

ITC: June 8th

# Capacity Building and Knowledge Sharing through NASA SERVIR's TensorFlow Working Group

Tim Mayer, NASA SERVIR Regional Science Coordination Lead - Hindu Kush Himalaya



- 
- SERVIR
  - Capacity Building
  - TensorFlow Working Group
  - Applications
  - Opportunities
  - Discussion

# Who is SERVIR?



- Poverty reduction and resilience
- Data-dependent issues in data-scarce places
- International field presence



- 30+ Earth observing satellite missions, free & open data policies
- Major research portfolio
- Societal benefit from space

## Regional Hub Host Institutions:



## Hub Consortium Members:



## Private sector collaborators:



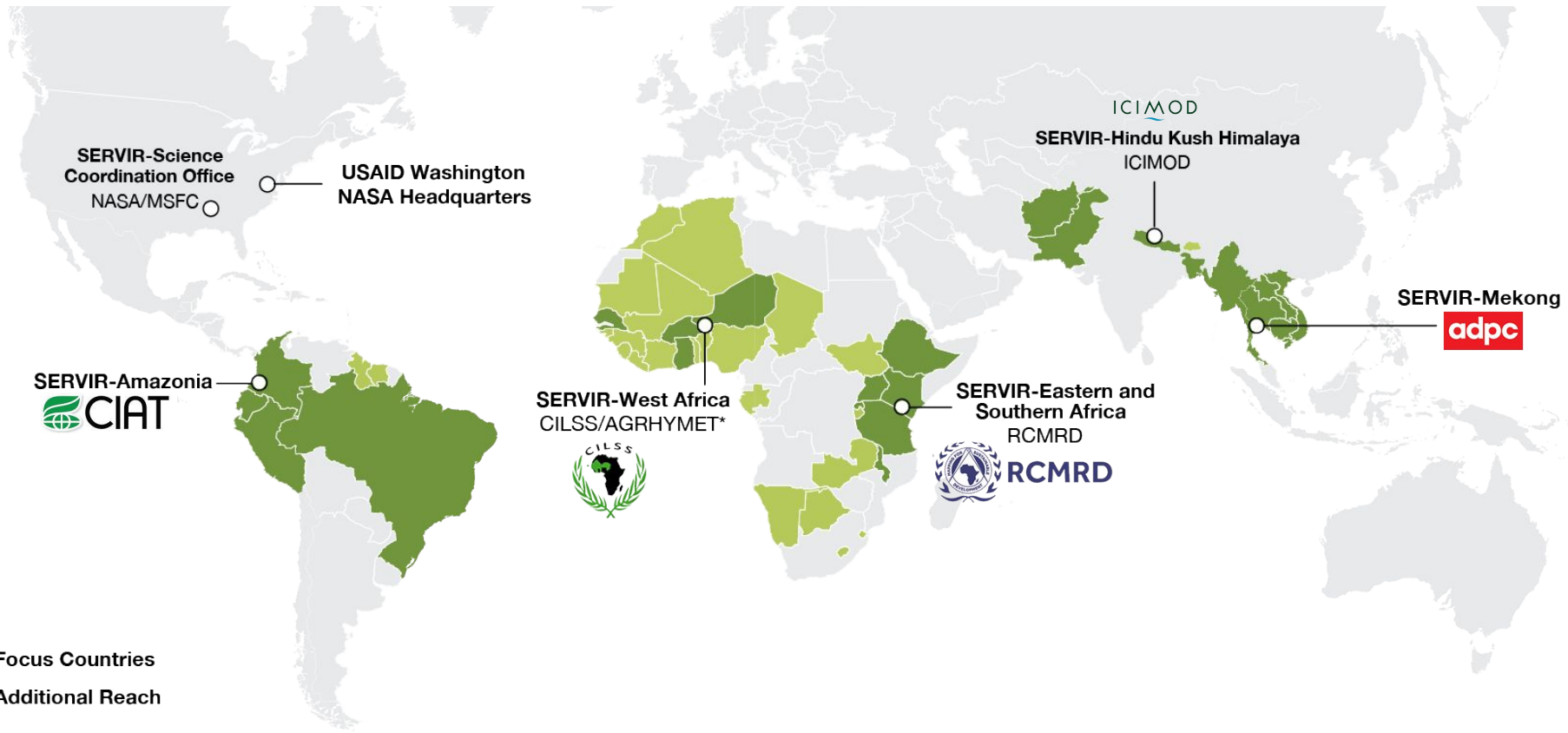
**Research collaborators:** Over 20 US universities and research centers through the Applied Sciences Team

**USG collaborators:** NOAA, USGS, USFS

**Intergovernmental, NGO collaborators:** Food and Agriculture Organization, World Food Programme, Red Cross, Mercy Corps

**University collaborators:** ITC, university networks in region

# SERVIR Focuses on Asia, Africa, and the Americas





**SERVIR Focus Countries**

**Additional Countries Reached**

## Geospatial Services

- **Regional land cover monitoring service**
- Regional drought monitoring and early warning
- Agro-met advisory for national and local level planning in Nepal, Bangladesh, and Pakistan
- Food security vulnerability information system of Nepal
- In-season wheat crop sown area assessment for Afghanistan
- Enhancing flood early warning systems
- **River and flood plain information management system**
- Forest vulnerability and management information system in Nepal
- Monitoring extreme weather



