

Monitoring of mangrove forests after the major *Tsunami disaster* in 2004 in Thailand using high resolution satellite data

Yasumasa Hirata¹, Ryuichi Tabuchi¹, Pipat Patanaponpaiboon²,
Sasitorn Pongparn², Reiji Yoneda¹, Yoshimi Fujioka³

Forestry and Forest Products Research Institute, Japan
Chulalongkorn University, Thailand
National Research Institute of Aquaculture, Japan

Roles of Mangrove Forest



- Mangrove forests in tropical and subtropical countries play important roles:
 - water quality maintenance
 - storm wave protection
 - fish habitat
 - ecotourism activities
 - carbon stocking
 - **trapping**

Background

- The Indian Ocean Major Earthquake off the Coast of Sumatra and **Tsunami** in the Indian Ocean occurred on 26 December, 2004.
- It caused much victims and heavy damages in **coastal zones**.
- Some studies reported that mangrove forests filled the role of mitigation of the damage by the Tsunami.
- On the other hand, Mangrove forest themselves suffered both direct and collateral damages of the Tsunami.





Damages by the Tsunami

- **Direct damages** resulted from fierce impacts of the Tsunami and objects damaged by it.
- Vibration of trunks by repetitious waves of the Tsunami and respiratory disorders from roots due to sedimentation of sands, which were brought by them, caused **collateral damages**.

Objectives

- This study aims to investigate the **direct** and **collateral** effects of the Tsunami on mangrove forests.
 - Detection of damaged area
 - Monitoring of gap dynamics
 - Monitoring of rehabilitation
 - Change detection by development after the Tsunami



