

04/24/24 | USAID Discussion



SERVIR: Machine Learning, Deep Learning, and Artificial Intelligence Efforts



Biplov Bhandari
*SERVIR Data and Research
Scientist*

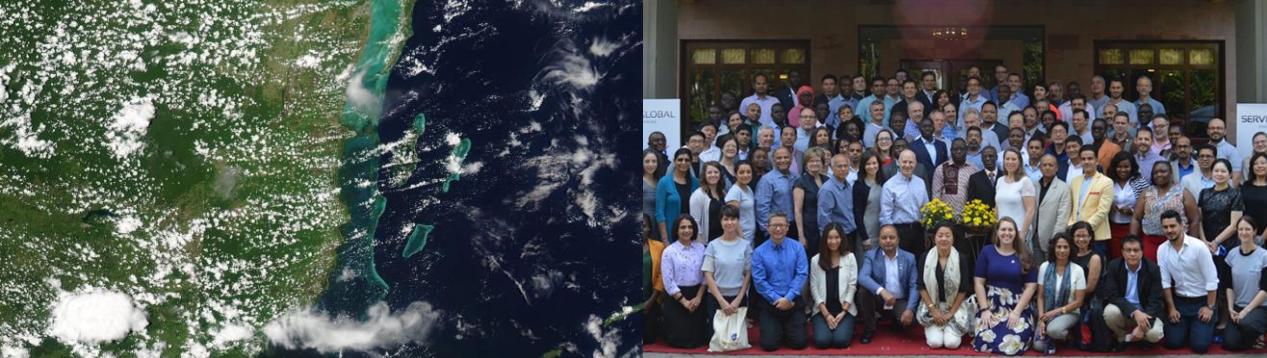


Tim Mayer
*SERVIR Data and Research
Scientist*



Emil Cherrington
*SERVIR Ecosystem & Carbon
Mgt. Lead*