**Agriculture and Food Security**



**Water and Water Related Disasters**



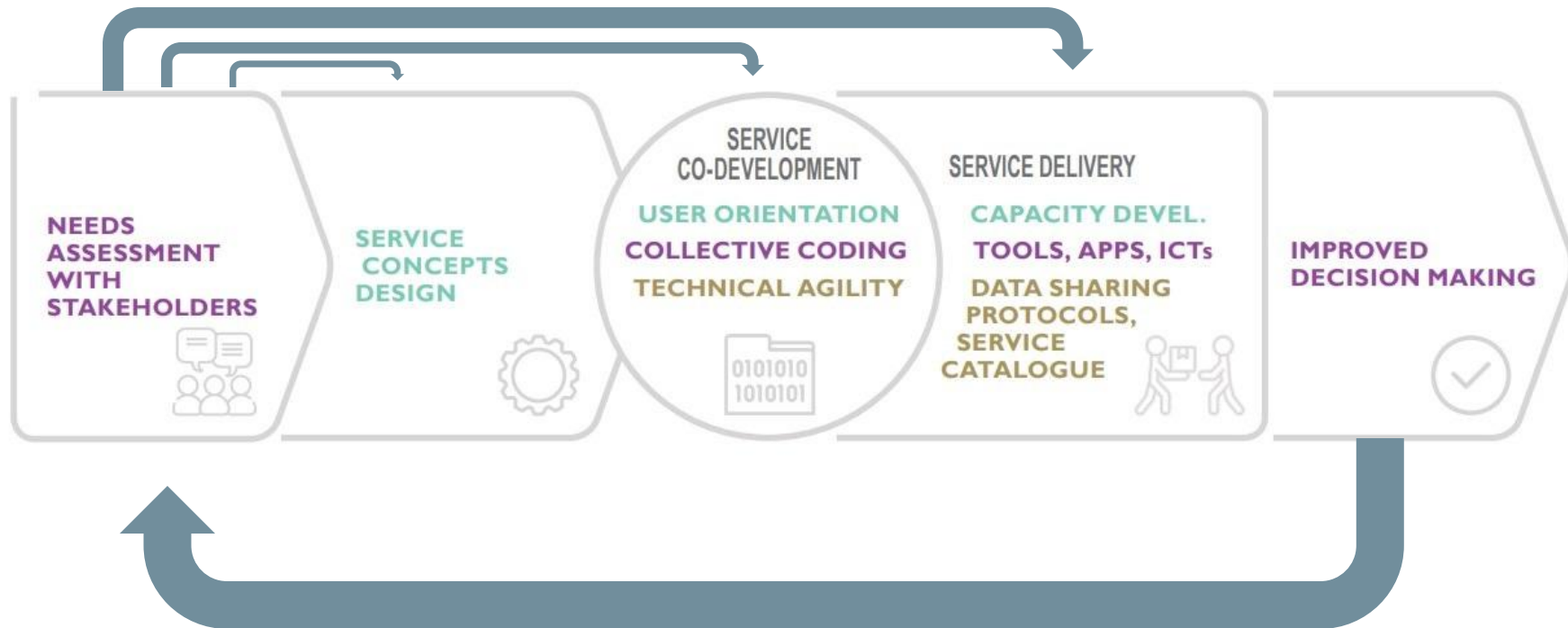
**Land Use and Ecosystems**



**Weather and Climate**

# SERVIR GLOBAL

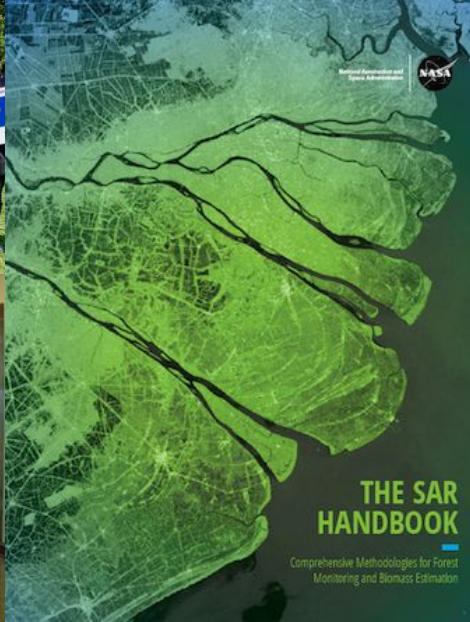
CONNECTING SPACE TO VILLAGE





# NASA Capacity Building Program: NASA SERVIR

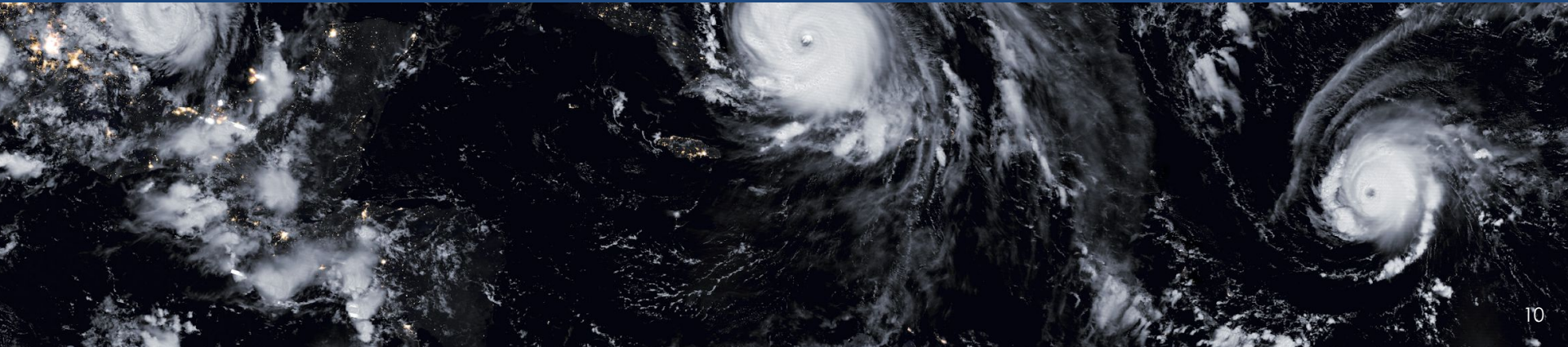
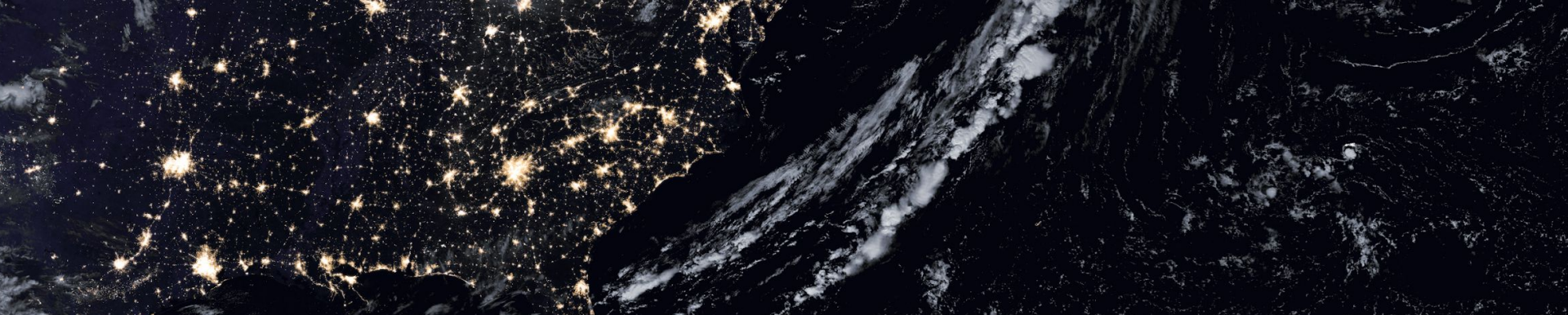
# Capacity Building and Trainings



NASA Capacity Building program

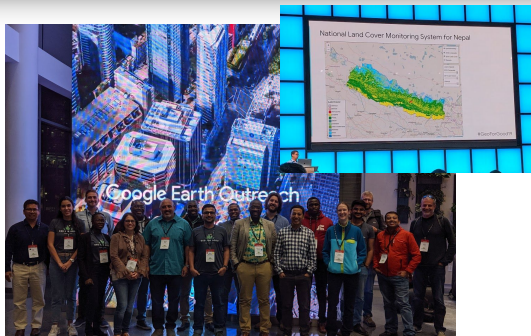
Collaboration with universities, civil society, governments, and other institutions





# **NASA SERVIR: TensorFlow Working Group (TFWG)**

# SERVIR: Review of Efforts [in recent memory] in the ML/AI Sector



Geo For Good 2019



Establishment of the TensorFlow Working Group (TFWG)



