Mapping Drainage Canals in Southeast Asian Peatlands and their Implications for Peatland Degradation

Nathan C Dadap[1*], Alexander R Cobb[2], Alison M Hoyt[3,4], Krishna K Rao[1], Charles F Harvey[5], and Alexandra G Konings[1]

EGU2020-12505

*ndadap@Stanford.edu, (1) Stanford University, (2) Singapore-MIT Alliance for Research and Technology, CENSAM, (3) Max Planck Institute for Biogeochemistry, (4) Lawrence Berkeley National Laboratory, (5) Massachusetts Institute of Technology

Stanford University

EGU General Assembly 2020

Remote Sensing Ecohydrology Group

Background

- Local hydrology mediates carbon storage dynamics in tropical peatlands
- Southeast Asian peatlands have experienced 30 years of extensive land use change, creating drainage canals that dry out peat soil
- Drainage alters peatland hydrology, leading to peat oxidation, causing carbon flux and subsidence, increased fire risk, and transport of dissolved organic carbon

➢ **There is a need to quantify drainage intensity and extent**

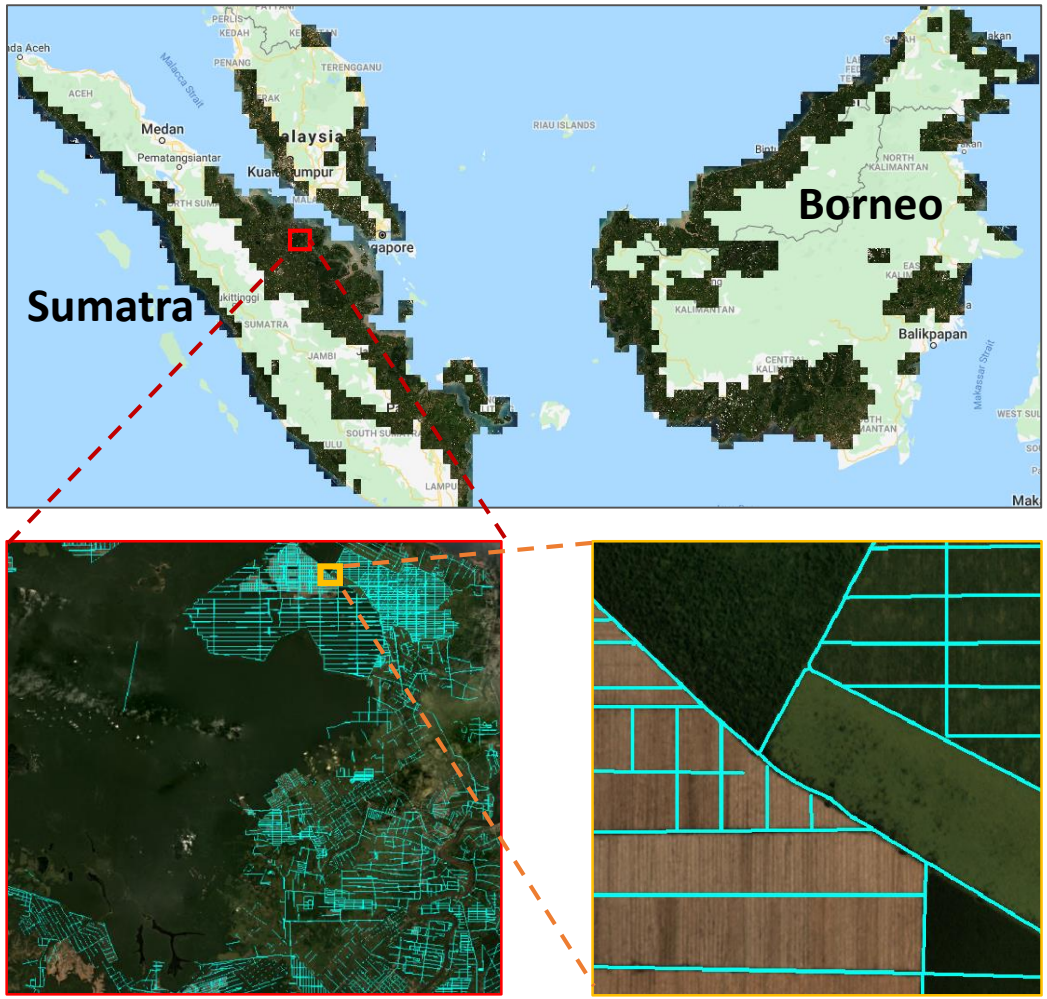
Project aims

1. Quantify extent of hydrologic disturbance by mapping drainage canals in Southeast Asian peatlands
2. Understand how drainage differs between land use classes
3. Determine if drainage is related to subsidence/CO_2 flux at large scales

Satellite data was labeled to create training and validation data

- 5 meter resolution Planet Basemaps product[1] is a mosaic of satellite images from 2017 with reduced cloud cover
- With no up-to-date canal maps, we manually labeled 2500 km^2 spanning multiple land use types
- 100 km^2 of labeled data was set aside for testing out of sample accuracy ("test set")

Planet Basemaps imagery in Southeast Asian peatlands

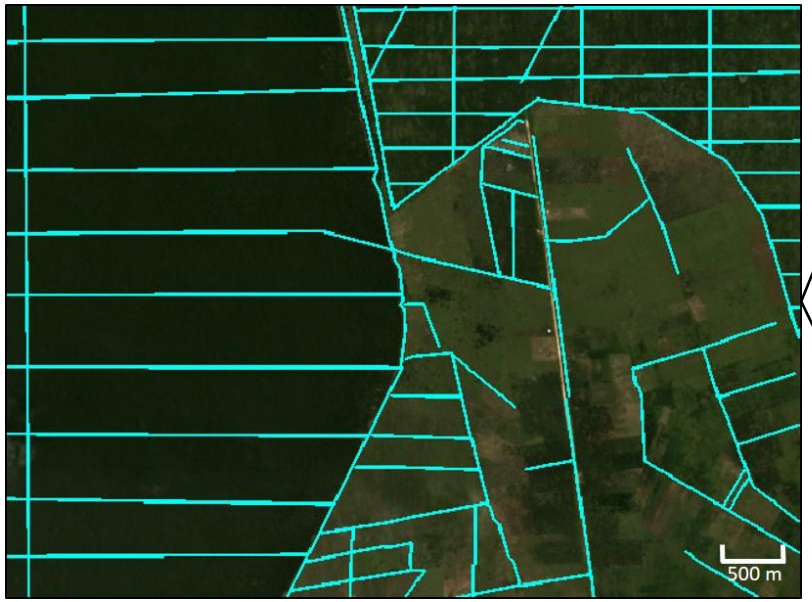


Labeled imagery (canals in turquoise), Sarawak, Riau, Indonesia

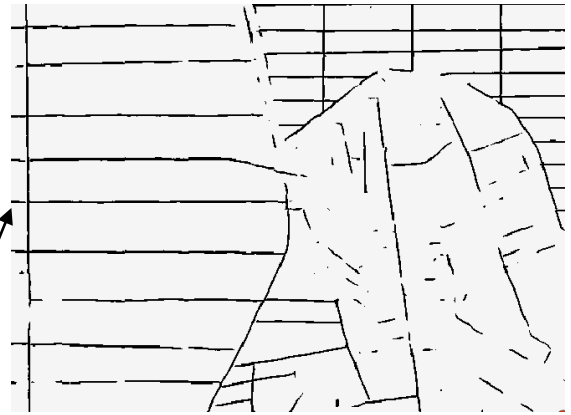
[1]Planet Team, 2017, *Planet Application Program Interface: In Space for Life on Earth*.