Agenda/Overview

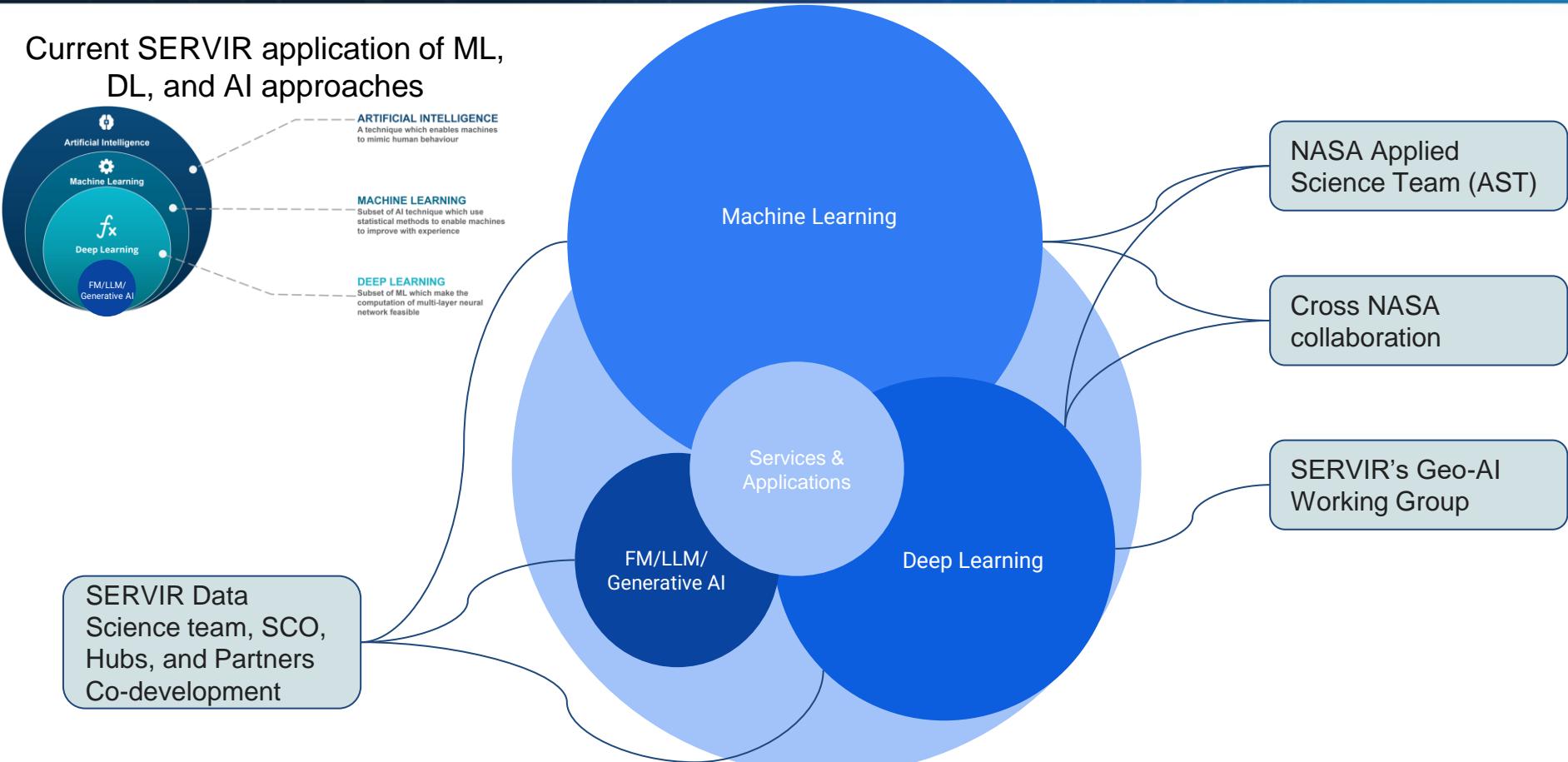


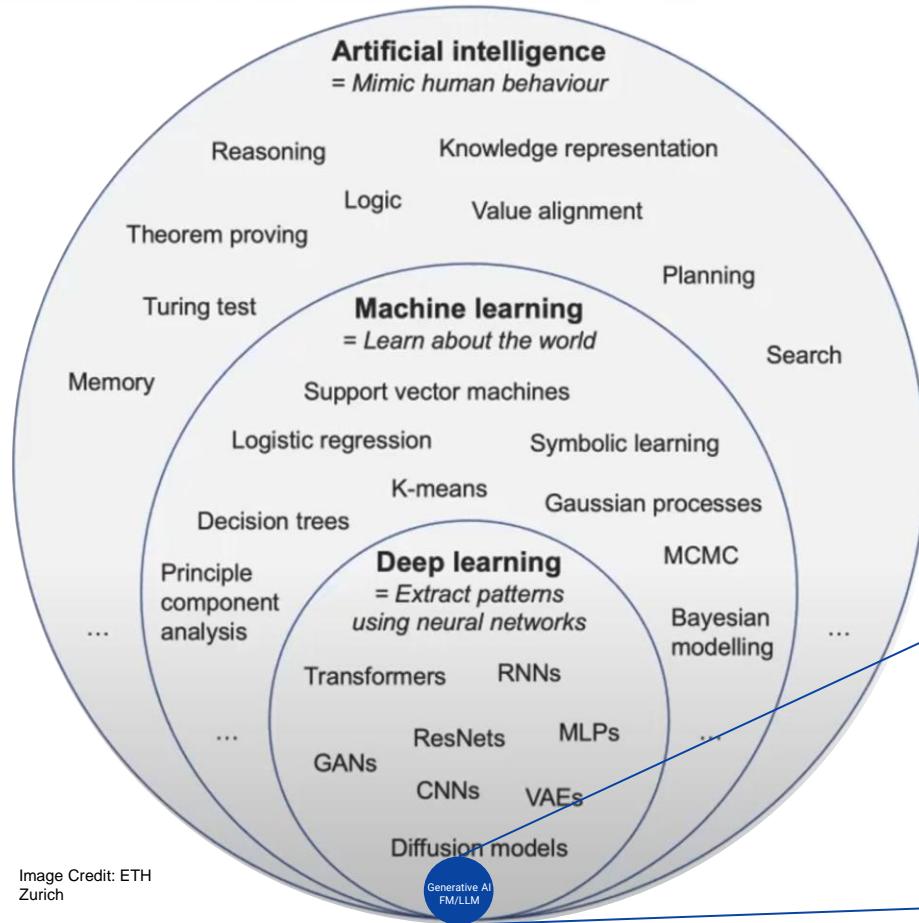
- **Outline Active ML, DL, & AI service and research development areas (15 minutes)**
- **Discussion on synergies/ next steps (10 minutes)**

Machine Learning (ML), Deep Learning (DL), Artificial Intelligence (AI)



