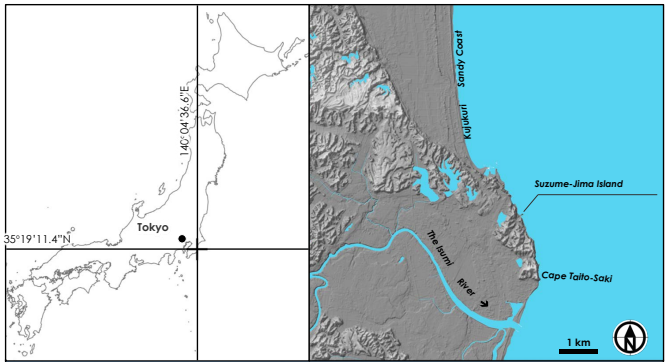
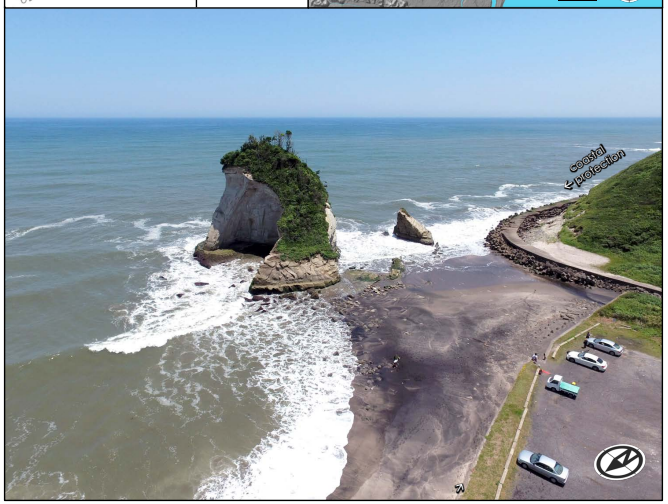
There-dimensional change detection in coastal cliffs using UAV and TLS

2020.05.08 fri

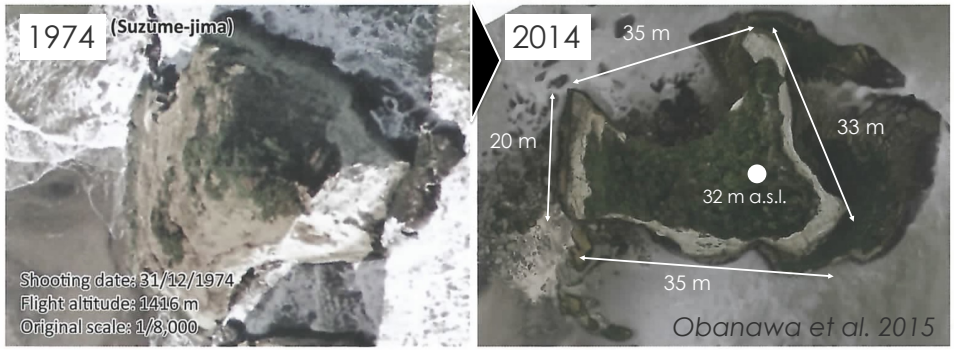
Yuichi S. Hayakawa* & Hiroyuki Obanawa
*Environmental Earth Science, Hokkaido University

