



The 6th AOGEO Workshop, Macau, May 29 -31, 2023

Capacity building of Remote Sensing Monitoring for Marine and Coastal Ecosystems in PICTs

Presenter: Wenting Cao¹

Huaguo Zhang¹, Zhigang Wang², Tagaloa Cooper-Halo³



1. State Key Laboratory of Satellite Ocean Environment Dynamics, SIO, MNR, China



2. China Center for Resource Satellite
Data and Applications, CASC, China



3. The Secretariat of the Pacific
Regional Environment Programme

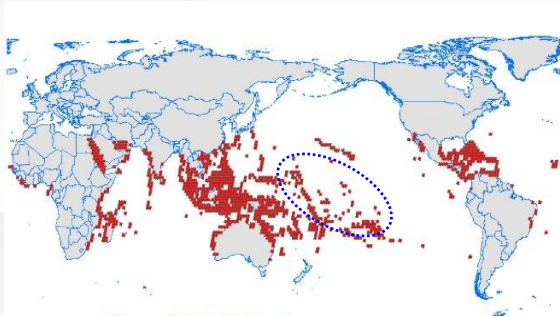
OUTLINE

- 1. Project overview**
- 2. Project progress and achievements**
- 3. Next steps**

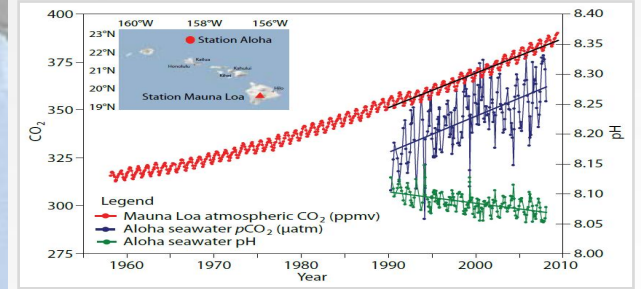
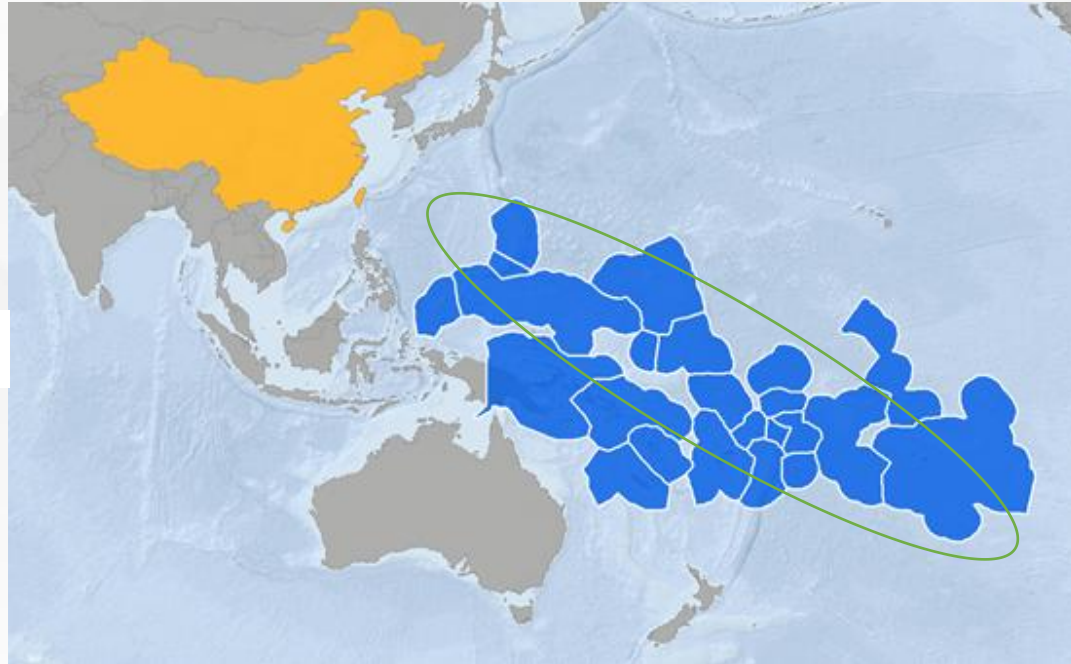


1. Pacific Island Countries and Territories (PICTs)

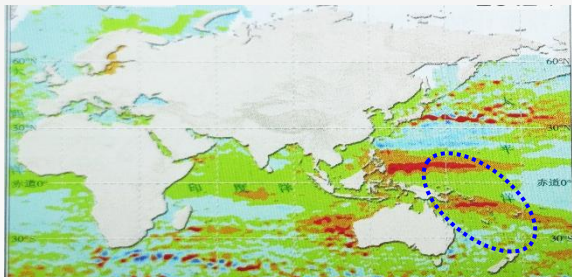




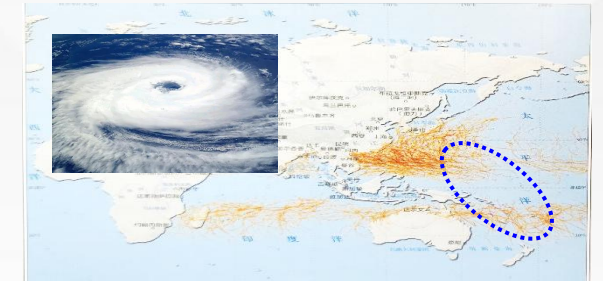
Coral reef distribution



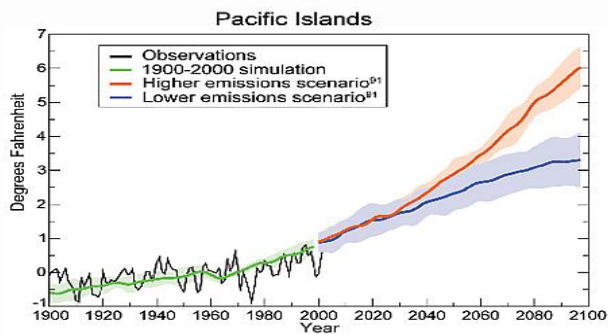
Marine acidification



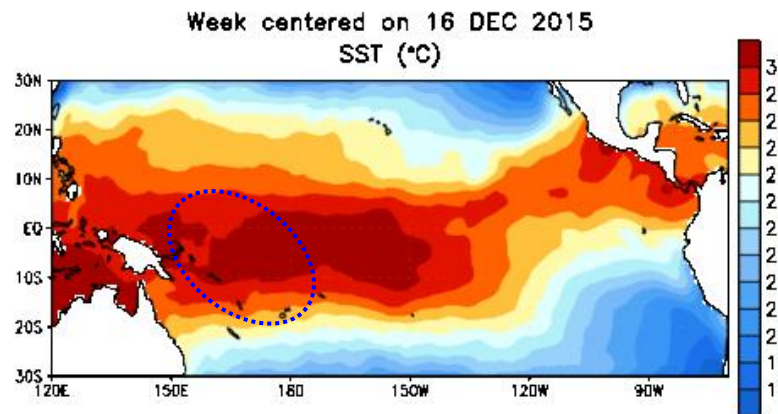
Sea level rising



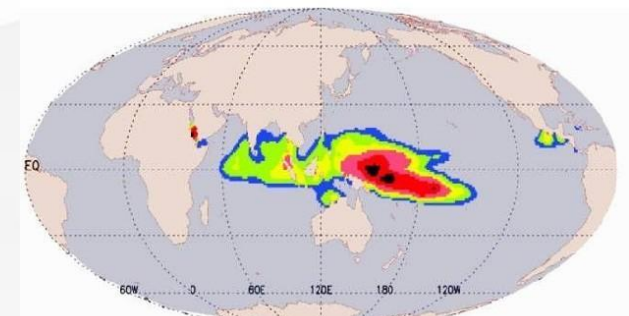
Cyclones



Global warming



ENSO



Indo-Pacific warm pool area

1. PICTs are vulnerable to environmental pressure and disasters



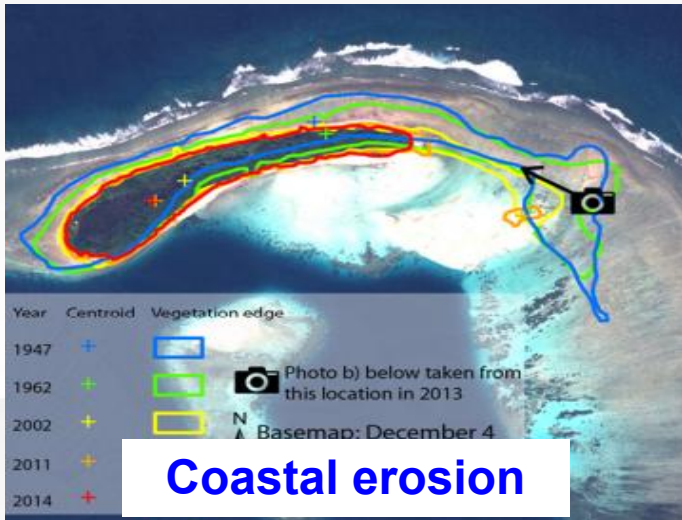
Coral reef bleaching



Deforestation



Water shortage



Coastal erosion



Flooding



Coastal destruction



1. PICTs is one of the AOGEO Integrated Priority Studies



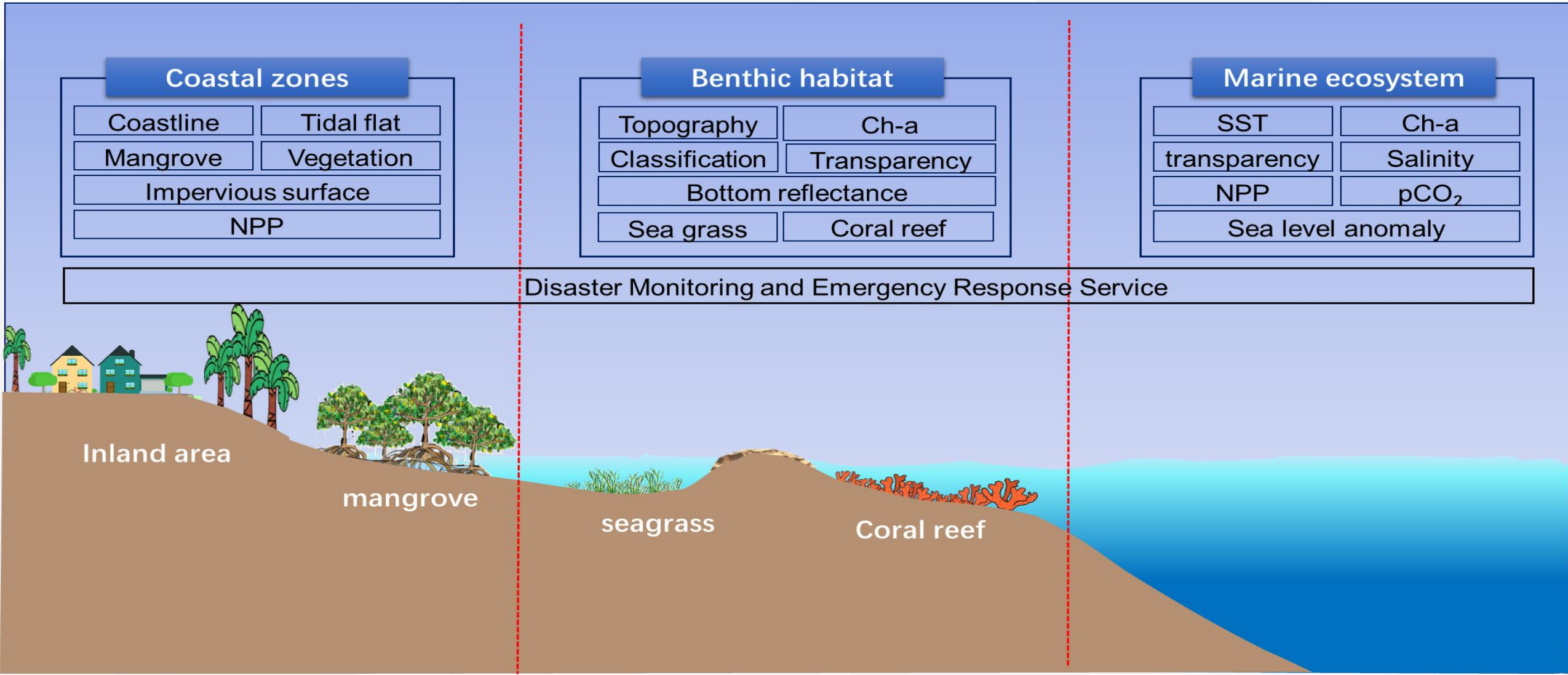
“**AOGEO Integrated Priority Studies: Himalayas, Mekong Basin and Pacific.....**”



