EO4PEAT

EO for Understanding and Monitoring Changing Conditions in Tropical Peatlands

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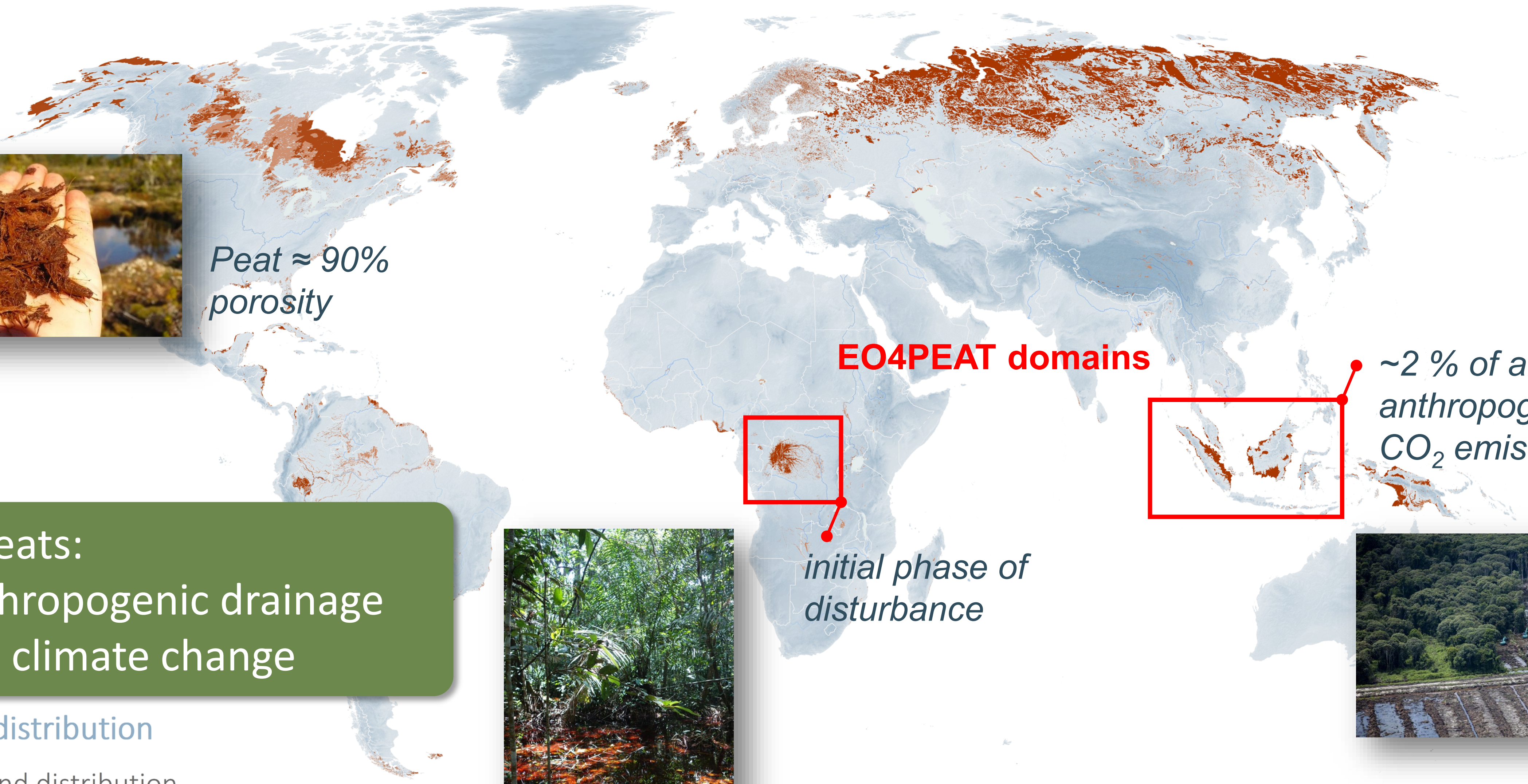
SMART Singapore-MIT Alliance for Research and Technology

Alex Cobb

+ 2 PhD (Belgium)
+ PhD / technical staff (DRC and Singapore)