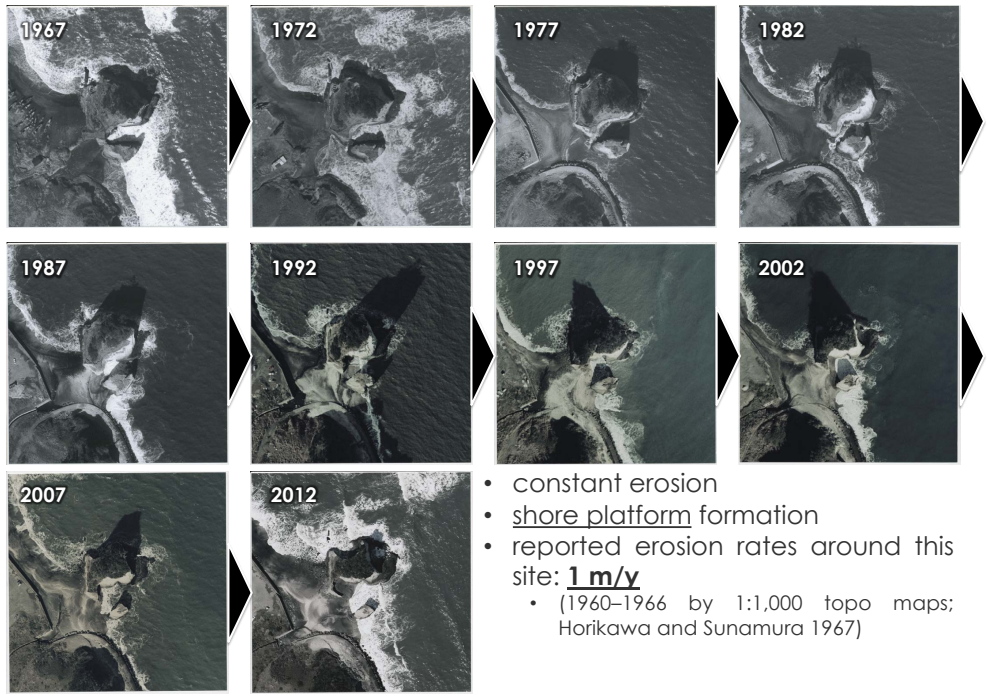
study site: rapidly eroded small coastal island





a rare opportunity in Japan: natural rapid processes of coastal erosion
out of the coastal protection
oceanic waves directly attacks the bedrock cliff
rapidly shrinking for decades





- constant erosion
- shore platform formation
- reported erosion rates around this site: **1 m/y**
  - (1960–1966 by 1:1,000 topo maps; Horikawa and Sunamura 1967)

TLS

TLS #1: TOPCON GLS-1500

a medium-range scanner
– max. distance: 500 m
– max. frequency: 30,000 pts/s
– range accuracy: 4 mm @150 m
– weight: 16 kg (body) + batteries

TLS #2: Trimble TX5

a short-range scanner
– max. distance: 120 m
– max. frequency: 900,000 pts/s
– range accuracy: 2 mm @25 m–
weight: 5 kg

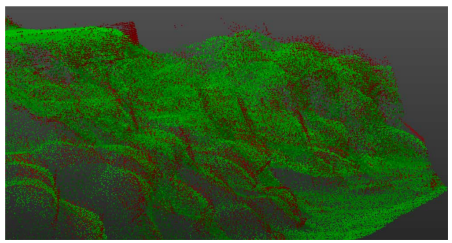
UAV

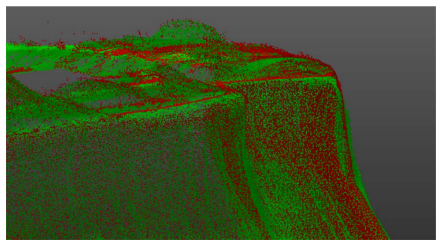
DJI Phantom 2 + NIKON COOLPIX A; Phantom 3 Professional/Advanced; Phantom 4; Mavic Pro; Mavic 2 Pro;

post processing

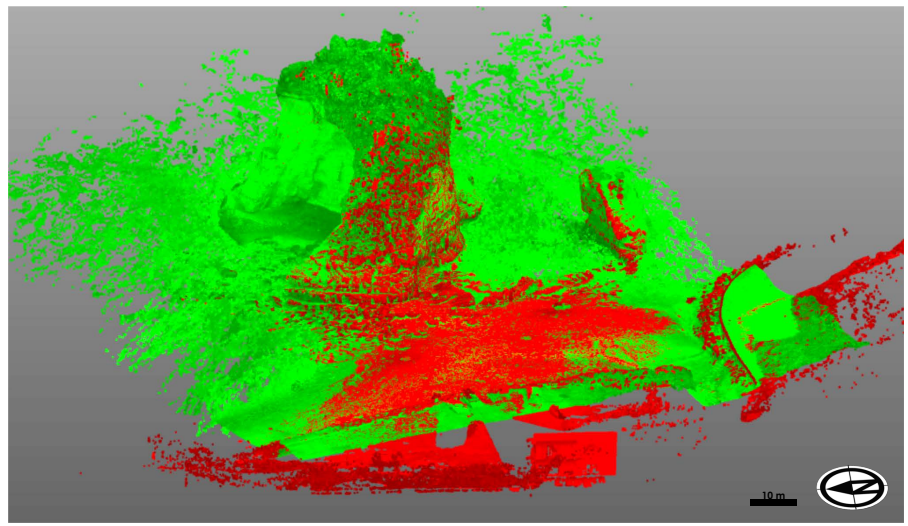
- SfM-MVS photogrammetry by PhotoScan
- 500-1,000 photos for each time
- positioning accuracy 1: camera-mounted GNSS, >1 m
- positioning accuracy 2: GCP by PPK-GNSS (fix solution) (Trimble GeoXH), 13.4–14.9 mm (14.4 mm RMS)

