Carbon Flux with Radar Satellites

Earth Observatory of Singapore - Remote Sensing Lab’s Support for Voluntary Carbon Markets

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Voluntary carbon markets suffer these days not because of lack of interest but because of lack of transparency.
CO₂ emission correlates with peatland subsidence (measurable)

Natural situation:
- Water table close to surface
- Peat accumulation from vegetation over thousands of years

Drainage:
- Water tables lowered
- Peat surface subsidence and CO₂ emission starts

Continued drainage:
- Decomposition of dry peat: CO₂ emission
- High fire risk in dry peat: CO₂ emission
- Peat surface subsidence due to decomposition and shrinkage

End stage:
- Most peat carbon above drainage limit released to the atmosphere within decades,
- unless conservation / mitigation measures are taken

Page et al. 2011
Satellite Synthetic Aperture Radar (SAR)

Source: NASA-JPL
Interferometric Synthetic Aperture Radar (InSAR)

From space we can measure land height change rates with a precision of cm/year or mm/year.
Ionosphere (80-600km above ground)

Ions and free electrons in the ionosphere cause a delay in microwave propagation
Ionospheric noise removal from InSAR (ALOS-2)

Optical Image (World View)  Before ionospheric correction  After ionospheric correction

Cheryl Tay
ASE, NTU

Velocity (cm/year)

subsidence  -5  uplift  5

Tay et al., in prep
InSAR offers high spatial & temporal resolution

- L-band ALOS-2 with better sensitivity to the peat surface beneath vegetation
- Observations: biweekly
- Pixel size: 100 m x 100 m

Palangkaraya

Velocity (cm/year)
- 3 uplift
- -3 subsidence

Pixel size ~100x100m
Two independent InSAR observations agree with each other

- ALOS-2 ScanSAR, StripMap
- Frequent imaging every 14 or 28 days
- Comparable peat motion measurements across acquisition modes and tracks

ScanSAR
355 x 355 km
100 m pixel size

StripMap
70 x 70 km
10 m pixel size

Tay et al., in prep
May 2024 Fieldwork

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ALOS-2 (JAXA)
628 km above ground

1 Singaporean, 2 Indonesians, 2 Bruneians, 1 Burmese, 1 Filipino, 1 Spanish, 1 British, 1 Korean American
March 2024 El-Nino driven wildfires destroyed our GNSS stations in Brunei

GNSS Stations installed in May 2023

March 2024 Fire
So we went to Brunei again. It was scorching hot,
or pouring rain. We were exhausted everyday.
We successfully installed the total of 8 GNSS stations and 6 peat cameras in Brunei and Central Kalimantan, Indonesia.
We compare InSAR observations with ground measurements

- Agreement between InSAR and ground measurements of peat motion

InSAR (Tay et al., in prep)
Peat camera (Evans et al., 2021)

Palangkaraya

Velocity (cm/year)
-3 uplift
dsubsidence

Pixel size ~100x100m

dry spell
InSAR observations agree with ground measurements.
We will contribute to improving **transparency** of voluntary carbon markets by providing **precise measurements** from satellite InSAR observations over tropical peatlands.

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