motivation



Peat ≈ 90% porosity

EO4PEAT domains

~2 % of annual anthropogenic CO_2 emissions

initial phase of disturbance

- Threats:
  Anthropogenic drainage and climate change

Peatland distribution

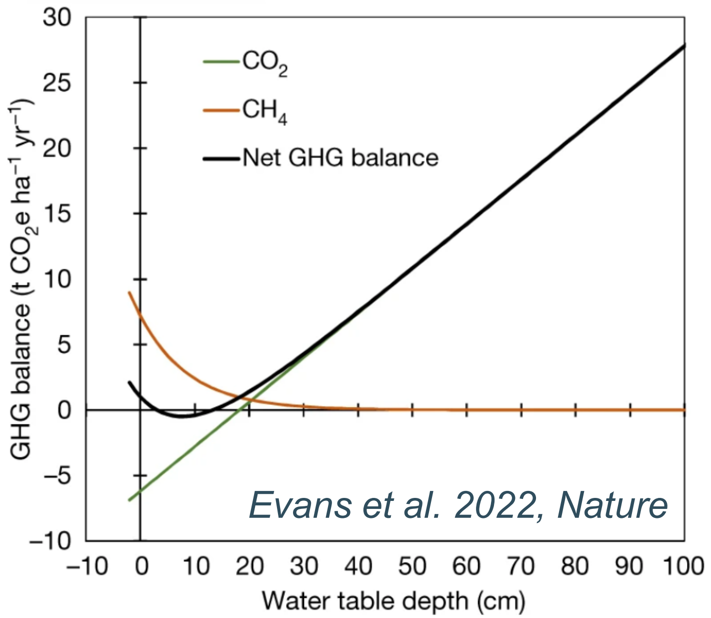
peatland distribution

peat in soil mosaic

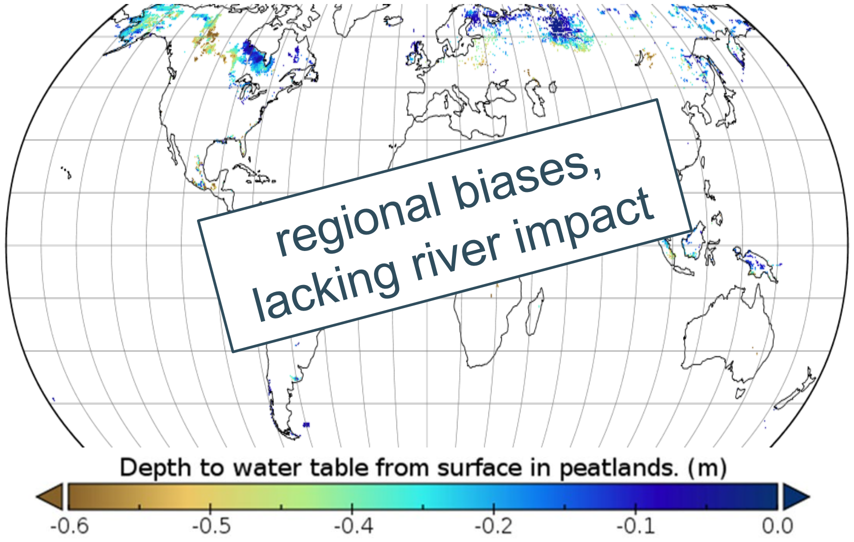
Boundaries: United Nations Geospatial, 2021. The boundaries and names shown, and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
Peatland distribution: Global Peatland Database, 2022.
Elevation: Jarvis et al. 2008. SRTM for the globe version 4.

UN environment programme

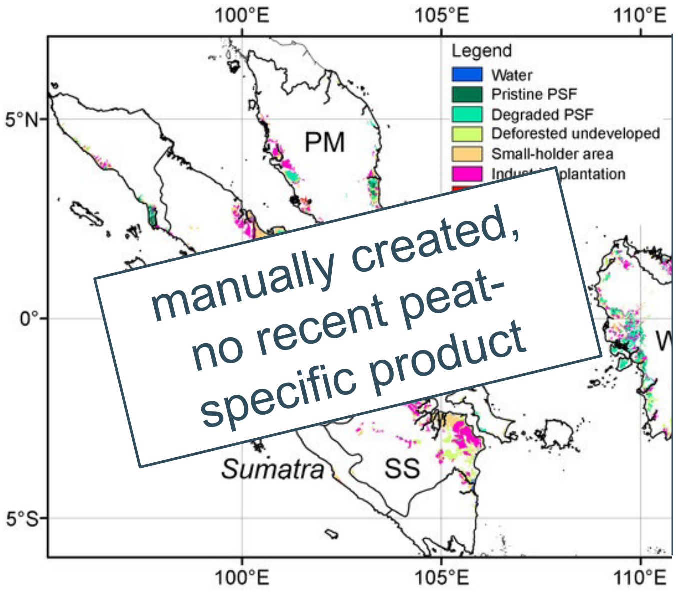
state-of-the-art



- Water table depth is main control of GHG balance in peatlands
- Strong connection between vegetation and hydrology



