Development of disaster prevention and mitigation technologies through forests as NbS and implementation examples in Vietnam - Case of coastal and mangrove forests -

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Forests have effects as NbS against various disasters as followings.

- Flood, Surface erosion.
- Tsunami by earth quake, Storm surges by typhoon.
- Land slide, Debris flow.
- Avalanche.
- Wild fire.
- Outflow of radioactive materials from forest areas to residential areas.

Today's Topic

1) The technology developed for coastal forest creation to reduce the force of tsunamis **in Japan.**
2) The application of this technology as a countermeasure against storm surges caused by typhoons **in Vietnam.**

Green infra vs. Gray infra

Coastal forest　　Seawall ,etc

	Green Infra	Gray Infra
Definition	Nature and ecosystems such as, trees and forests	Artificial structures made of concrete, etc.
Limit Level of DRR function	○	◎
Long-lasting	◎	○
Cost	◎	○
Recovery from degradation	◎ (Self-recovery)	× (Artificial repair)
Time required to fully demonstrate functions	△ (Trees need time to grow)	◎ (Demonstrates functions immediately after construction)

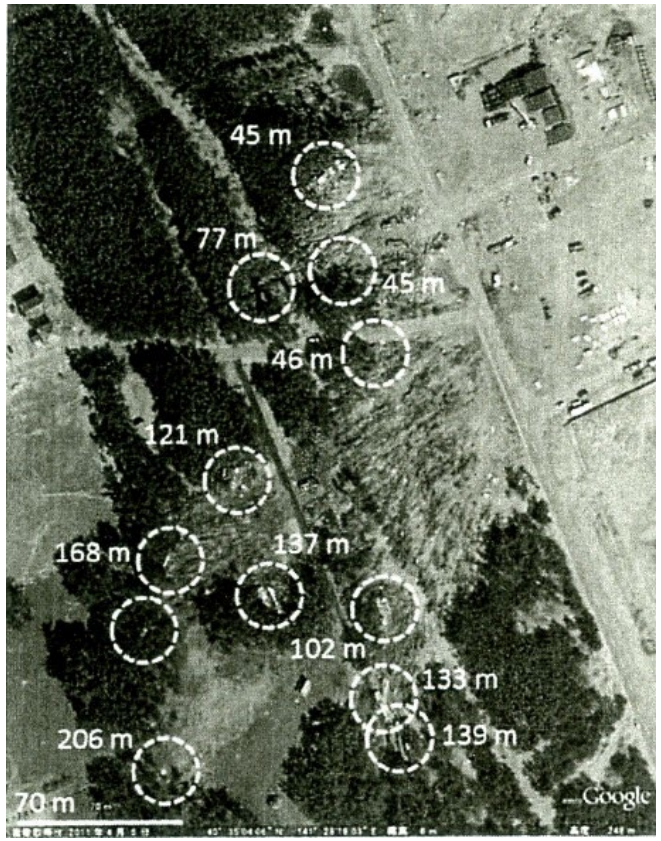
Colored cell: Advantage

- With these pros and cons and the scale of the disaster to prepare for, the combination of GreenInfra and GrayInfra should be designed.

Tsunami (Tidal wave)