China-GEO joint scientific research project supported by MOST
Capacity building on uses of satellite remote sensing for monitoring marine and coastal ecosystems in Pacific Island Countries

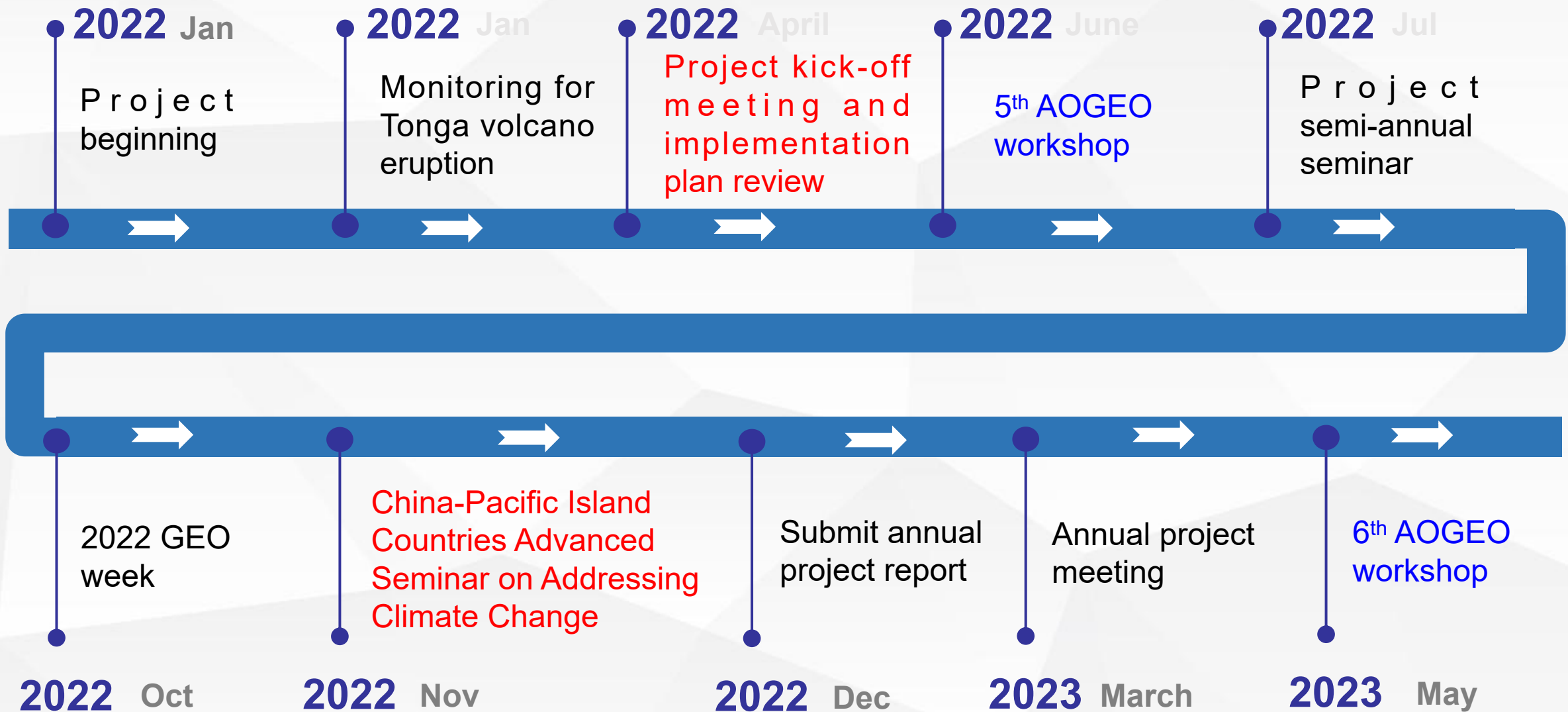
1. Overview of the project content

- ❑ A total of 20 ecological elements, and disaster monitoring in **coastal zones**, **benthic habitat**, and **marine ecosystems**.





2. Implementation progress of the project





2. Key project achievements



2.1 China's satellite collection

2.2 Marine environment changes

2.3 Benthic habitat mapping

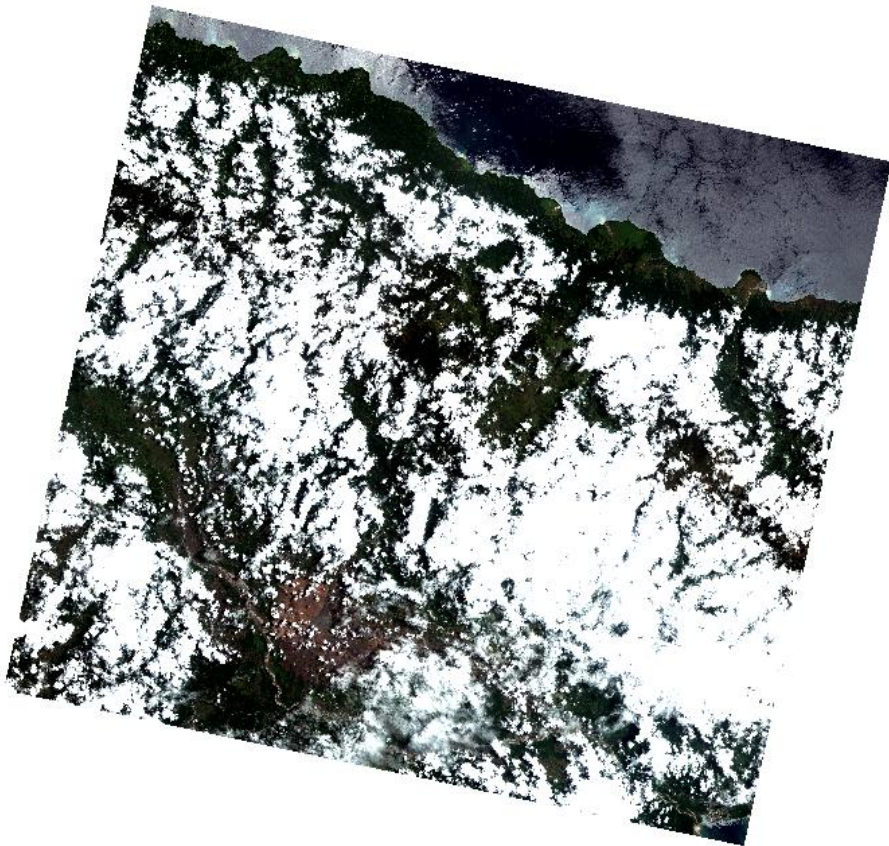
2.4 Human settlement changes

2.5 Coastline erosion detection

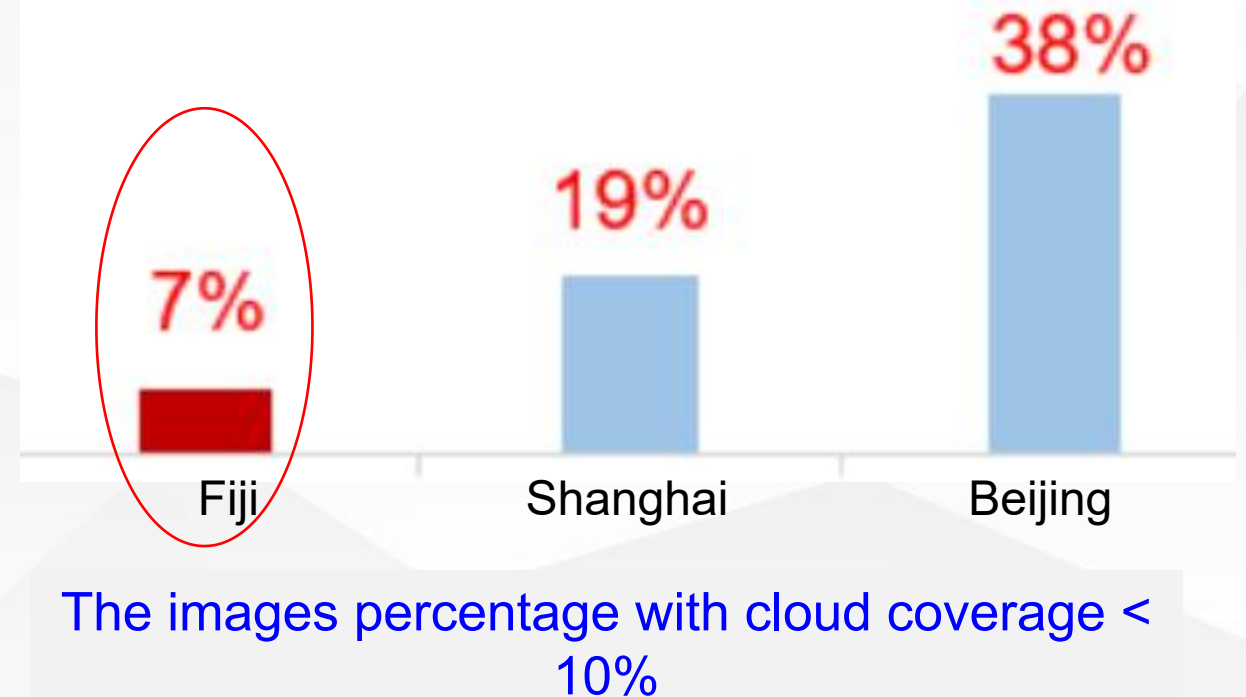
2.6 Disaster Monitoring and Emergency Response Service



Satellite images of the study area are **heavily affected by clouds**, so an important part of our project was to capture as many satellites as possible.



A cloudy satellite image in TBE





2.1 China's satellite collection



- By a large number of arrangement of China's satellite shots, more than 1,000 images with high-quality has been obtained covering more than half of the study areas.

Num	Remote sensing data acquisition task	Task status
1	5-30m satellite images of land in Pacific island countries	Arranged a total of 14 satellites, took 1,557 shots and obtained 14,882 images , 1,168 in high-quality
2	5-30m satellite images of typical ecological zones	Arranged a total of 14 satellites, took 213 shots and obtained 667 images, 316 in high-quality
3	1-10m satellite images of typical coastal erosion zones	Arranged a total of 9 satellites, took 217 shots and obtained 299 images, 243 in high-quality
4	1-10m satellite images of typical cities	Arranged a total of 9 satellites, took 170 shots and obtained 320 images, 211 in high-quality
5	4-10m satellite images of typical shallow benthic ecological zones	Arranged a total of 9 satellites, took 82 shots and obtained 230 images, 101 in high-quality
6	Disaster emergency monitoring services for Pacific island countries	Launched a total of 8 services, arranged 19 satellites, obtained 206 images, provided 6 reports



2.2 Marine environment changes



✓ Time-series variation analysis of marine ecological parameters

Parameters	Temporal span	Frequency	Spatial resolution	Satellites
SST	1998-2023	Monthly	5 km	HY-1, AVHRR, seaWiFS, MODIS, VIIRS
Chl-a			5 km	
NPP			9 km	
SDD			5 km	
pCO2			5 km	
SSS	2010-2023		1 degree	SMOS, SMAP, Aquarius
SLA	1993-2023	Annual	25 km	HY-2, CFOSAT, JASON, ENVISAT, TOPEX/POSEIDON

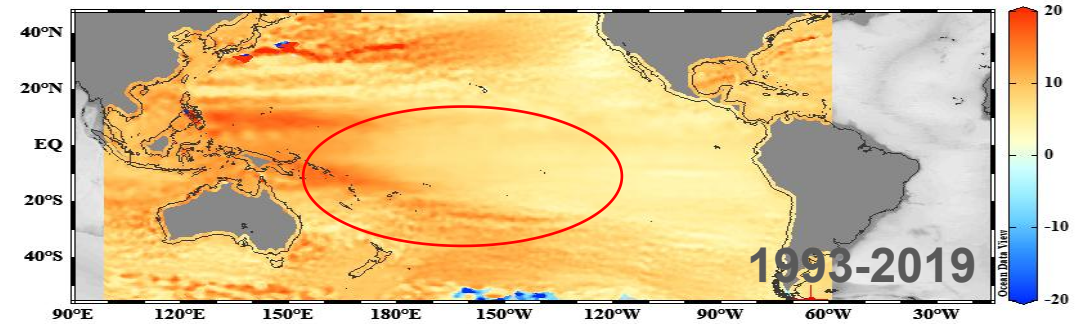


- **Sea level rise** and **SST warming** commonly exist in the surrounding waters of Pacific island countries.

- Significant spatial variation in **sea surface salinity**: opposite trends in East and West Pacific.

