Detecting floods from space: the advantages of high resolution and high temporal Planet images.

Social [Pixel] Lab

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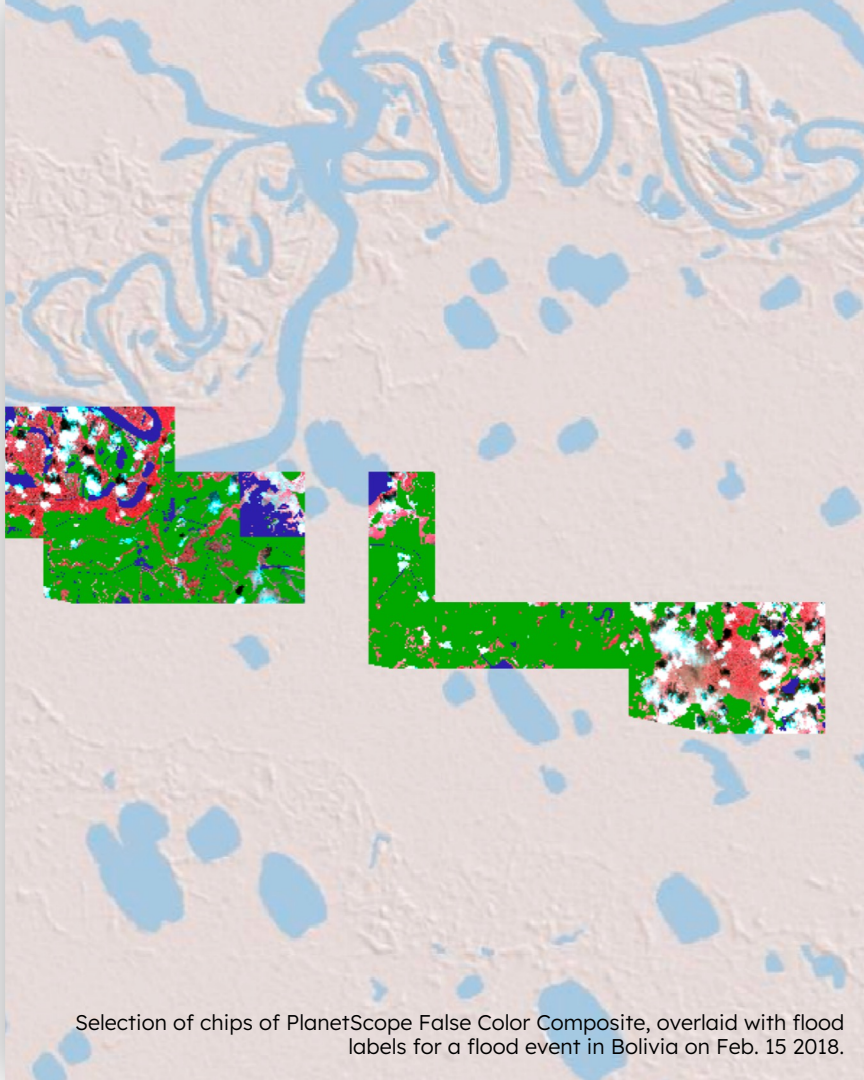
NASA



Selection of chips of PlanetScope False Color Composite, overlaid with flood labels for a flood event in Bolivia on Feb. 15 2018.

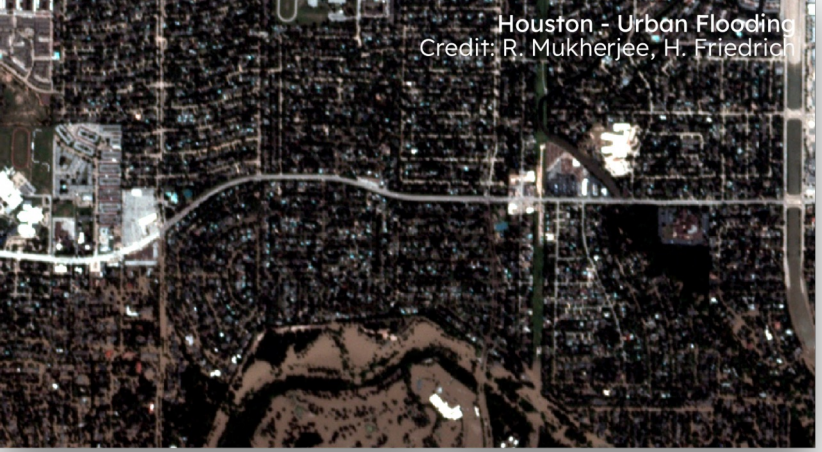
Using satellites to improve flood risk estimates, enable insurance expansion, and promote environmental justice