Great Earthquake (March 11, 2011.)　・Inundate area :561km^2

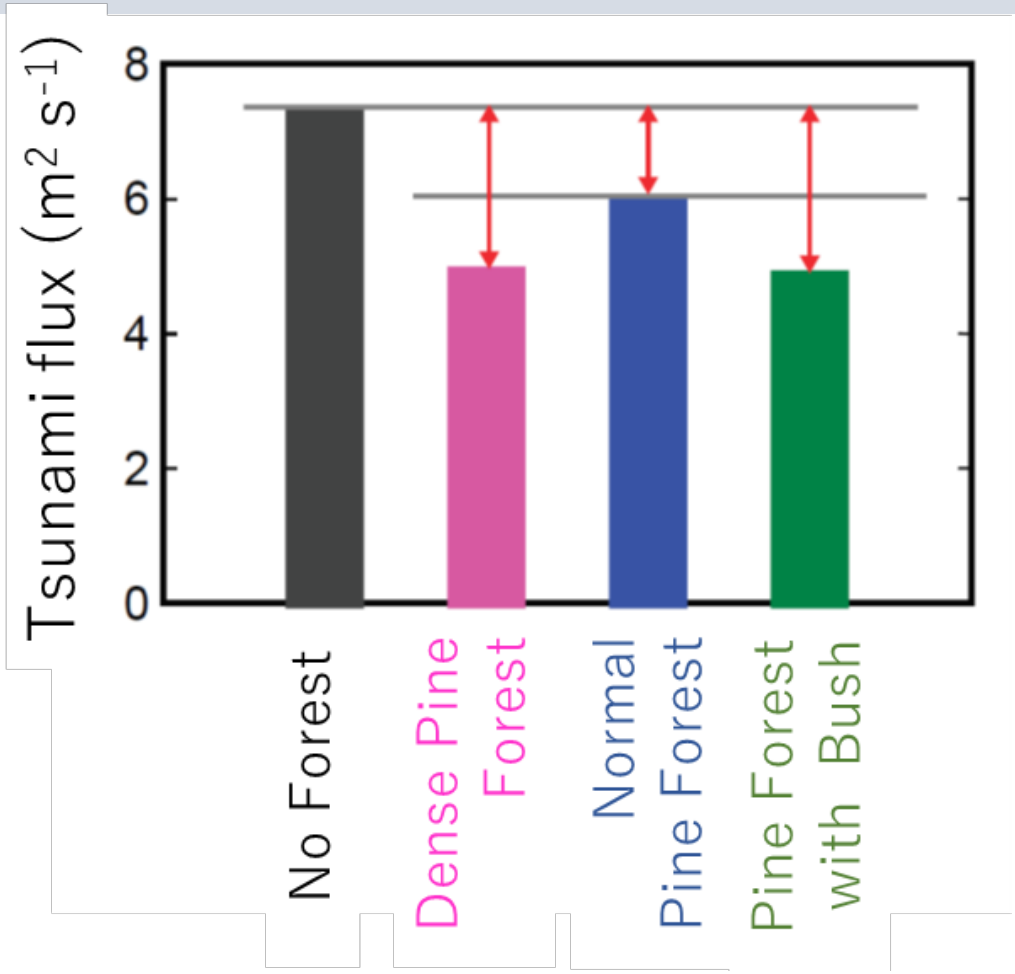
The tsunami damaged buildings.



12 ships trapped in the coastal forest
（Sakamoto et al, 2012）

Coastal forests caught ships and prevented them from being pushed up in land and damaging buildings.

Tsunami (Tidal wave)



The effect on reduce the force of tsunami by the coastal forest. (Noguchi et al, 2015)

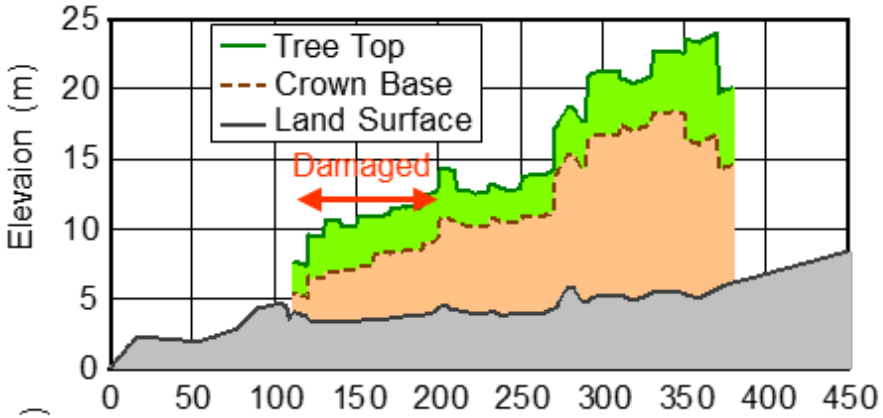
In general, the denser forests, the greater the effect of tsunami weakening.