Damage in a permanent plot for ecological study

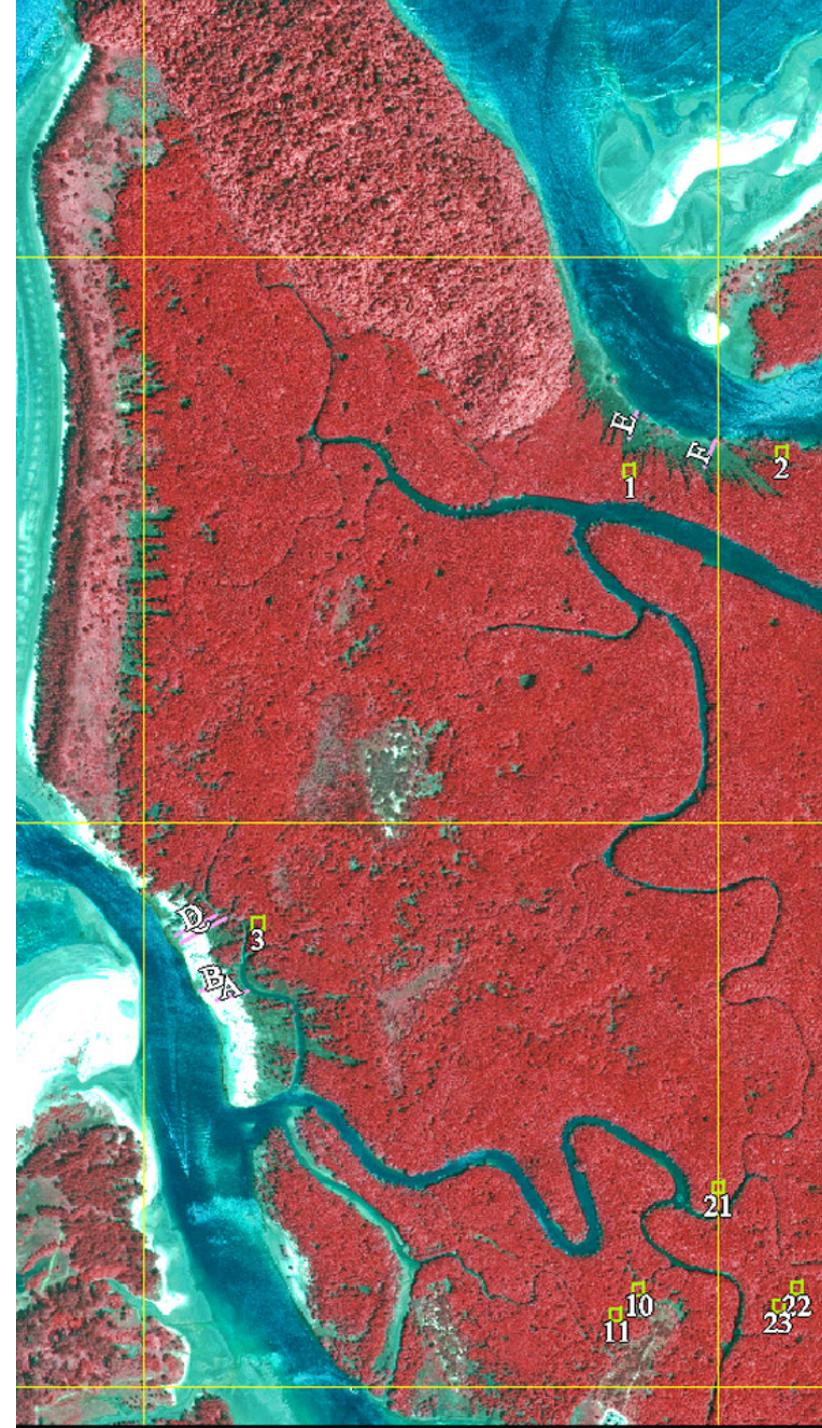


Study Area

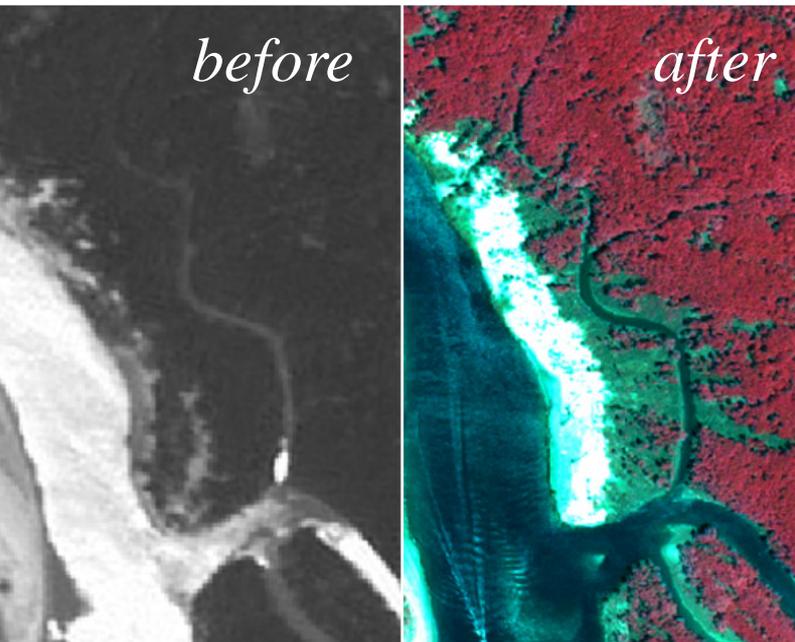
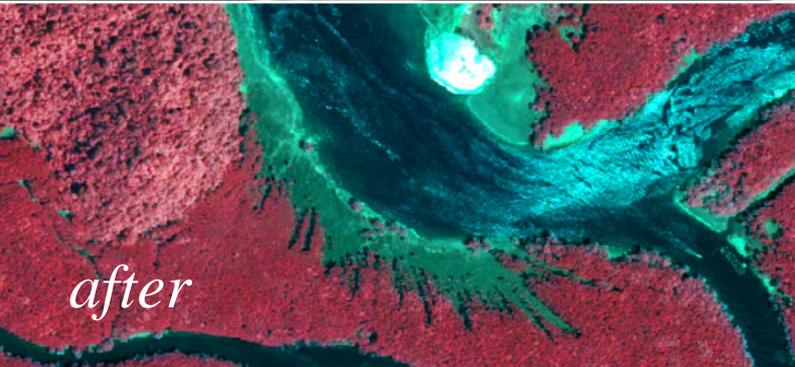
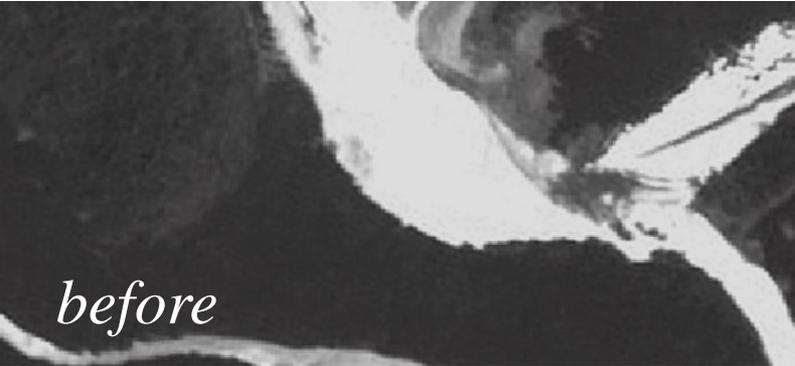
- The study area is located at the coastal zone of Ranong, Thailand.
- Four permanent plots for ecological study of mangrove forests had been established before the Tsunami.
- Twenty-one temporary plots with the area of 0.04 ha were set in the study area.
- Six line plots were put from the seashore to the edge of remaining mangrove forest in the damaged area.
- All plots were positioned with GPS.