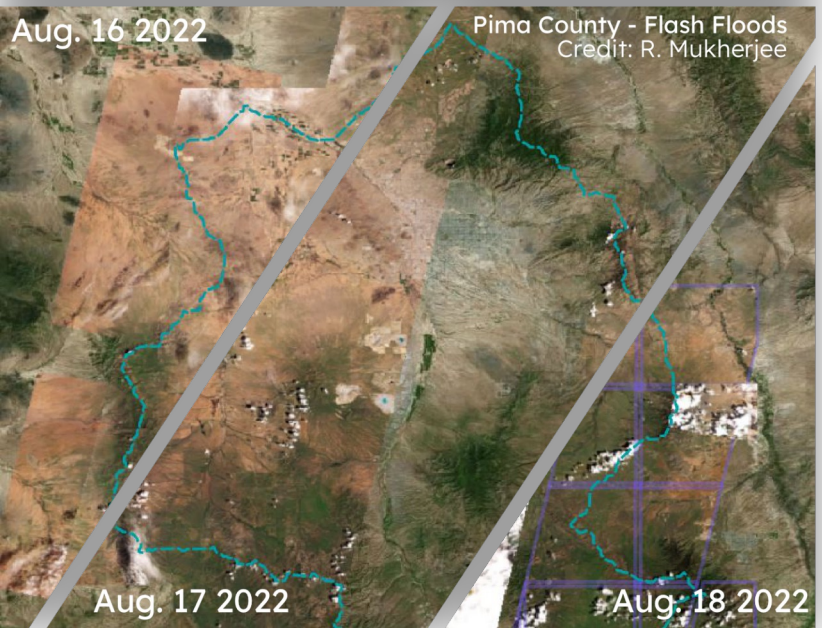
97% of flood risk is uninsured Tellman et al, 2021

Millions at risk of flooding Tellman et al, 2021

Asia lost 48 billion USD in agricultural production from 1980-2013 (60% due to floods) FAO 2015

Mitigation requires to detect floods from space





Planet: Provides High Resolution and High Temporal Optical Imagery

Floods need to be captured in time and space

Coarse resolution (> 10 meters): does not capture flood details (e.g. urban areas)

Low satellite revisit time: unable to capture peak flood, miss flood completely, captured days under clouds

Planet: near **daily** near **global** image cover, at **high spatial resolution** (3 meters)

Social [Pixel] Lab: Planet used in 3 ways

Detect Rapid Floods and Flood **Peaks**

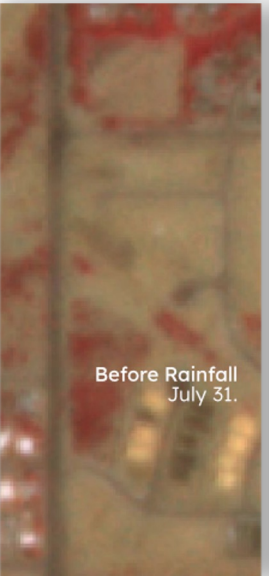
E.g. Flooding in the desert (Pima County)