Machine learning model used to classify drainage canals

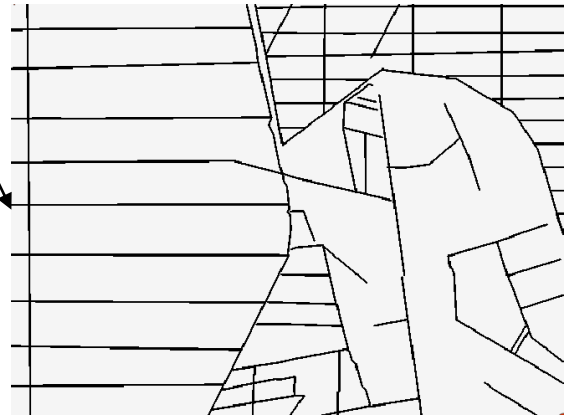
- Fully convolutional neural network (U-Net architecture[2]) used for classification
- Similar models have been used for road mapping tasks
- Trained model was applied to all imagery in SE Asia peatlands



Labeled canals in test area
Riau, Sumatra



Classification result

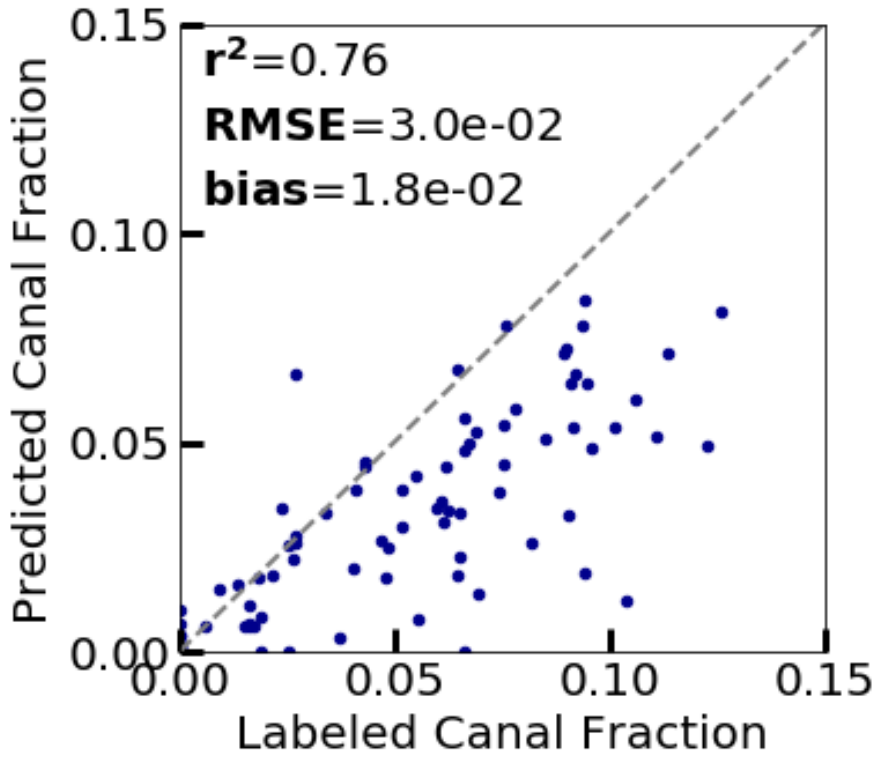


Labels