TLS + UAV

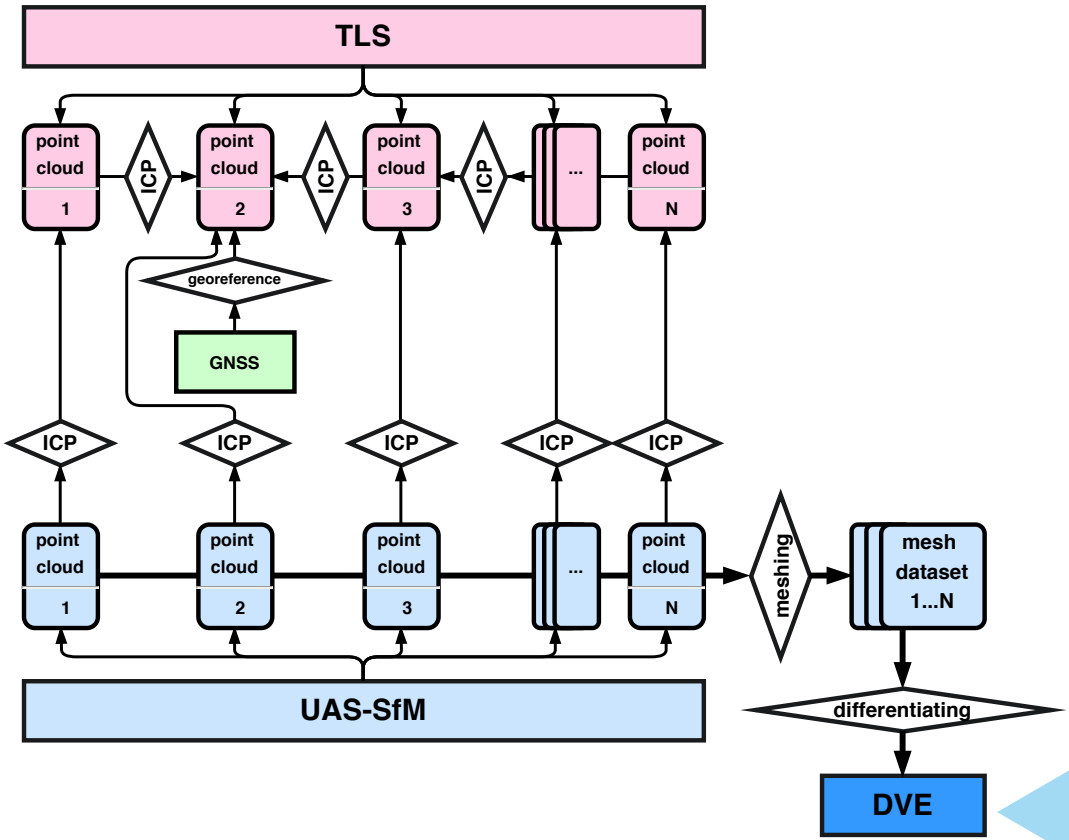




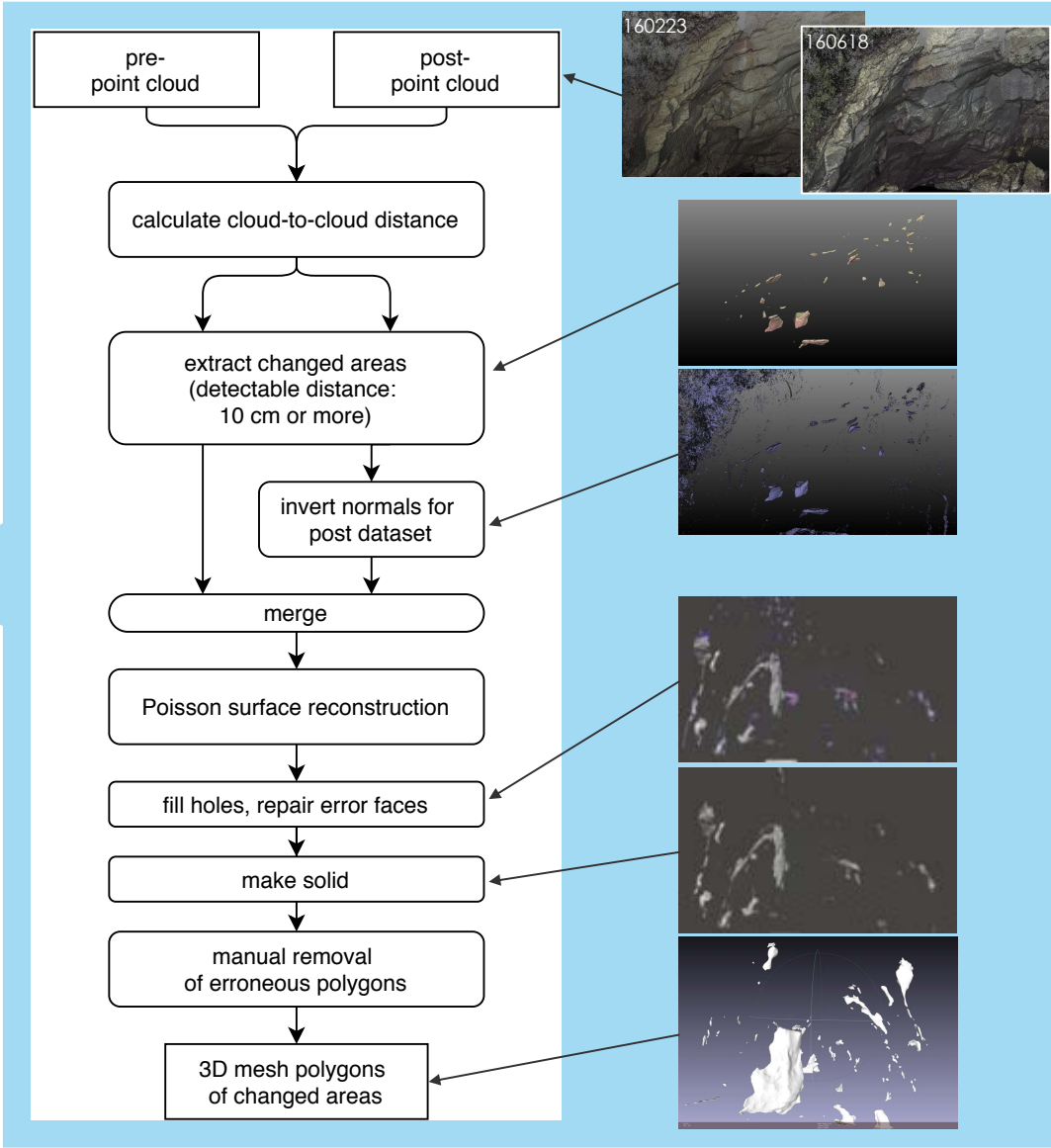
- further aligned by ICP
  - – UAS dense cloud → TLS cloud
  - – CloudCompare / Trimble RealWorks
  - – cloud-based registration (ICP), errors: 25.1–39.7 mm