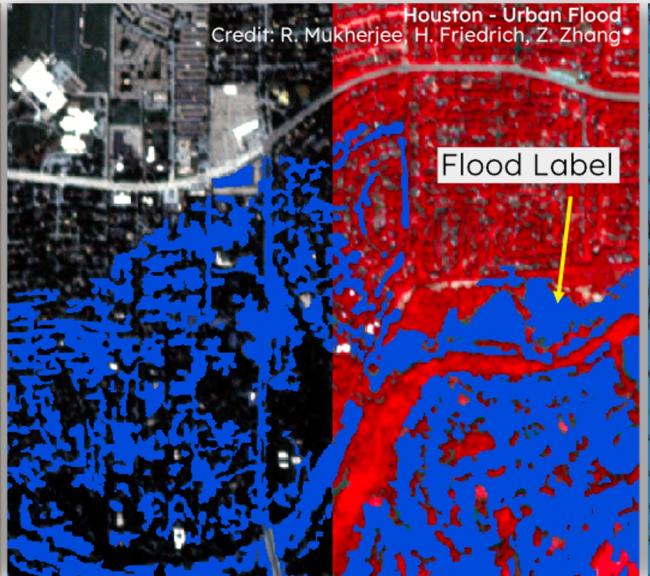
Detect floods in **complex** areas

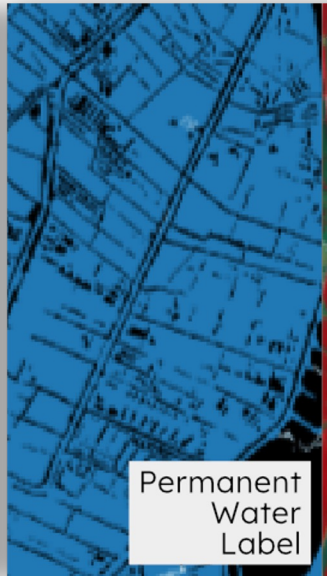
E.g. Urban floods

Validate other sensors and models

E.g. Sentinel-1 images, threshold and machine learning based models

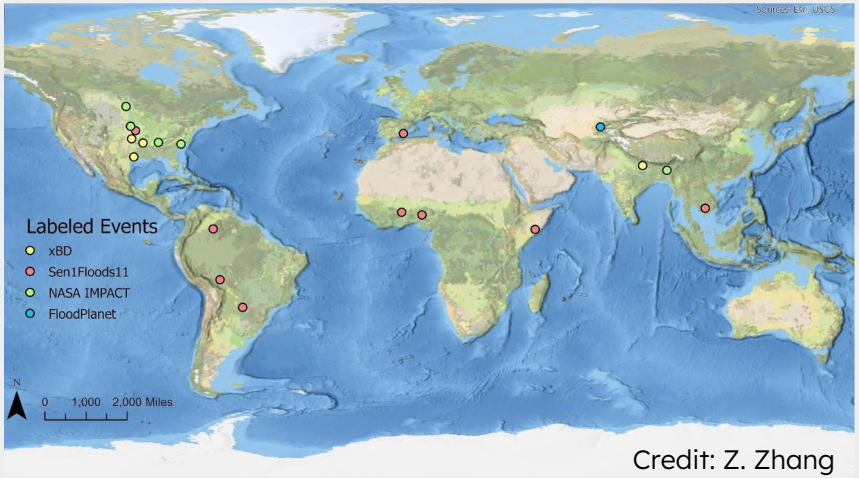






Common methodology: Machine Learning

Requirement: label flood/water extents



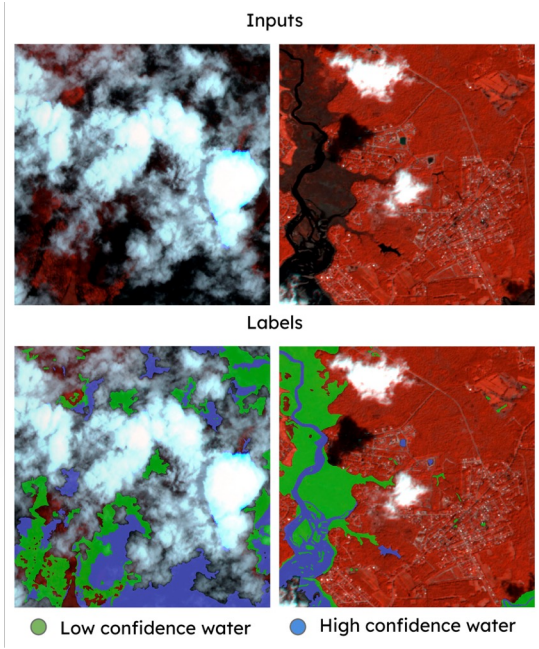
Credit: Z. Zhang

Permanent Water Sites

Credit: R. Mukherjee, R. Wang

We labeled:

- >600 Flood chips
- 33 flood events
- 90 Permanent Water chips

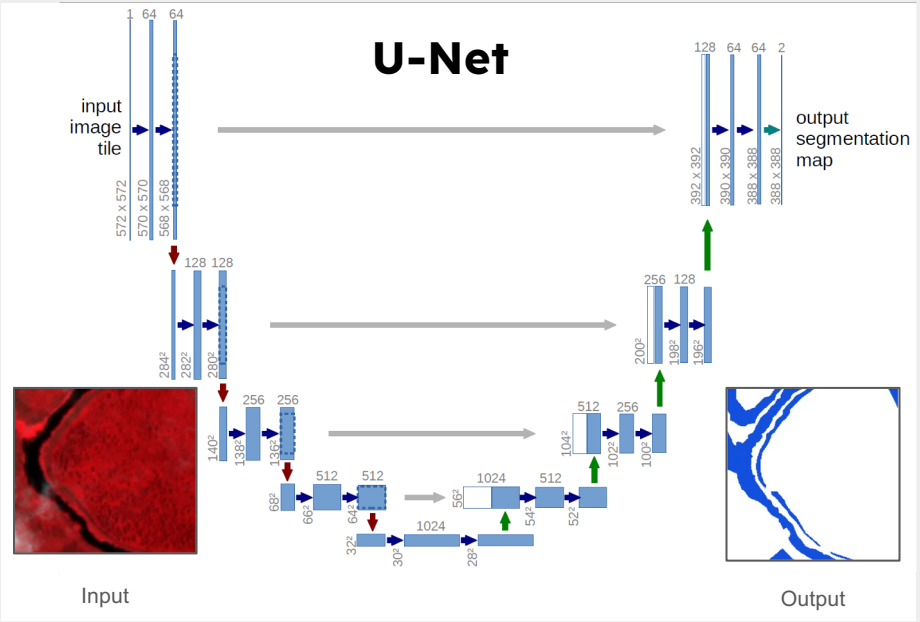


Credit: Z. Zhang

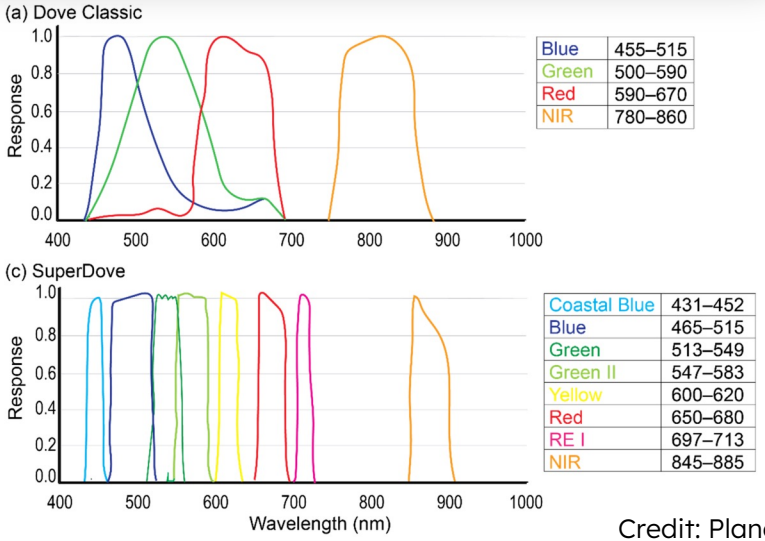
Machine Learning

Deep Learning: uses all planet bands to infer flood extent

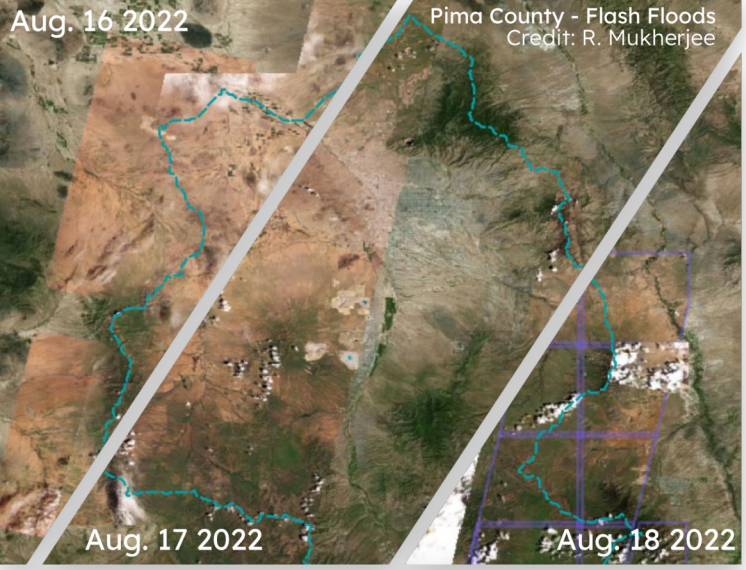
U-Net: one possible deep learning architecture that uses convolutions to infer spatial context

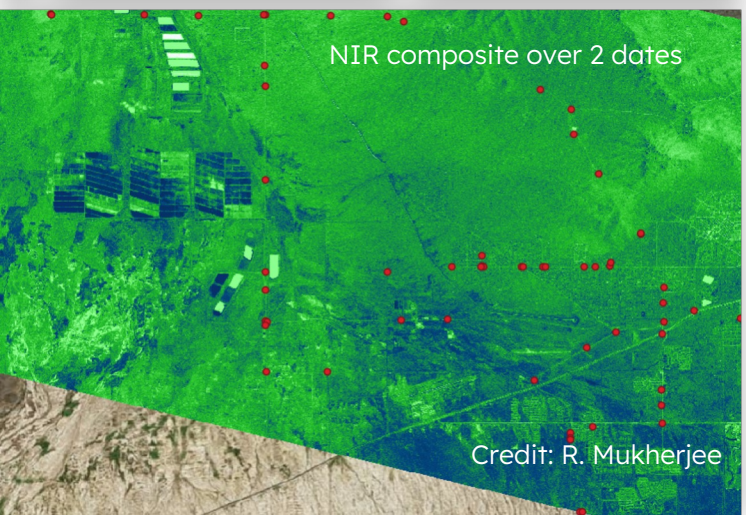


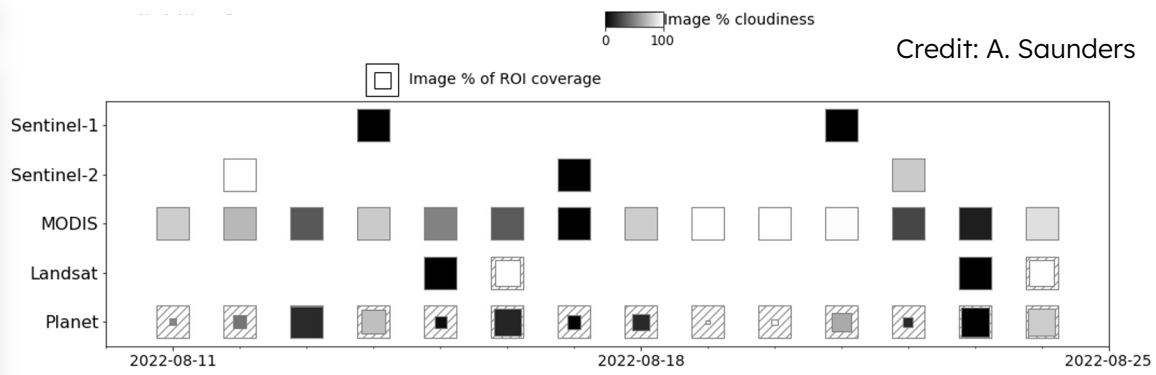
Credit: R. Mukherjee



Credit: Planet.com







Credit: A. Saunders

Detect Rapid Floods and Flood Peaks

Publicly available satellites have a longer revisit time

Planet: higher temporal frequency

- Allows to capture change
- High probability to have an image with less clouds
- Higher probability to detect maximum flood extent (peak)