Geo For Good 2020

August 2019

Sep 2019

Sep 2020

March 2021

Sep 2019

Jan 2020

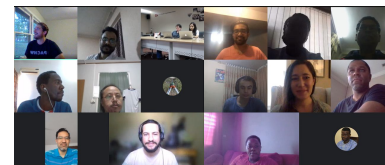
Oct 2020

State-of-the-Art Land Cover Change Methods workshop

2019 TensorFlow Technical Exchange

2020 TensorFlow Technical Exchange

ML/AI/DL SAGE 2021



# SERVIR TFWG: Who Are We (to name a few)



Google Earth Outreach



THE UNIVERSITY OF  
ALABAMA IN HUNTSVILLE UNIVERSITY OF  
SAN FRANCISCO

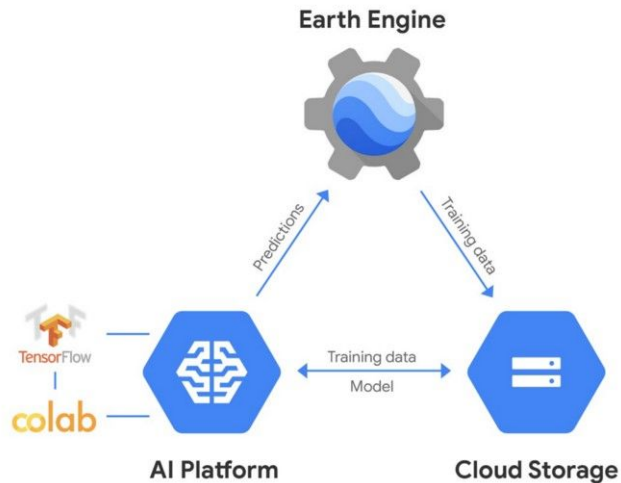


Radiant MLHub  
EARTH IMAGERY FOR IMPACT



# TFWG Goals

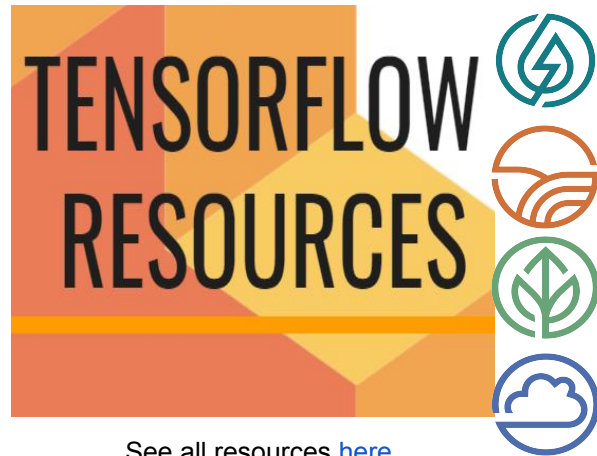
1. Build capacity
2. Applications
3. Knowledge sharing



# TensorFlow Working Group Efforts and Examples



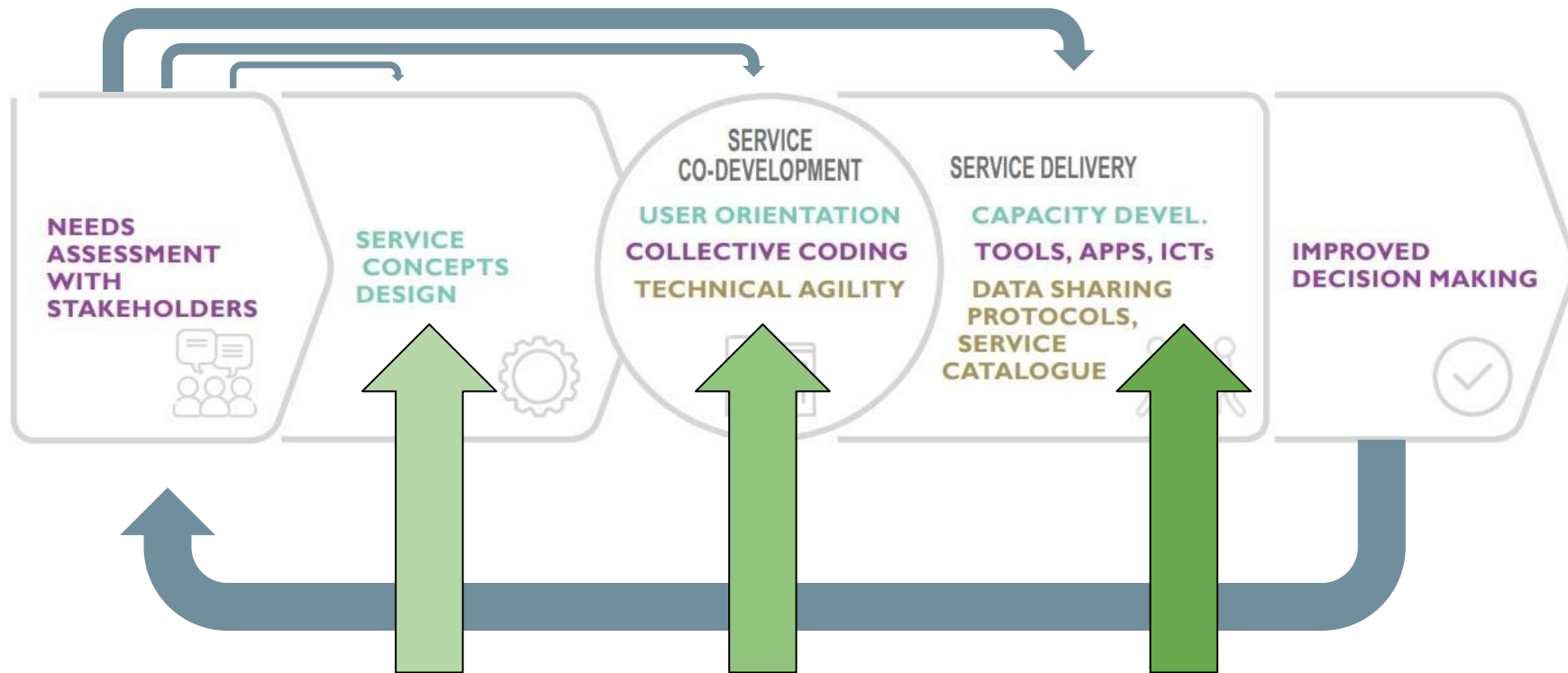
- Isla Duporge (University of Oxford) and Olga Isupova (University of Bath): Leveraging Drone technology for applied Deep Learning and Artificial Intelligence: [Slides](#) | [Video](#)
- Jack Killbride (Oregon State University) Forest Degradation and Deforestation Alert system: [Video](#)
- Hamed Alemohammad (Radiant Earth): Vision of AI; [Slides](#) | [Video](#)
- Ate: Sugar Cane mapping: [Slides](#) | [Video](#)
- John Brandt (WRI) A global method to identify trees outside of closed-canopy forests: [Slides](#) | [Video](#)
- Milagros, Lucio, Karen, & Karis (SERVIR AMZ): Gold Mining: [Slides](#)
- Tim Mayer (NASA SERVIR SCO): [Cloud To Street Slides](#)
- Kel Markert & Nick Clinton (NASA SERVIR SCO): Landsat quality band generation with TensorFlow on GEE: [Slides](#); [Video](#)
- Geo For Good: [Mekong Slides](#) | [HKH Slides](#)
- Katie Strattman (NASA SERVIR SCO) Thesis Close Out: [Slides](#);
- John Dilger (SIG): Lake Tahoe Mapping: [Slides](#); [Video](#)
- Santiago: AMZ Gold Mining [Video](#)
- Ate & Nyein (SERVIR Mekong): Surface Water Mapping [Slides](#) [Video](#)
- Katie Strattman (NASA SERVIR SCO): [Colab Pro](#)
- Abena & Modou (SERVIR WA): Illegal Mining [Slides](#)
- Louis & Thibaud (SERVIR AMZ) : Tree crops [Slides](#); [Video](#)
- Katie Strattman (NASA SERVIR SCO): Mangrove Mapping [Slides](#); [Video](#)
- Biplov Bhandari (NASA SERVIR SCO): Sugarcane Mapping [Slides](#); [Audio](#)
- Ate & Nyein (SERVIR Mekong): Impervious Surfaces [Slides](#); [GEE virtual meetup video](#)



