Area-based conservation and management of coral reefs for climate change adaptation of tropical Pacific islands

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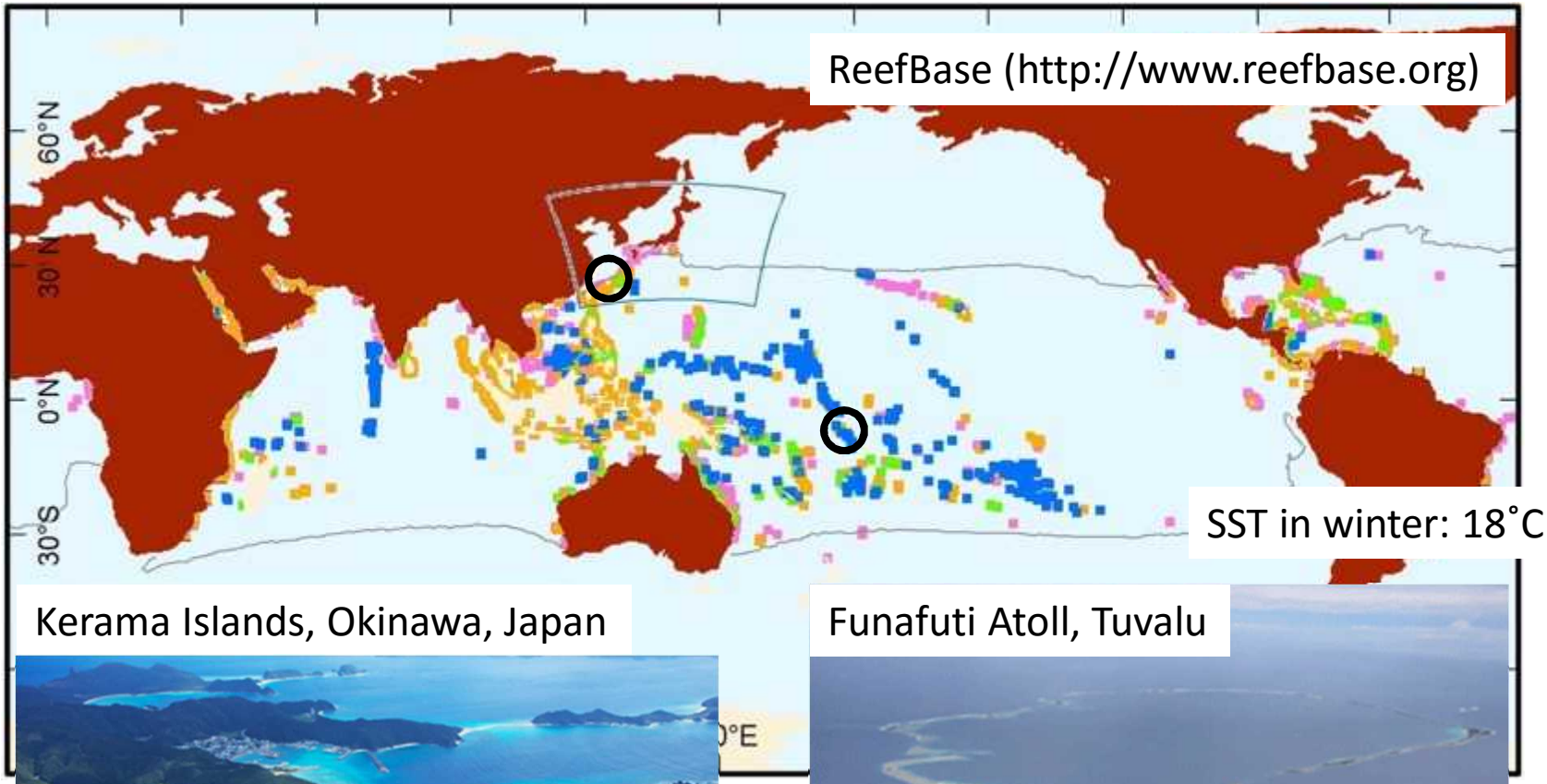
Topics

- MPA (marine protected area) management planning at Keramashoto (Kerama Islands) National Park, Okinawa, Japan

- Science-based approach, by using coral distribution modeling and the future projections based on in-situ and earth observation data

- Results may directly contribute to Aichi Biodiversity Targets 10 (vulnerable ecosystems) and 11 (protected areas)