Here: Pima county floods - water recesses rapidly

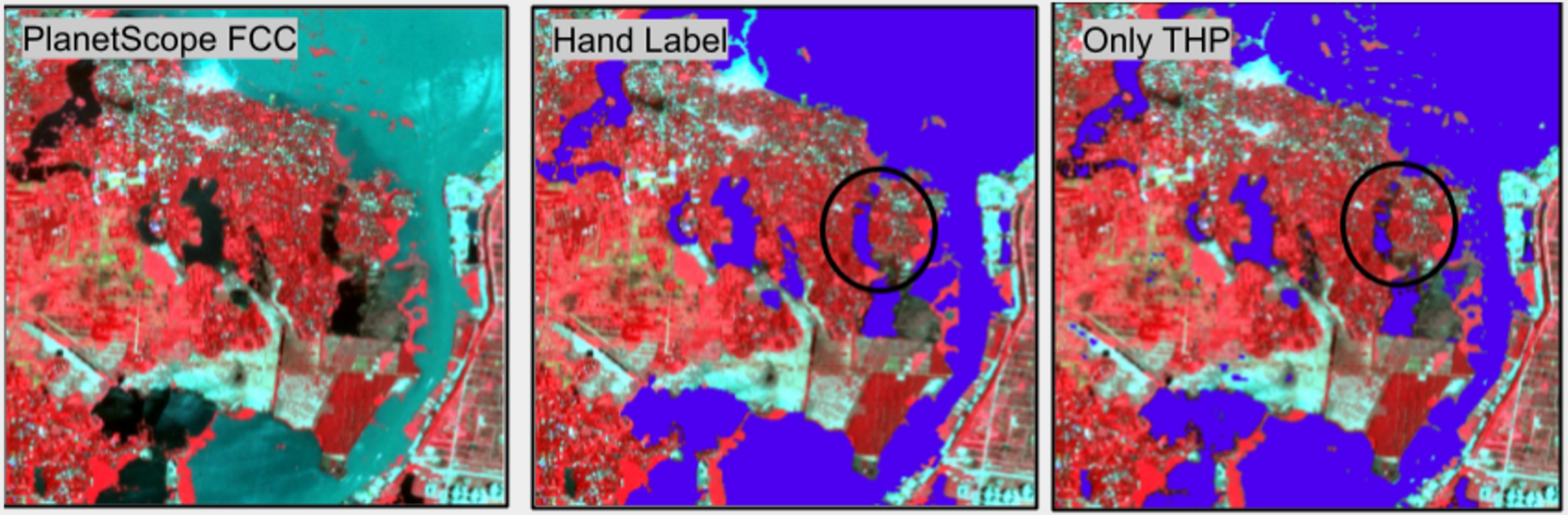
Floods in complex areas

Floods in complex terrain is hard to detect

- Urban areas
- Complex landscapes

Planet allows to model small scale features

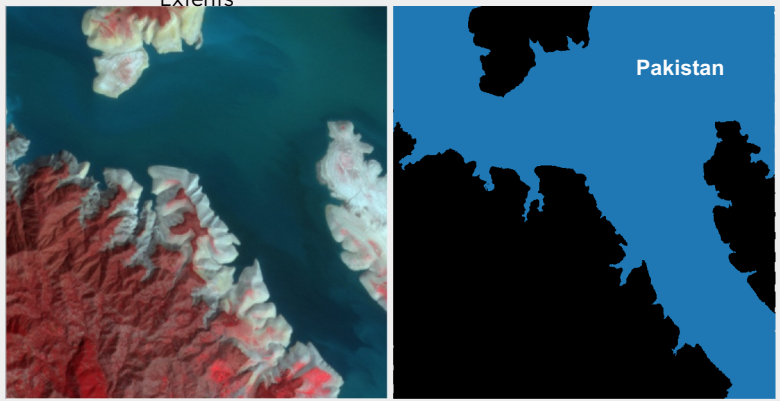
Outperforms other remote sensing products in accuracy