See all resources [here](#)

# Capacity Building and Knowledge Sharing

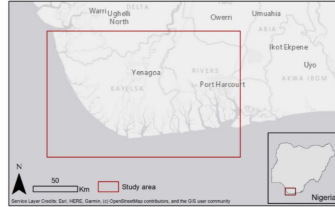
**SERVIR**  **GLOBAL**  
CONNECTING SPACE TO VILLAGE



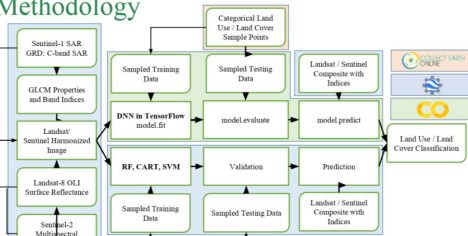
# SERVIR TensorFlow Working Group Examples

## Study Area

- Nigeria
  - Largest area of mangroves in Africa; fifth largest extent globally
  - Humid tropical climate
  - 5 dominant mangrove species
  - Wet season: April to October
  - Dry season: November to March

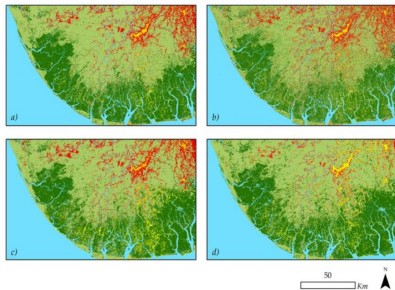


## Methodology

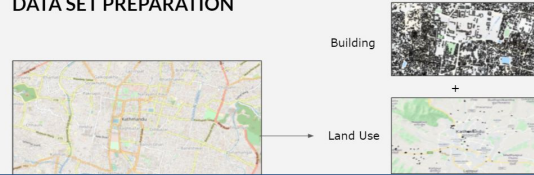


## Results

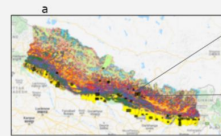
- a) RF
- b) CART
- c) SVM
- d) DNN



## DATA SET PREPARATION



## TRAINING DATASET



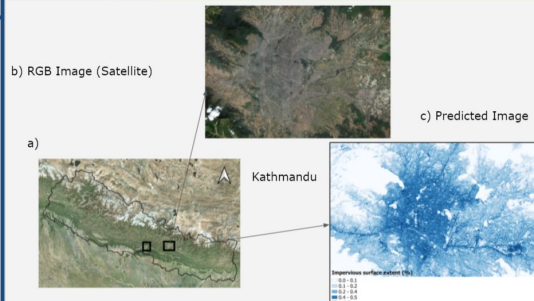
## FEATURES

Landat 8 Surface Reflectance  
Optical Bands: [B1, B2, B3, B4, B5, B6, B7]  
+ Thermal Bands: [B10, B11]

## LABEL

OSM Patches (Buildings, landuse and roads) → Impervious (Calculated in percentage) Value: [c, d]

## SERVIR HINDU KUSH HIMALAYA



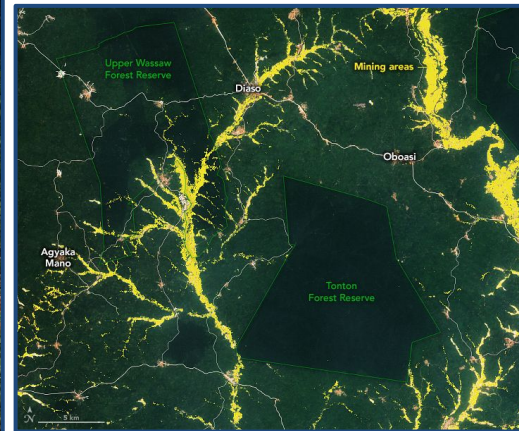
- Tanuja Shrestha: Impervious Surfaces [Slides](#)
- Katie Strattman: Mangrove Mapping [Slides](#); [Video](#)

# SERVIR TensorFlow Working Group Examples



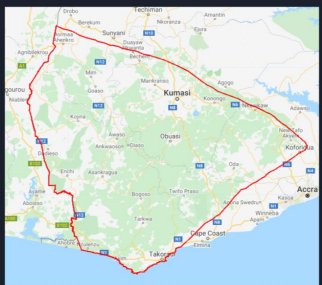
Detecting Gold Mining in Ghana  
Earth Observatory [Article](#)

Abena & Modou: TFWG Illegal  
Mining [Slides](#)

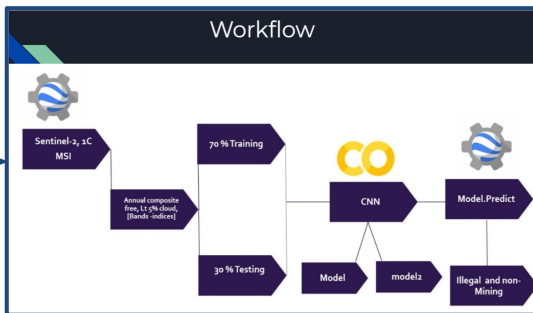


## Study Design

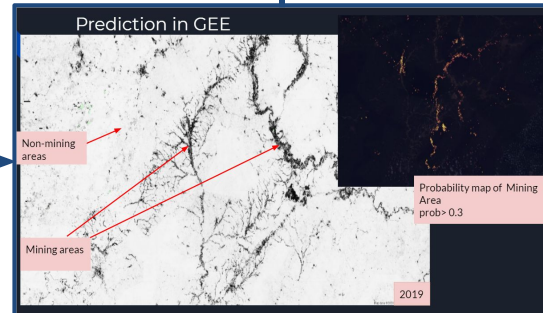
- Study area
  - South-Western belt of Ghana
  - 2015-2019
- Inputs
  - Sentinel 2
- Training data
  - Point feature