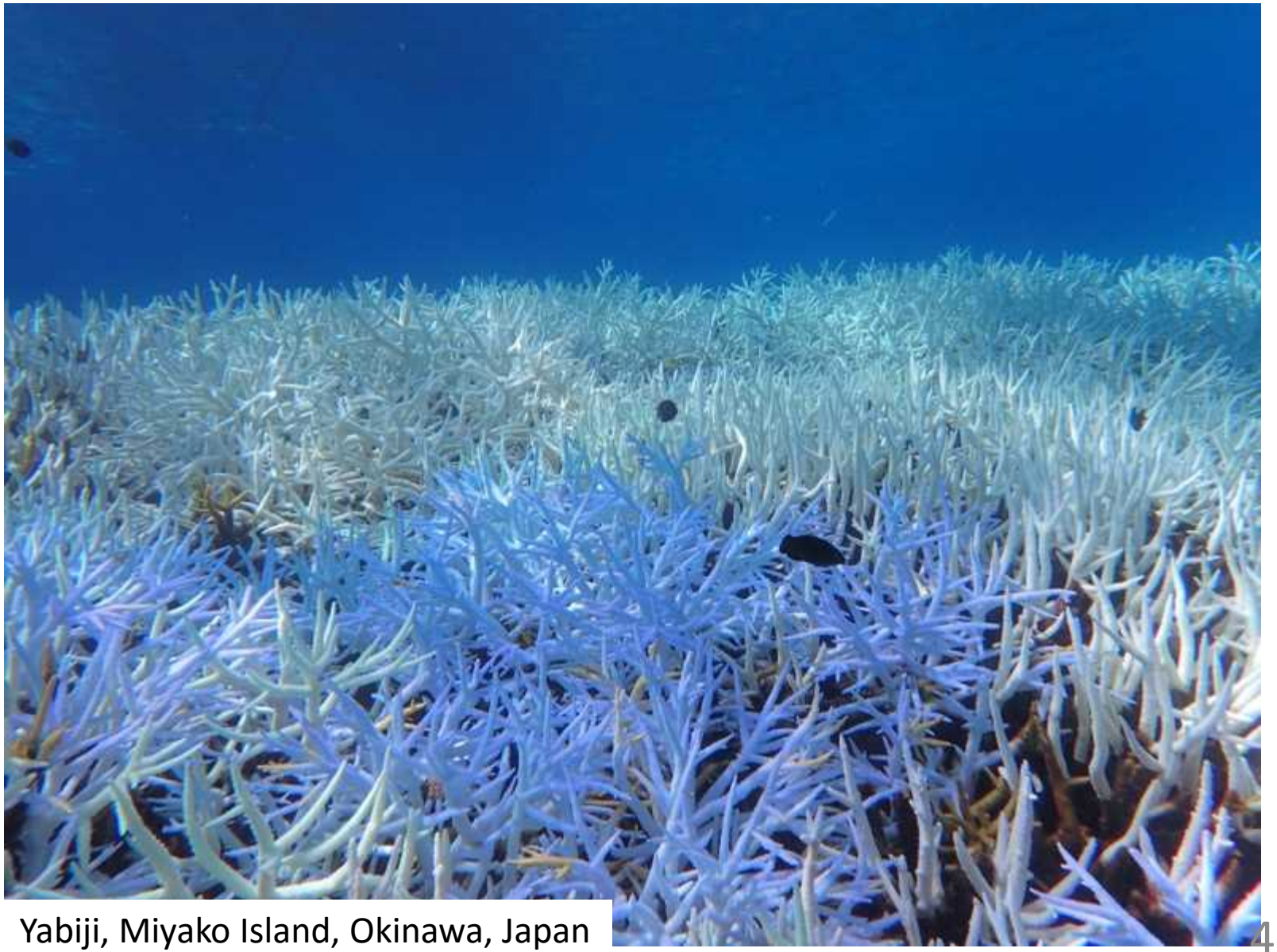
Distribution of corals and coral reefs



https://www.t-marche.com/tripper/article/839/

Photo: Shuichi Endo

Mass coral bleaching due to high SST in the 2016 summer

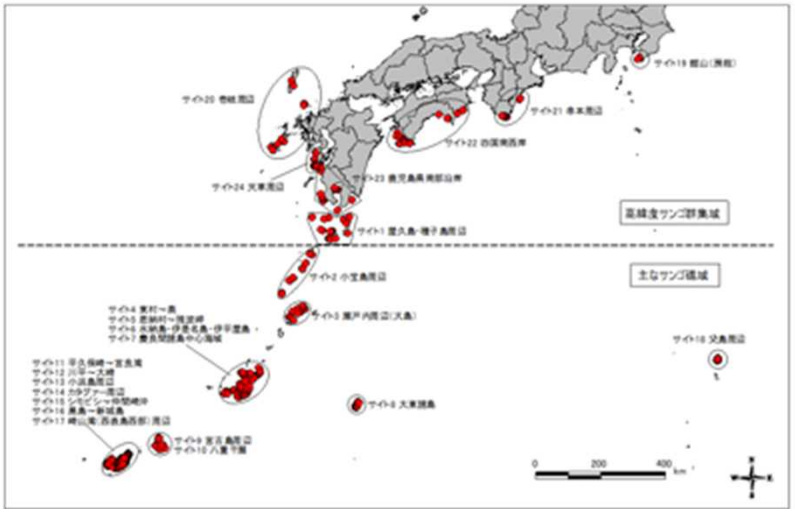


Yabiji, Miyako Island, Okinawa, Japan

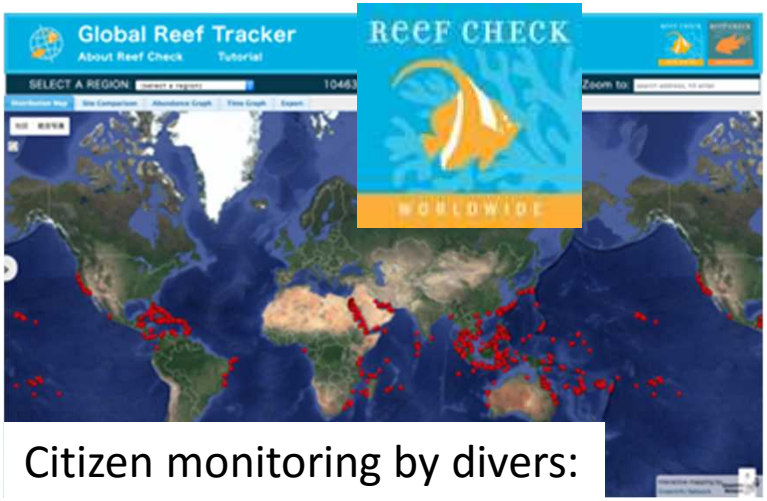
Mass coral mortality due to the bleaching in 2016