Current SERVIR application of ML,
DL, and AI approaches

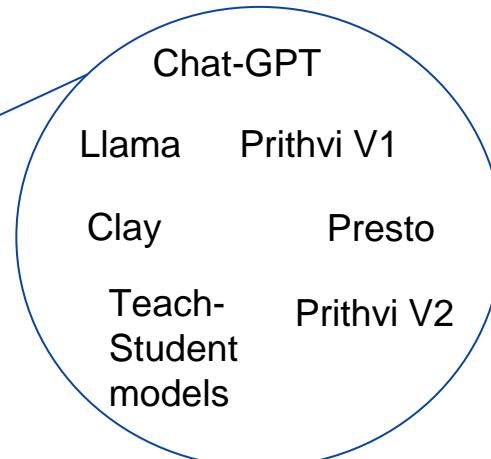




SCO has many services that leverage the listed methods

-

Especially using Machine Learning, Deep Learning and now Generative AI including Foundational Model



Machine Learning (ML)

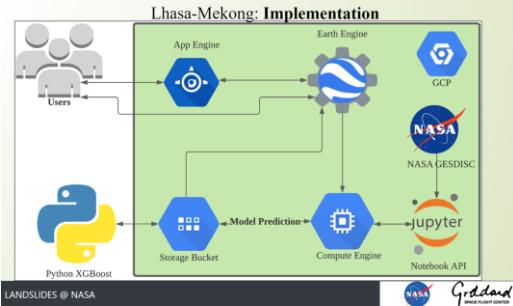
ML



SERVIR



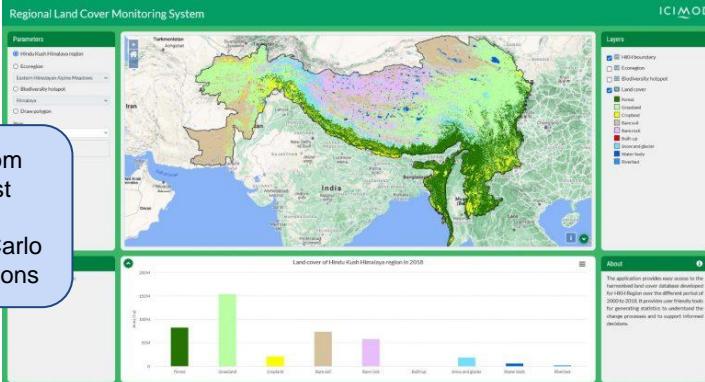
AST-3 Landslide Hazard Assessment for Situational Awareness



eXtreme
Gradient
Boost
(XGBoost)



Regional Land Cover Monitoring System (RLCMS)



Random
Forest

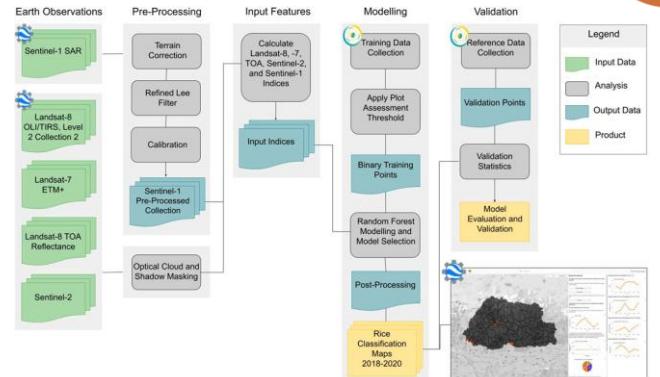
Monte Carlo
Simulations

Random
Forest

AST-4 AQ WRF-CHEM ML modeling (Active)



Agricultural Classification and Estimation Service (ACES)



Random
Forest

Deep Learning (DL)