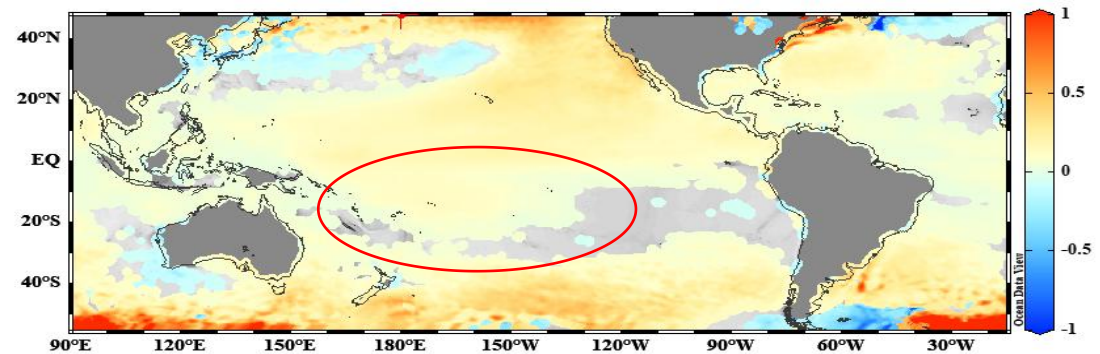
SLA (sea level anomaly)

Rate_Relative @ Dummy=first



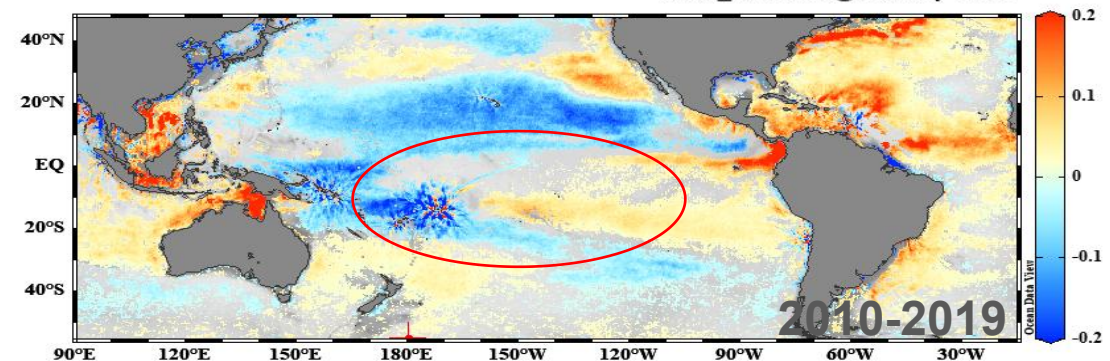
SST (sea surface temperature)

Rate_Relative @ Dummy=first



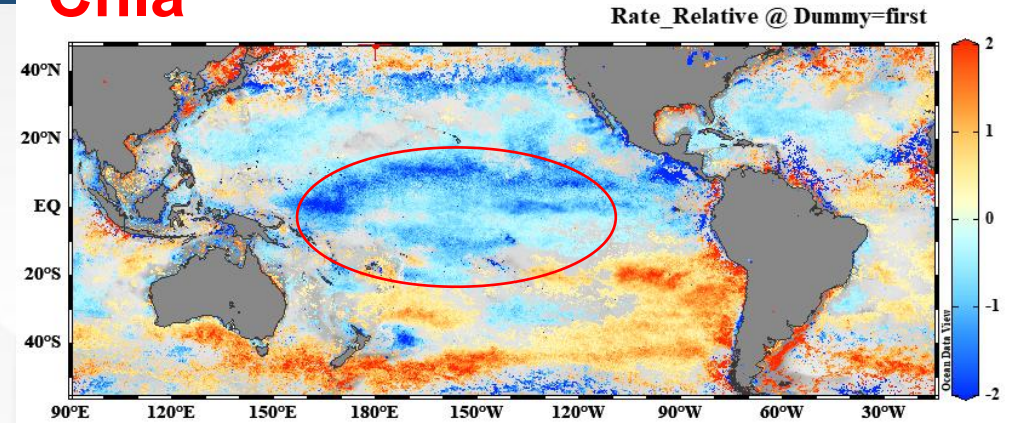
SSS (sea surface salinity)

Rate_Relative @ Dummy=first

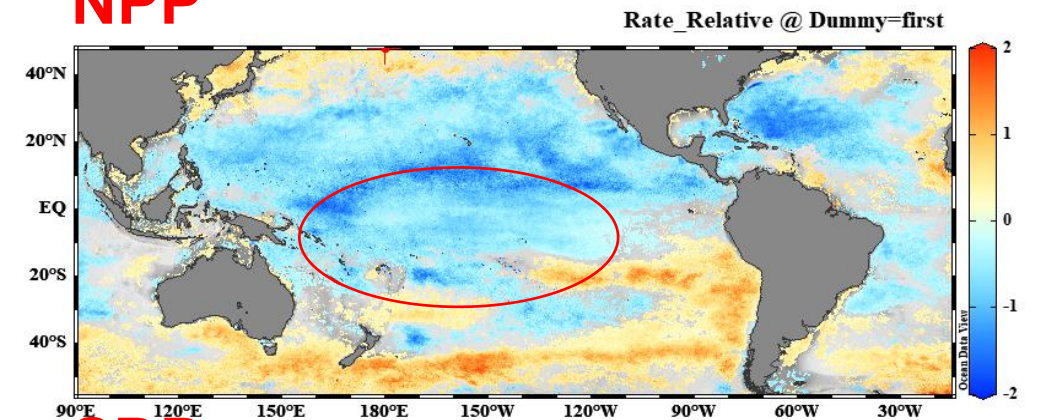


- ❑ North of the equator: *Chla* and *NPP* decreased significantly.
- ❑ South of the equator
 - ❑ *Chla*, and *NPP* **increases** along the Tonga-New Zealand direction;
 - ❑ *Chla*, and *NPP* **decreases** along the Papua New Guinea-Tuvalu direction.