Yabiji, Miyako Island, Okinawa, Japan

Coral monitoring network in Japan



Government monitoring:
Monitoring Sites 1000 by Ministry of the Environment (2003-)



Citizen monitoring by divers:
ReefCheck (1997-)

https://www.sangomap.jp

Citizen monitoring by divers/snorkelers:
Sango (Coral) Map Project (2009-)

Predictive modeling of coral bleaching and mortality

Coral distribution, bleaching and mortality data

In situ data by monitoring programs

Environmental variables

Earth observation data

Sea surface temperatures: (MUR-SST; AMSR-E, GCOM-W1, MODIS, and AVHRR blended)

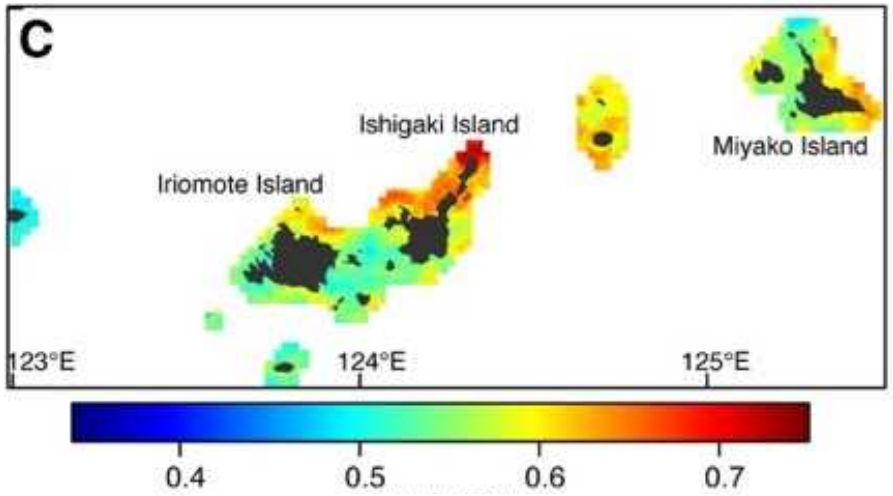
Irradiance: UV-B (JASMES; MODIS)

Water current: Northward/eastward current velocity (HYCOM)

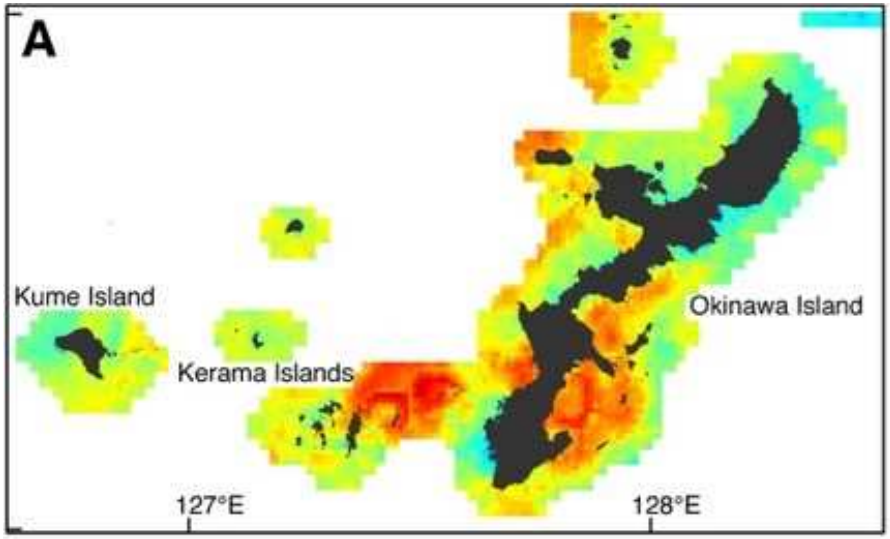
Turbidity: k490 (NOAA OceanColor Database; MODIS)

Modeling

Machine learning
(Random Forest)