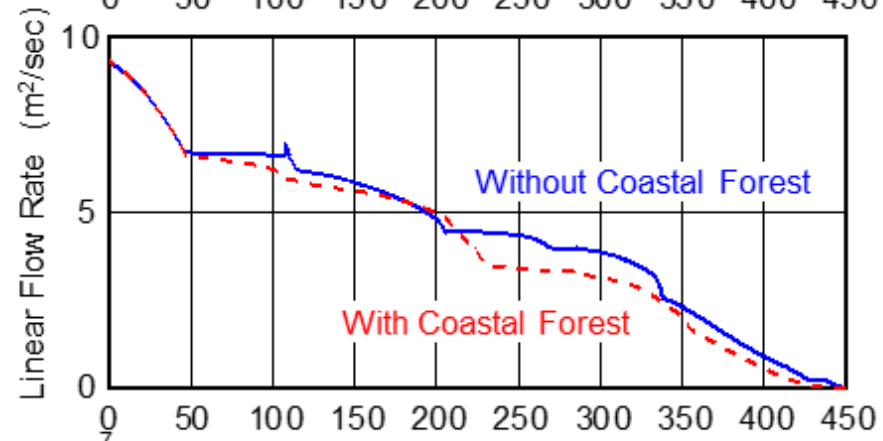
However, many coastal forests were destroyed because they could not resist the force of the tsunami.

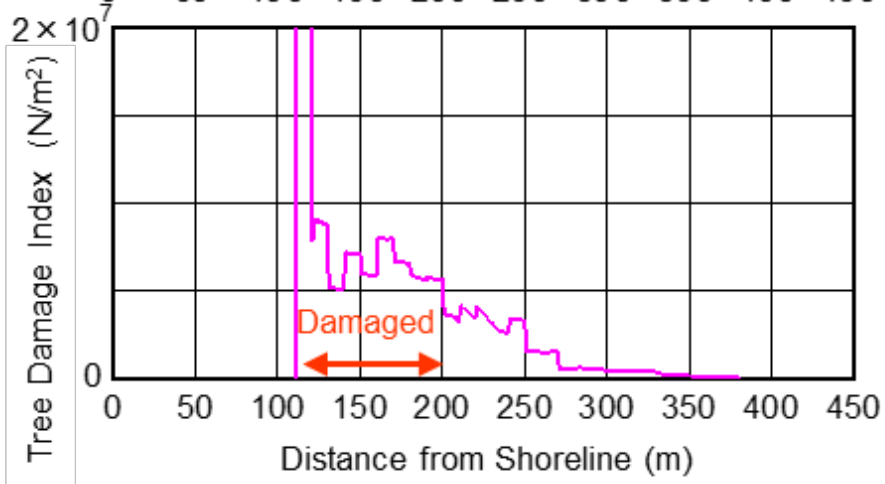
Coastal forest damaged by the tsunami and turned into driftwood at Fudai Village