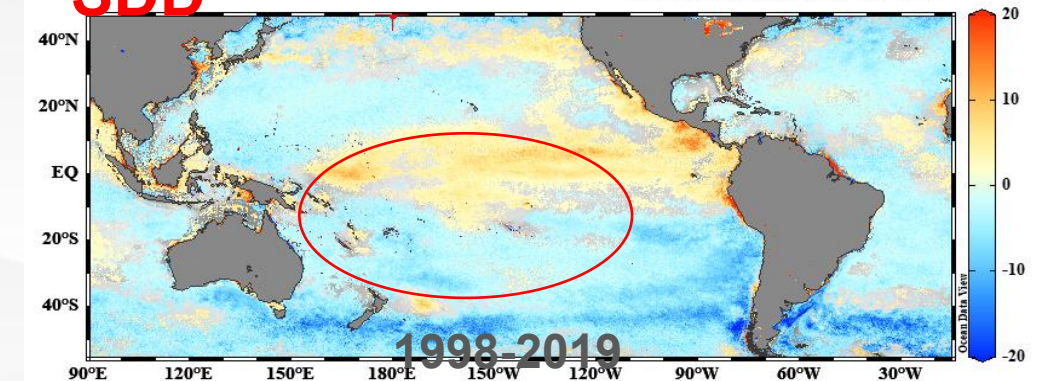
Chla



NPP



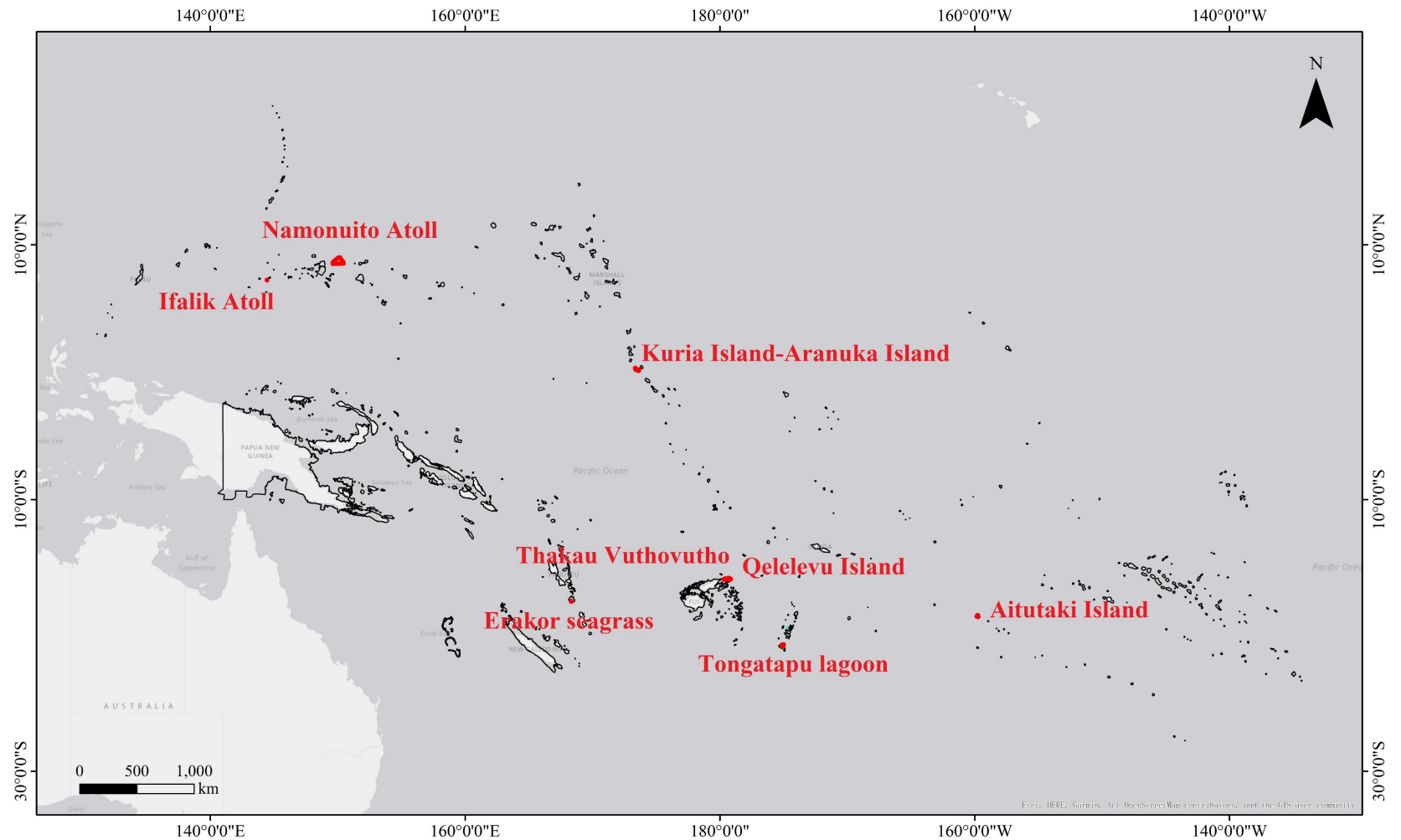
SDD

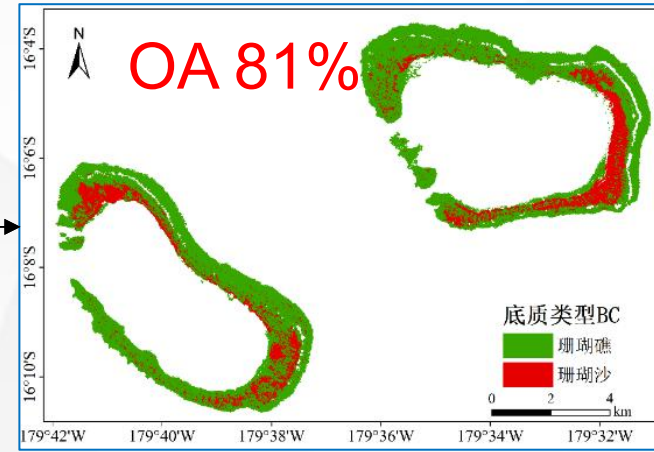
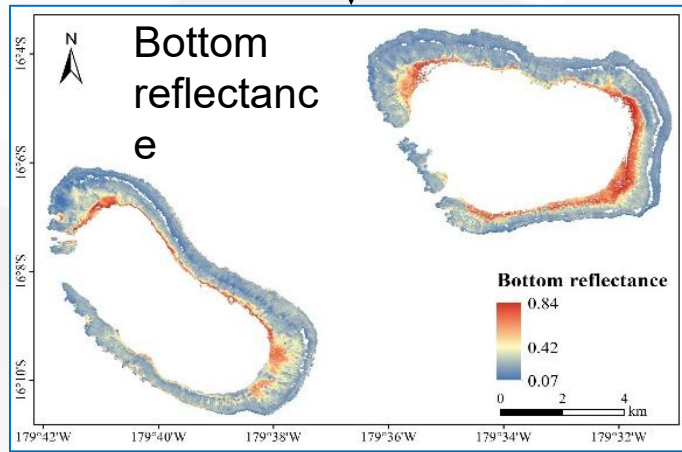
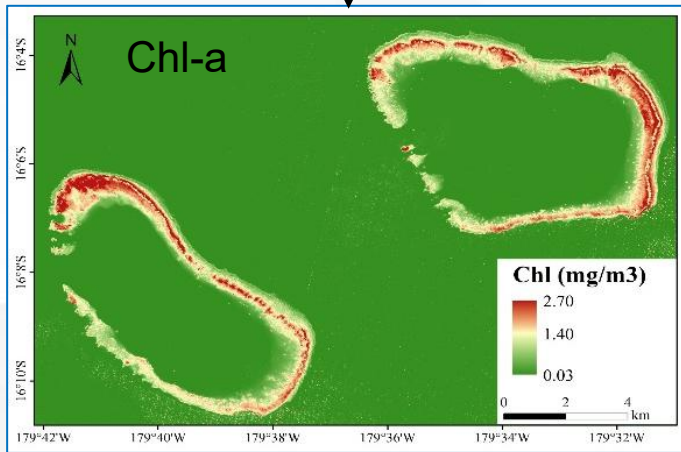
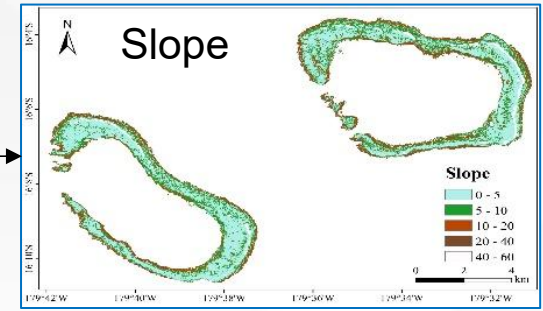
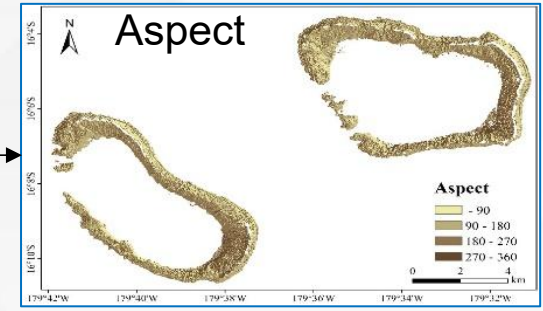
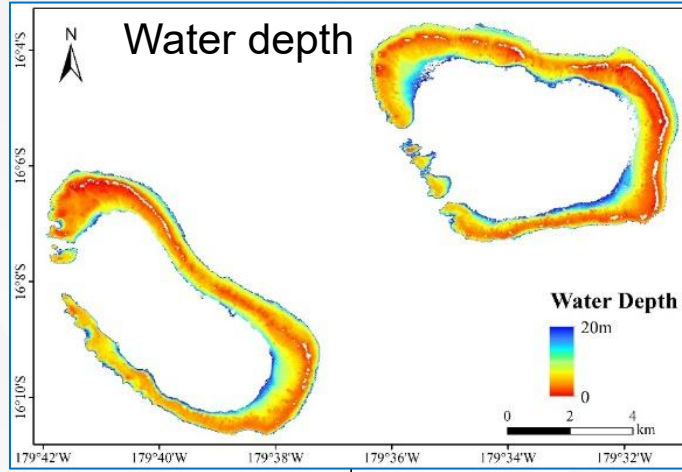
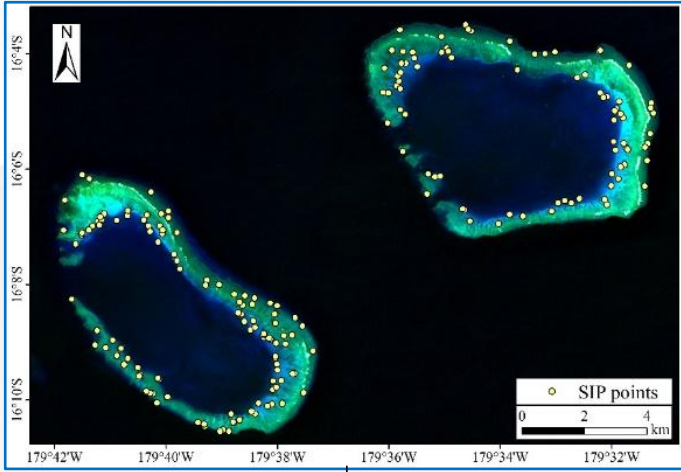




□ The benthic habitat elements including *bottom reflectance*, *chlorophyll concentration*, and coral reef distribution have been quantitatively assessed by remote sensing.

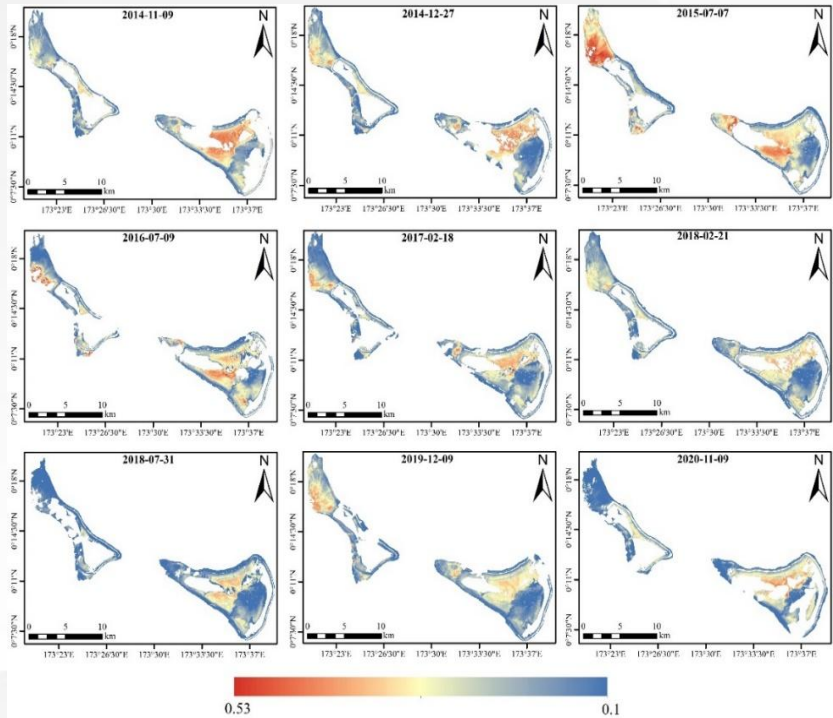
□ 8 typical regions across the Pacific island countries



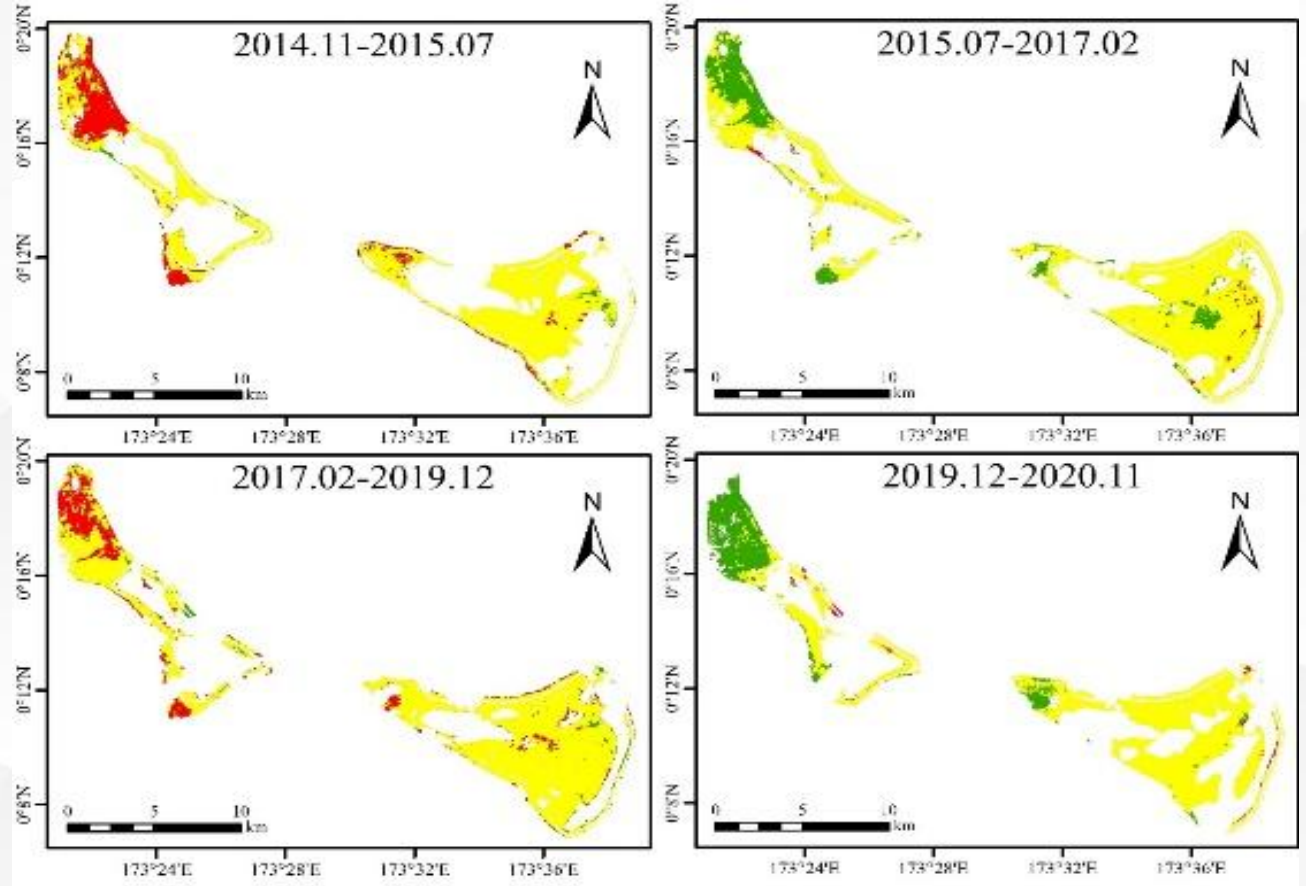


We used the time series of bottom reflectance to identify the spatial-temporal pattern of coral reef bleaching and recovery.

Kuria Island-Alanuka Atoll in Kiribati



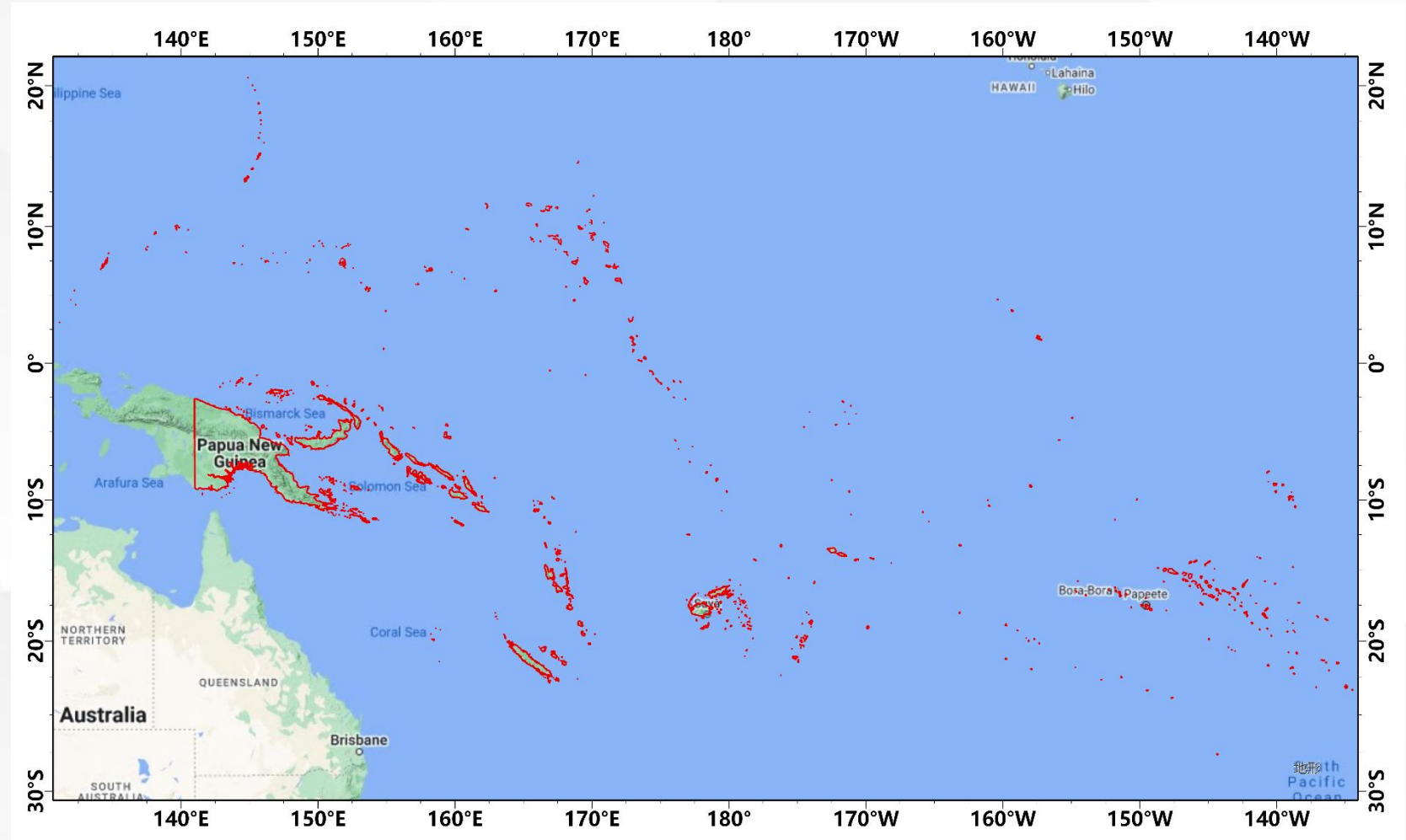
bottom reflectance



■ bleaching
 ■ no-change
 ■ recovery

We develop a coastline erosion detection method for the study area, and obtain the coastline erosion dynamics in the past 20 years.

