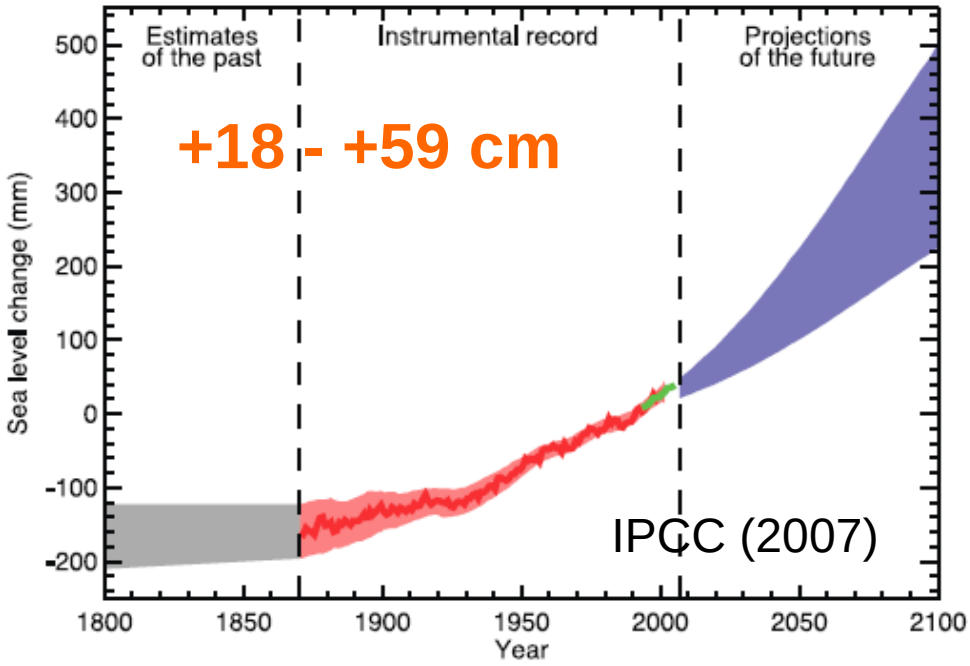

A hope…

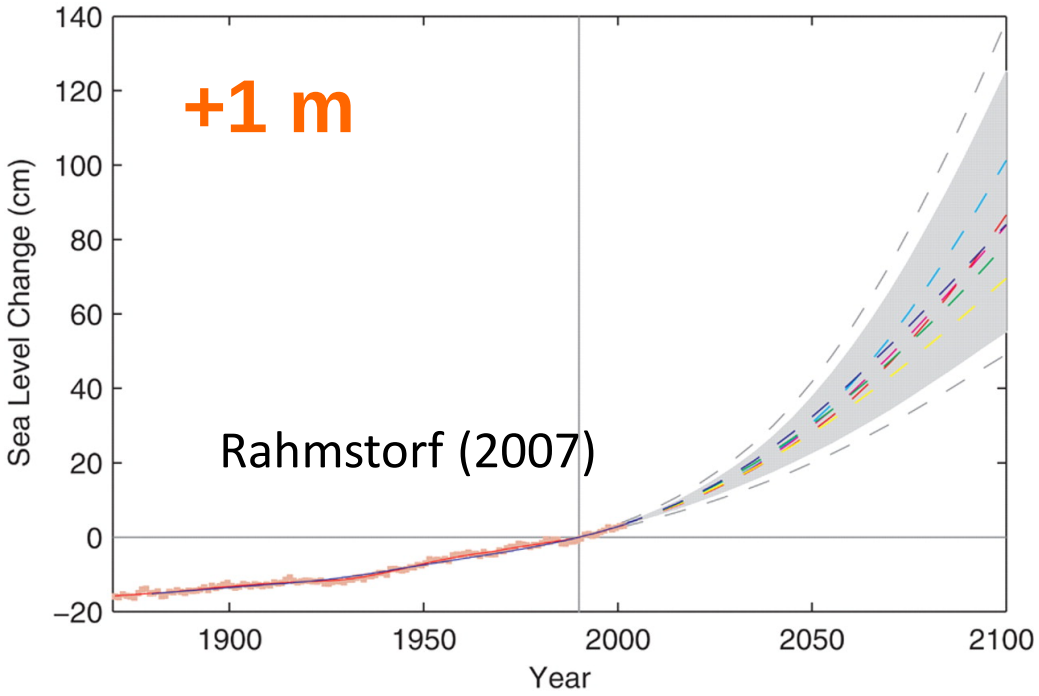
Distribution of atolls in the world



atoll barrier reef fringing reef others

Sea level is rising and will rise





by the end of this century.