Reichle et al. 2023, SMAP L4 product

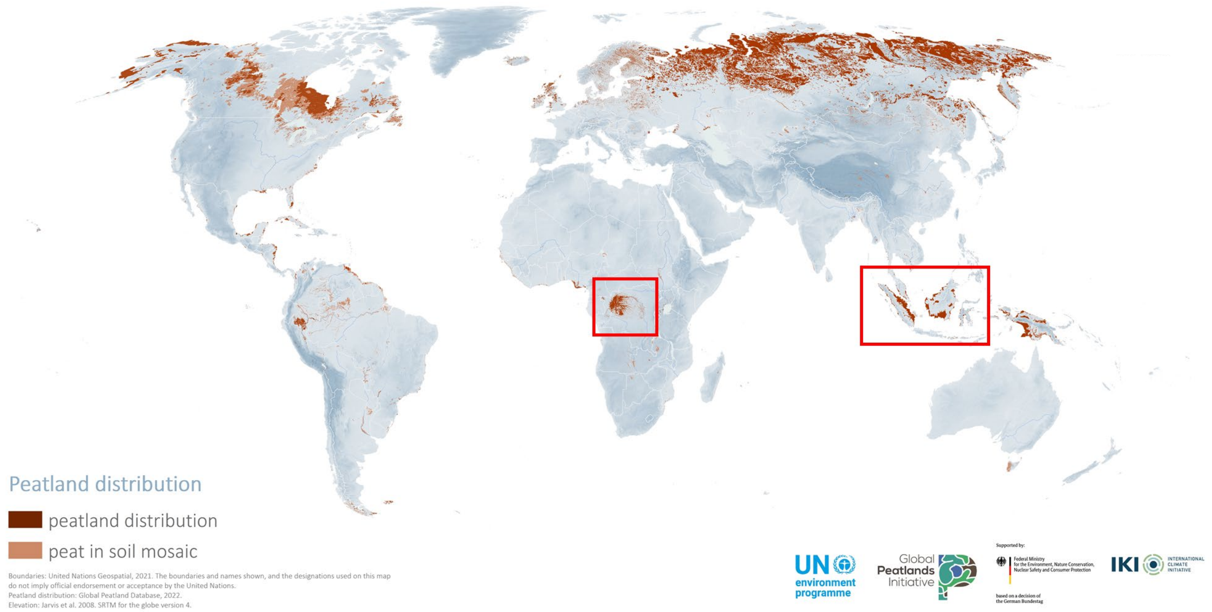


Miettinen et al. 2016, GEC

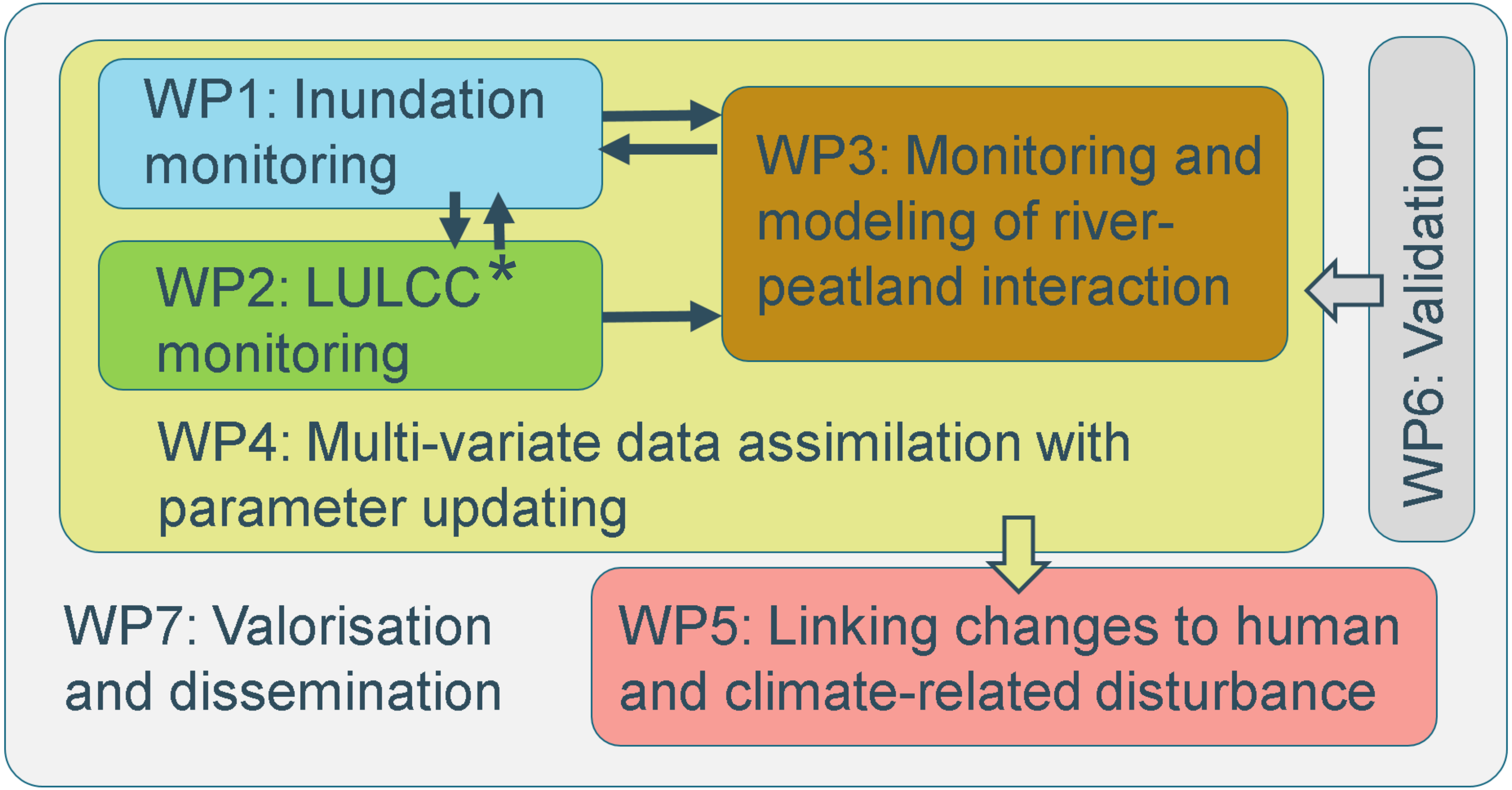
- Peatland-specific data assimilation product
- EO-based mapping of peatland land use land cover change (LULCC)

science objectives

- Enhancing the accuracy of peatland-specific monitoring
- Improving the process understanding in peatlands facing different types of human and climate disturbance