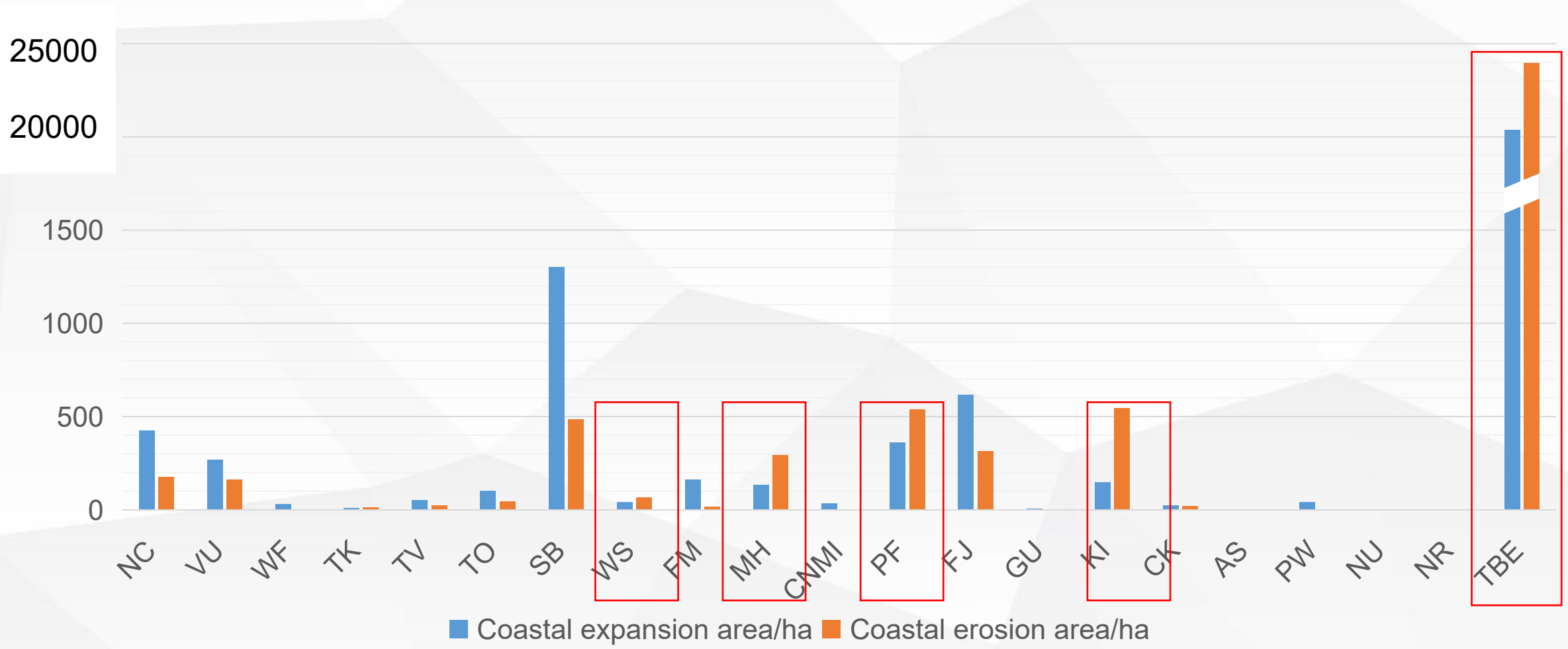
- 14 countries and 7 territories
- The years of 2000, 2010, 2015, and 2020



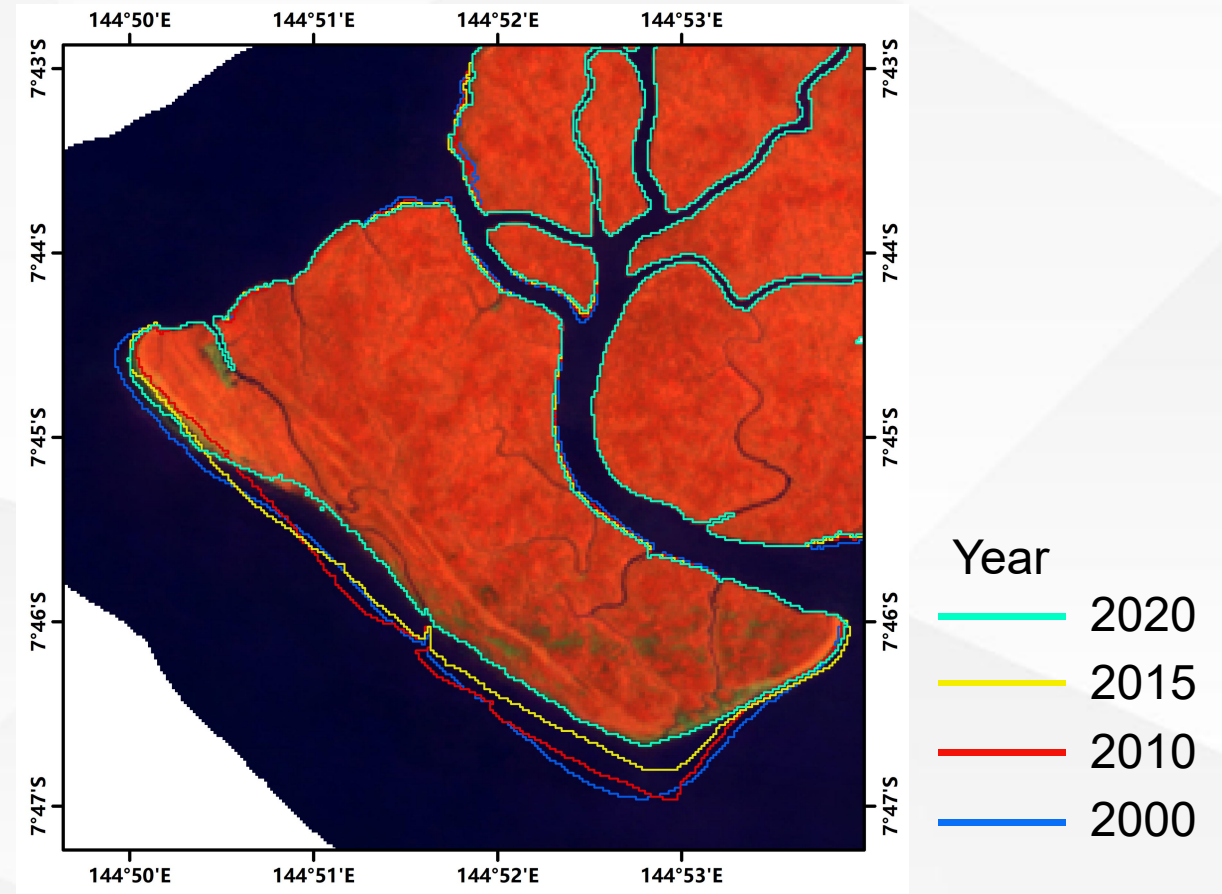
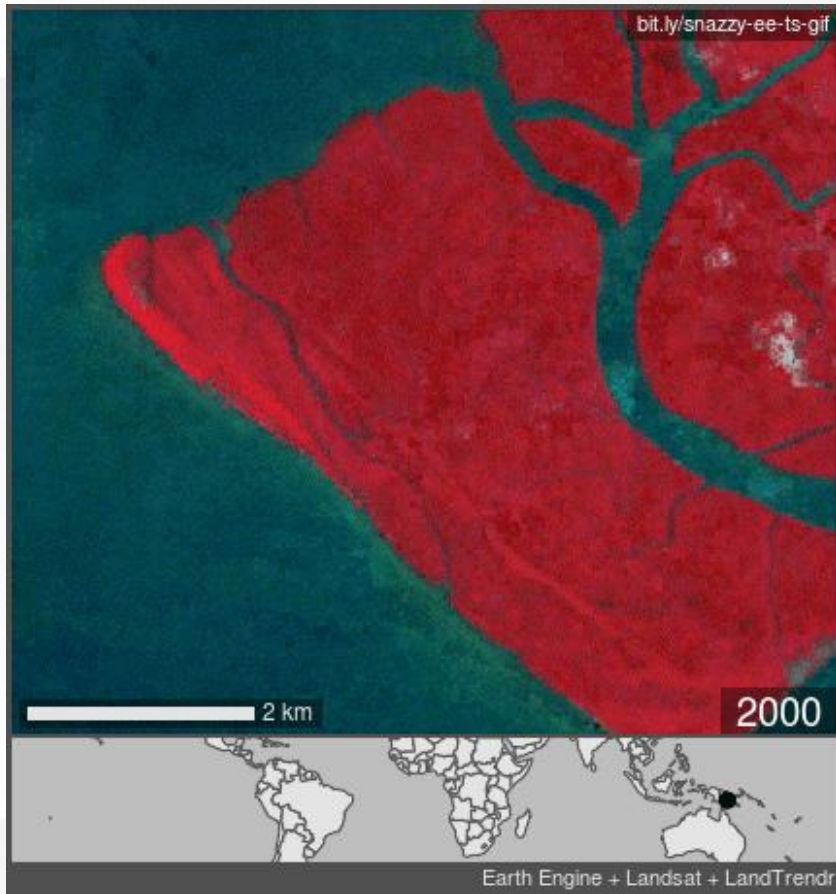
2.4 Overview of coastline erosion



Samoa, Marshall Islands, French Polynesia, Kiribati, and Papua New Guinea are at risk of coastal erosion.