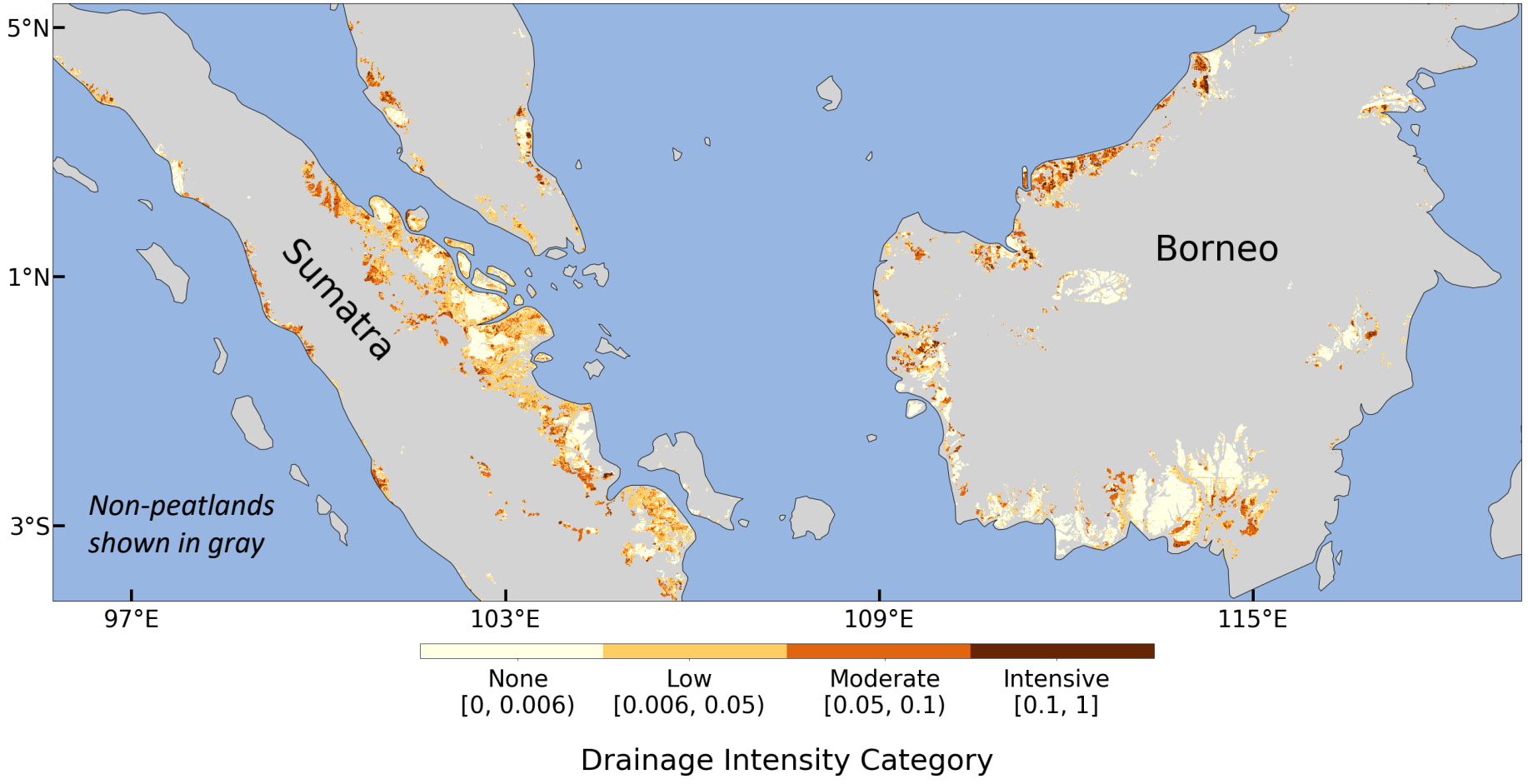
[2]Ronneberger, et al., 2015, *Lecture Notes in Computer Science*.

Classification is biased low, but works reasonably well

- Overall accuracy of 97%
- Data was aggregated to 1 km for validation analyses
- Validation data was labeled by different person to account for possible labeler bias
- Dense vegetation or canals narrower than 5 meters may cause false negative classification