The coastline with damaged forest :
more than 130km

Tsunami simulation around Coastal forest







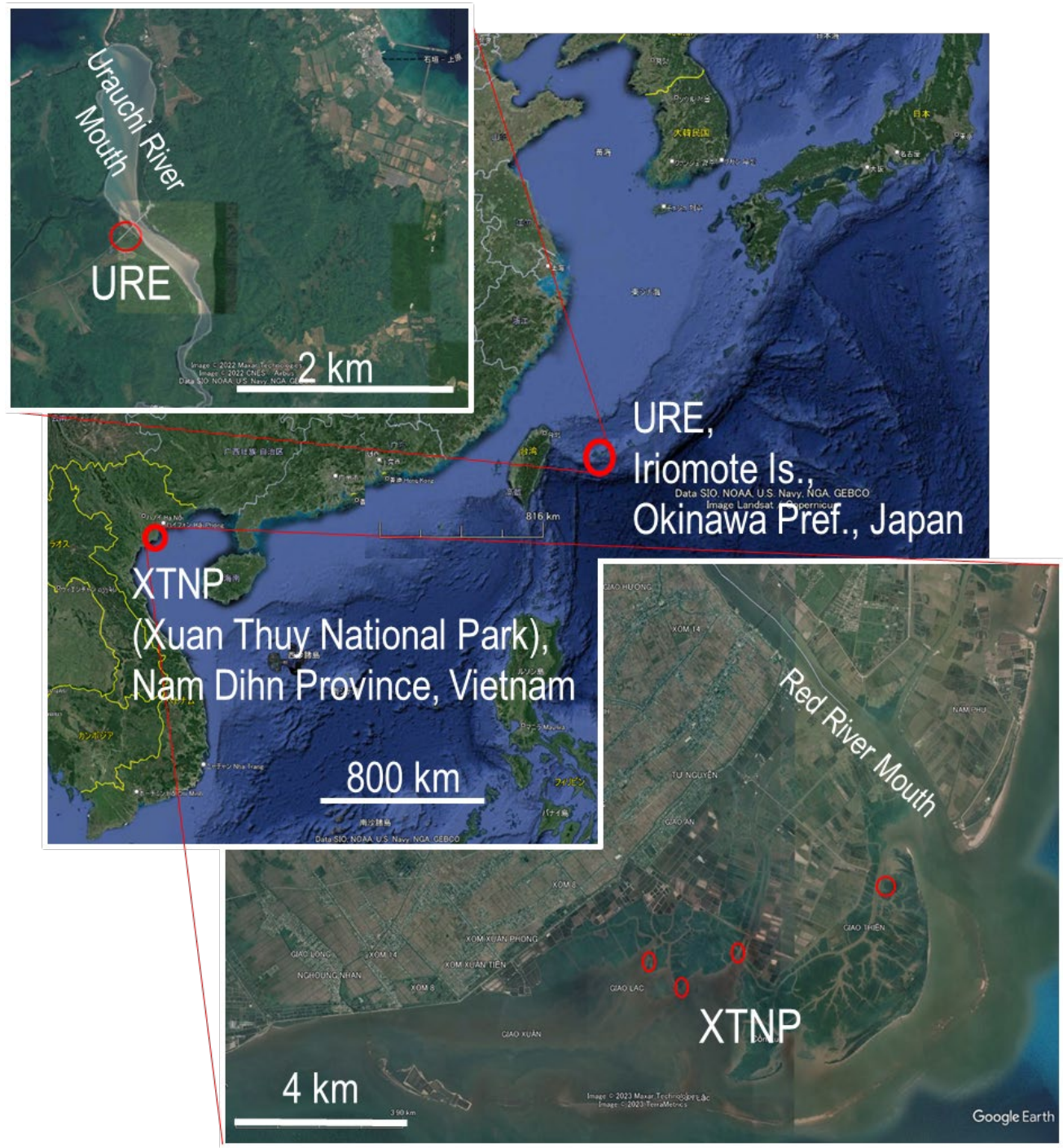
Restoration of coastal forests has been completed on 130 km of coastline by 2020.

Pine saplings planted for coastal forest recovery

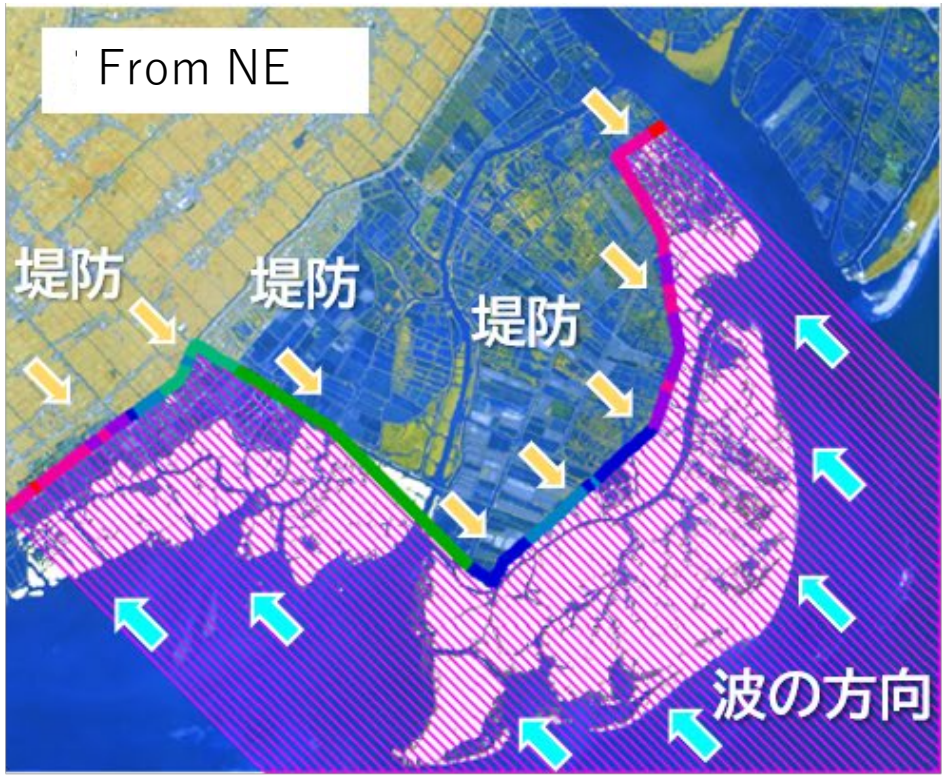
https://www.rinya.maff.go.jp/tohoku/sidou/kyoutei/other/kaigan_kyoutei_natori.html