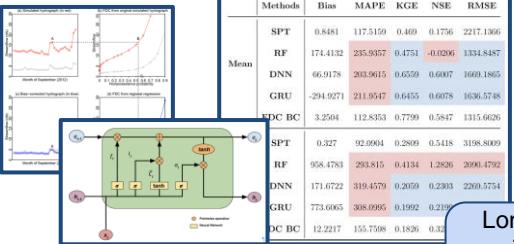
DL



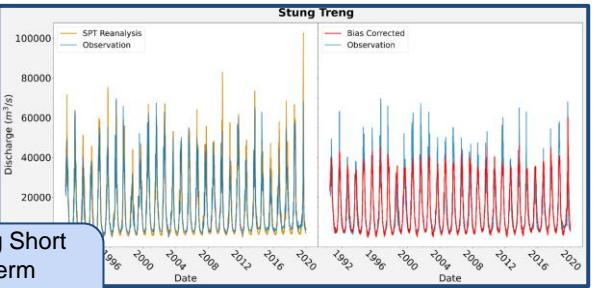
SERVIR



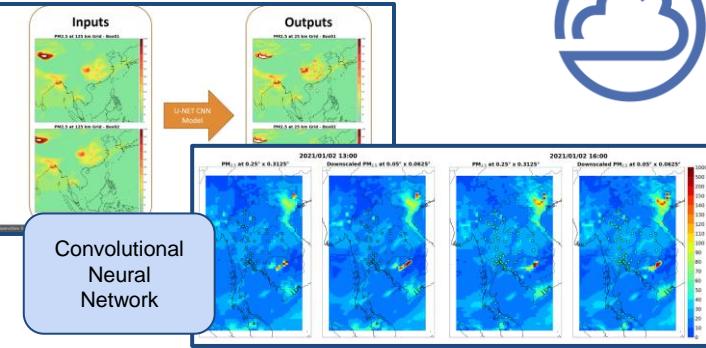
Continuous bias-corrected streamflow predictions with DL



Long Short Term Memory Model



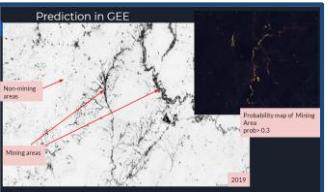
Downscaling $PM_{2.5}$ from ~25 km to ~5km



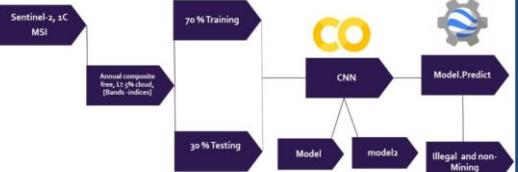
Monitoring of Artisanal Mining (Galamsey) in Ghana



Convolutional Neural Network



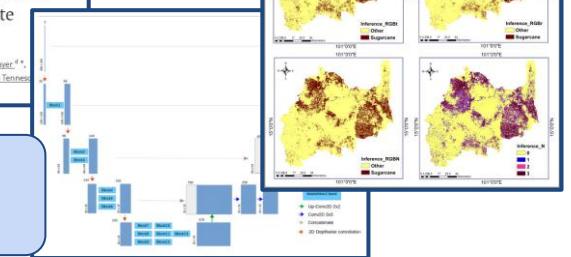
Work



Crop Type Mapping using DL



U-Net



DL including Foundational Model, Large Language Models (LLM)



(POC) ClimateGPT

Climate GPT

Ask me anything! I'm a GPT model specialized in SERVIR's ClimateSERV.

Enter your ClimateSERV related prompt here...

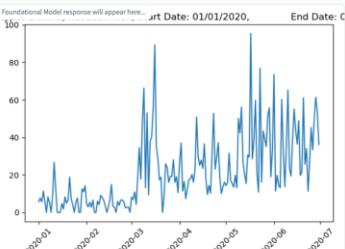
What is the maximum rainfall for Cambodia for first half of 2020?

Chat-GPT

Clear Submit

Value

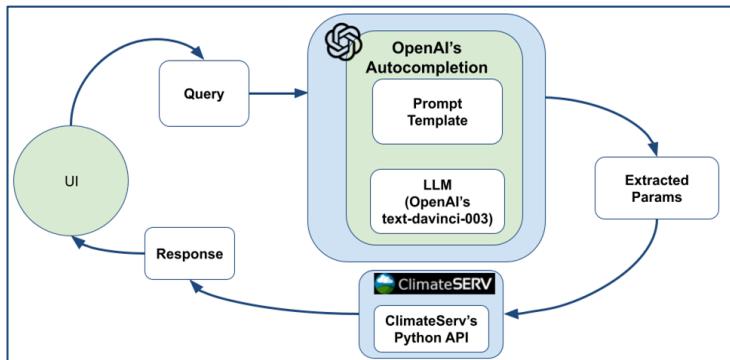
Foundational Model response will appear here. Start Date: 01/01/2020, End Date: 01/01/2020



Date: 2020-01, 2020-02, 2020-03, 2020-04, 2020-05, 2020-06, 2020-07

What is the average centralasiaemodis value between 2018-01-03 to 2018-03-16 for Kenya? What is the maximum rainfall for Cambodia for first half of 2020?

What is the mean smap value for Vietnam for the first quarter of 2019? What is the maximum chirps value for Bangladesh for monsoon of 2020?



(POC) Ag-LLM.