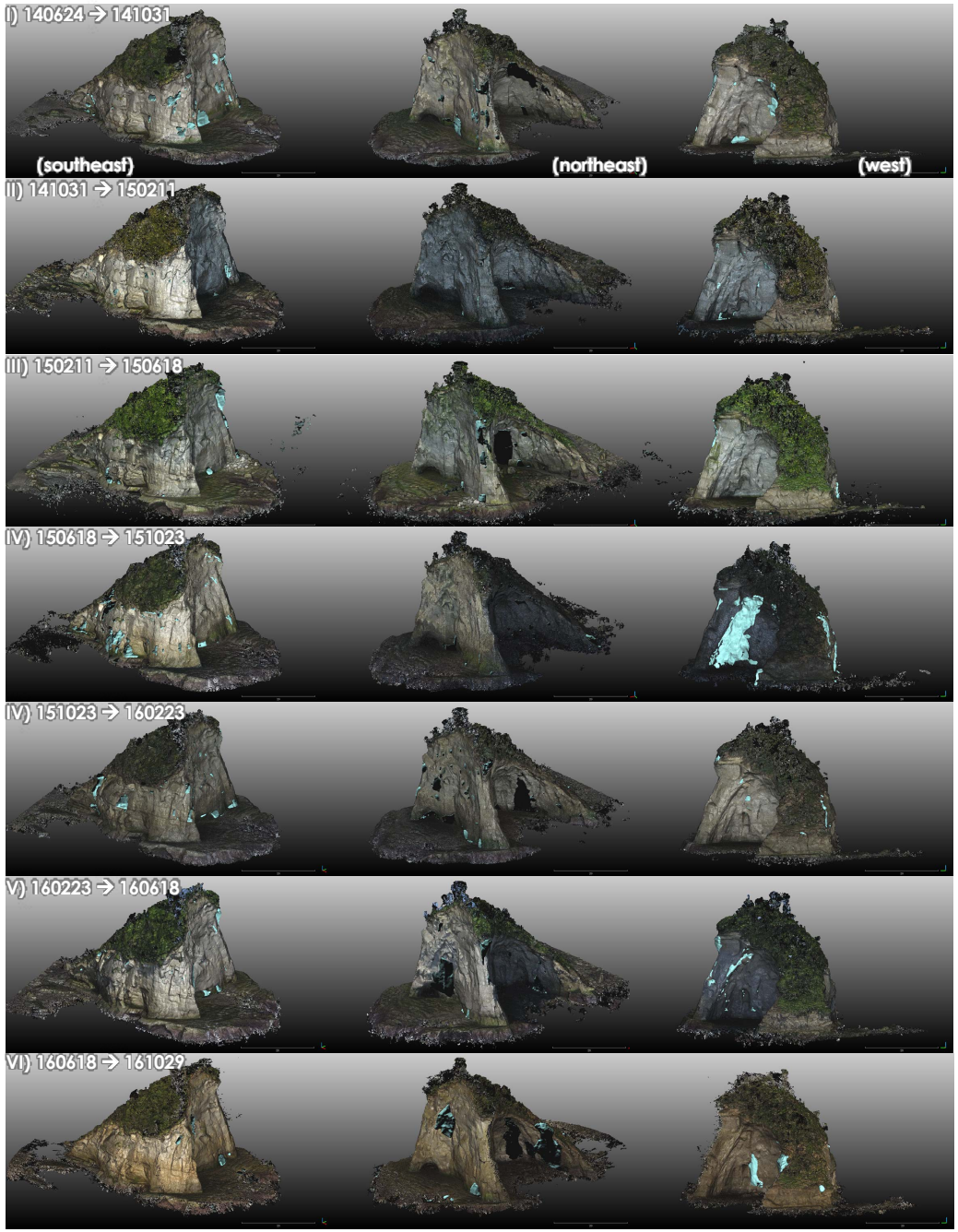
methods – workflow

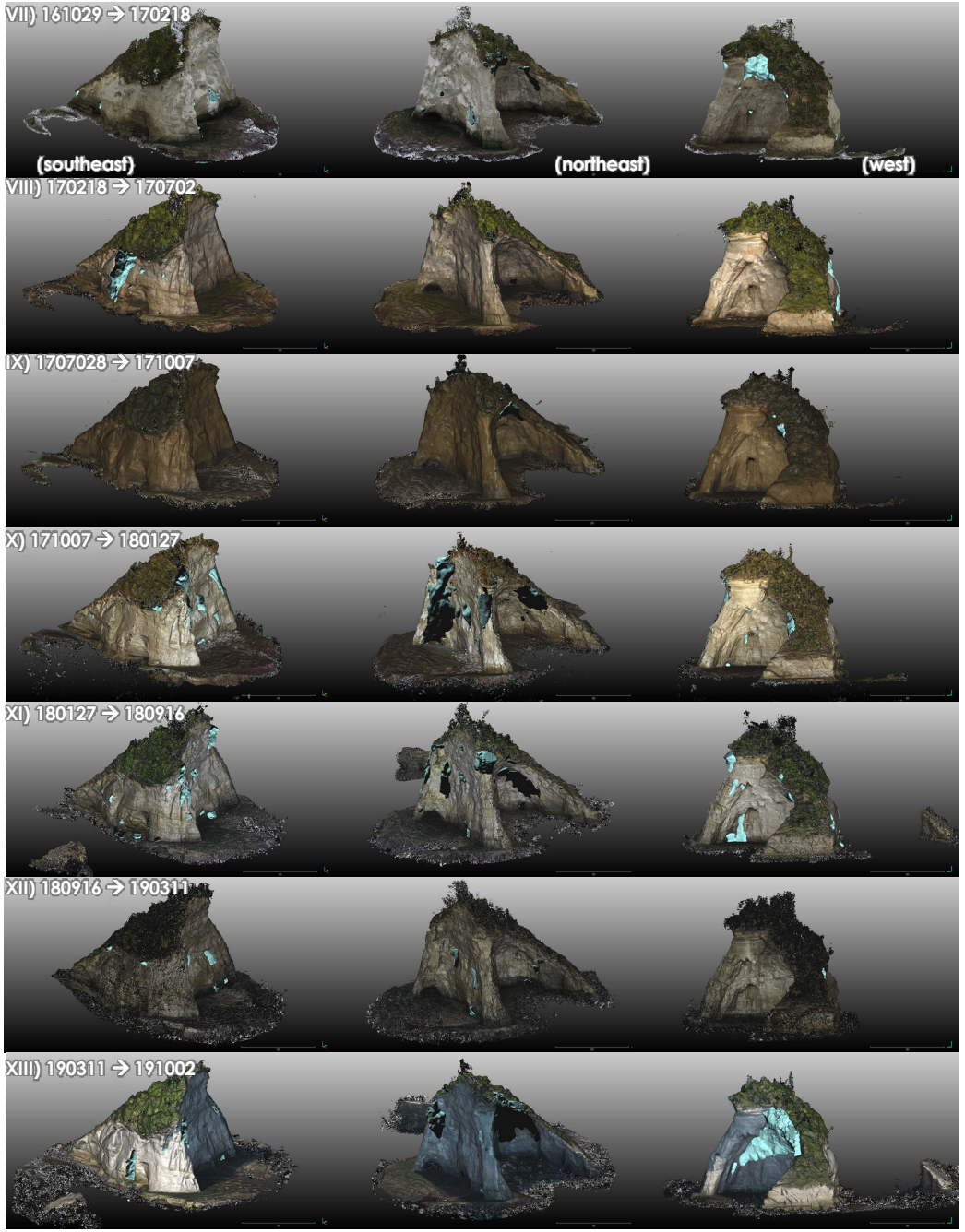