## Workflow



## Prediction in GEE

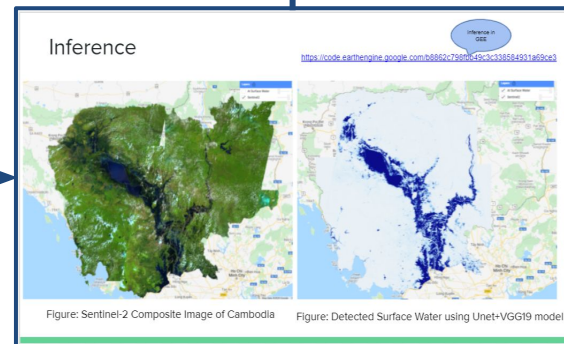
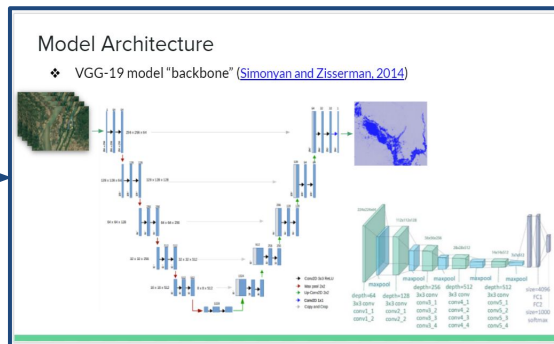
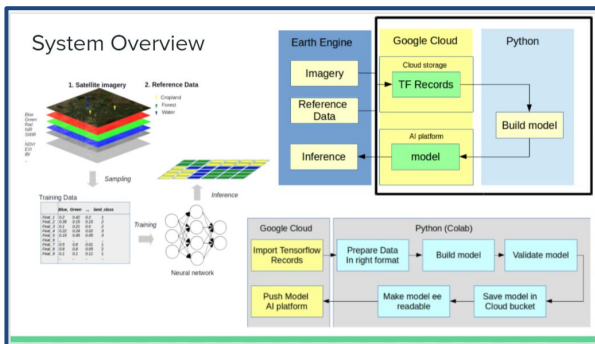
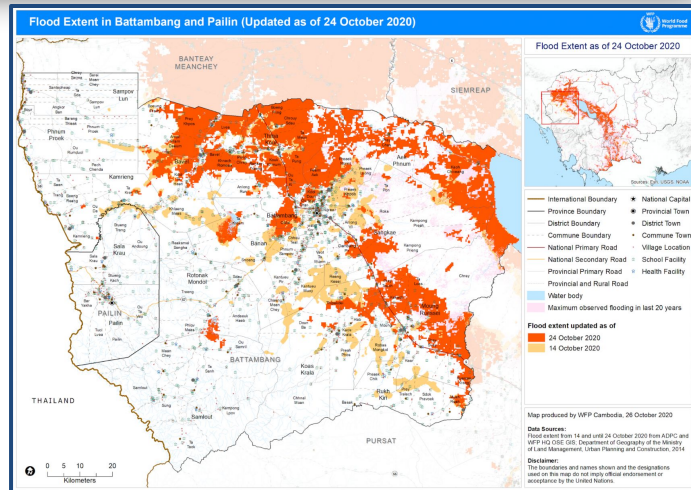


# SERVIR TensorFlow Working Group Examples

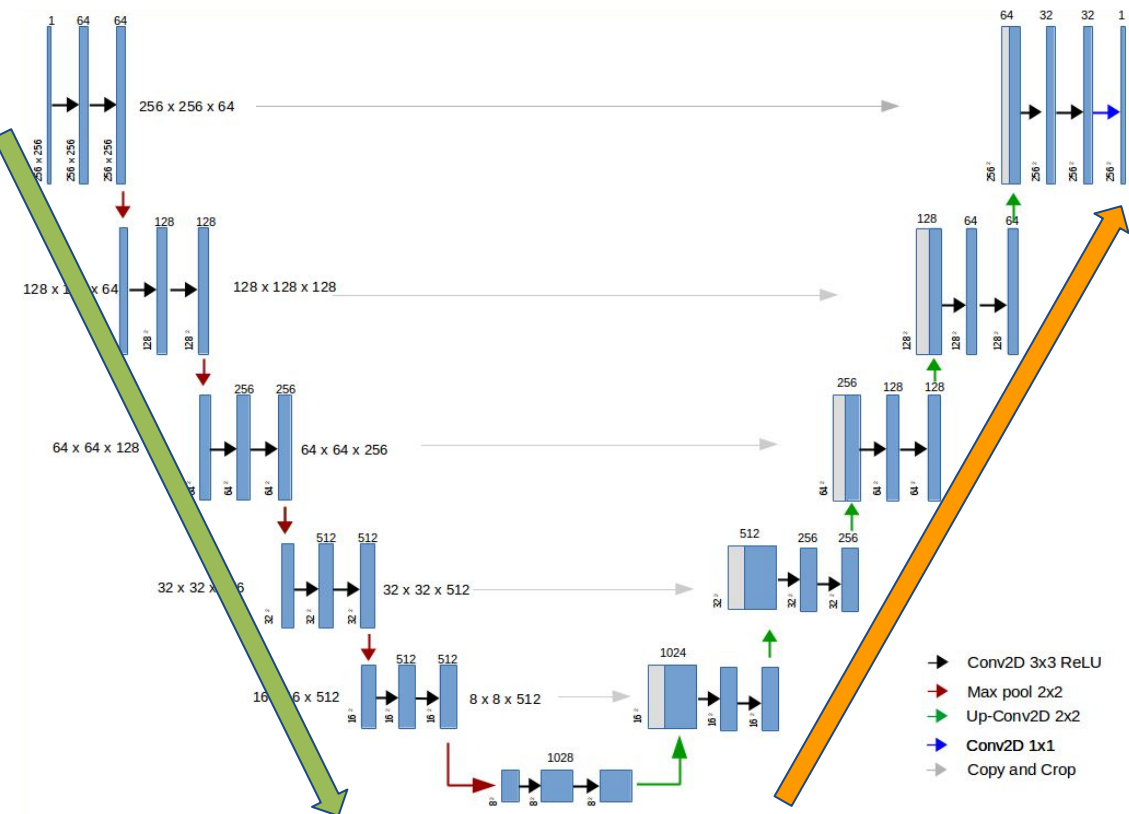


SERVIR Flood Mapping Service  
Brings Speed to Cambodia  
Disaster Management: [Article](#)

Biplov Bhandari: Flood Mapping  
[Slides](#)