Display Prompt

How many hectares of land were flooded in Kenya?

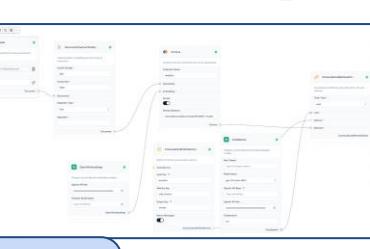
2,360 hectares of farmland were damaged by flooding in Kenya.

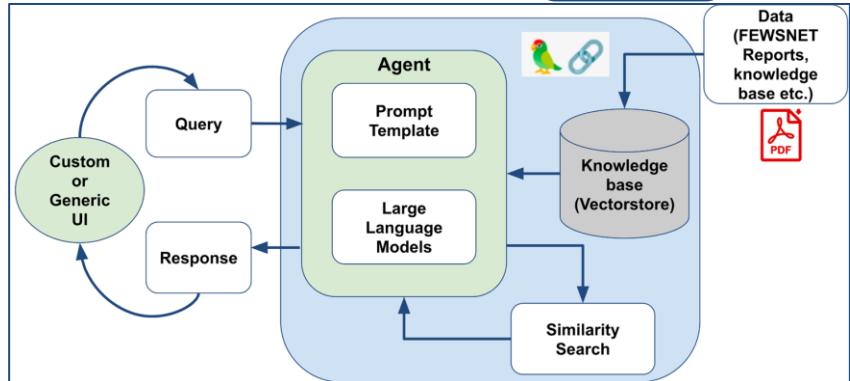
Display Prompt

What were the vegetation conditions?

The vegetation conditions in Kenya have significantly improved due to above average rainfall. The satellite-derived eVIIRS normalized difference vegetation index (NDVI) indicates that vegetation greenness, which is a proxy for vegetation health, is above average in most parts of the country. In eastern Turkana and western Marsabit, it is 70 to 95 percent of the 20-year average. In western, central, southeast, and coastal areas, it is 95 to 120 percent of normal. In northern, southern, and eastern Kenya, where significantly above average rains were observed, vegetation greenness is over 120 percent of the average. This above-average vegetation supports the recovery of livestock body conditions and suggests that the ongoing short rains season is progressing well and likely to be above average.

Llama





DL including Foundational Model, Large Language Models (LLM)



(POC) Prithvi Foundational Model (FM) Downstream applications

Hugging Face Search models, datasets, users... Models Datasets Spaces Posts Docs Solutions Pricing Log In Sign Up

IBM NASA Geospatial Community

AI & ML interests Geospatial foundation models using HLS2 data

Team members 38

Organization Card

NASA and IBM have teamed up to create an AI Foundation Model for Earth Observations, using large-scale satellite and remote sensing data, including the Harmonized Landsat and Sentinel-2 (HLS) data. By embracing the principles of open AI and open science, both organizations are actively contributing to the global mission of promoting knowledge sharing and accelerating innovations in addressing critical environmental challenges. With Hugging Face's platform, they simplify geospatial model training and deployment, making it accessible for open science users, startups, and enterprises on multi-cloud AI platforms like [Watson](#). Additionally, Hugging Face enables easy sharing of the pipelines of the model family, which our team calls [Prithvi](#), within the community, fostering global collaboration and engagement. More details on Prithvi can be found in the joint IBM NASA [technical paper](#).

Watch Prithvi end-to-end demo

More information: [NASA Blue post](#) | [NASA Veda system](#) | [IBM Press/Blue post](#) | [ESI Code](#)

Spaces 4

Prithvi 100M Demo

Prithvi 100M Burn Scars Demo

Prithvi 100M Multi Temporal Crop Classification Demo

Prithvi 100M Sen1floods11

IMPACT-SERVIR-HLS-FM-Customer-Container-G4G.ipynb

File Edit View Insert Runtime Tools Help Last edited on Dec 24, 2023

Code + Text

```
1 # Copyright 2023 NASA
2 #
3 # Licensed under the Apache License, Version 2.0 (the "License");
4 # you may not use this file except in compliance with the License.
5 # You may obtain a copy of the License at
6 #
7 #     https://www.apache.org/licenses/LICENSE-2.0
8 #
9 # Unless required by applicable law or agreed to in writing, software
10 # distributed under the License is distributed on an "AS IS" BASIS,
11 # WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
12 # See the License for the specific language governing permissions and
13 # limitations under the License.
```