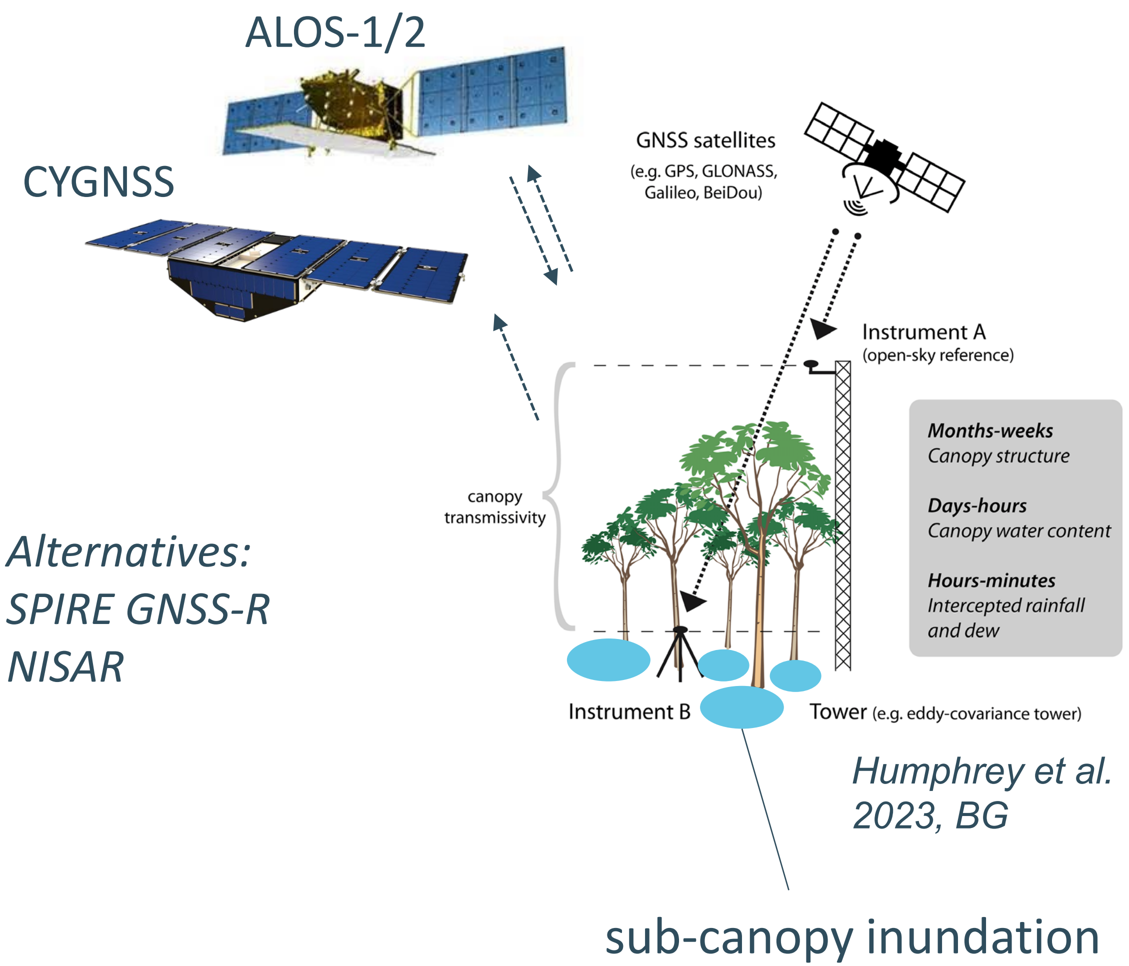
methodology



*LULCC: Land use land cover change

WP1: inundation monitoring

Goal: Monitoring inundation dynamics using L-band active microwave data



Humphrey et al. 2023, BG

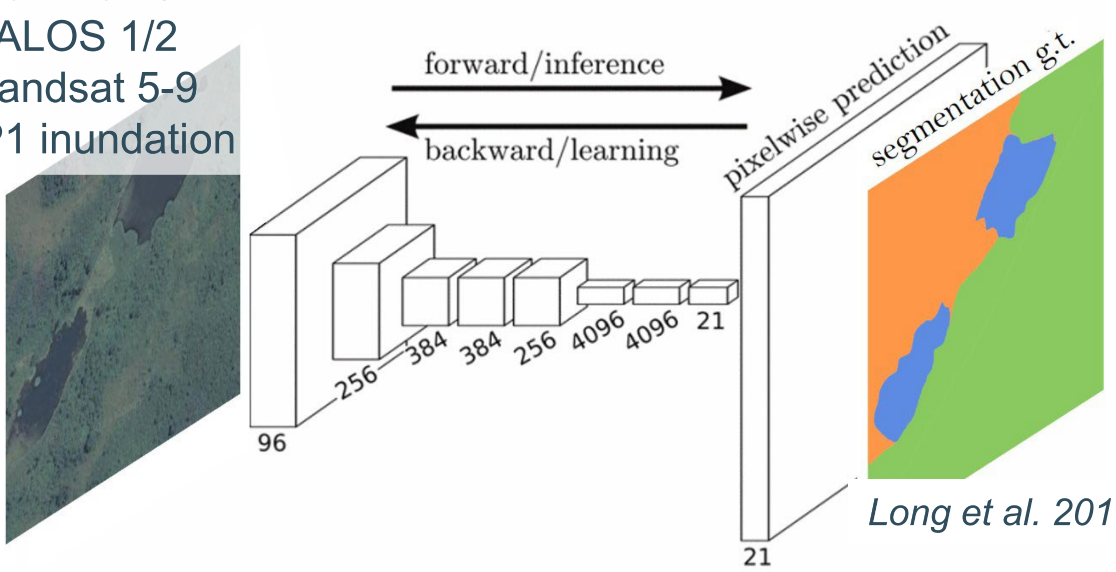
Alternatives:
SPIRE GNSS-R
NISAR

- GNSS-R and SAR
- Statistical vs. physics-based retrievals
  → use of full-wave radar modeling
- Validation:
  e.g., Brunei flux tower (International partner: Cobb)