Satellite Data

- Before the Tsunami
 - Spot 5 panchromatic data (2.5m)
 - Acquired on 13 March 2004
- After the Tsunami
 - QuickBird panchromatic (0.7m) and multi spectral data (2.8m)
 - Acquired on 5 March 2005, 23 January 2006 and 15 October 2006.
- Twenty-four ground control points were acquired to register satellite images.



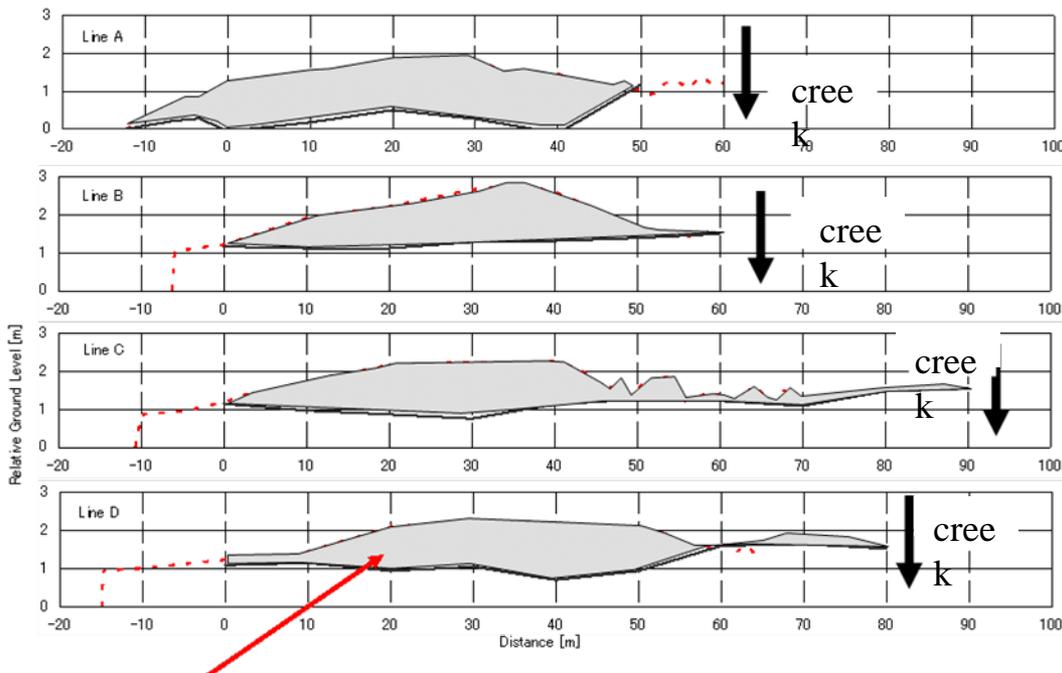
Detection of damaged Area by the Tsunami



- Comparing satellite images before and after the Tsunami.
- Nevertheless the difference of data types (panchromatic of SPOT-5 & pansharpen of QuickBird), damaged area can be identified from these data.
- Multi spectral data of SPOT-5 should be prepared for detailed analysis to identify mangrove from other vegetation.