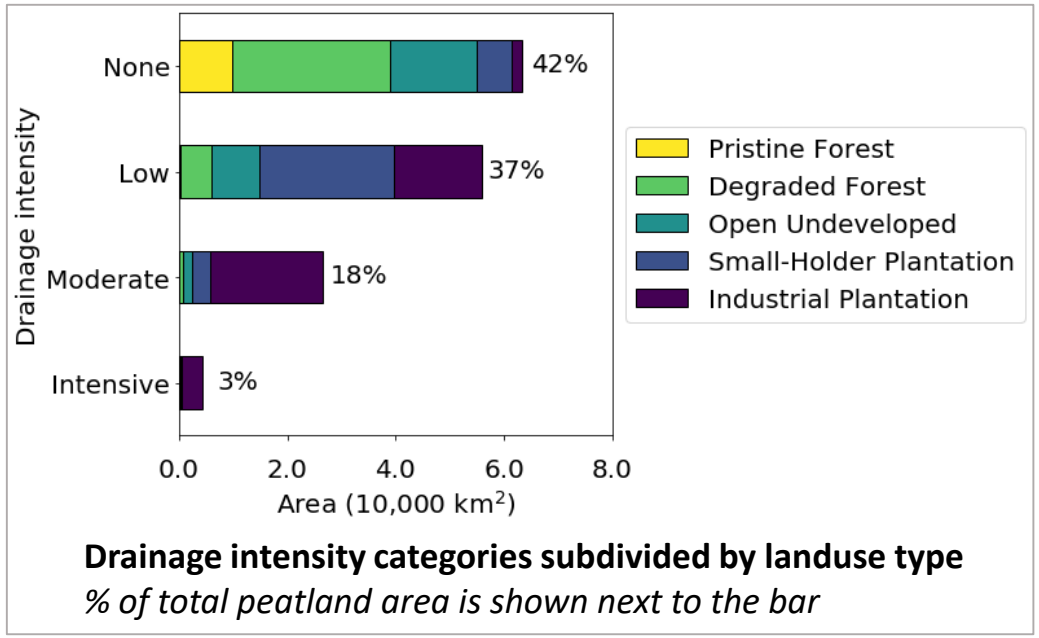
Drainage intensity categorized by canal area density



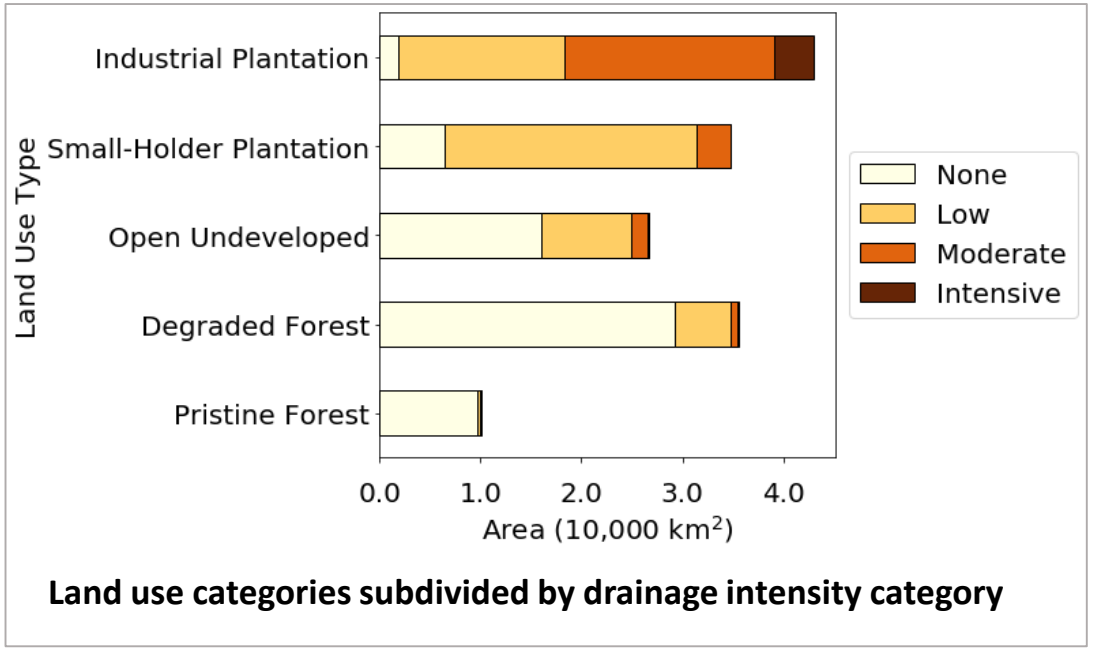
- Drainage categories were defined by canal area at 1 km resolution
- “None” category accounts for false positives in classification
- At least 58% of regional peatlands are drained