WP2: LULCC monitoring

Goal: Near real-time peatland-specific LULCC monitoring

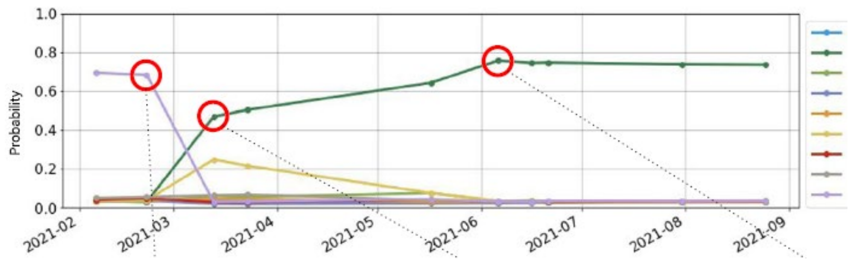
Sentinel 1/2
ALOS 1/2
Landsat 5-9
WP1 inundation



Long et al. 2015, CVPR

- Fully convolutional neural networks
- Use of 3D convolutional layers to capture both spatial and temporal features

→ Time series of class probabilities

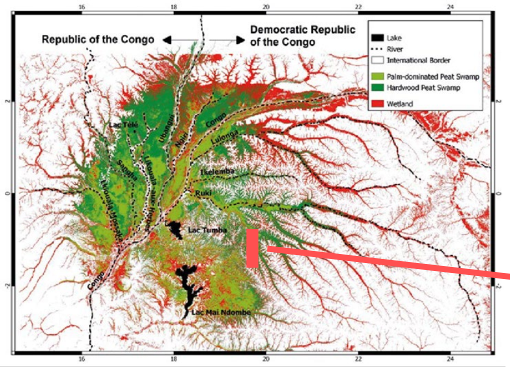


Water
Seasonal water
Pristine peat swamp forest
Degraded peat swamp forest
Tall shrub/secondary forest
Ferns/low shrub
Small-holder area
Industrial plantations
Built-up area
Clearance
Mangrove

After Brown et al. 2022, Sc. Data

WP3: river-peatland interaction

Goal: Monitoring and modeling of river-peatland interaction



300 km

WP1 sub-canopy inundation

SWOT

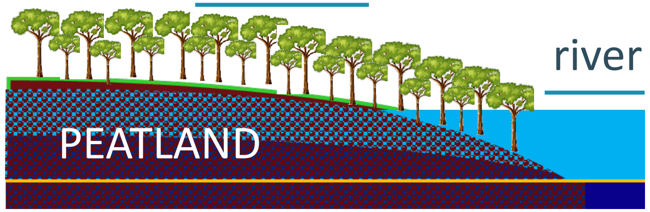
rain-fed peat

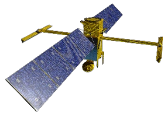
no impact

indirect impact

direct flooding

river

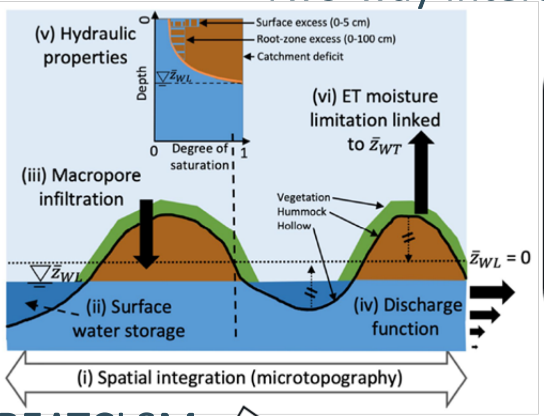




incorporation into models

- In synergy with development of wetland module in operational hydrological model for DRC (Tshimanga)