Monitoring in Damaged Area

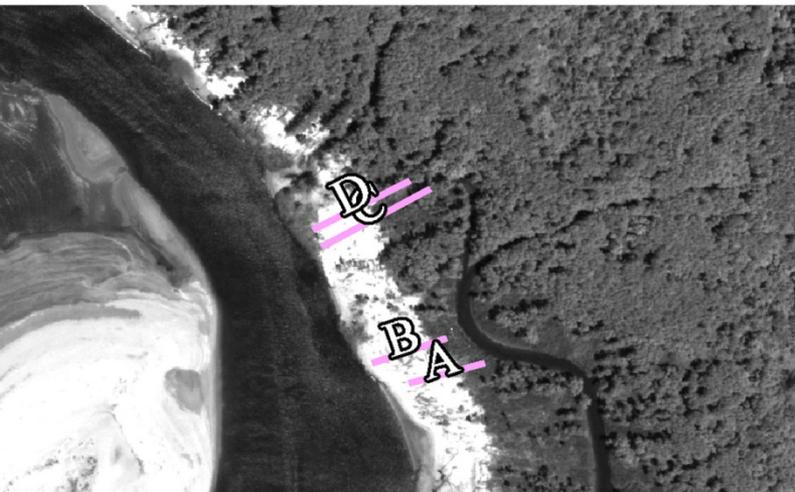
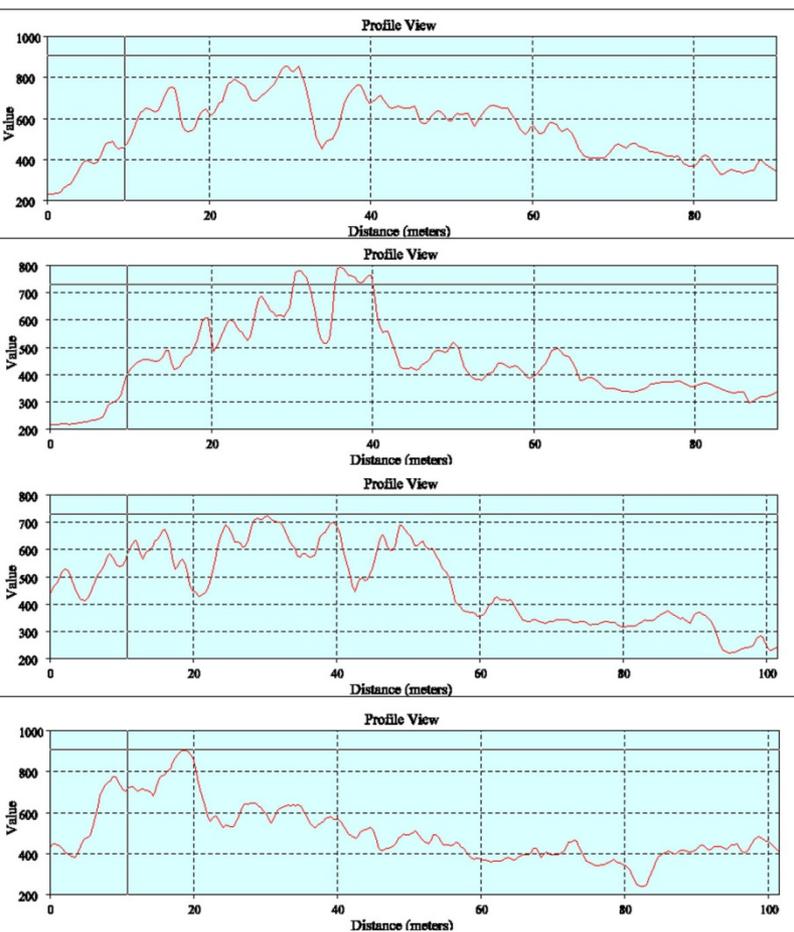
- Sand depth influences restoration and rehabilitation of vegetation in damaged area.
- Investigating sand depth at every 10 m interval along the line from seashore to edge of remaining mangrove forest.



Sand accumulation



Profiles of DN along Line Plots in Damaged Area

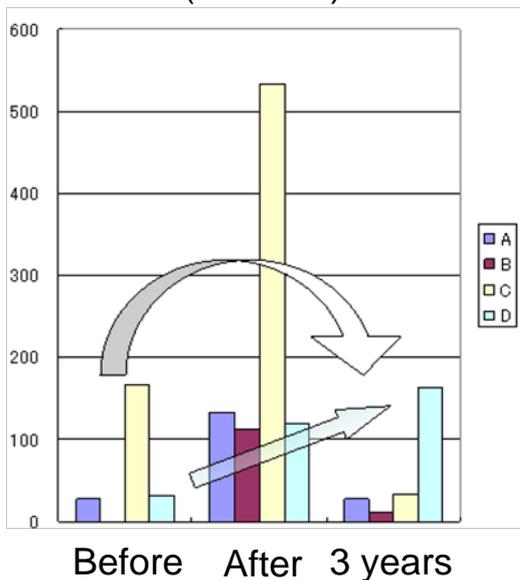


- Profiles of digital number (DN) of QuickBird panchromatic data along line plots damaged area.
- Waveforms of their profiles were strongly related to sand depth (ranges were **more than 500**).
- In the line plots of the northern damaged area, where there is few sand accumulation, DN was relatively stable (ranges were **around 80**).
- Use of profiles of DN is effective to identify sand accumulation.