Probability of bleaching

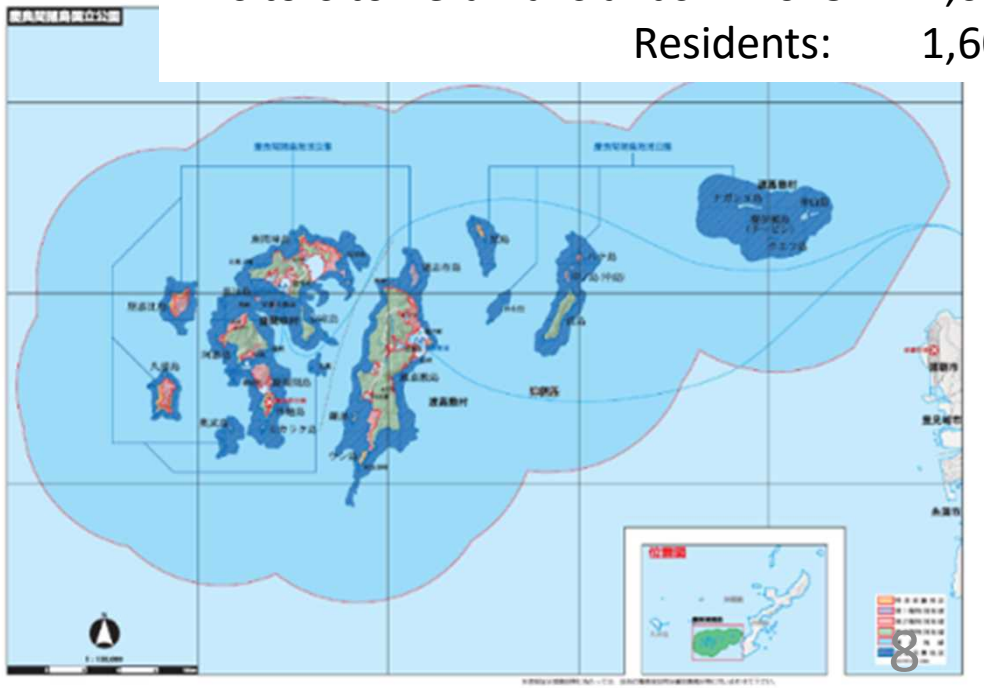


Kumagai, Yamano, and Sango Map Project Committee (2018) *PeerJ*

Keramashoto (Kerama Islands) National Park

https://www.env.go.jp/en/nature/nps/park/kerama/index.html

Visitors to Kerama Islands in 2015: 224,000
Residents: 1,600



Purpose

Management planning at Keramashoto National Park under changing climate

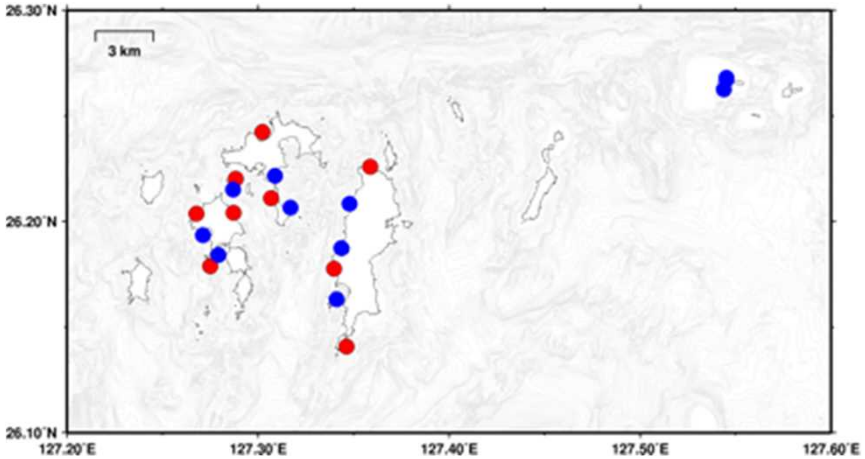
Target items determined through discussion with park managers (Ministry of the Environment and Zamami/Tokashiki villages), diving operators, fishermen, and local residents

- Conservation target: Coral
  Collection of coral distribution and bleaching data (in-situ data + coral distribution maps by earth observation satellite data)
  Collection of environmental variables (earth observation data)
- Spatial resolution: 10-100m (visible by divers)
  Downscaling of the earth observation data

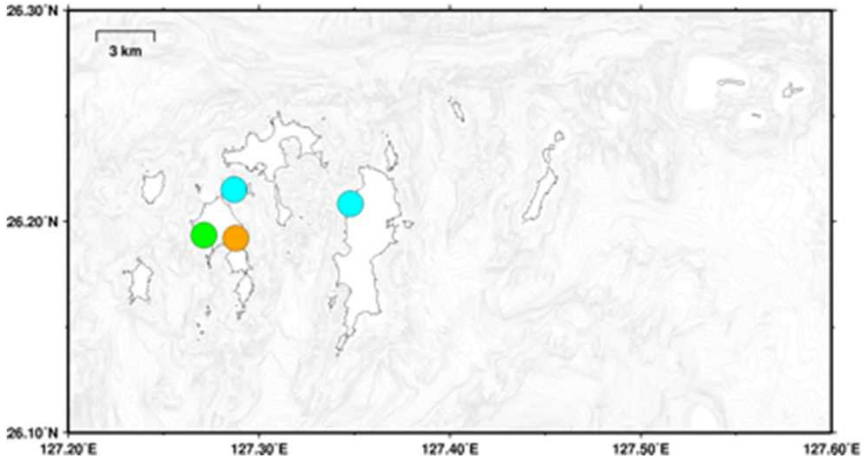
Identify the future coral ”micro-refugia” (areas with lower temperatures) to inform the management and conservation