Two-way interaction

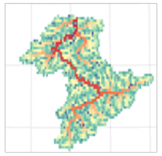


Tropical PEATCLSM

Bechtold et al. 2019, 2020

Apers et al. 2022

River routing

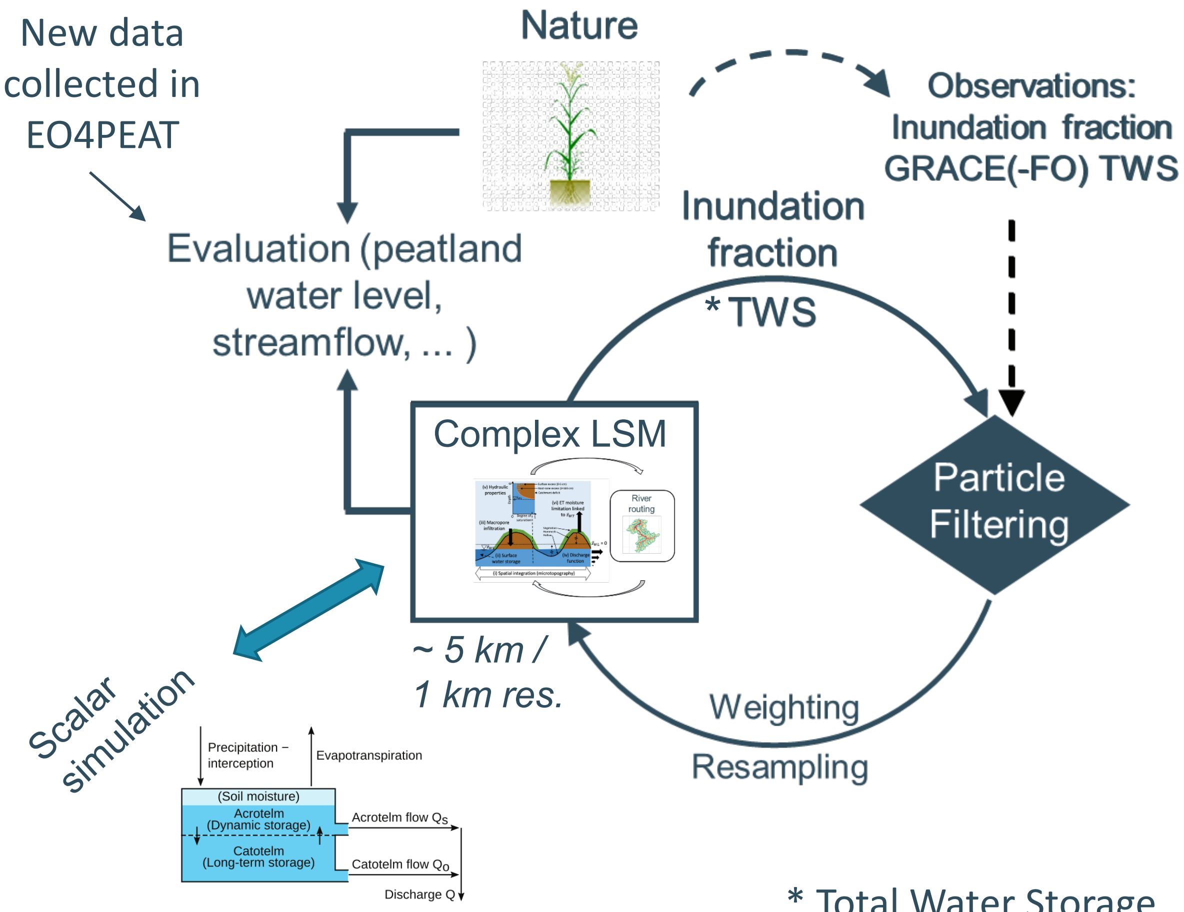


~ STEREO III,

Bechtold et al., 2024, JHM

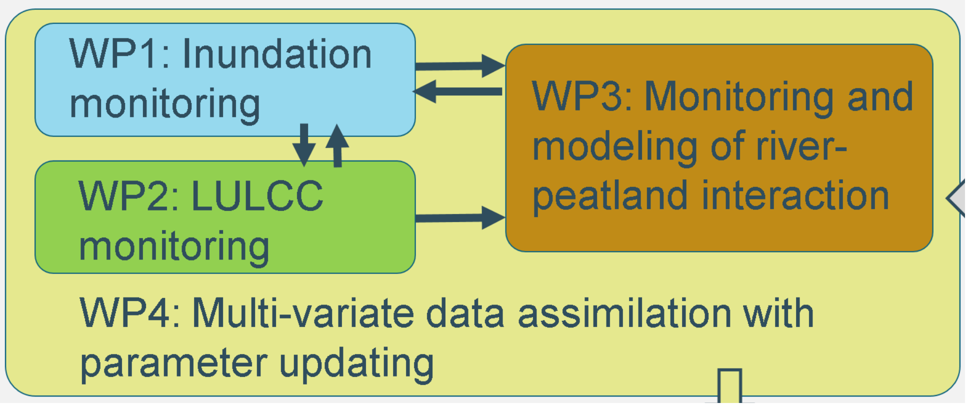
WP4: data assimilation

Goal: Gaining accuracy and insights from data assimilation with parameter updating



Cobb and Harvey 2019, WRR

* Total Water Storage (over Congo)



- Data assimilation without (or with low order) of prior rescaling of observations → Reduce spatially variable model bias

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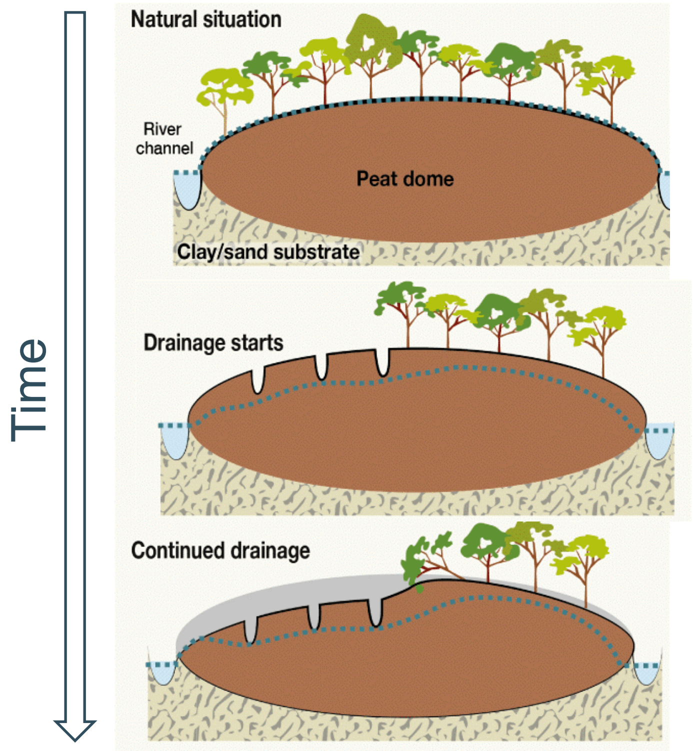
WP5: human and climate disturbance

