Mangrove Growth Monitoring from Multi-temporal UAV-LiDAR

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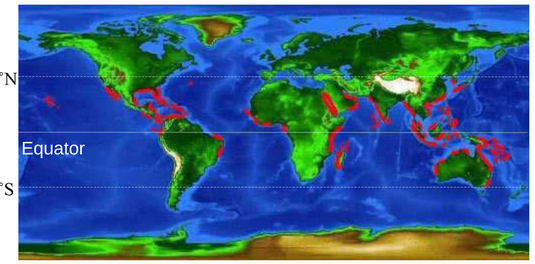
I. Background - Mangrove

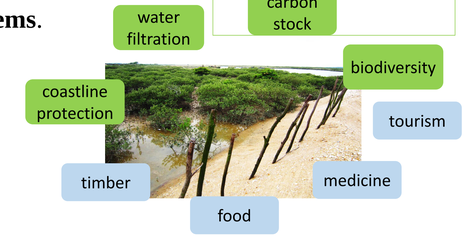


World distribution map of mangroves (red color).
(Image courtesy: Florida Museum of Natural History)

Mangroves: trees and shrubs at tropical and sub-tropical coastal zones

Mangroves provide a variety of unique environmental and social services and are among the **most carbon-rich ecosystems**.

v.s. terrestrial ecosystems:
- Area <0.4%
- Comparable carbon storage

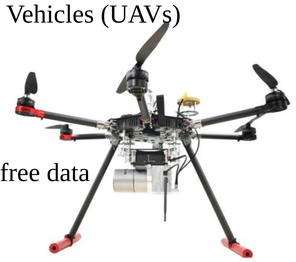


II. Gap

The swampy environment, and the very dense canopy and roots make the mangrove forests mostly **not accessible**.

The height dynamics of mangrove forests have **not** been investigated, especially for large areas.

Opportunity:
Unmanned Aerial Vehicles (UAVs)
Remote sensing



- Cloud and tide free data
- Affordable
- Easy to capture

III. Objectives and VI. Findings

We propose the first study to monitor mangrove height dynamics using UAV-LiDAR.

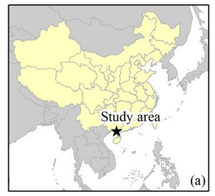
- What is the growth rate of mangrove trees?
  On average, 7.1 cm·yr^{-1}
- Does different species have different growth rates?
  Yes. × *Rhizophora stylosa* : 9.8 cm·yr^{-1}
  × *Avicennia marina* : 9.2 cm·yr^{-1}
  × *Kandelia candel* : 5.9 cm·yr^{-1}
  × *Aegiceras corniculatum* : 3.0 cm·yr^{-1}
- Does environment (clumped vs. isolated) affect the growth rate?
  Yes.* × Isolated : 10.6 cm·yr^{-1}
  × Boundary: 6.7 cm·yr^{-1}
  × Clumped: 6.4 cm·yr^{-1}
  (*Needs more work.)

Plant *Rhizophora stylosa* and *Avicennia marina* for faster growth and protection.

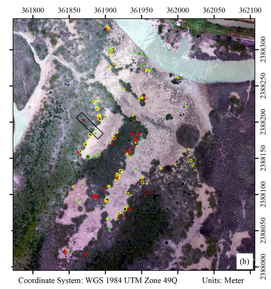
Leave space inbetween for faster growth and protection.

IV. Data and Methods

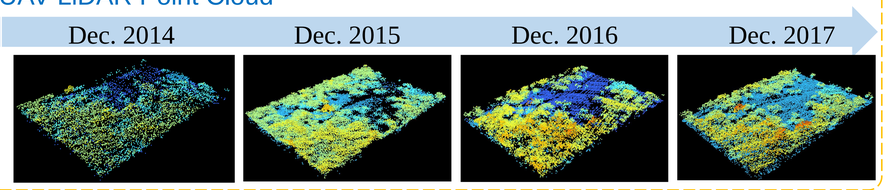
Shankou National Mangrove Nature Reserve, Guangxi, China.