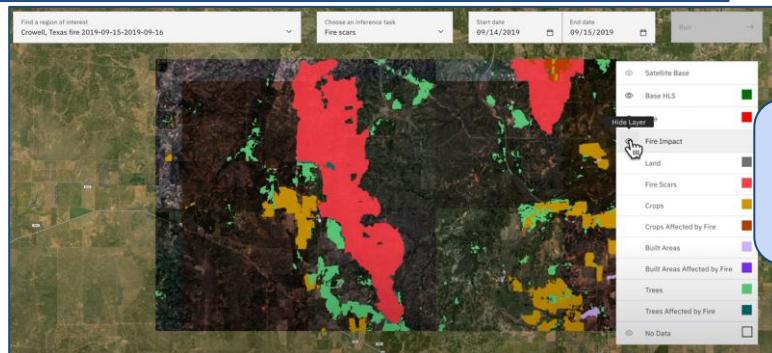
Deploying Harmonized Landsat and Sentinel-2 (HLS) Foundational Model to Vertex AI using custom container serving

Run in Colab View on GitHub

This notebook is also available in this GitHub repo: <https://github.com/NASA-IMPACT/hls-foundation-vertexai>. Navigate to the notebooks folder.

AI & Geospatial for Climate 1 HR CRASH COURSE

Earth Observation Foundational Model Prithvi V1

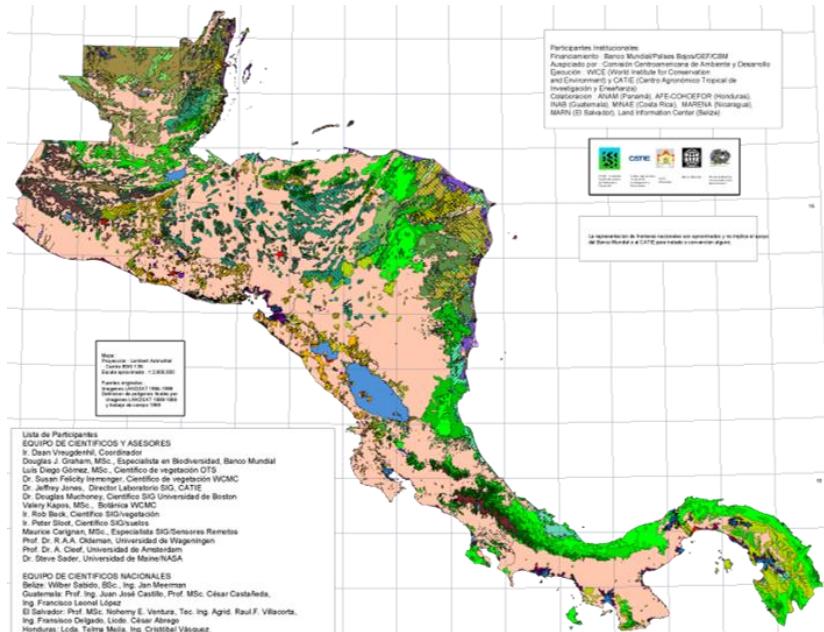


Earth Observation Foundational Model Prithvi V2

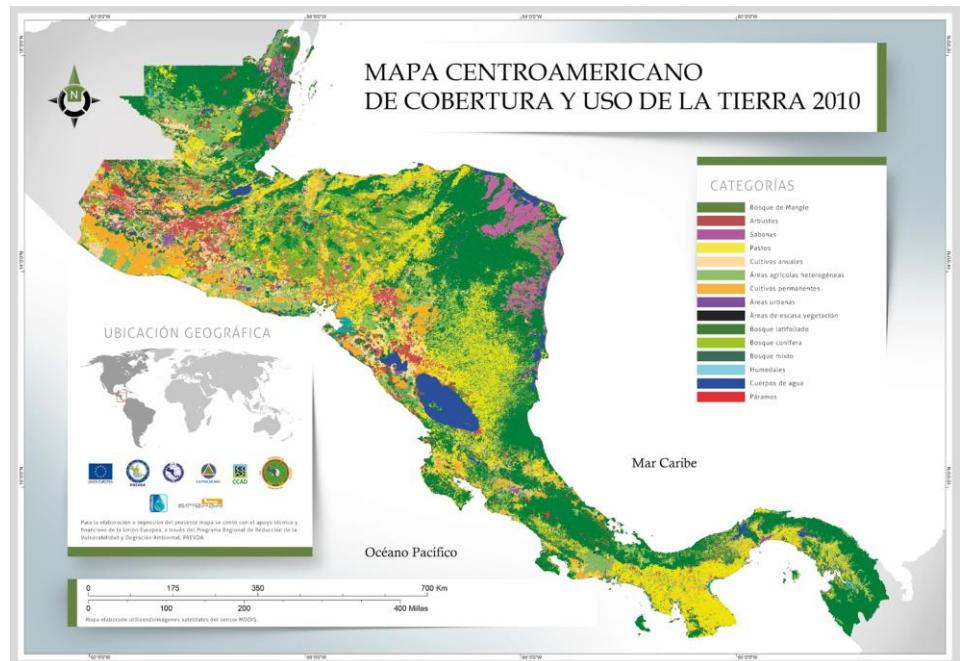


Other Machine Learning examples from Central America

1: Ecosystem map generated using visual interpretation



2: Generated using automated ML techniques