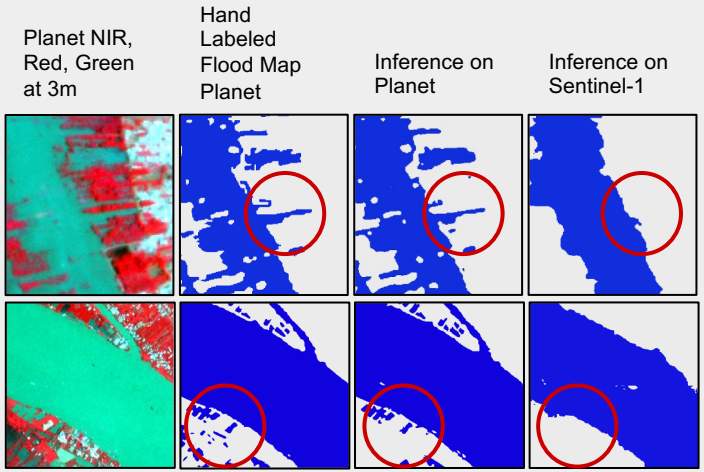
Credit: R. Mukherjee

Validate Permanent Water Extents

Credit: R. Mukherjee, R. Wang



Compare Planet Algorithm with Sentinel-1 Algorithm

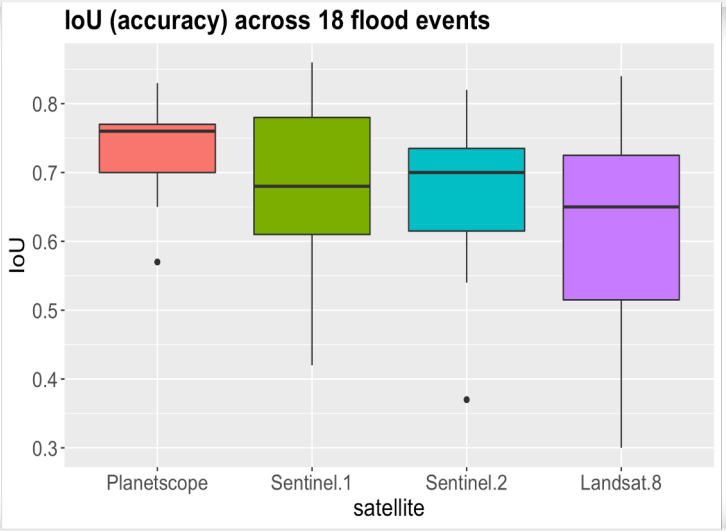


Floods in **Sudan**, 25th August, 2020

Credit: R. Mukherjee, Z. Zhang

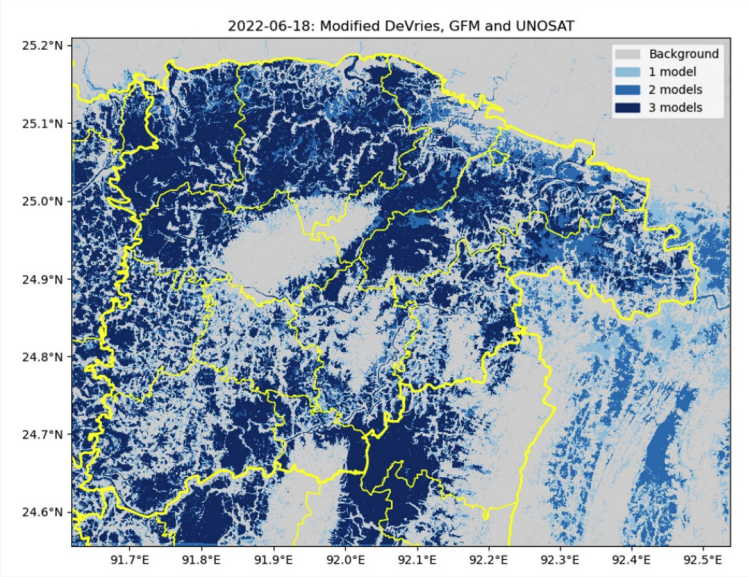
Validation for other sensors and methods

High resolution Planet labels to benchmark permanent water detection models

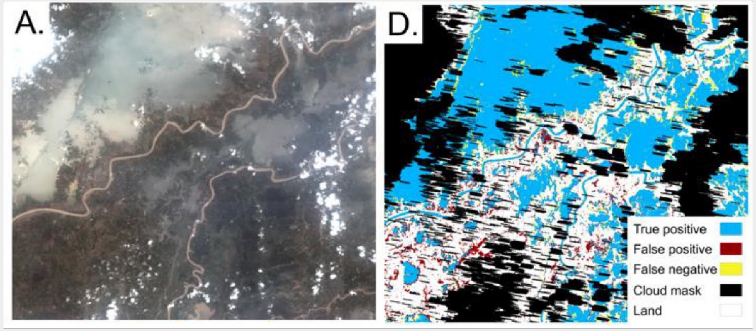


Planet:

- 5-13% more accurate
- 2-3x more consistent



Credit: A. Saunders



Credit: T. Mitchell et al., IEEE JSTARS 2023

Application: Validating Global Flood Algorithms for Insurance

Global and local algorithms need **validation**

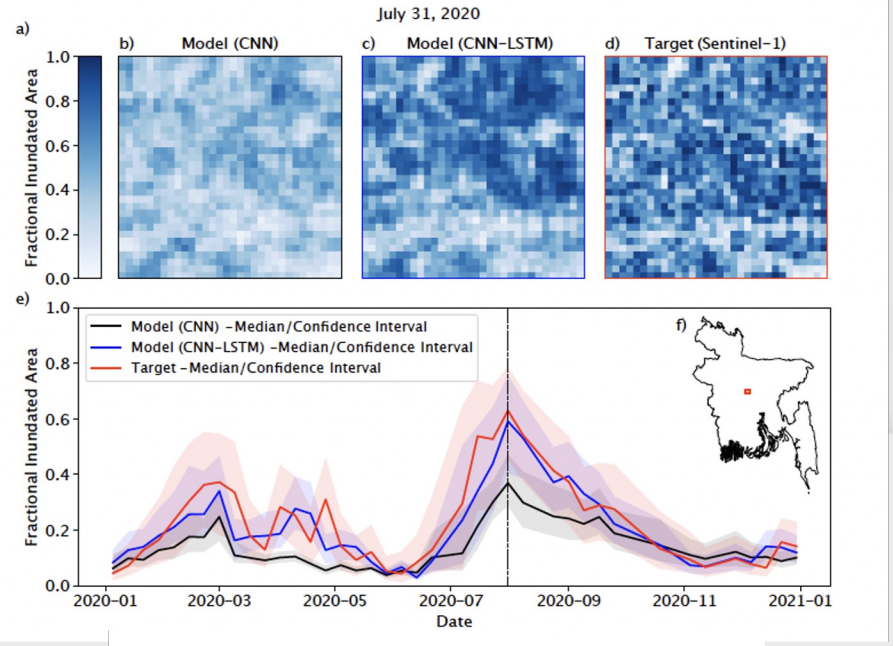
Compare multiple algorithms based on **Sentinel-1** (radar satellite, “sees” through clouds)

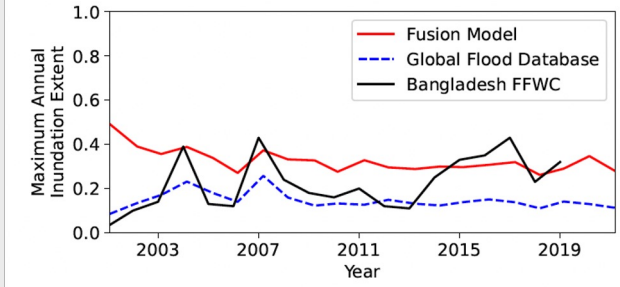
Validate algorithms with high-resolution **Planet** data on cloud free days

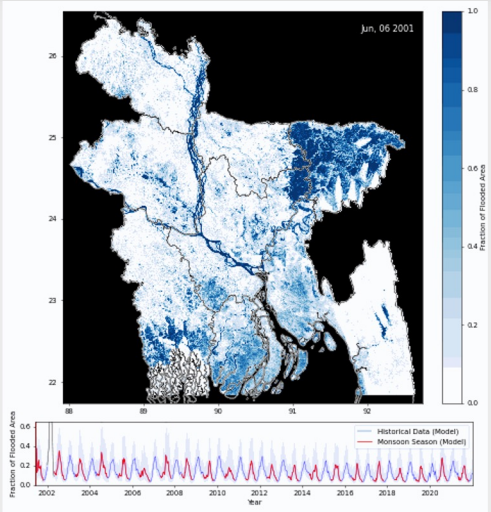
Flood Algorithms for Insurance In Bangladesh (NASA Early Investigator Award)

Uses a CNN-LSTM to fuse MODIS and Sentinel-1, R2 values .62-.72, compared to .55-.63 with CNN alone

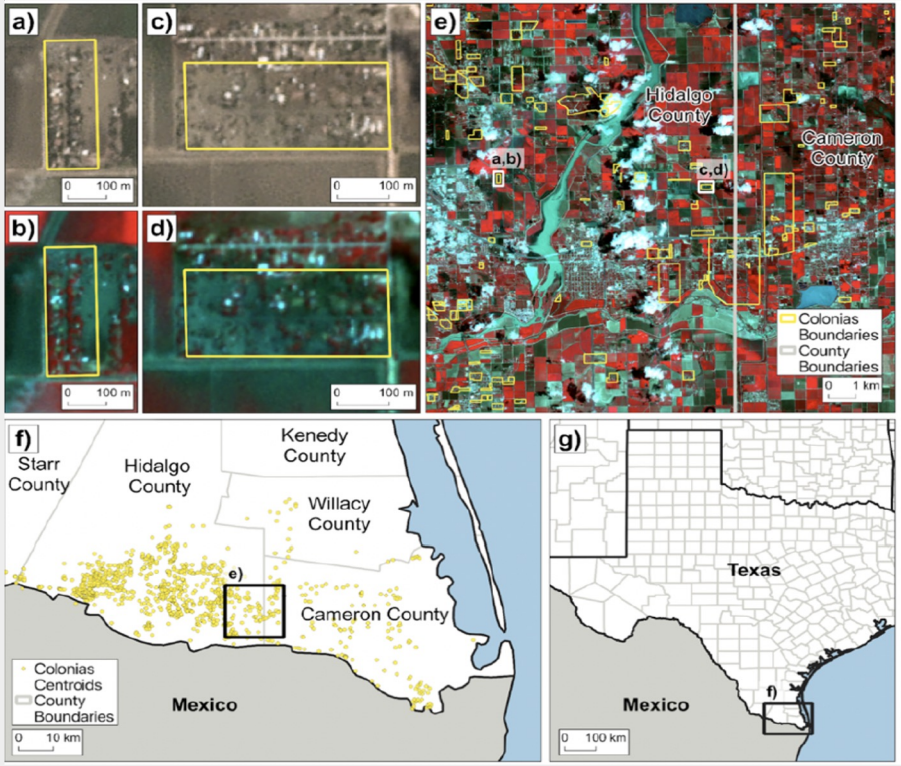
20 years **historical** flood mapping for **return period estimates** over Bangladesh reduces uncertainty and could lower insurance premiums