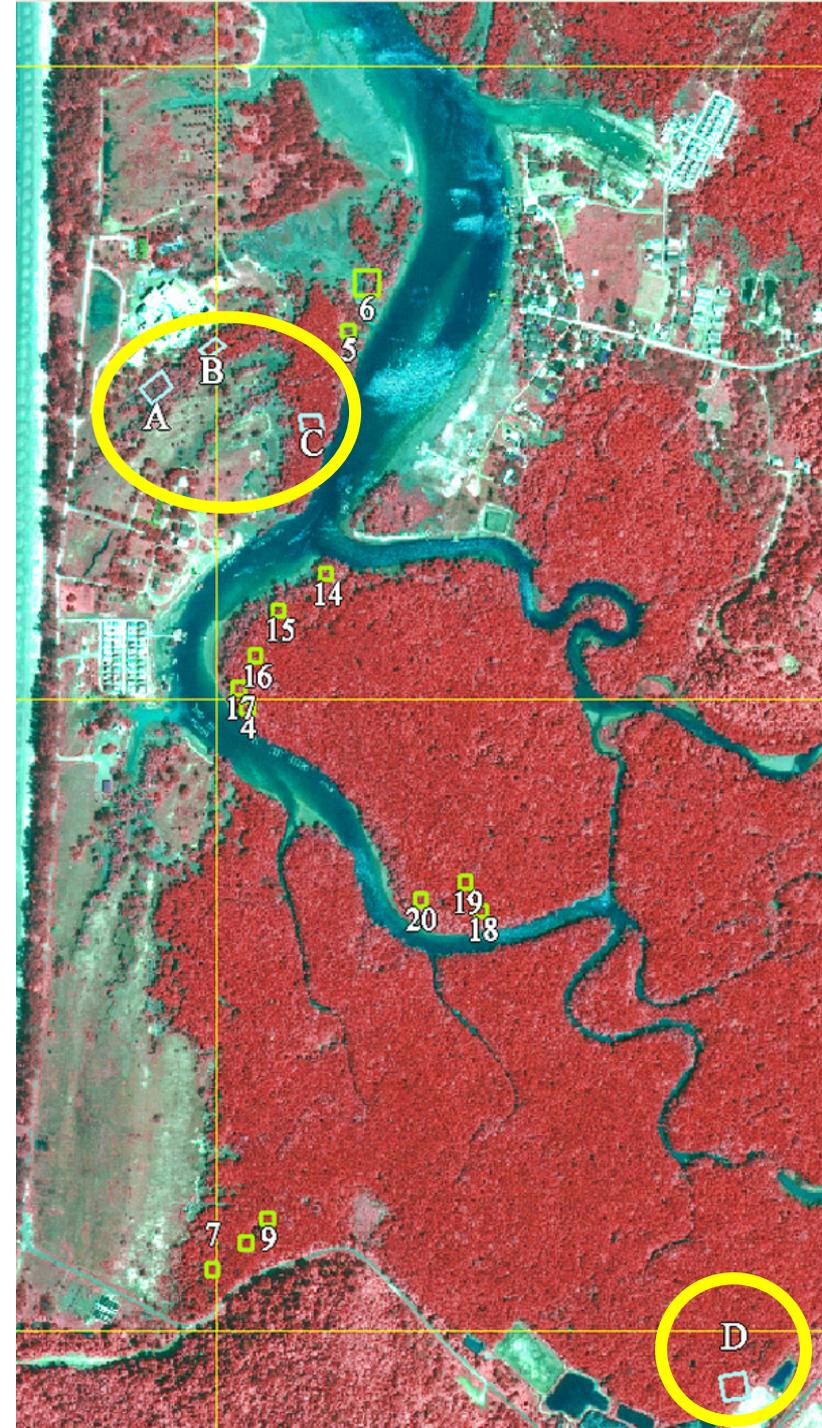
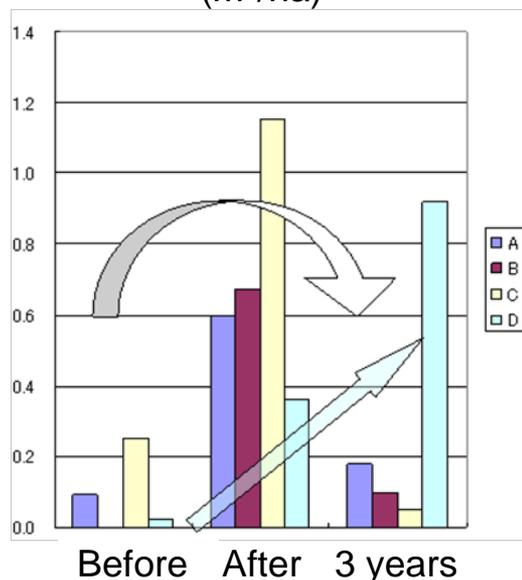
Forest Dynamics