workflow of Differential Volume Estimate



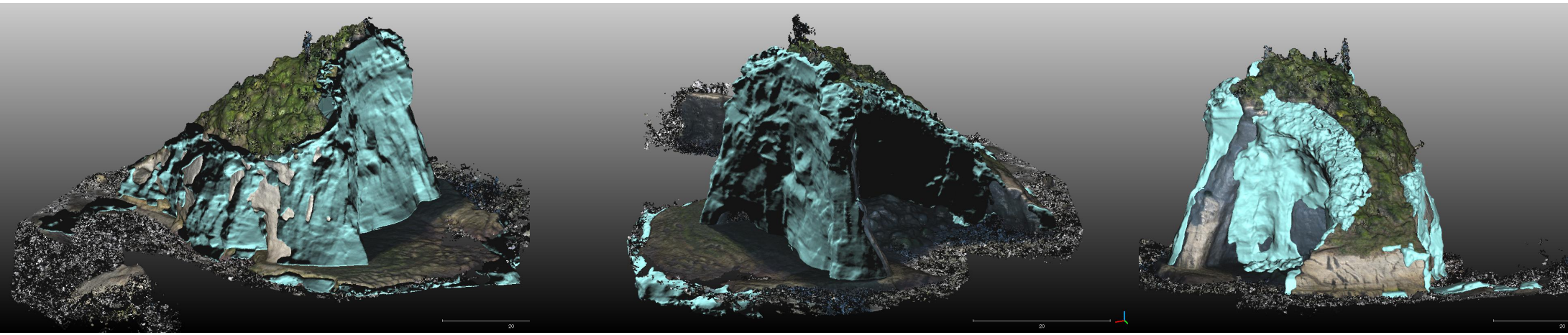
interval changes 2014.06.24 → 2019.10.02