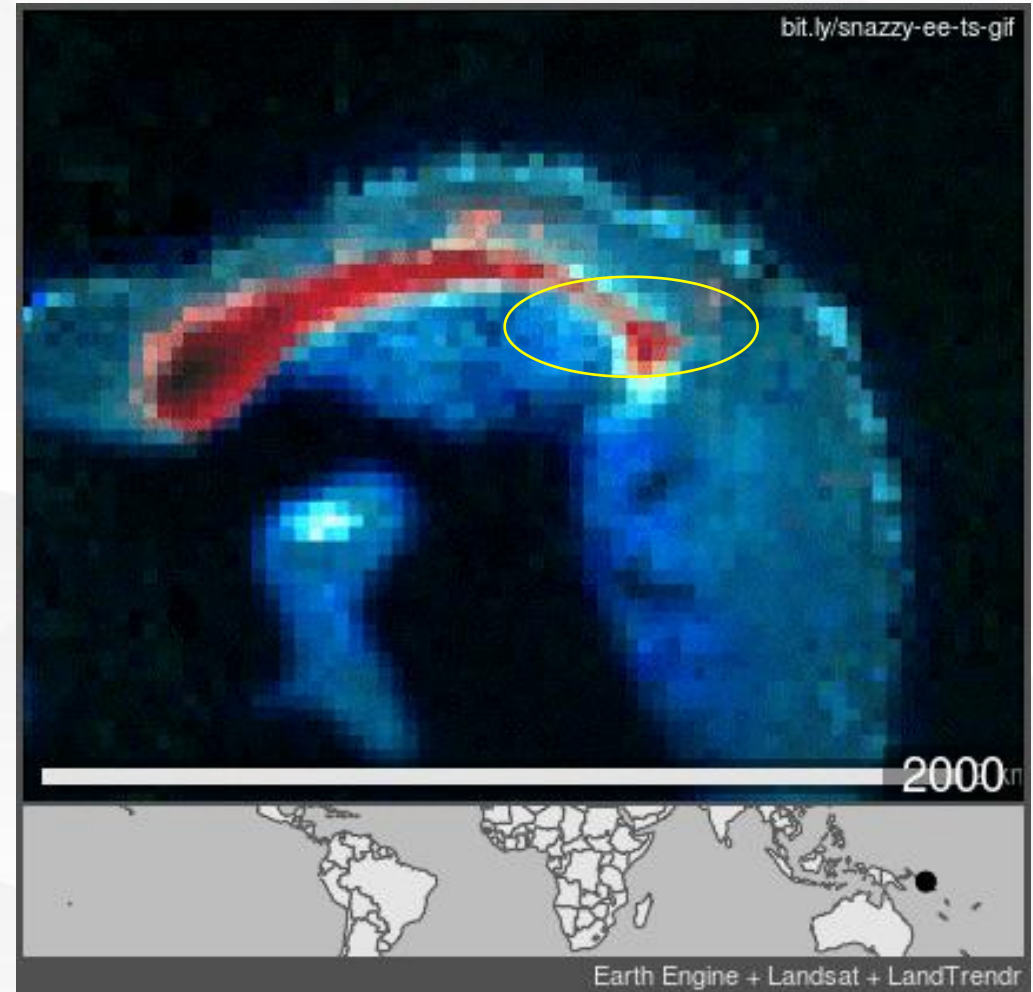
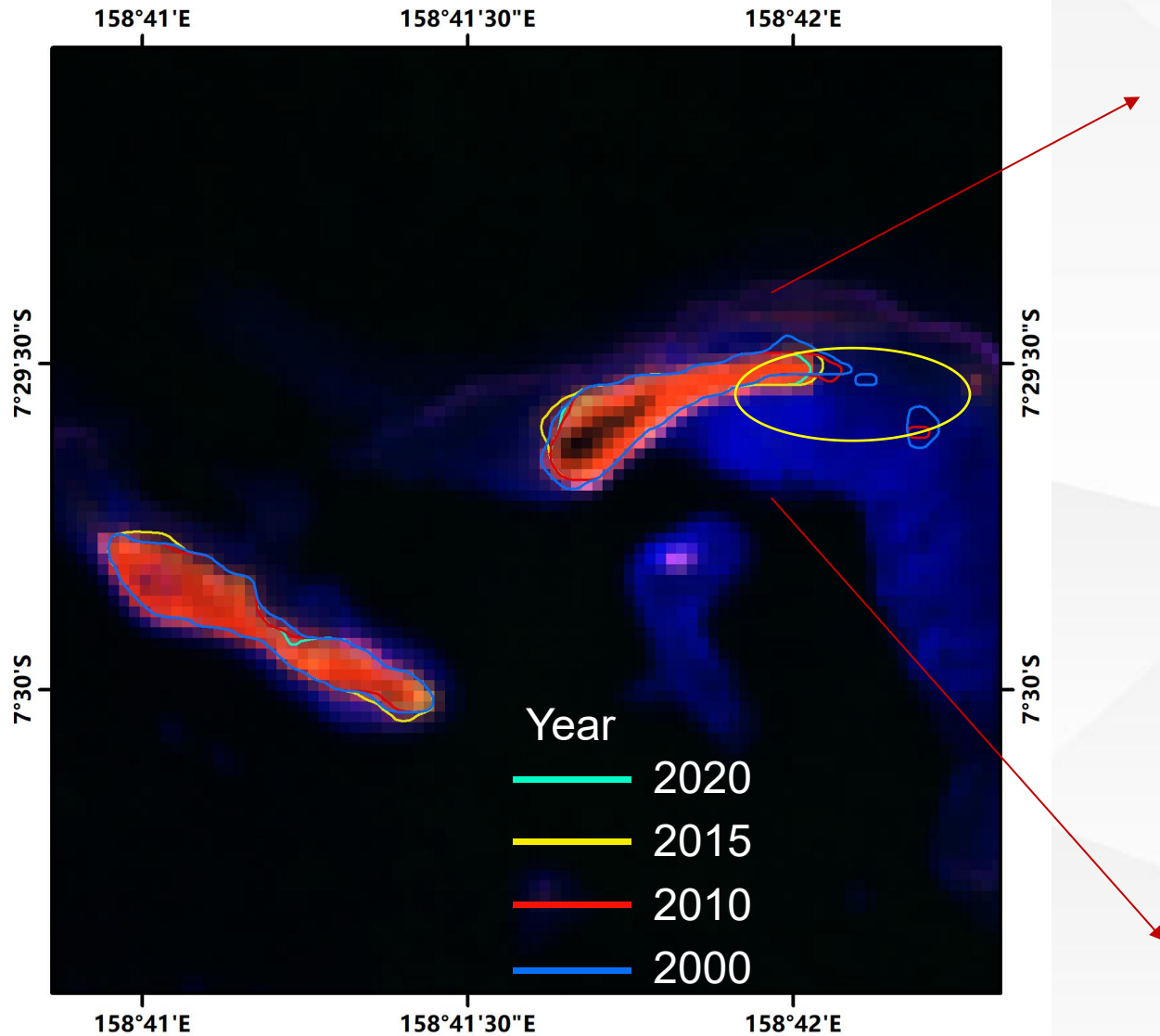
The Independent State of Papua New Guinea



Mangrove coast changes



Solomon islands



Republic of Vanuatu

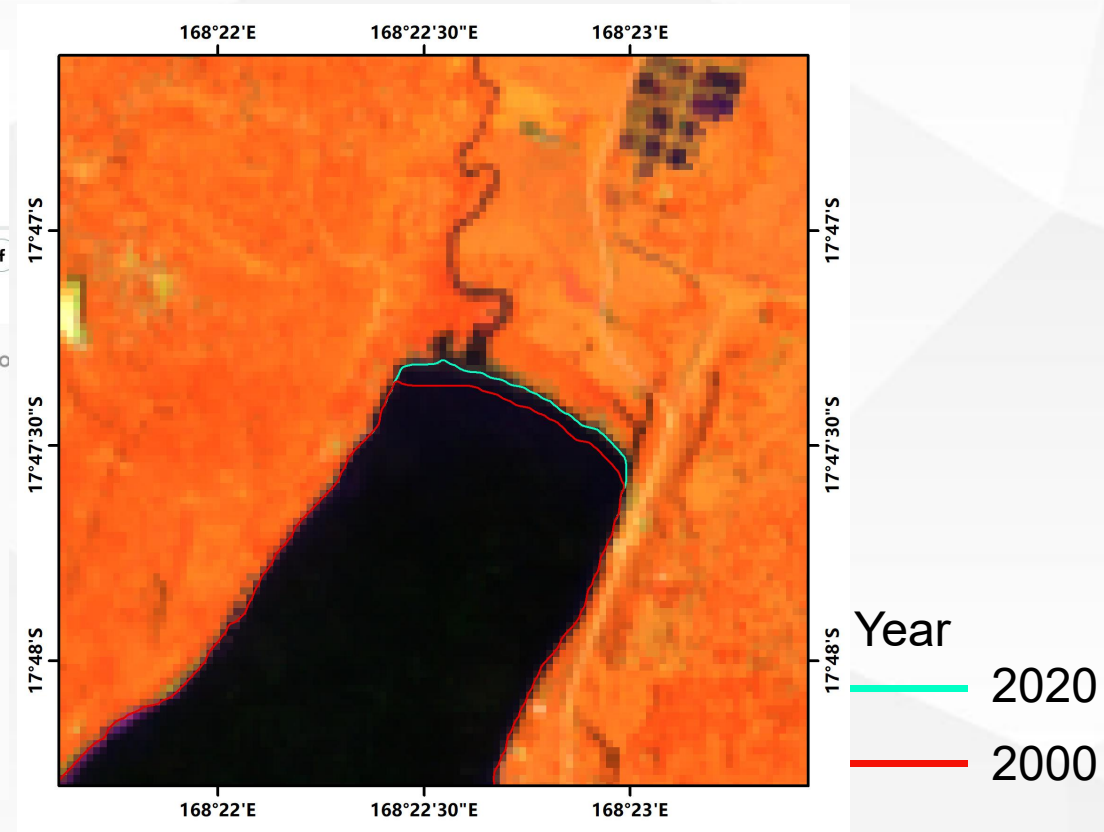
HOME > SCIENCE

The Pacific Islands are drowning under rising sea levels. These stunning photos show their precarious way of life.

James Pasley Jan 28, 2020, 11:55 PM



Young villagers play in the Pacific Ocean in the village of Waisisi on December 3, 2019 in Tanna, Vanuatu. Mario Tama / Getty



2.5 Human settlement changes



- We used the impervious surface as the indicators of human settlement, and mapped its changes for all pacific islands during 2000-2020.