- Permanent plots were damaged by the Tsunami.
- Investigation of the plots were conducted before and after the Tsunami.
- Damages were different between plots in the front and in the back.

Decrease of stand density (trees/ha)

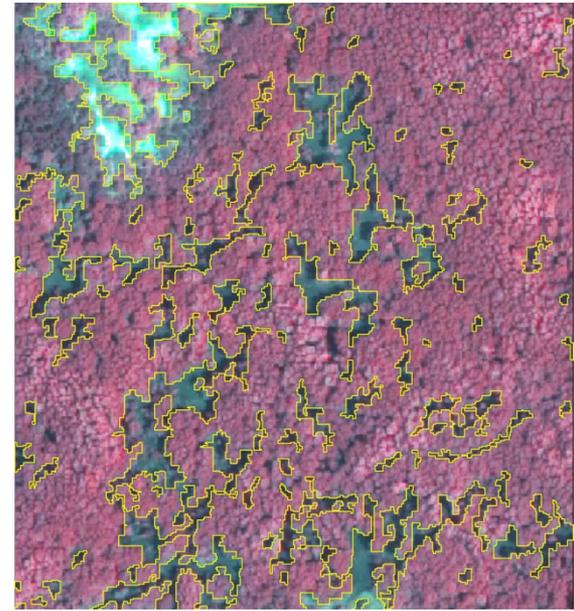


Decrease of basal area (m²/ha)

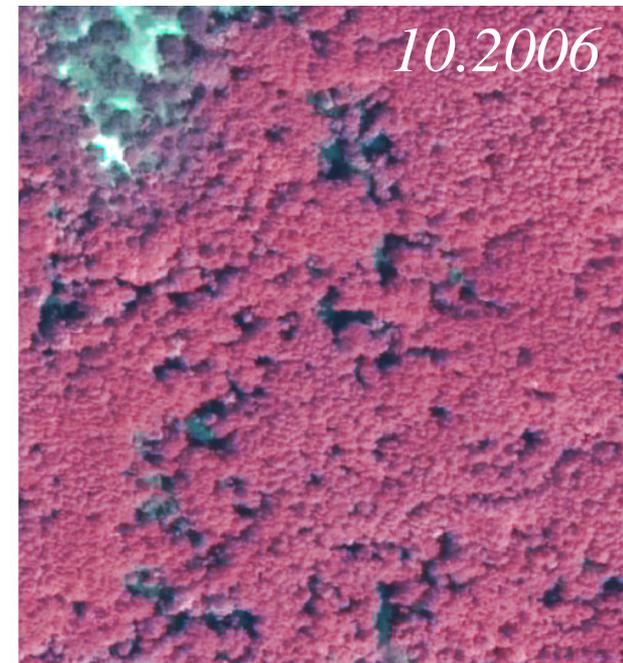
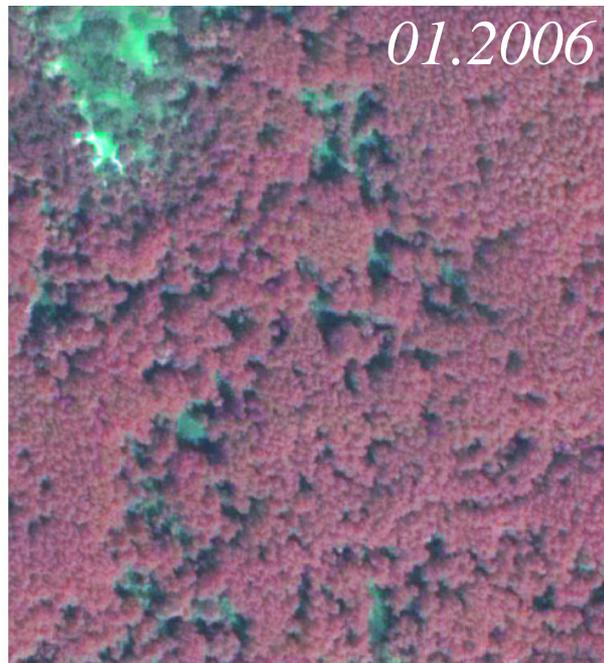
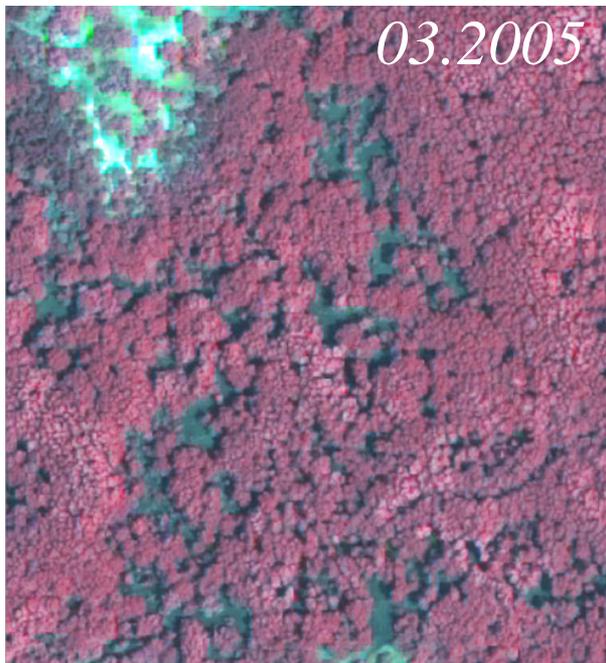