Goal: Attributing changing conditions to the cause of disturbance

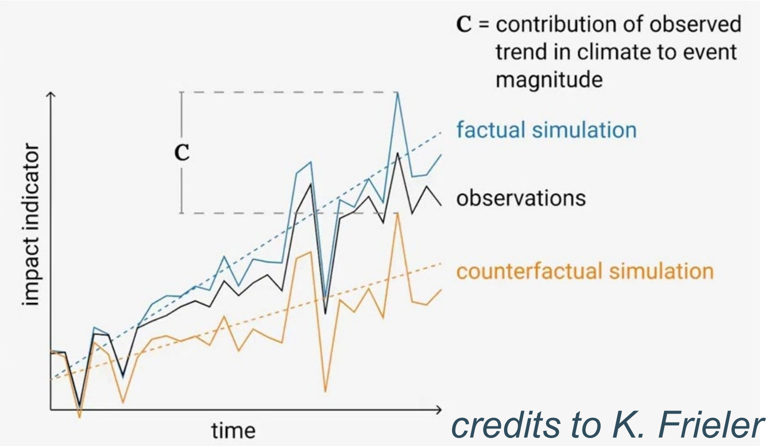
- Analysis of abrupt changes or trends in hydrology and vegetation

- Scenario-based separation of climate-related trends and direct human induced trends

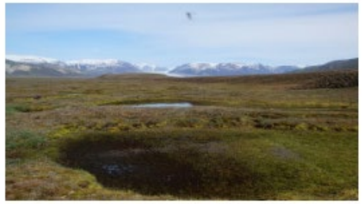


Avagyan et al. 2017, Env. Sci.

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project



credits to K. Frieler



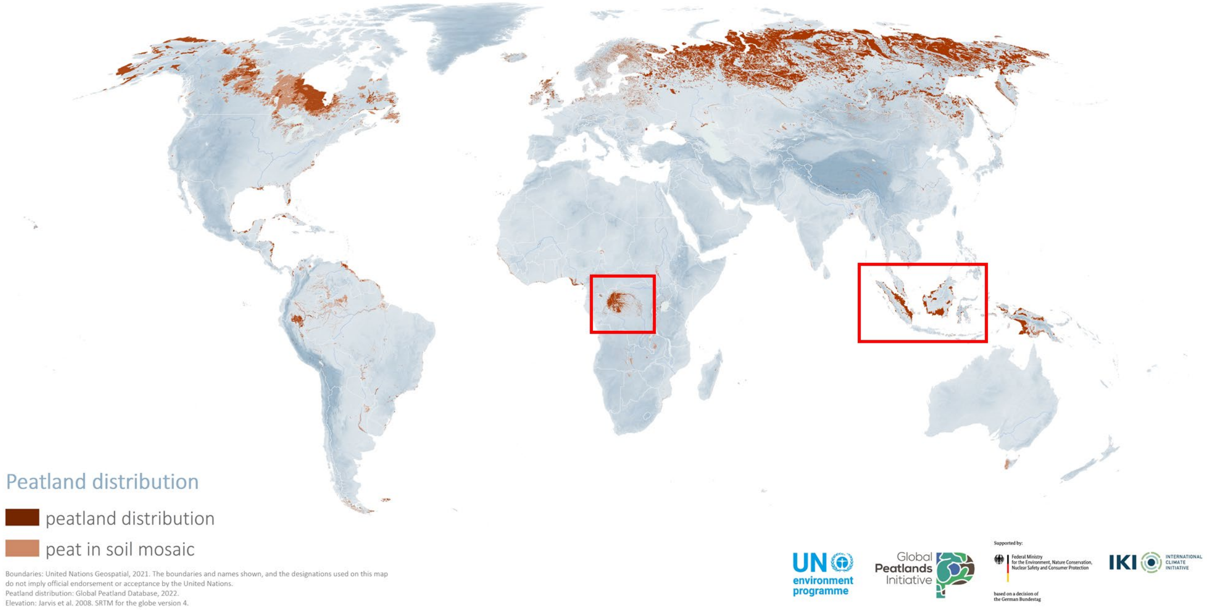
Peat
Sarah Chadburn
Angela Gallego-Sala
Noah Smith
Michel Bechtold

expected impact

Innovative exploitation of EO data for peatlands

- New datasets and tools
  (In situ data, sub-canopy inundation, LULCC, modeling and DA)
- Insights into changes in hydrology and vegetation and their interplay
- Communication to academic and policy/broad public sector for optimized climate action

GitHub



Global Peatlands Initiative

esa
European Space Agency

MINISTÈRE DE L'ENVIRONNEMENT ET DÉVELOPPEMENT DURABLE

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

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research team

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KU LEUVEN


Peatland research
Land surface modeling
Data assimilation

Patrick Willems

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River hydrology and hydraulics
Regional hydrological modeling