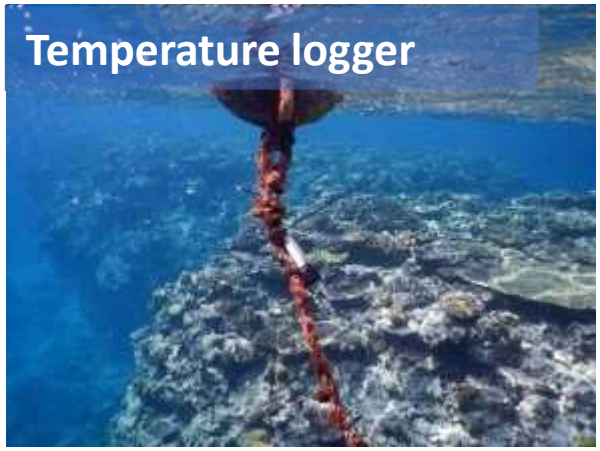
In-situ survey

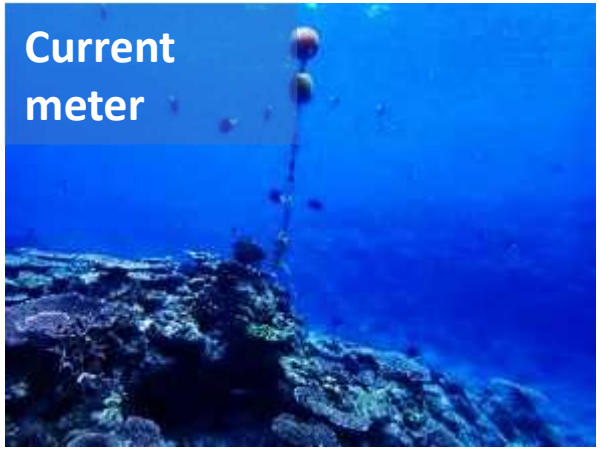
Water temperatures



Currents and water levels



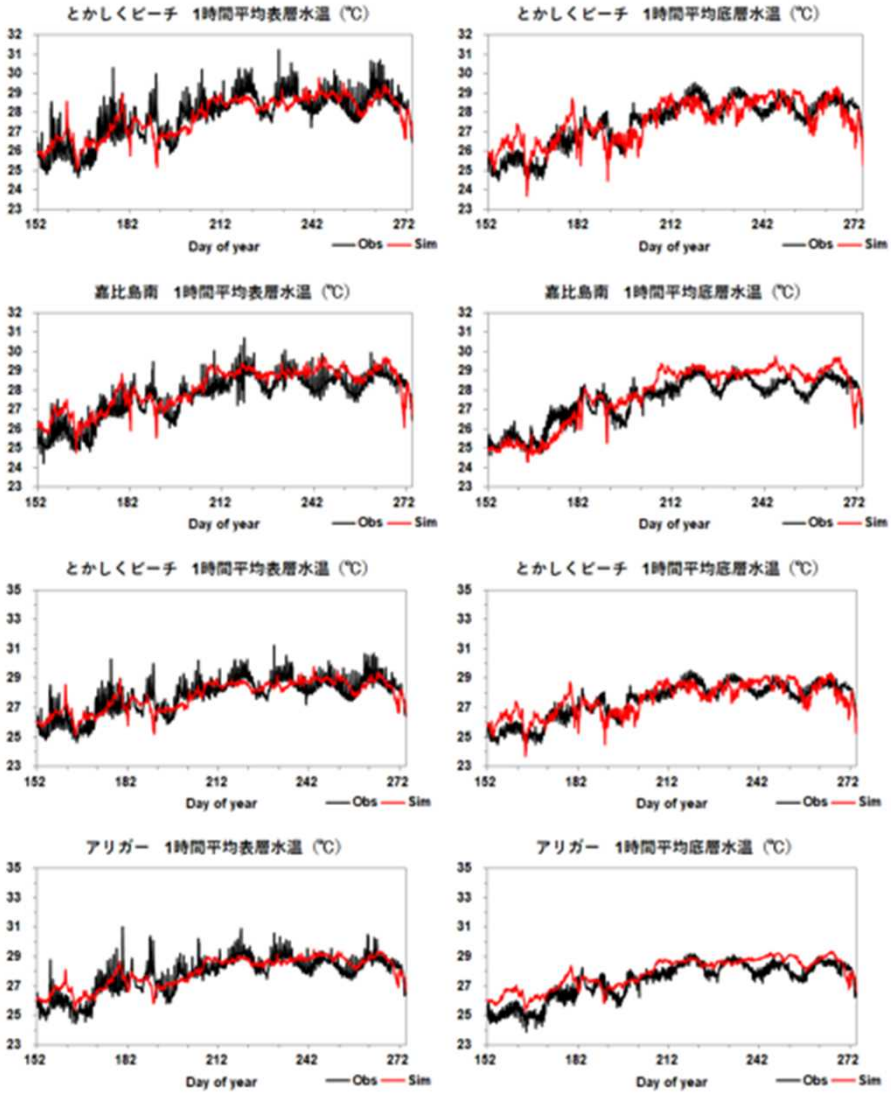




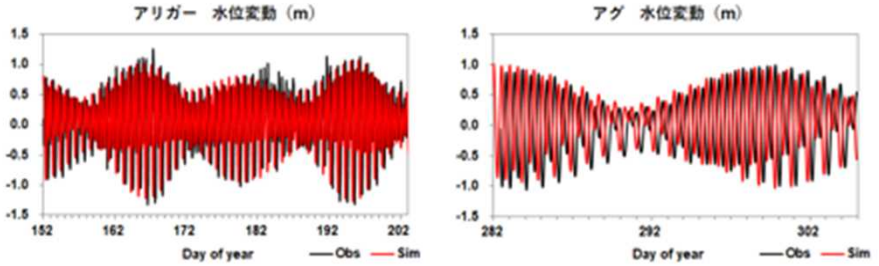
➡ **Validation of current velocity modeling**