Canopy dynamics

- Canopy gaps can be extracted from QuickBird data using object-oriented classification for quantitative analysis.
- Canopy closing can be identified from multi-temporal data.
- Sensor angle should be discussed in further study.

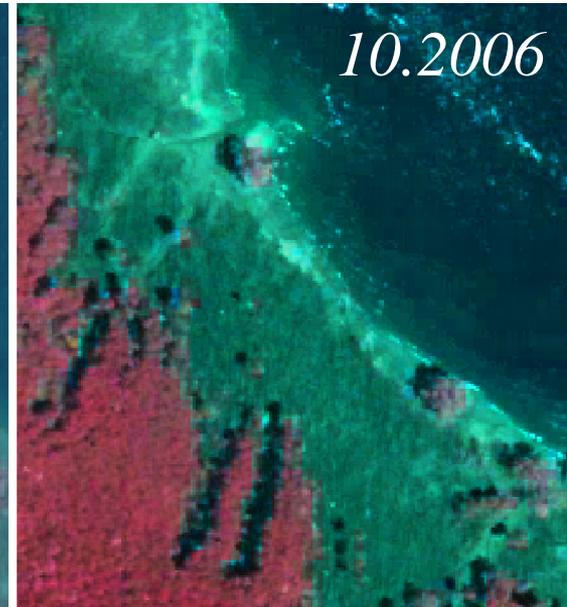


Gap extraction using object-oriented classification



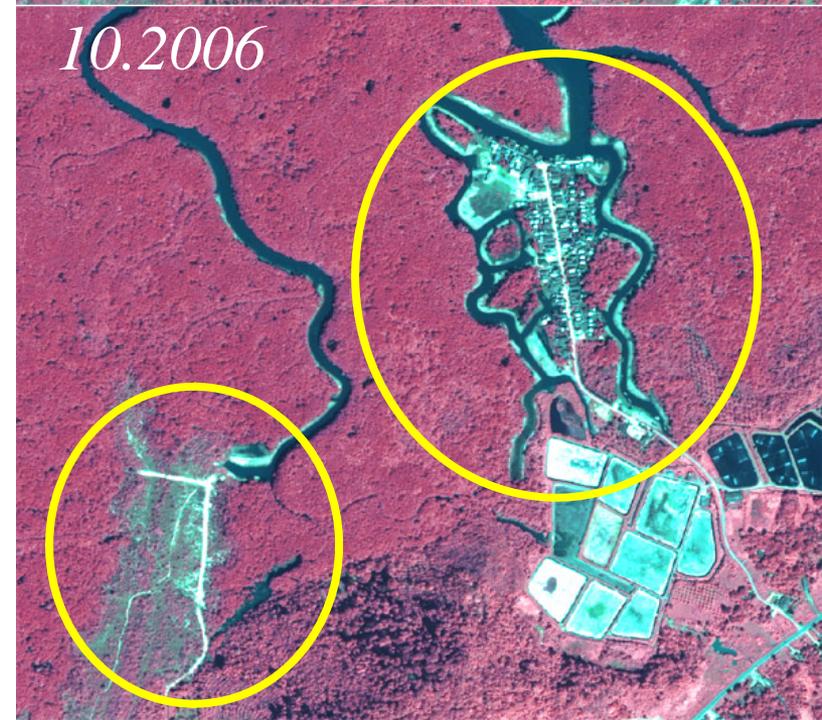
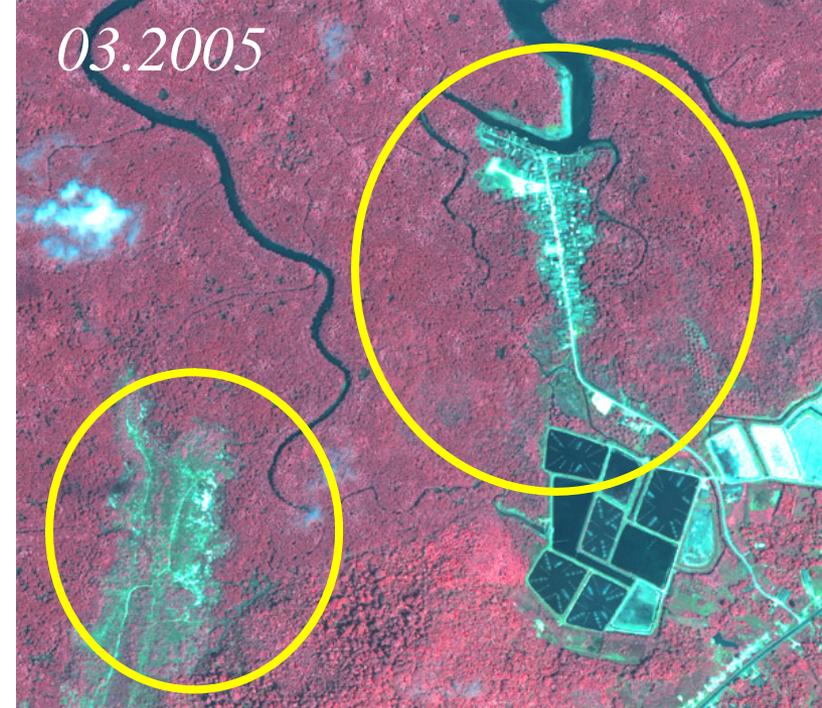
Rehabilitation

- Because of small ratio of canopy of mangrove seedlings, any evidence of success of rehabilitation did not verified from satellite data, including NDVI.
- Further monitoring is required to evaluate the success of rehabilitation after the Tsunami disaster.



Development in Mangrove

- Development of mangrove forest for shrimp farm is not direct damage, but after the Tsunami disaster, development became rapid.
- New developments should be monitored from a viewpoint of conservation of mangrove forests because they cause not only deforestation but also degradation of surrounding mangrove forests.



Discussion



- Though it was difficult to distinguish the damages on mangrove forests from their dynamics, this study made it clear that high resolution satellite data were useful to identify the local changes of canopy of mangrove forests in wide area.
- Further studies for integrating the results of this study using high resolution satellite data to evaluate the Tsunami disaster on mangrove forests with ecological investigation of mangrove forest dynamics are required.

Conclusions

- Forest canopy dynamics can be identified using object-oriented classification for multi-temporal high resolution satellite data.
- Use of profiles of DN is effective to identify sand accumulation.
- Because of small ratio of canopy of mangrove seedlings, any evidence of success of rehabilitation did not verify from satellite data, including NDVI.
- New developments should be monitored from a viewpoint of conservation of mangrove forests.



A photograph of a person wearing a white long-sleeved shirt, dark pants, and a white cap, standing in a mangrove field. The foreground is filled with young mangrove saplings with green leaves and exposed roots. To the left, a larger, mature mangrove tree is visible. In the background, the ocean and a clear blue sky are seen.

Thank you for your attention!

**Any questions?
hirat09@affrc.go.jp**