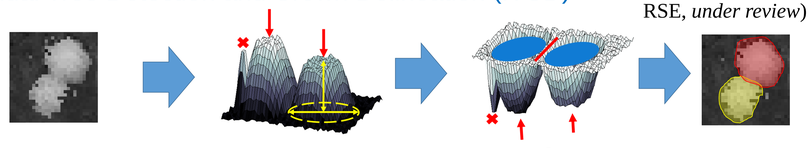
Clumpingness Groups
Isolated
Boundary
Clumped



UAV LiDAR Point Cloud



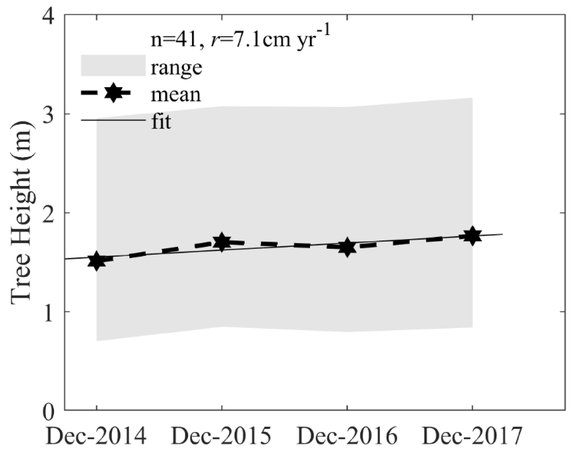
Individual Tree Detection and Crown Delineation (ITCD) (Yin and Wang, RSE, *under review*)



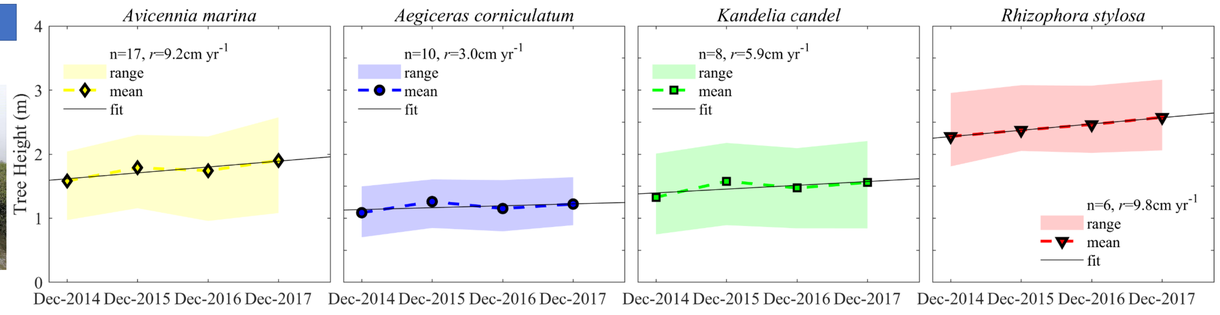
Multi-temporal comparison → Growth rate *r* (cm·yr^{-1})

V. Results

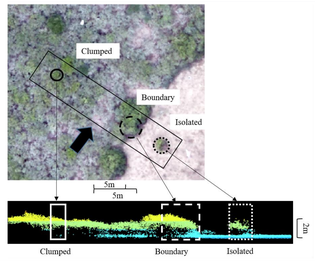
Mangrove growth rate

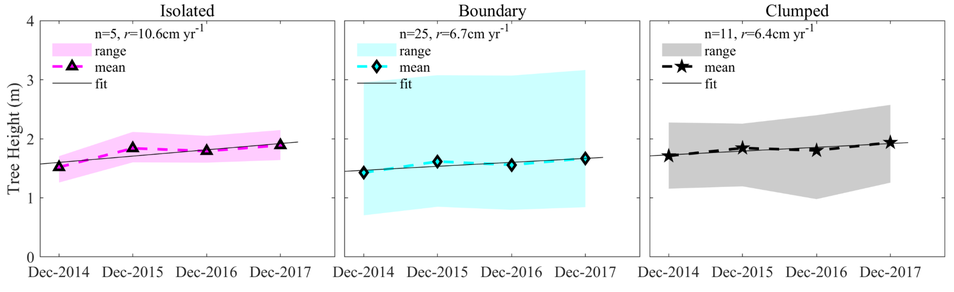


Species growth rate



Clumpingness affects growth rate?





VII. Limitations and Future Work

- Uncertainties in field measurement and LiDAR has not been investigated.
- Geo-referencing among different LiDAR / CHM datasets is worth exploration, especially in the mangrove forested area.
- ITCD accuracy can be further improved by adjusting algorithm parameters and refining ITCD algorithms.
- Change of biomass and carbon storage in the mangrove ecosystem can be analyzed by combining the current results with published allometric equations.