Model validation

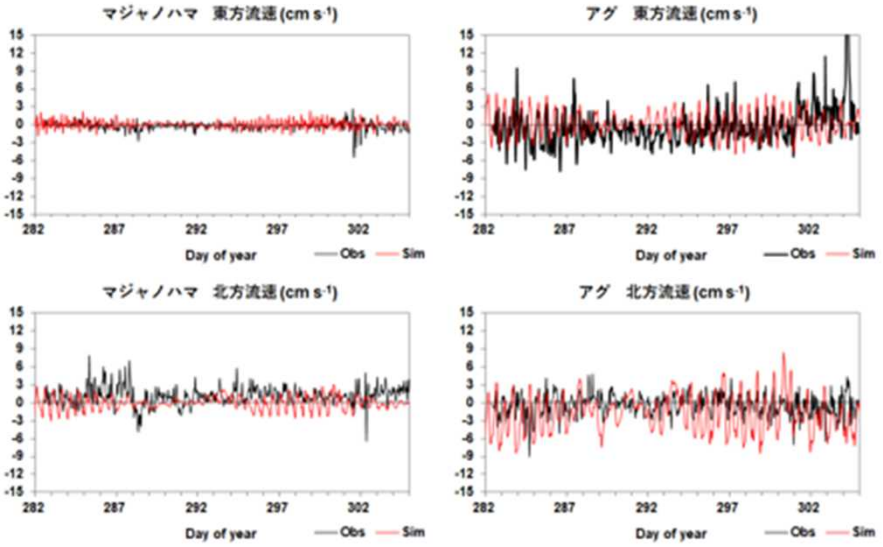
Water temperature



Water level

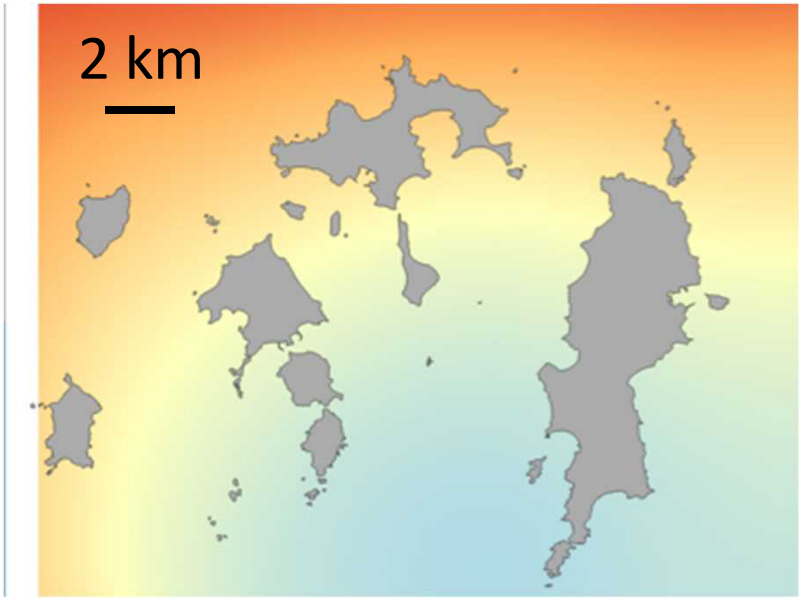


Current velocity



— Observed — Modeled

Downscaling based on modeling physical environment