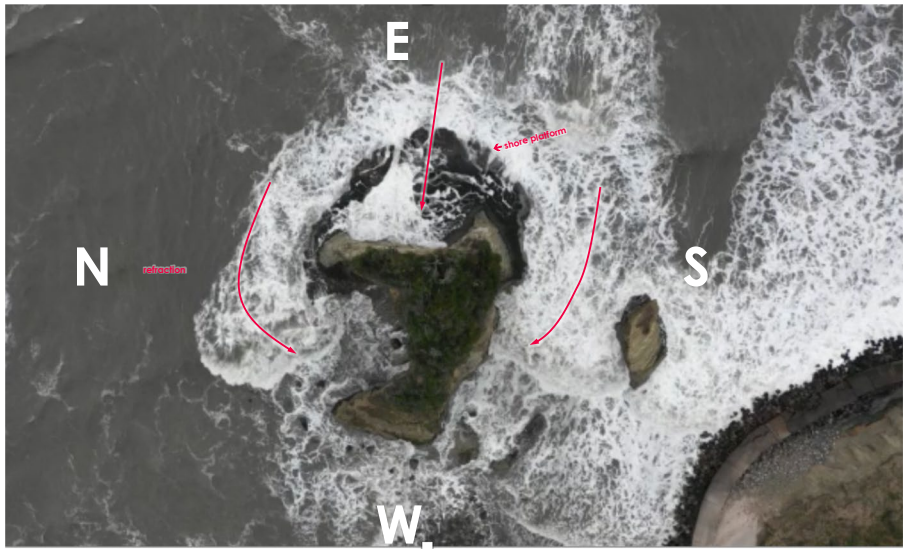
results – quantification of volumetric changes was successful!

total changes 2014.06.24 → 2019.10.02



total volume loss: 1,980 m^3
average volume loss per month: 30 m^3
current volume of the island: 11,300 m^3
estimated time to fully eroded: ca. 30 years

spatial variations: differences in wave attacks

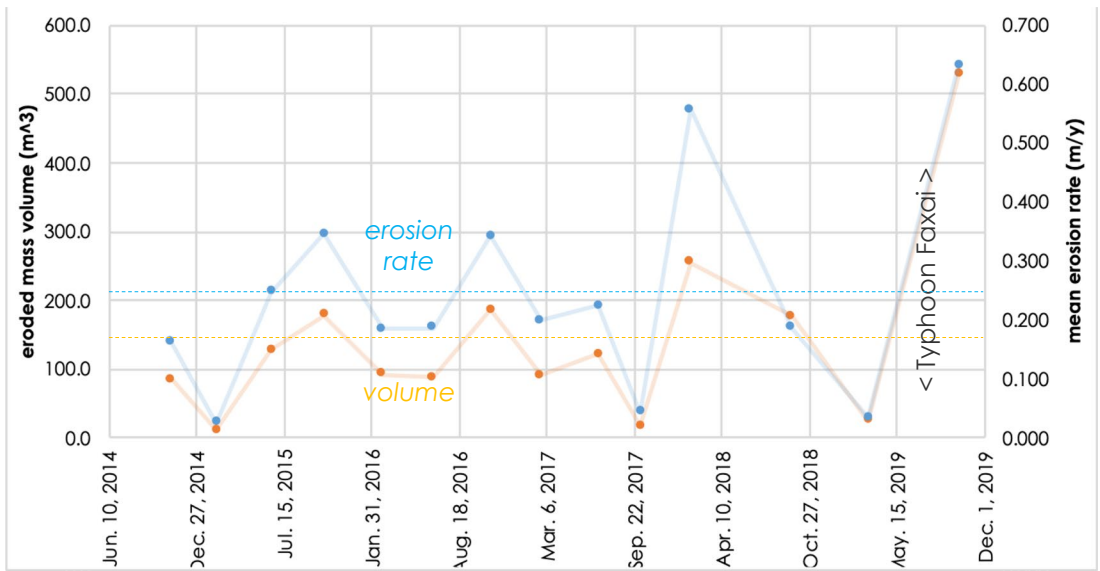


◀ different directions of wave attacks for the cliff faces of the island could cause differences in the amount of erosion

although the relation is not clear, attacks by high tidal waves could have affected the amount of erosion

▼

temporal variations: frequency of high tidal waves and erosion mass volume



- mass volume varies, **10.6 – 527.7 m³** per 4-7 months
- equivalent annual erosion rates: **0.03 – 0.63 m/y**
  - cf. approx. projected area of bedrock: 1,436 m²