Giezendanner, et al. Accepted. “Inferring the Past: A Combined CNN–LSTM Deep Learning Framework to Fuse Satellites for Historical Inundation Mapping.” *CVPR*, Earth Vision 2023



Credit: L. Belury, H. Friedrich

Application: Challenging Flood Injustice through Co-Produced Geospatial Knowledge

Environmental Justice (as a verb!)

Map chronic floods in the Rio Grande Valley

Collaborate with **Texas Rio Grande Legal Aid**

- Advocates for flood mitigation and **sued** FEMA for discrimination against Hispanic communities

Why Flood Maps from Planet?

- Important to map maximum extent
- Complex structures

Thank you for your attention!

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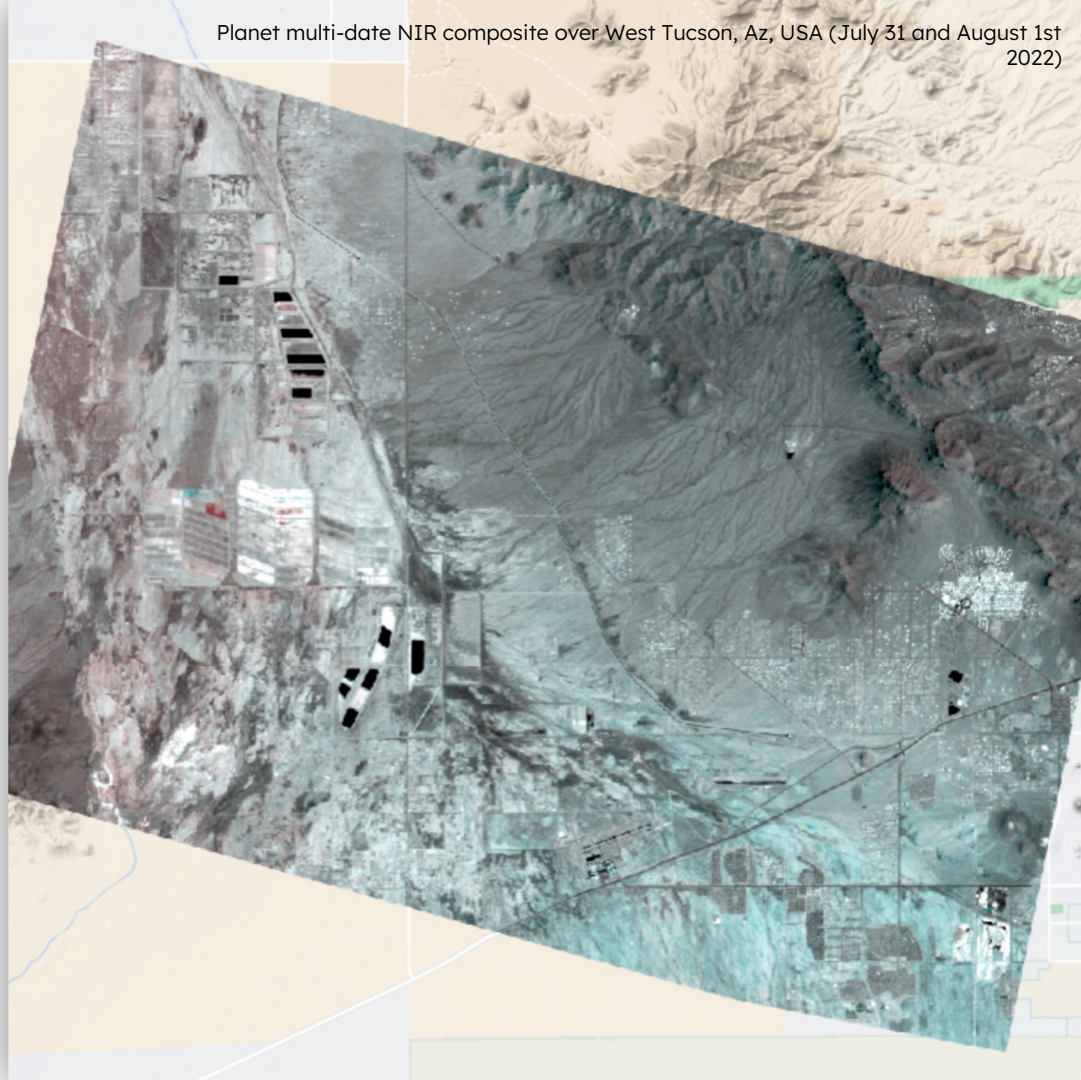

Planet multi-date NIR composite over West Tucson, Az, USA (July 31 and August 1st 2022)