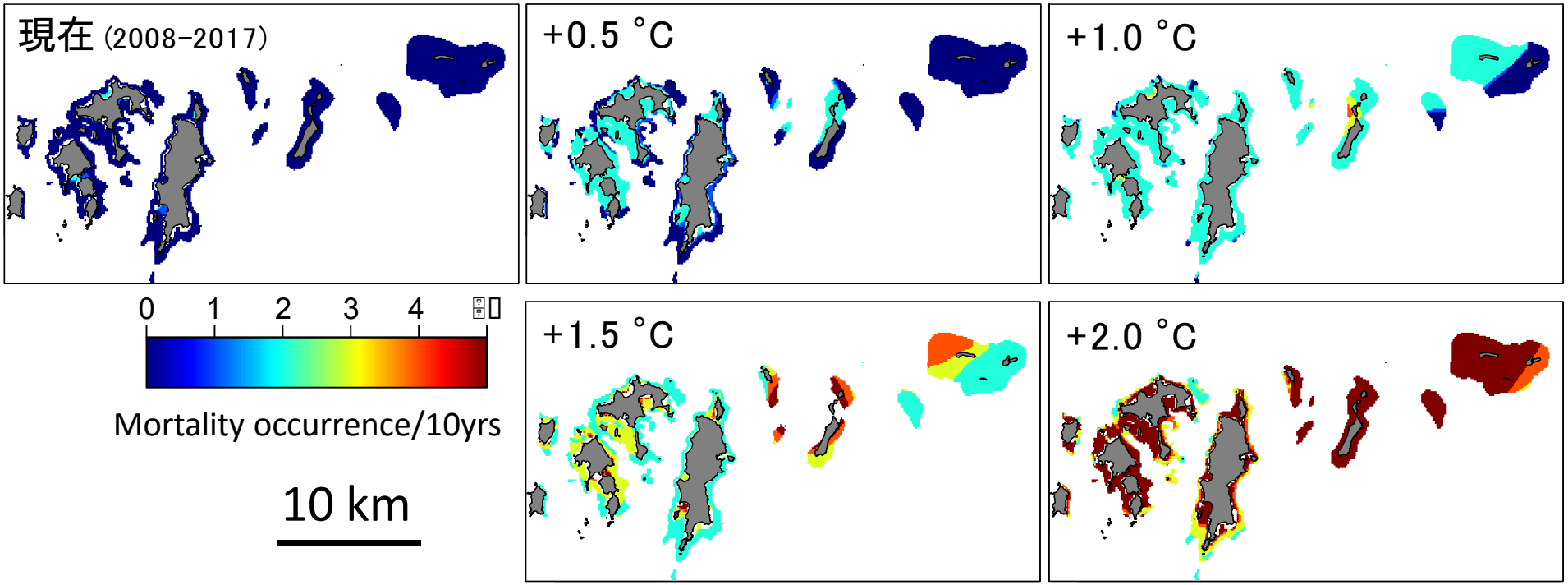


Original SST
(MUR-SST, 1 km resolution)

Downscaled SST
(100 m resolution)

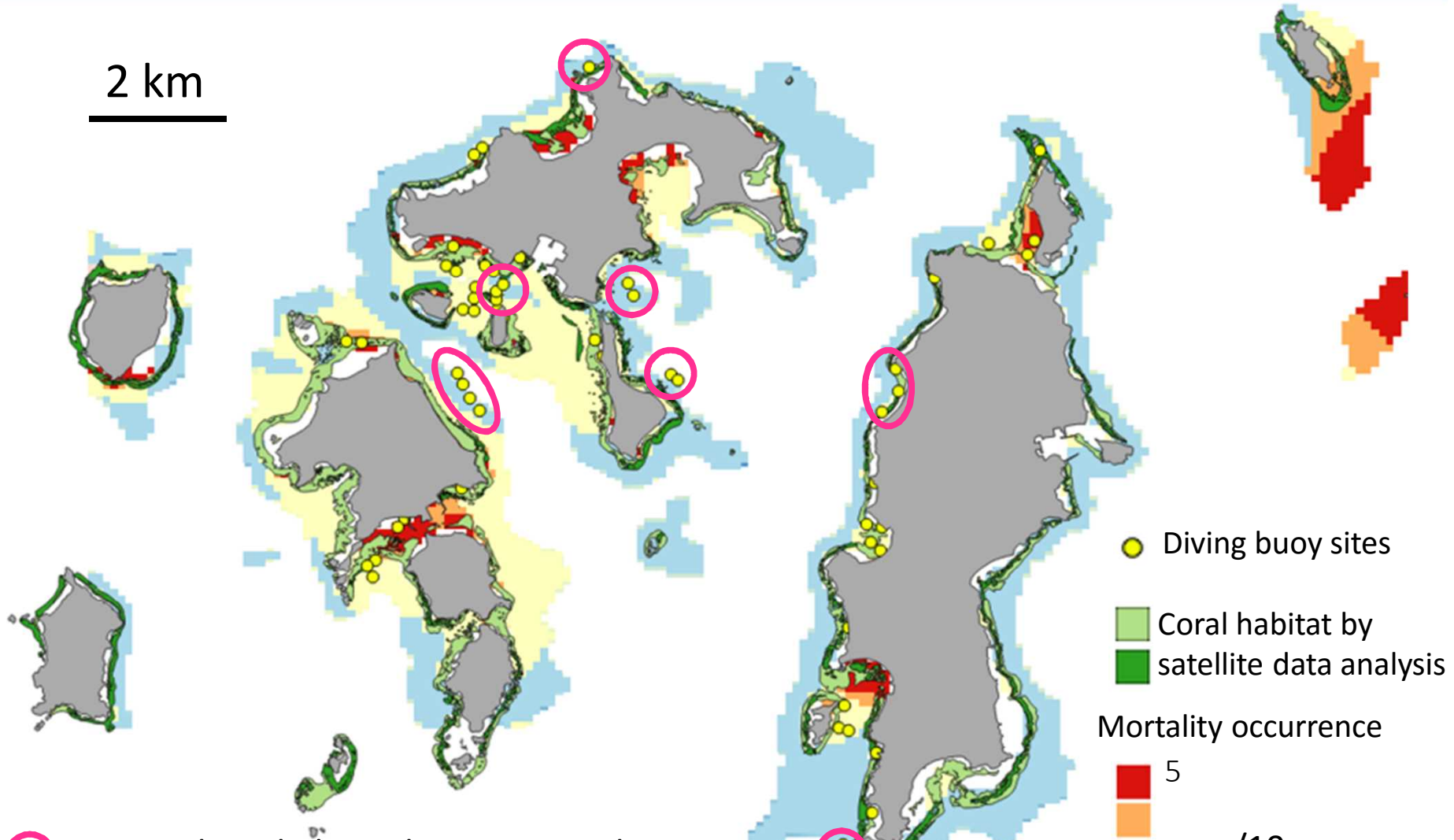
Future projection of coral bleaching and mortality