Lae



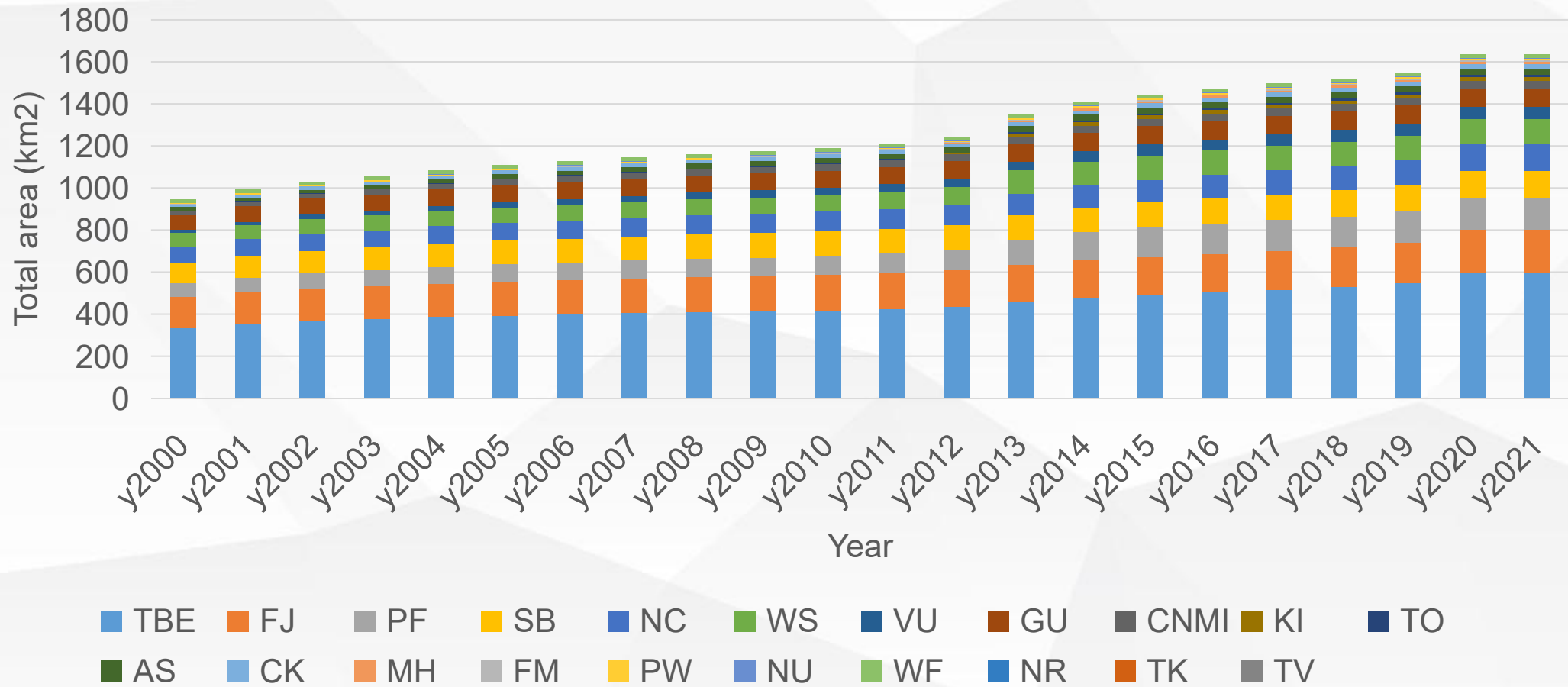
Port-Vila



2.5 Human settlement changes

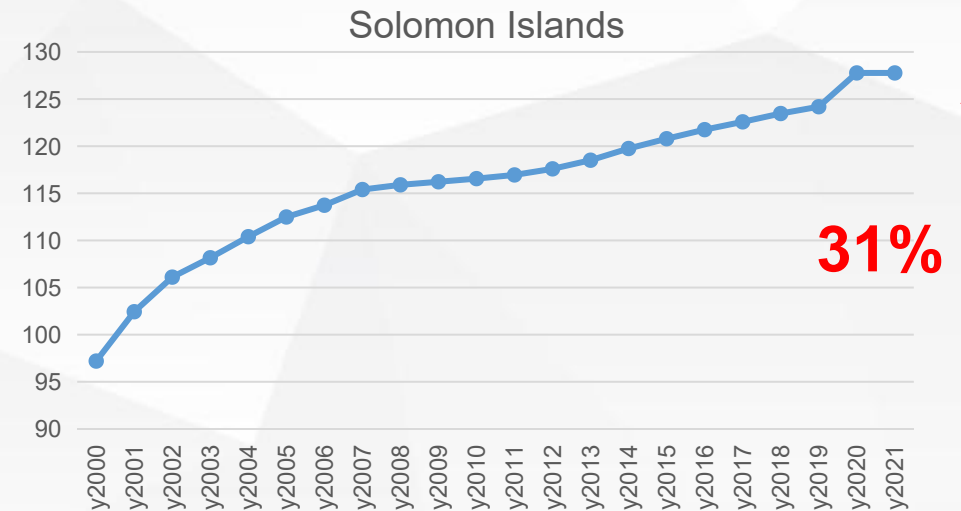
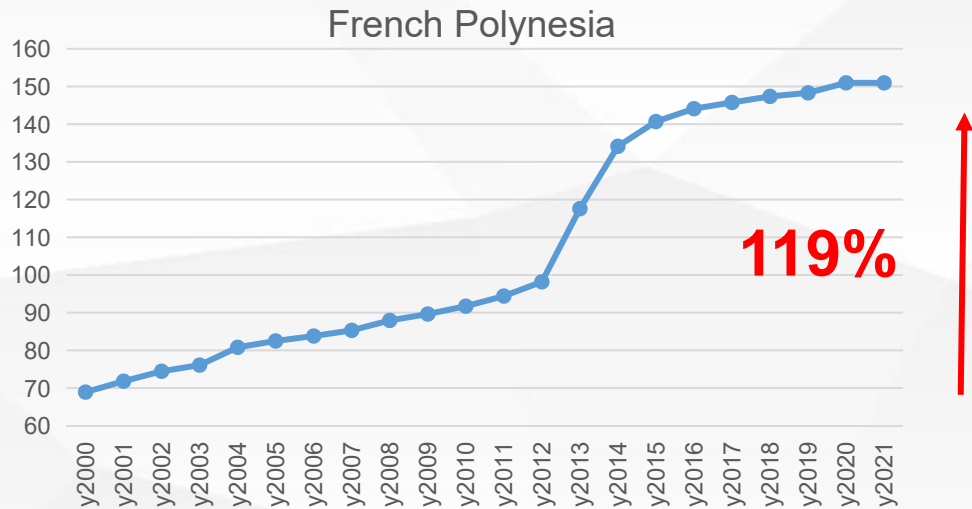
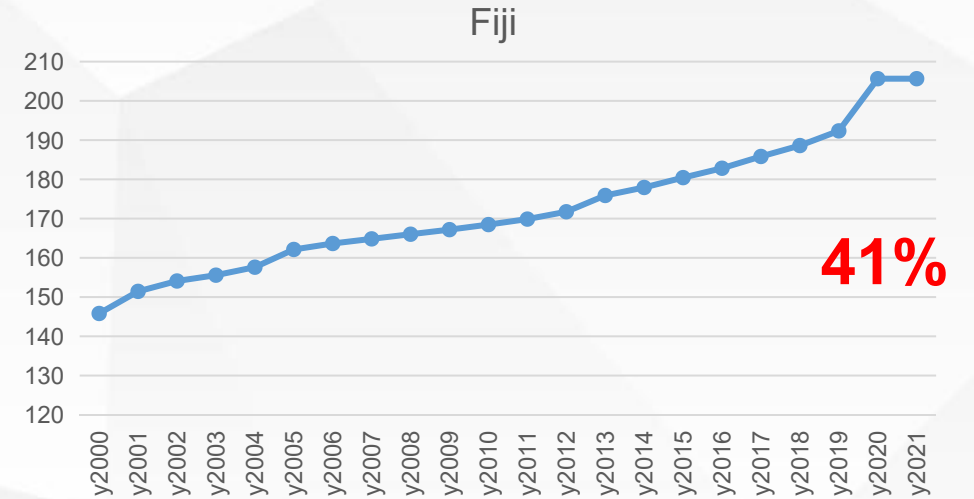
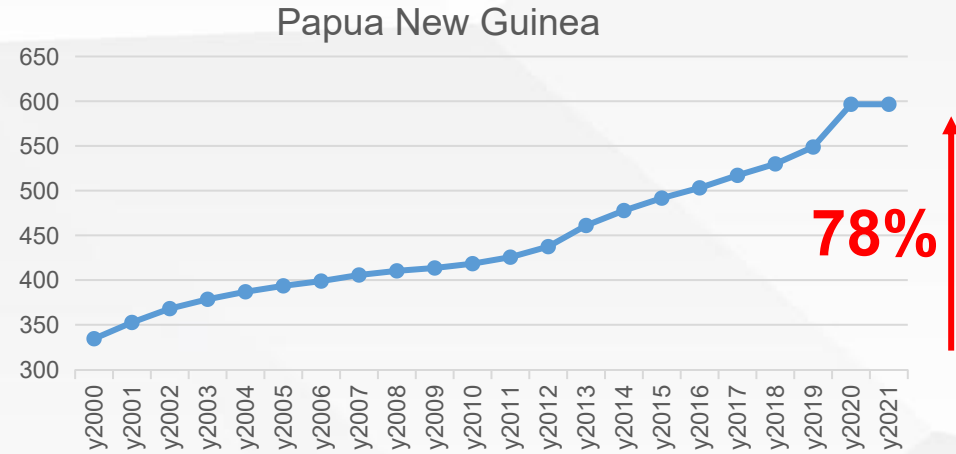


- Papua New Guinea, Fiji, French Polynesia, and Solomon Islands account for more than 50% of the total impervious surface area.



Annual statistics of impervious surface area for all PICTs

Top 4 countries have the largest ISA amount as well as increasement.





2.6 Disaster Monitoring and Emergency Response Service



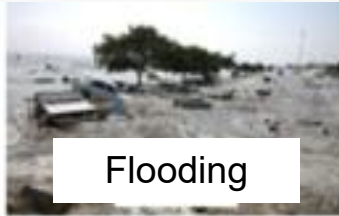
Disasters



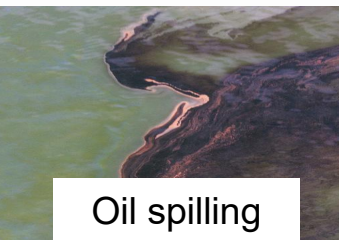
Landslide



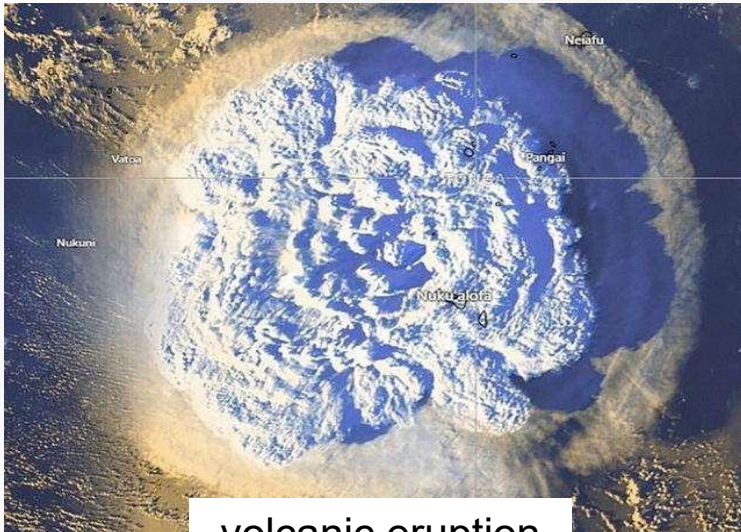
Earthquake



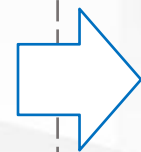
Flooding



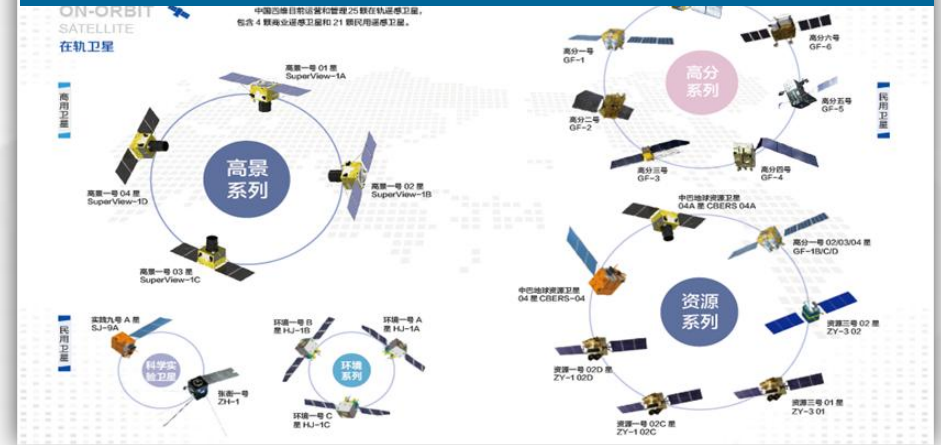
Oil spilling



volcanic eruption



China's satellite data



Monitoring service



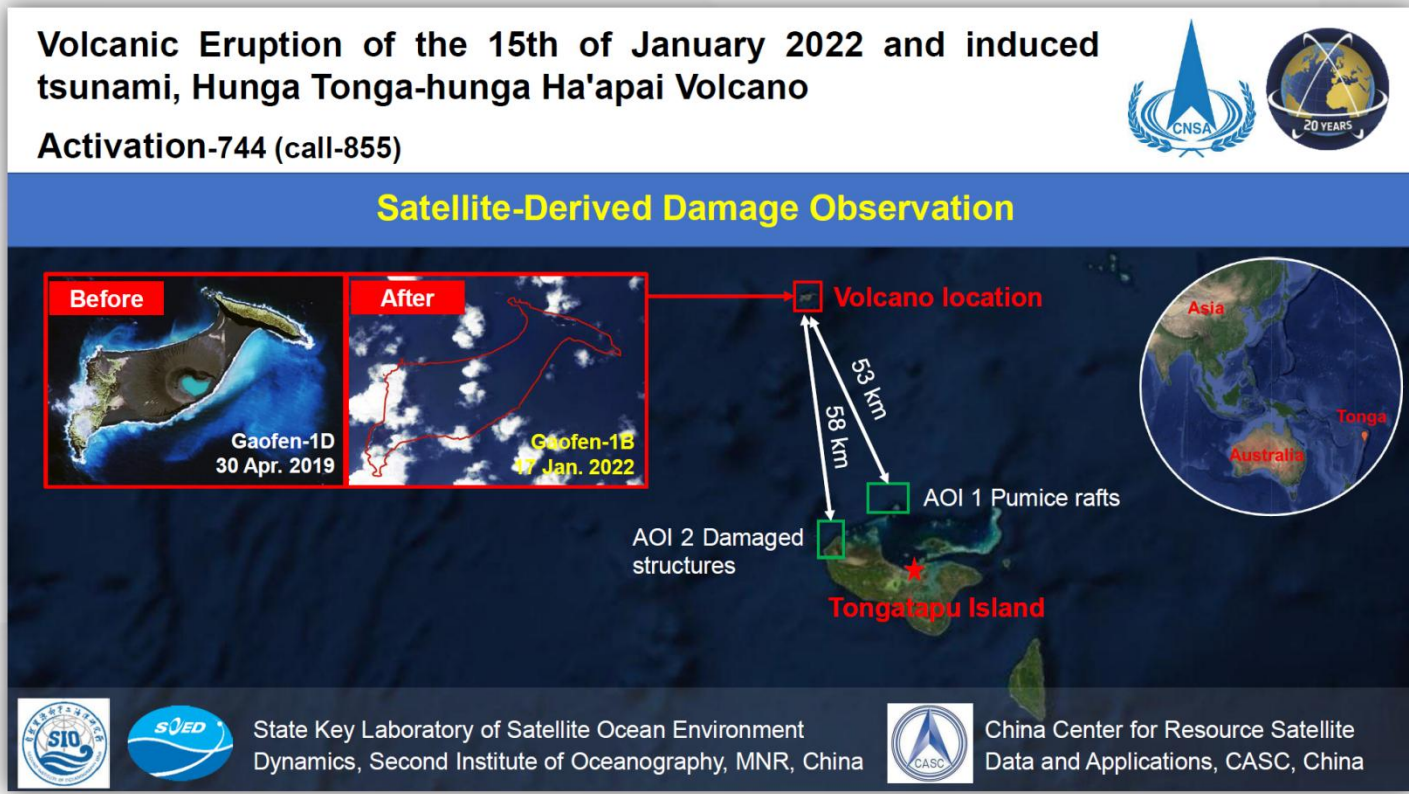


Disaster Monitoring and Emergency Response Service Events



NO.	Disaster	Disaster area	Occurred time (UTC+8)	Response time (UTC+8)	Remote sensing images	report
1	volcanic eruption	Tonga	2022.Jan.15 12: 20	2022.Jan.15 11: 42	84	Yes
2	typhoon	Vanuatu	2022.May 19	2022.May 19 9: 45	23	Yes
3	earthquake	Papua New Guinea	2022.Sep.11 7: 46	2022.Sep.11 10: 56	20	Yes
4	earthquake	Solomon Islands	2022.Nov.22 10: 03	2022.Nov.22 13: 49	4	No
5	earthquake	Vanuatu	2023.Jan.8 8: 32	2023.Jan.9 11: 38	5	No
6	typhoon	Solomon Islands / Vanuatu	2023.Feb.27	2023.Feb.27 16: 21	23	Yes
7	typhoon	Vanuatu	2023.Mar.2	2023.Mar.2 11: 16	13	Yes
8	earthquake	New Caledonia	2023.May 19 13: 57	2023.May 19 18: 58	34	No

We have generated 3 post-event assessment reports using high-resolution satellites including **Gaofen**, **HJ**, and **Jilin** for the Tonga volcanic eruption.