Other Machine Learning examples from Central America



Forecasting Algal Blooms in Lake Atitlan, Guatemala

1

FORECAST

Daily algal bloom probability

2

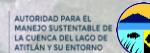
VERIFICATION

Informs water quality field campaigns by Guatemalan government and Universidad del Valle de Guatemala

3

ALERT

HAB Alert System / Activate Action Plan

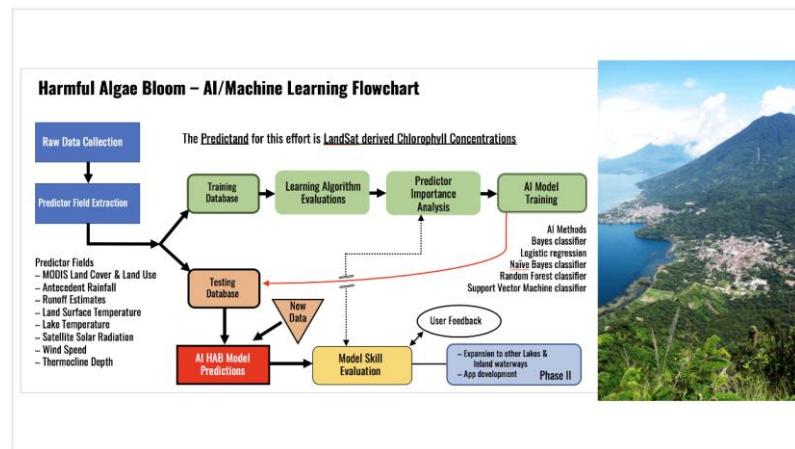




Other Machine Learning examples from Central America



Africa I. Flores-Anderson, John Mecikalski, Xiang Li, Billy Ashmall, Emil Cherrington, Betzy Hernandez, Christopher Jewett, Robert Griffin, Alma Meyer, Jim Nelson, Fatima Reyes, Mónica Martínez, Flor Barreno, Jorge José García, Claudia Romero, Jorge Luis Galindo, Pedro Toc.