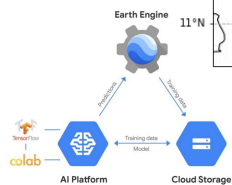
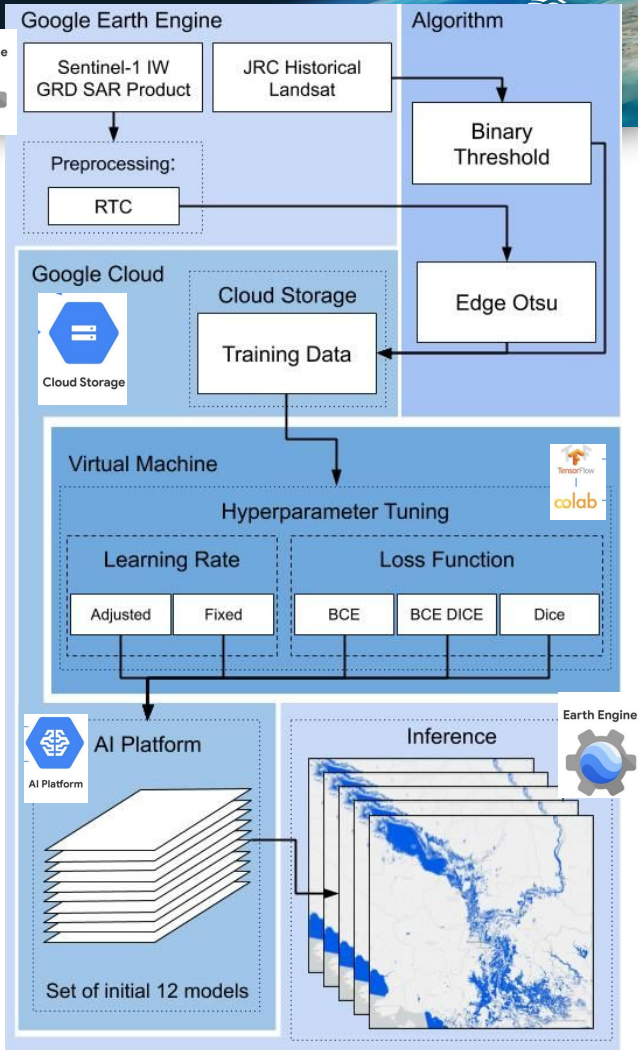
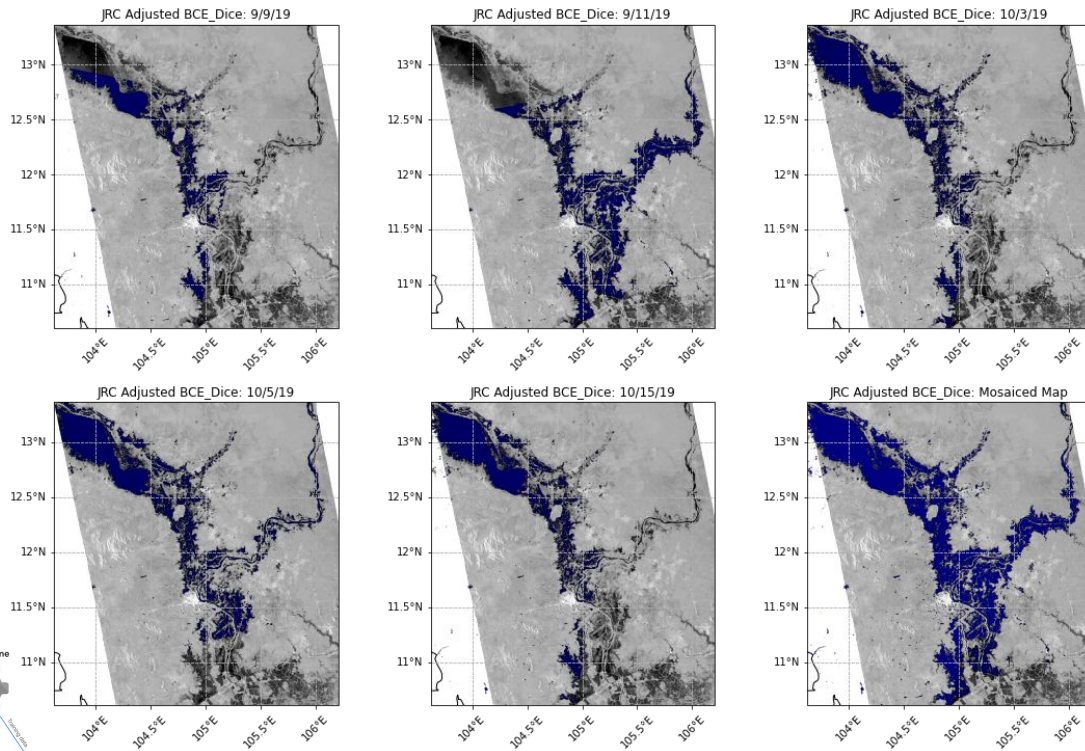
# Model Details



## VGG-19 model “backbone” ([Simonyan and Zisserman, 2014](#))

- Five multiple convolution layer **encoding** blocks with a distinct max pooling layer at the end of each block
- 5 blocks custom **decoder**
  - 1) bilinear upsampling layers
  - 2) convolutional layers
    - (initialized with using [He normal initializer](#) [Paper](#))
    - [Batch Normalization](#)
    - [Rectified Linear Unit](#) (ReLU) activation
  - 3) regularization layers
    - [L2 regularization](#) ([Past Slides](#)) to penalize overfitting
    - [Gaussian noise](#) layer after each activation
    - [dropout layer](#) after the first convolution within each decoder block
- Exit Branch:
  - [2D spatial dropout](#) and a final [1x1 convolution](#) employing a [Softmax](#) activation function

# Workflow -- when applied



# Hydrological Remote Sensing Analysis of Floods (HYDRAFloods)



## Comparing Sentinel-1 Surface Water Mapping Algorithms and Radiometric Terrain Correction Processing in Southeast Asia Utilizing Google Earth Engine

by Kel N. Markert<sup>1,2</sup>, Amanda M. Markert<sup>1,2</sup>, Timothy Mayer<sup>1,2</sup>, Claire Nauman<sup>2,3</sup>, Arjen Haas<sup>4</sup>, Ate Poortinga<sup>5,6</sup>, Biplov Bhandari<sup>5</sup>, Nyein Soe Thwal<sup>5,7</sup>, Thannarat Kunlaimai<sup>5,7</sup>, Farrukh Chishtie<sup>5,6</sup>, Martijn Kwant<sup>4</sup>, Kittiphong Phongsapan<sup>5,7</sup>, Nicholas Clinton<sup>5</sup>, Peeranan Towashiraporn<sup>5,7</sup> and David Saah<sup>5,6</sup>

## A 30 m Resolution Surface Water Mask Including Estimation of Positional and Thematic Differences Using Landsat 8, SRTM and OpenStreetMap: A Case Study in the Murray-Darling Basin, Australia

by Gennadi Donchyts<sup>1,2</sup>, Jaap Schellekens<sup>2</sup>, Hessel Winsemius<sup>2</sup>, Elmar Eiseemann<sup>3</sup> and Nick Van de Giesen<sup>2</sup>

## Operational Flood Detection Using Sentinel-1 SAR Data over Large Areas

by Han Cao<sup>1,2</sup>, Hong Zhang<sup>1,2</sup>, Chao Wang<sup>1,2</sup> and Bo Zhang<sup>1</sup>



Remote Sensing of Environment

Volume 241, May 2020, 111732

Hindcast and forecast of daily inundation using satellite SAR and altimetry data with empirical orthogonal function analysis: a study in Tonle Sap Lake Floodplain

Chi-Hung Chang<sup>a</sup>, Hyongki Lee<sup>a,\*</sup>, Donghwan Kim<sup>a,b</sup>, Euiho Hwang<sup>c</sup>, Faisal Chishtie<sup>a,f</sup>, Susantha Jayasinghe<sup>a</sup>, Senaka Basnayake<sup>a</sup>

## Generic Water Mapping Algorithms

The goal of `hydralfloods` is to provide efficient, easily accessible surface water maps. To that end, there are a few generic surface water mapping algorithms available that can be used with virtually any dataset (given some customization of parameters). Here is a list of the water mapping algorithms available:

- Edge Otsu: `hydralfloods.edge_otsu` (Donchyts et al., 2016; Markert et al., 2020)
- Bmax Otsu: `hydralfloods.bmax_otsu` (Cao et al., 2019; Markert et al., 2020)
- KMeans Extent: `hydralfloods.kmeans_extent` (Chang et al., 2020)