Volcanic Eruption of the 15th of January 2022
Activation-744 (call-855)



The impact of Tonga volcanic eruption on the vegetation of the surrounding islands

Key messages:

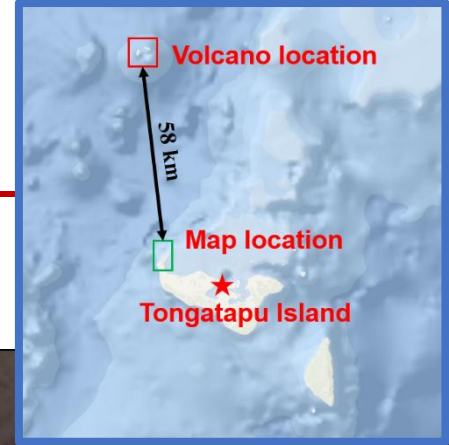
- The vegetation is covered by a large amount of volcanic ash and the NDVI values are almost smaller than 0 on the islands within 138km of the volcano eruption.
- The vegetation is almost unaffected by the volcanic ash and the NDVI values are greater than 0.1 on the islands more than 138 km away from the volcanic eruption location.

Satellite Image: PlanetScope, Resolution: 3m, Copyright: @ Planet Labs.



Volcanic ash covers the vegetations and structures.

Significant **tsunami damages** are observed on the northeast coast of the Tongatapu Island.



Gaofen-1B / 30 May 2019



Jilin-1 / 17 Jan. 2022

Event 2: The impact of Tropical Cyclone Judy on Solomon's Tikopia


Feb. 27-Mar. 7, 2023

Activation-806 (Call-928)



Satellite-Derived Damage Observation



AOI-1


Cyclone Judy



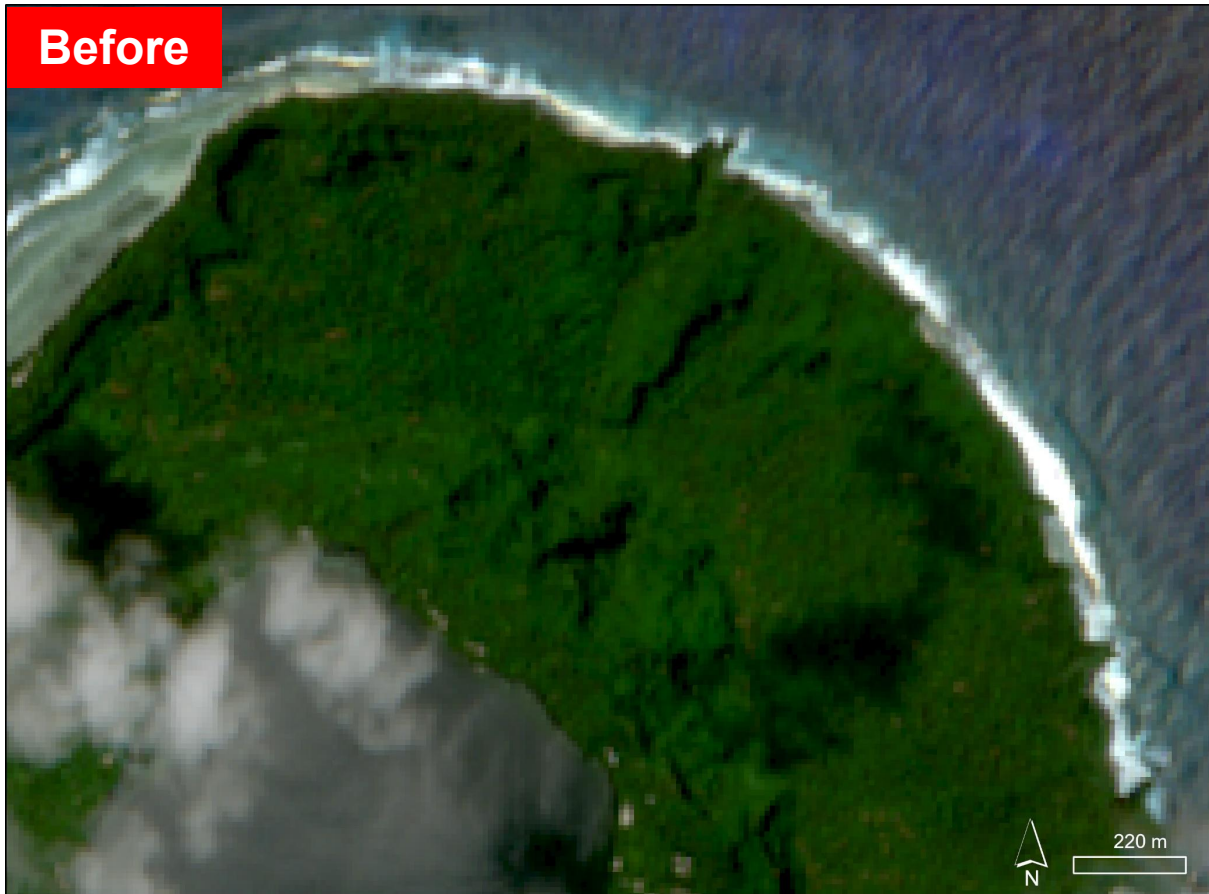
State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, MNR, China



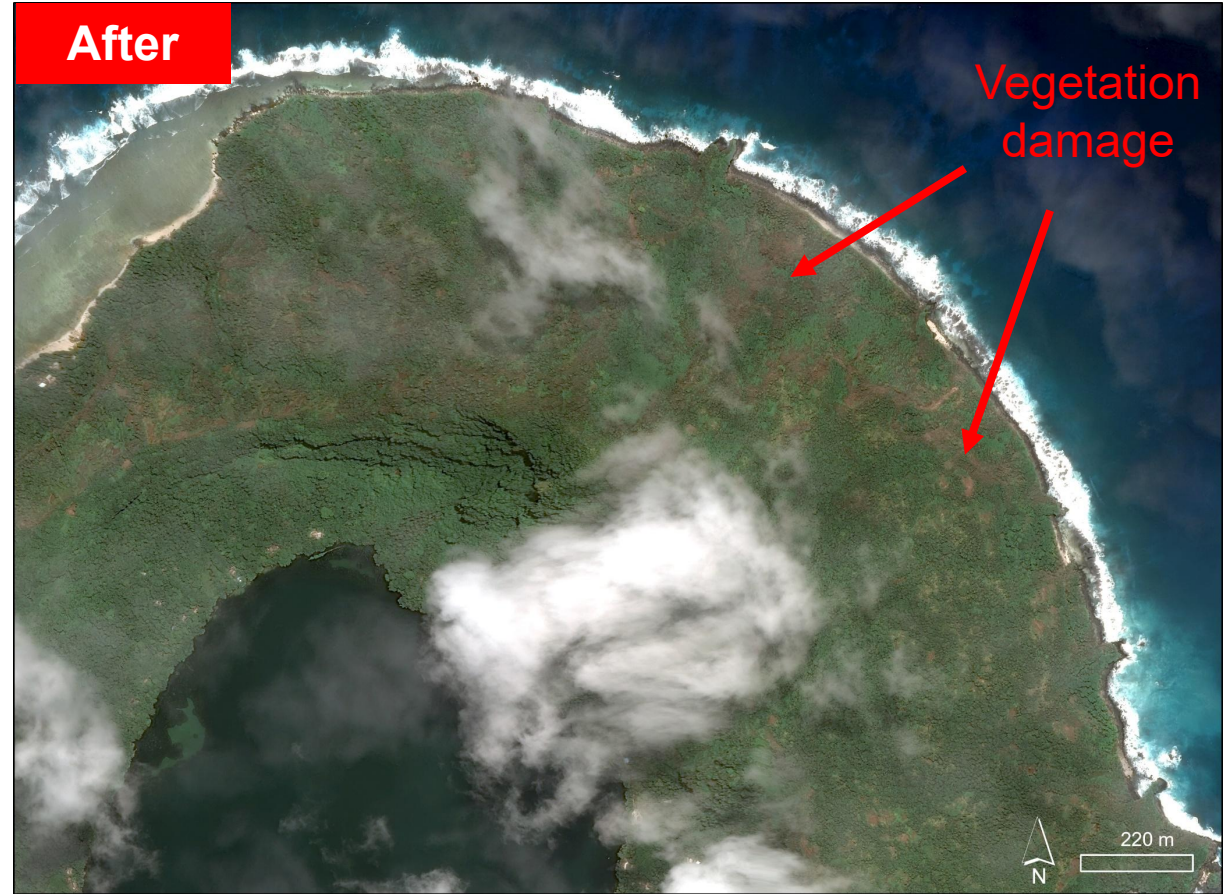
China Center for Resource Satellite Data and Applications, CASC, China



II East of the AOI-1



Sentinel-2 / 19 Dec. 2022



Pleiades / 6 Mar. 2023

We have sent the monitoring reports to Disaster Charter and user agency, and received **positive feedbacks** that they are **useful for the post-disaster recovery**.



The impact of Tropical Cyclone Judy on Solomon's Tikopia Island, Feb. 27-Mar. 7, 2023

[Download full report](#)

Source: Pleiades / Sentinel-2

Acquired: Pleiades: 06/03/2023

Sentinel-2: 07/03/2023

Type of Event:	Cyclones
Location of Event:	Solomon Islands
Date of Charter Activation:	2023-02-27
Time of Charter Activation:	14:02
Time zone of Charter Activation:	UTC+11:00
Charter Requestor:	NDMO
Activation ID:	806
Project Management:	Wenting CAO (The Second Institute of Oceanography (SIO))

----- Replied Message -----

From [Jonathan Tafiariki <JTafiariki@ndmo.gov.sb>](mailto:Jonathan.Tafiariki@ndmo.gov.sb)

Date 3/11/2023 06:12

To [cos2@disasterscharter.org <cos2@disasterscharter.org>](mailto:cos2@disasterscharter.org)
[caowt@sio.org.cn <caowt@sio.org.cn>](mailto:caowt@sio.org.cn)

Subject RE: Charter Activation 806 (928) - summary of metadata or product upload

From [Jonathan Tafiariki <JTafiariki@ndmo.gov.sb>](mailto:Jonathan.Tafiariki@ndmo.gov.sb)

Date 3/14/2023 06:36

To [Wenting CAO <caowt@sio.org.cn>](mailto:Wenting.CAO@caowt.sio.org.cn)

Subject RE: Charter Activation 806 (928) - summary of metadata or product upload

Dear Dr Wenting,

Thank you for giving access to the files and also for coordinating on the products.

Dear Charter Support,

Much appreciated the support in providing imagery and products.

Thank you for the products update.

Thank you

Lookinh forward for value added products.

Jonathan Tafiariki

Director NDMO



3. Next steps



1. Producing more **remote sensing products** for coastal, offshore, and marine ecosystems in PICTs using **China's satellite data**;
2. Releasement of the **Remote Sensing Service Online Platform**;
3. **Disaster** monitoring and emergency services;
4. **Visiting Samoa and Fiji in August 2023** for promoting the project products.



Thank you

Dr. Wenting CAO

Email: caowt@sio.org.cn