Present



Species distribution model was based on Kumagai et al. (2018) *PeerJ*

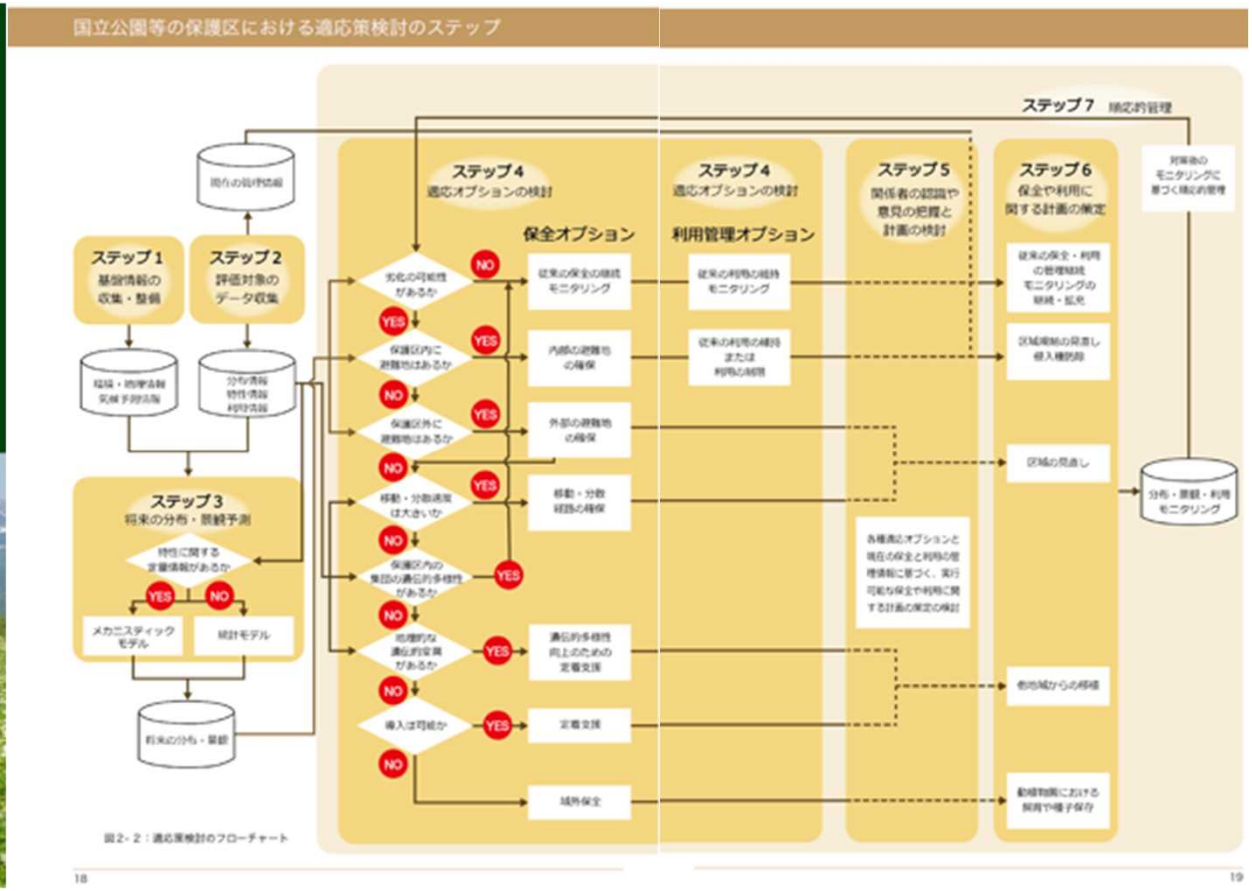
SST +1.5˚C



Areas where balance between coral conservation and use is needed and current conservation efforts (e.g., removal of coral-eating starfish) might be concentrated

Publication of a guide for climate change adaptation in protected areas (currently in Japanese only…)

Flowchart to set up conservation measures



Ministry of the Environment and National Institute for Environmental Studies (2019)

Concluding remarks

- Small islands in the tropical Pacific depend heavily on ecosystem services of coral reefs, including tourism, fisheries and island formation/maintenance
- Area-based conservation and management of coral reefs are essential for sustaining biodiversity and the ecosystem services for the Pacific islands under climate change
- Data obtained by in-situ monitoring network and earth observations would be of great help to MPA planning and management
- Results may directly contribute to Aichi Biodiversity Targets 10 and 11, and could further contribute to the Post-2020 by enhancing area-based conservation measures and ecosystem-based adaptation (EbA) to climate change

Acknowledgments

The works were conducted in collaboration with
Ministry of the Environment, Japan (Kerama),
Zamami and Tokashiki villages (Kerama),
citizen divers/snorkelers