Frieke Van Coillie

GHENT UNIVERSITY

Object-Based Image Analysis / LULCC
Remote Sensing

Sébastien Lambot

UCLouvain

Radar electromagnetic modeling
Inverse modeling

Raphael Tshimanga

CRREBaC

Monitoring and modeling of Congo basin hydrology

Alex Cobb

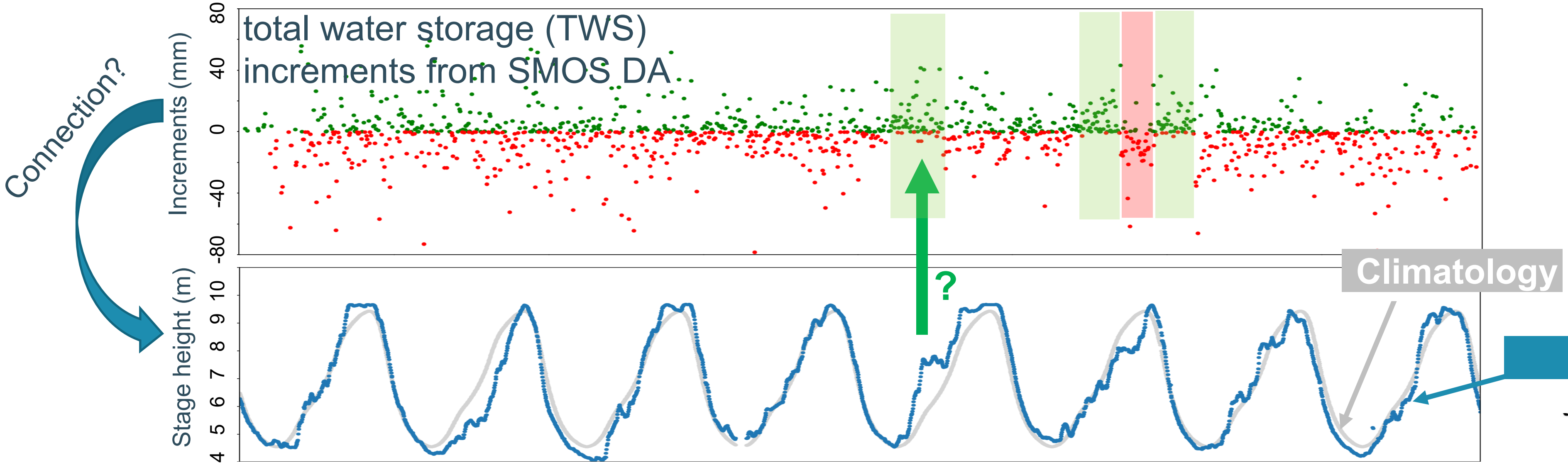
SMART Singapore-MIT Alliance for Research and Technology

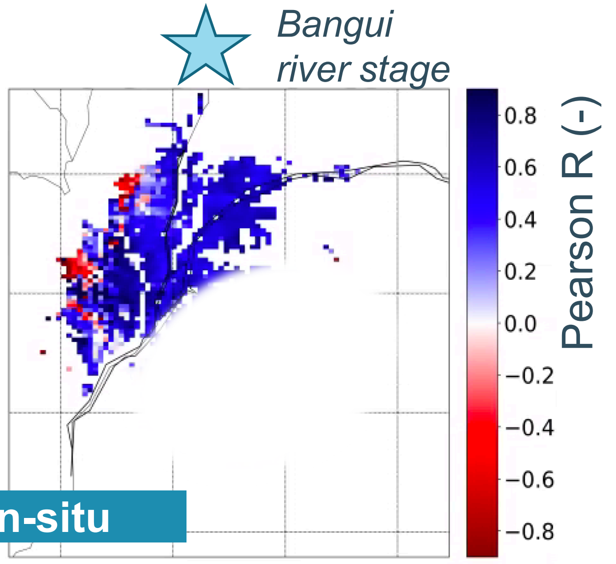
Peatland research
Monitoring and modeling of Southeast Asian peatlands

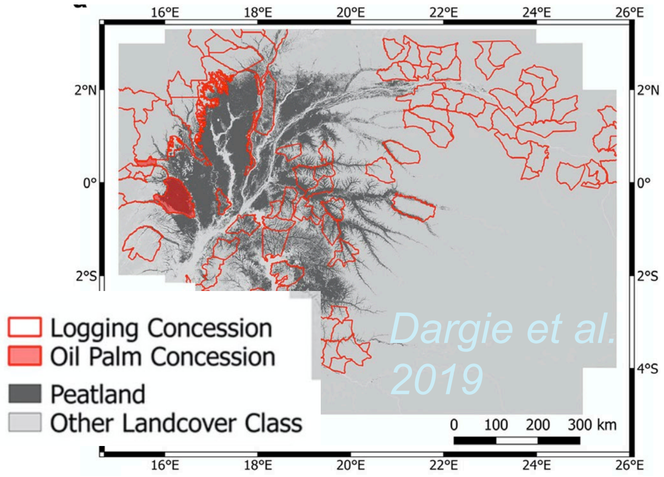
Thanks for your attention!

Extra slides

Quantifying ground/surface water influence







DA diagnostics (SMOS) suggest

- influence of river stage height anomalies on peatland water tables
- possible drainage

Apers et al. (2024), in prep

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