To begin, we will access optical and SAR data for a coincident time period following the example from Using Datasets:

```
# area where overlap is known
region = ee.Geometry.Rectangle([103.6334, 12.4368, 104.8419, 13.2615])
# month where we know coincident data
start_time = "2019-02-01"
end_time = "2019-03-01"
```

```
# get Landsat 8 dataset
lc8 = hf.Landsat8(region, start_time, end_time)
# add the mndwi water index to the lc8 dataset
lc8 = lc8.apply(func(hf.add_indices_indices("mndwi")))
```

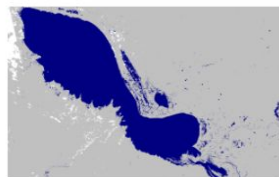
Landsat 8 Image



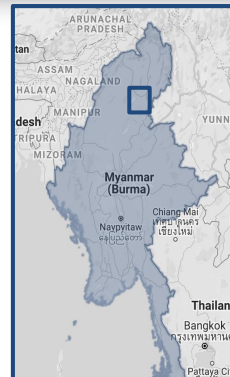
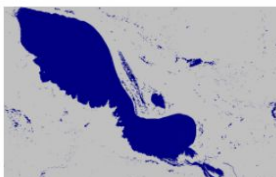
SAR Image



Landsat 8 Water Map



SAR Water Map

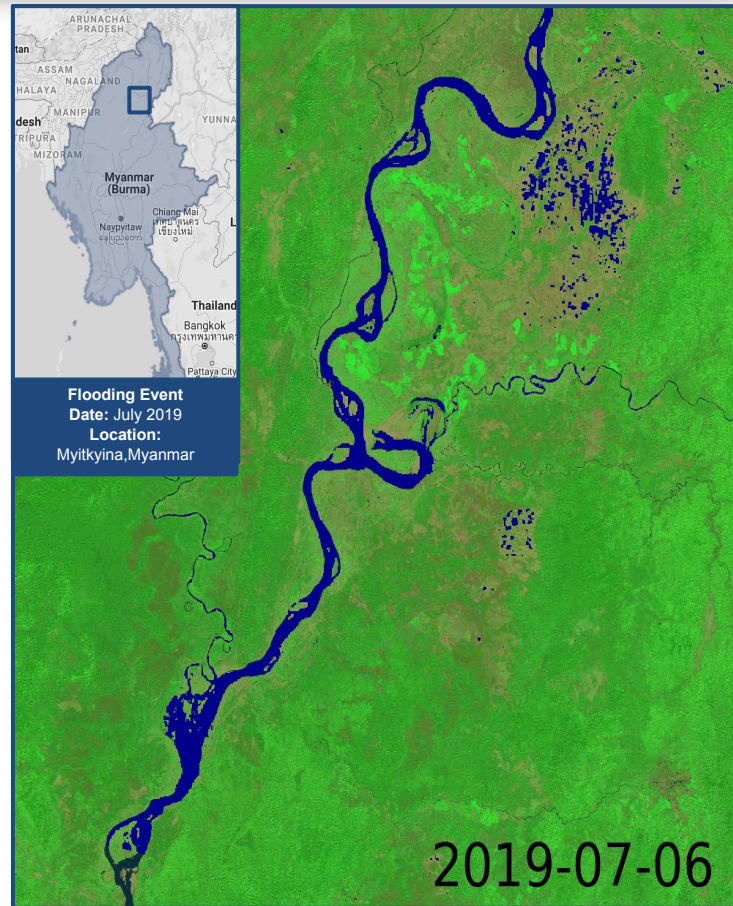


Flooding Event

Date: July 2019

Location:

Myitkyina, Myanmar



## Automatic Detection of Impervious Surfaces from Remotely Sensed Data Using Deep Learning

Jash R. Parekh<sup>1</sup>, Ate Poortinga<sup>1,2</sup>, Biplov Bhandari<sup>3,4</sup>, Timothy Mayer<sup>3,5</sup>, Farrukh Chishtie<sup>1,2,\*</sup>, David Saah<sup>1,2,6</sup>

## Deep Learning approach for Sentinel-1 Surface Water Mapping leveraging Google Earth Engine

Timothy Mayer<sup>1,2</sup>, Ate Poortinga<sup>4,5</sup>, Biplov Bhandari<sup>2,3</sup>, Andrea P Nicolau<sup>1,2</sup>, Kel Markert<sup>1,2</sup>, Nyein Soe Thwal<sup>5,6</sup>, Amanda Markert<sup>1,2</sup>, Arjen Haag<sup>5,7</sup>, John Kilbride<sup>8</sup>, Farrukh Chishtie<sup>4,5</sup>, Amit Wadhwa<sup>9</sup>, Nicholas Clinton<sup>10</sup>, David Saah<sup>4,5,11</sup>

## Mapping sugarcane in Thailand using transfer learning, a lightweight convolutional Neural Network, NICFI high resolution satellite imagery and Google Earth Engine

Ate Poortinga<sup>1,2</sup>, Nyein Soe Thwal<sup>2,3</sup>, Nishanta Khanal<sup>1,2</sup>, Timothy Mayer<sup>4,5</sup>, Biplov Bhandari<sup>5,6</sup>, Kel Markert<sup>4,5</sup>, Andrea P Nicolau<sup>4,5</sup>, John Dilger<sup>1,2</sup>, Karis Tenneson<sup>1,2</sup>, Nicholas Clinton<sup>7</sup>, David Saah<sup>1,2,8</sup>

<sup>1</sup> Spatial Informatics Group, LLC, 2529 Yolanda Ct., Pleasanton, CA 94566, USA

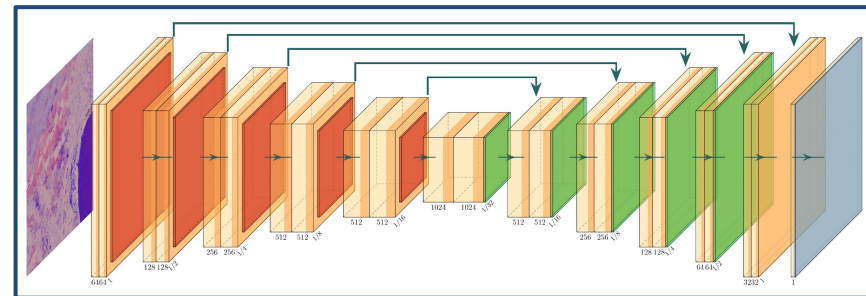
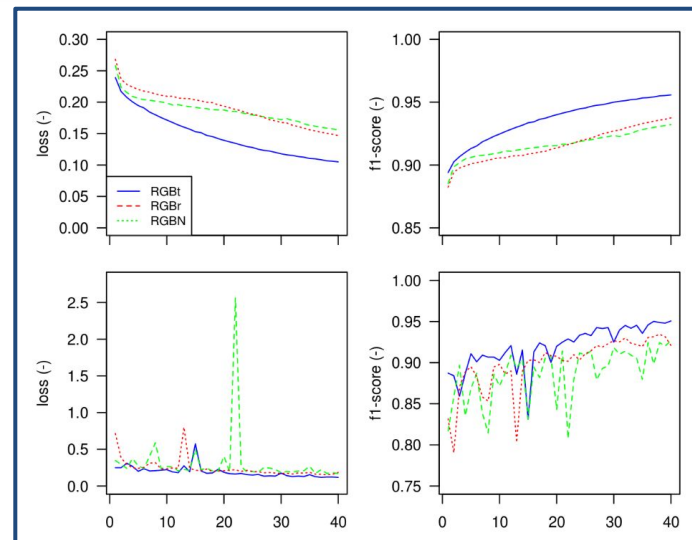
<sup>2</sup> SERVIR-Mekong, SM Tower, 24th Floor, 979/69 Paholyothin Road, Samsen Nai Phayathai, Bangkok 10400, Thailand