Drainage intensity is related to land use

- Drainage intensity was compared to 2015 land use maps[3]
- Majority of moderate and intensively drained areas are industrial plantations



Drainage intensity categories subdivided by landuse type
% of total peatland area is shown next to the bar



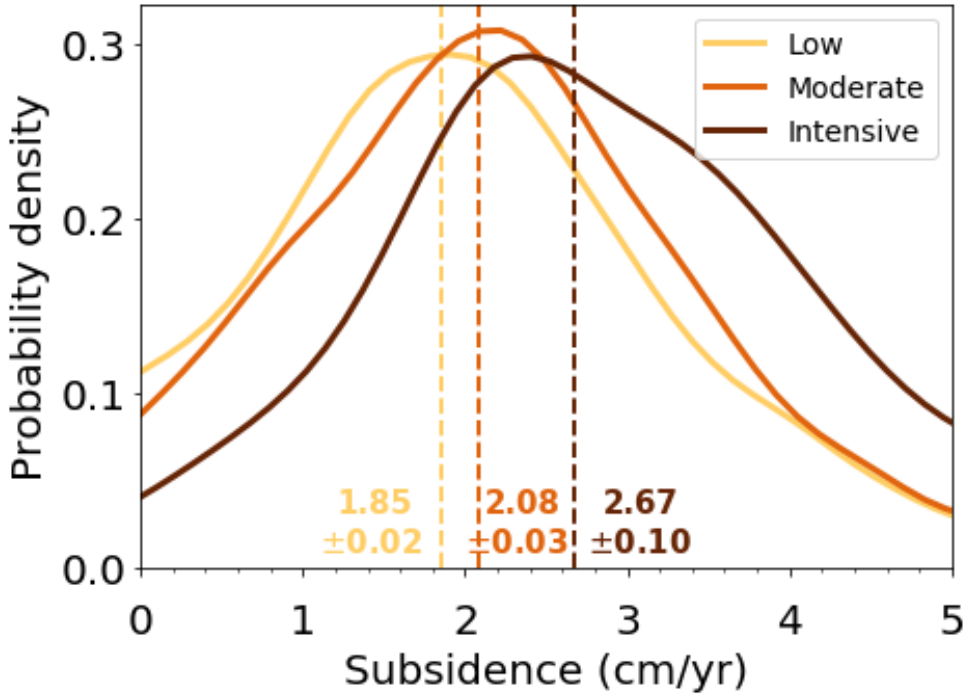
Land use categories subdivided by drainage intensity category

- Land use categories show diversity in hydrologic disturbance
  - ➢ **Can't assume one-to-one relationship between drainage and land use type**

[3]Miettinen et al., 2016, *Global Ecol. and Cons*.

More intensive drainage correlates with higher subsidence

- Subsidence rates are related to water table depth at individual sites
- To test relationship at regional scale, we compared 2017 drainage intensity to InSAR-based subsidence measurements[4] from 2007-2011
- Median subsidence rates were 0.82 cm/yr (or 1.4x) greater in areas with *Intensive* vs *Low* drainage intensity



Probability distributions of subsidence grouped by drainage intensity. Dashed vertical lines show median subsidence and standard error for each distribution. Positive subsidence denotes downward ground surface displacement or net CO_2 release to the atmosphere.

[4]Hoyt et al., 2020, *Nature Geoscience*, accepted.

Main findings

- A map of drainage canals will soon be available across Southeast Asian peatlands
- Drainage is widespread - at least 58% of peatlands are drained
- Drainage intensity is related to land use, but broad land use classes do not capture wide range of hydrologic disturbance
- Drainage is correlated with subsidence and carbon flux at large scales