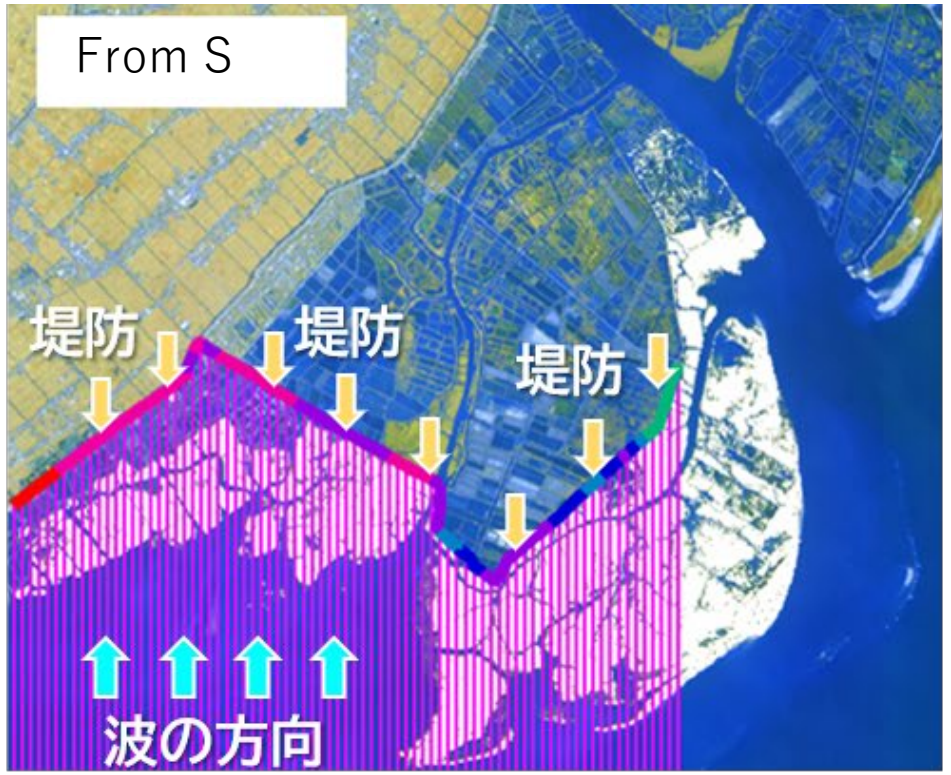
Input Data to Model

- Depth of coastal forest
- Tree Density
- Resistance of tree bodies to tsunamis.

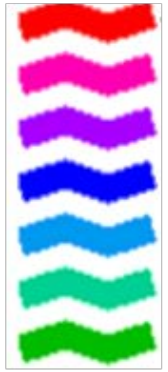

Urauchi River Mouth
URE
2 km
URE,
Iriomote Is.,
Okinawa Pref., Japan
816 km
XTNP
(Xuan Thuy National Park),
Nam Dinh Province, Vietnam
800 km
Red River Mouth
XTNP
4 km
Google Earth

Mapping information on the effectiveness of mangrove forests in reducing the force of storm surges is expected to be used for efficient seawall management and disaster prevention planning.