<sup>3</sup> Asian Disaster Preparedness Center, SM Tower, 24th Floor, 979/69 Paholyothin Road, Samsen Nai Phayathai, Bangkok 10400, Thailand

<sup>4</sup> Earth System Science Center, The University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35805, USA

<sup>5</sup> SERVIR Science Coordination Office, NASA Marshall Space Flight Center, 320 Sparkman Dr., Huntsville, AL 35805, USA

<sup>6</sup> Department of Atmospheric and Earth Science, The University of Alabama in



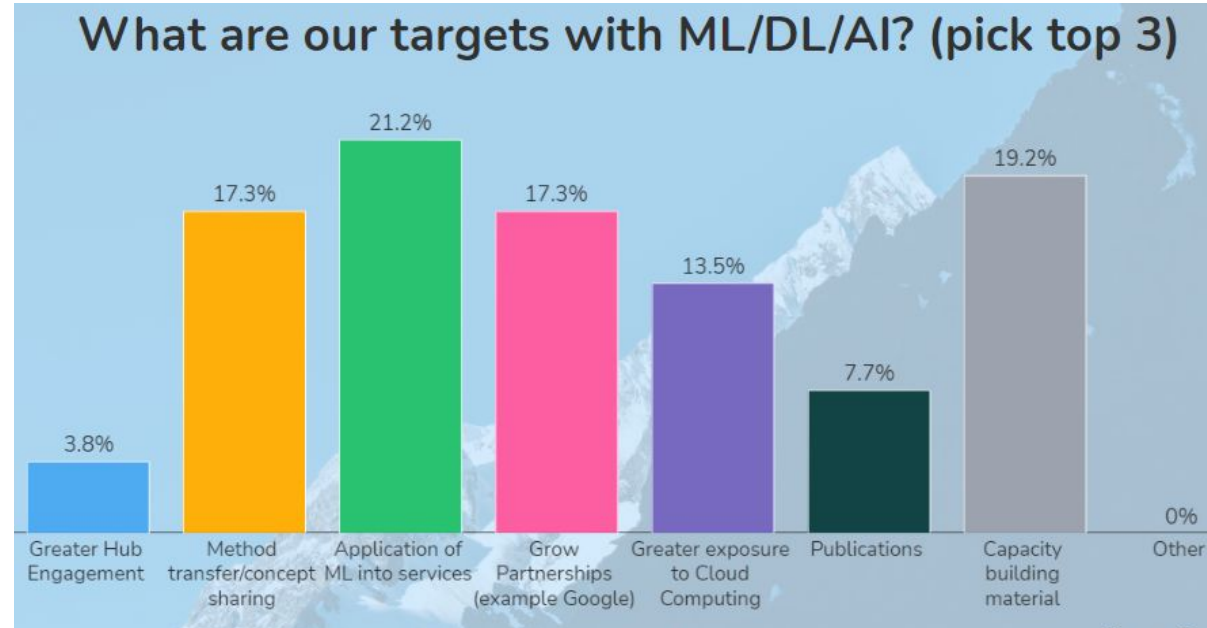
# What's Next for the TFWG?



# SERVIR Annual Global Exchange (SAGE) Goals



1. Applications of ML into Service
2. Capacity building Material
3. Grow partnerships
4. Methods Transfer/Concept Sharing



# Next Steps: How to get Involved?- We meet Bi Weekly



Skype:

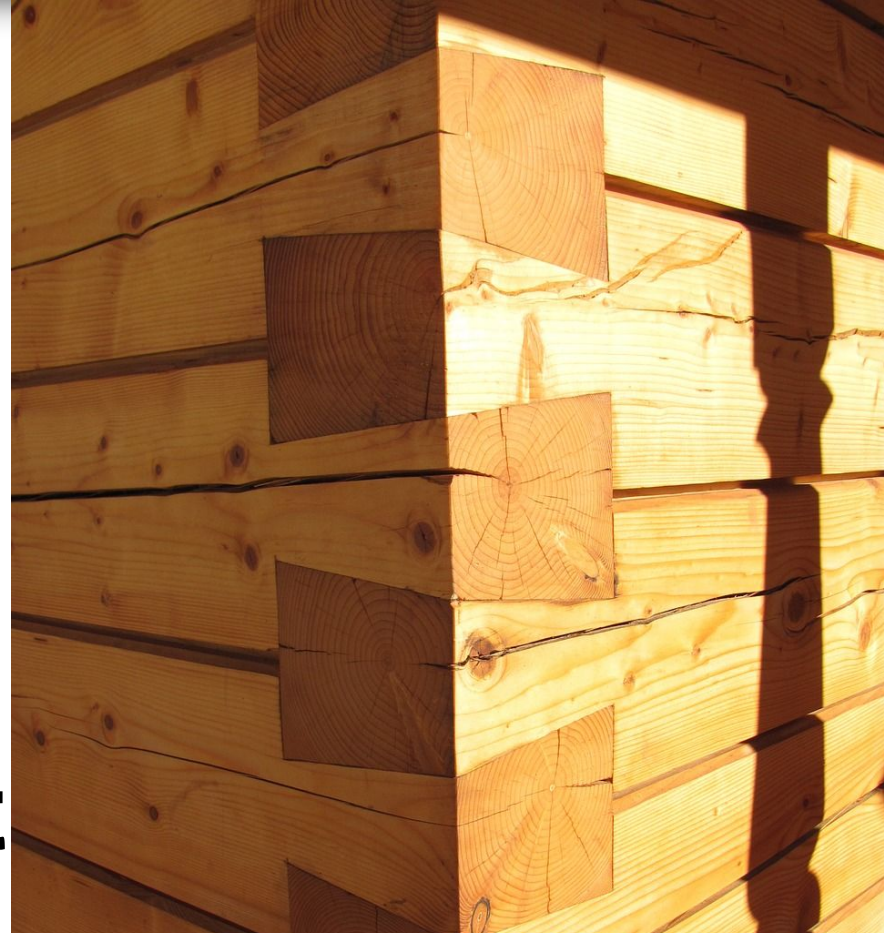
TF Working Group

MatterMost:

Messaging



**Mattermost**



# Capacity: Power & Depth of the SERVIR Network



*2020 SERVIR Annual Global Exchange, Siem Reap, Cambodia*



# Thanks to Google Earth Outreach Team and the SERVIR TFWG teams!

Tim Mayer, NASA SERVIR Hindu Kush Himalaya  
Regional Science and Coordination Lead



Let's follow-up at the bi-weekly TFWG



RCMRD

ICIMOD

adpc

CIAT

**Thanks!**

**Questions and  
Discussion**