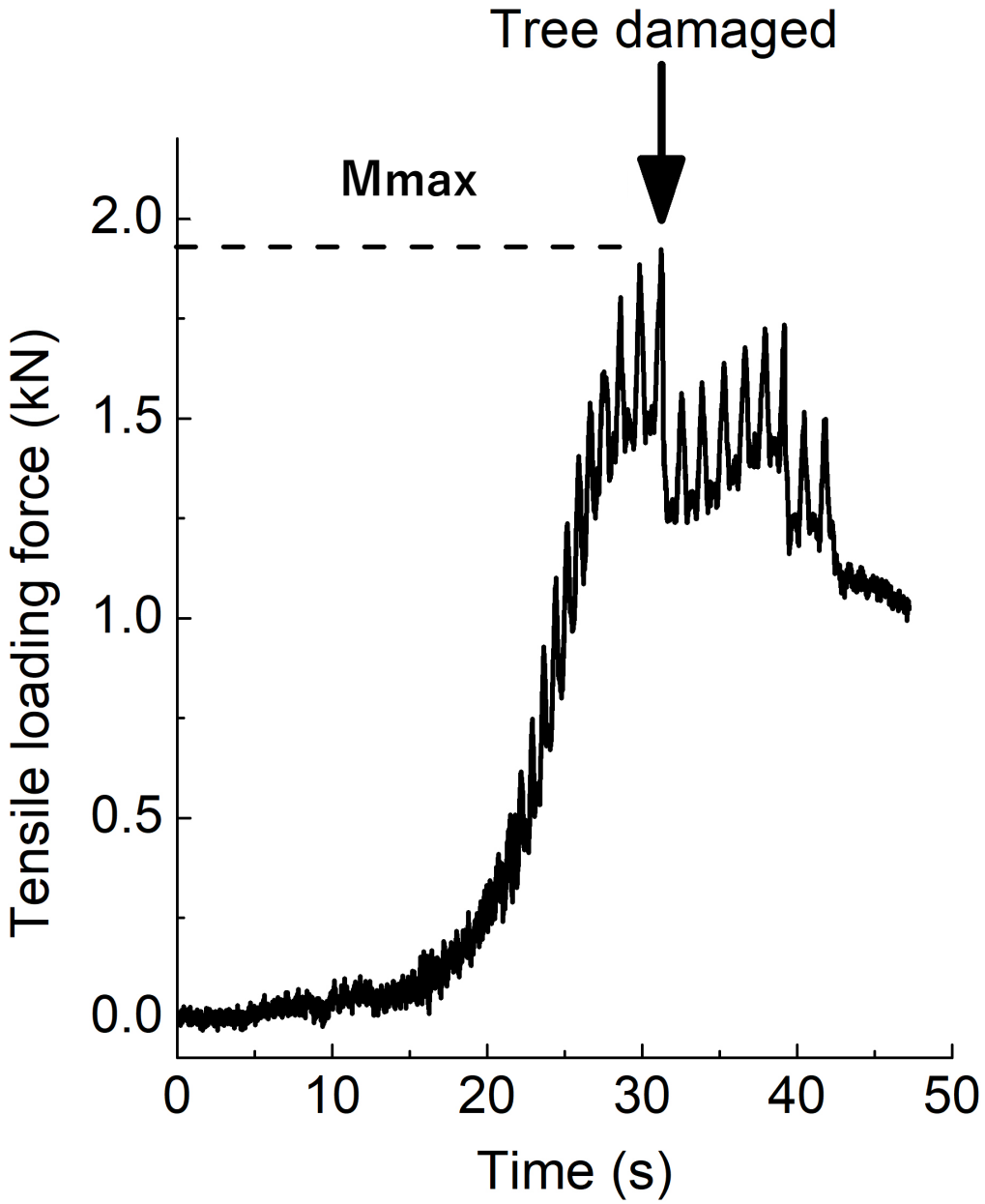


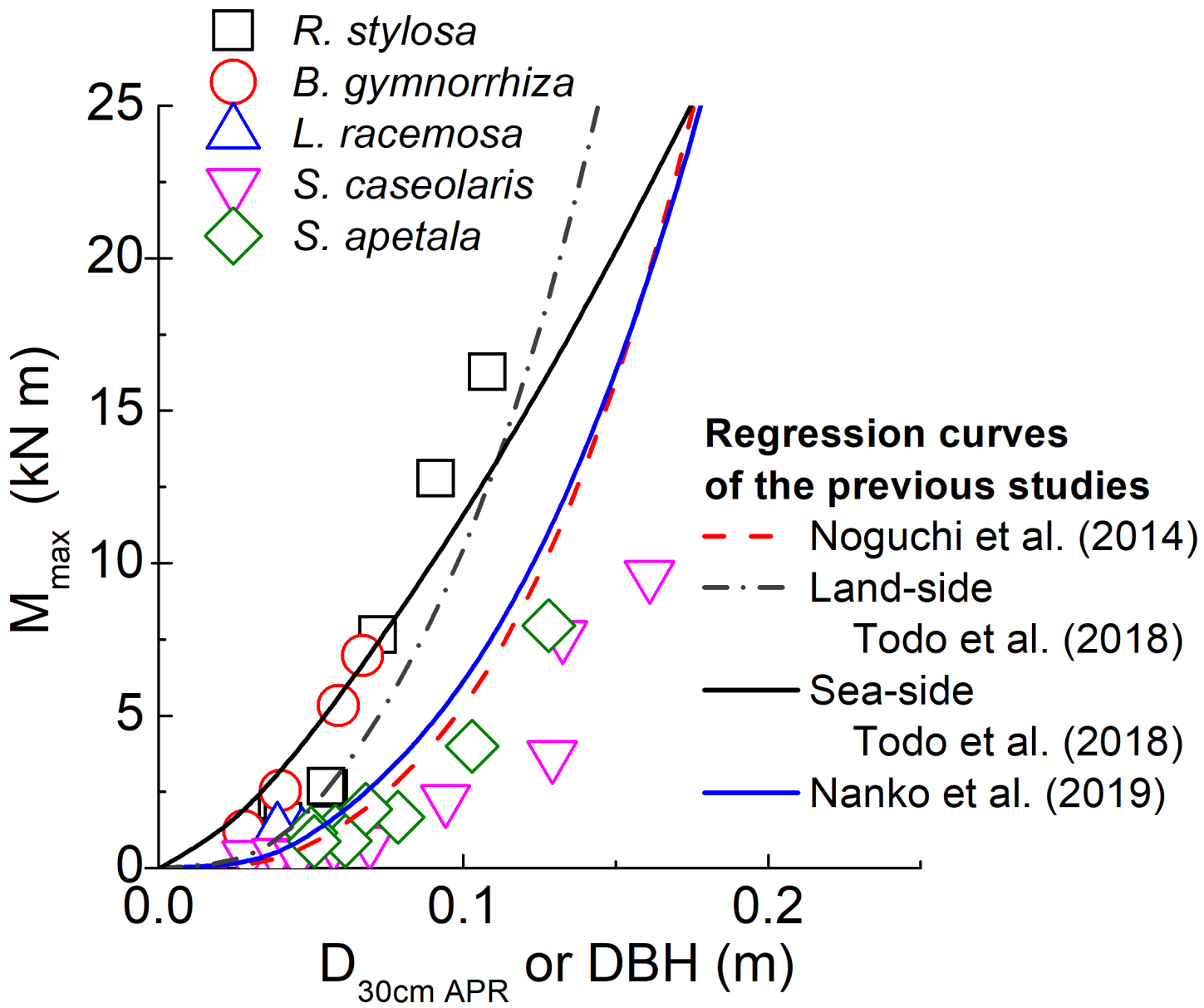
Depth of the mangrove forest through the storm surge passes before reaching the seawall (km)



0.0 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 3.5

Important Factors in Model
- Depth of coastal forests
- Tree Density
- Strength of the tree body


Tree damaged
Mmax
2.0
1.5
1.0
0.5
0.0
Tensile loading force (kN)
0
10
20
30
40
50
Time (s)


R. stylosa
B. gymnorrhiza
L. racemosa
S. caseolaris
S. apetala
25
20
15
10
5
0
0.0
0.1
0.2
M max (kN m)
D 30cm APR or DBH (m)
Regression curves
of the previous studies
Noguchi et al. (2014)
Land-side
Todo et al. (2018)
Sea-side
Todo et al. (2018)
Nanko et al. (2019)