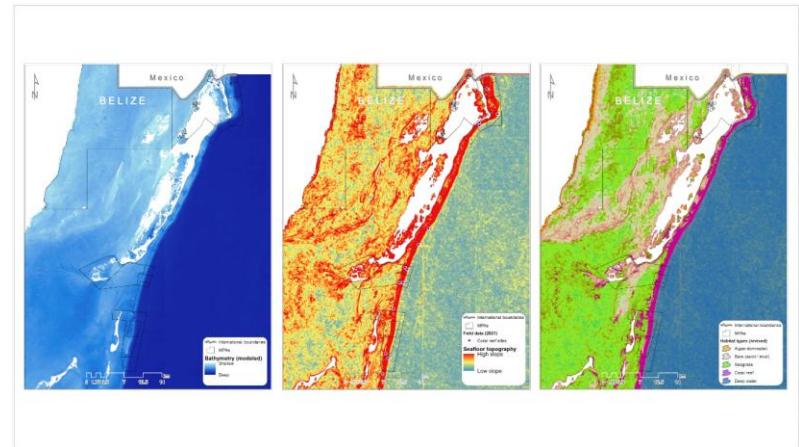
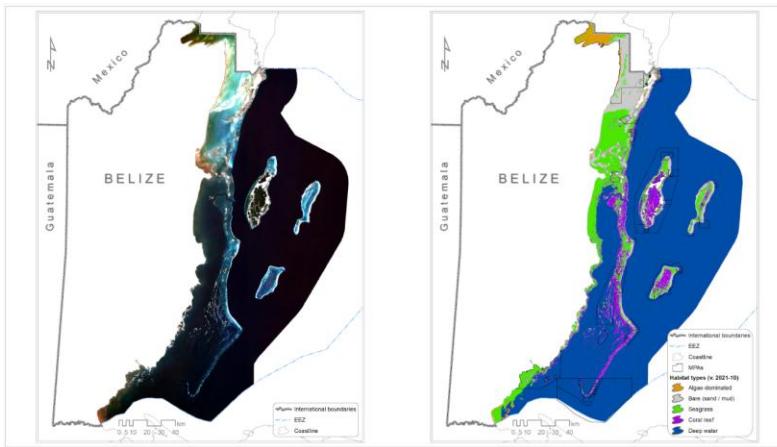
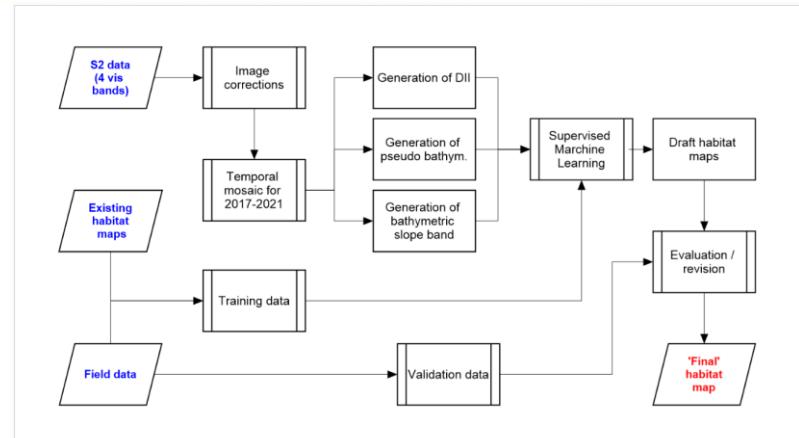
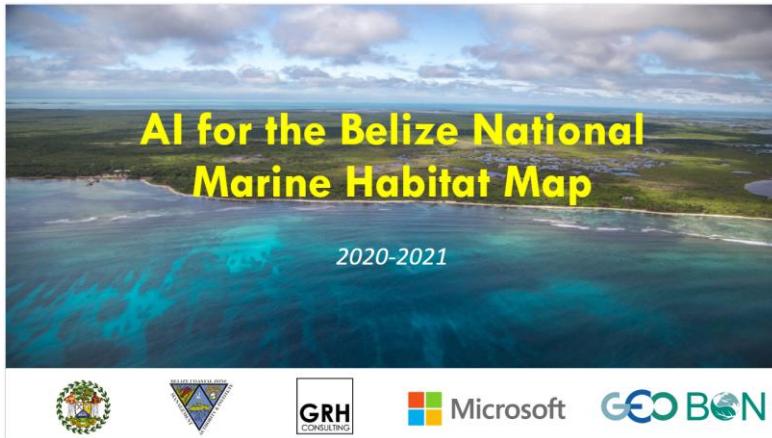
Qué variables utilizamos en el modelo?

No.	Datos	Variable	Fuente de los datos
1	Profundidad Óptica de Aerosoles	ACD	MODIS
2		Temperatura máxima del lago	MODIS
3	Temperatura del Lago	Temperatura media del lago	MODIS
4		Temperatura máxima del suelo	MODIS
5		Temperatura media del suelo	MODIS
6	Precipitación	Precipitación acumulada de 1 semanas	TRMM yIMERG
7		Precipitación acumulada de 2 semanas	TRMM yIMERG
8		Precipitación media	IMERG
9	Escorrentía superficial	Escorrentía	GEOGloWS model
10	Humedad Relativa	Humedad relativa diaria media	Global Forecast System model
11		Temperatura (2mts) diaria media	Global Forecast System model
12	Temperatura media a 2 metros	Temperatura (2mts) media de 5 días	Global Forecast System model
13		Anomalia de temperatura media de 5 días	Global Forecast System model
14	Dirección del viento	Dirección del viento diaria media	Global Forecast System model
15		Velocidad del viento diaria media	Global Forecast System model
16	Velocidad del Viento	Velocidad del viento medio de 3 días	Global Forecast System model
17		Velocidad del viento media de 5 días	Global Forecast System model





Other Machine Learning examples from Central America



SERVIR: Review of Efforts [in recent memory] in the ML, DL, & 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

Creation of
Geo-AI
Working
Group (then
Tensorflow
Working
Group)

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



2019 TensorFlow Technical Exchange



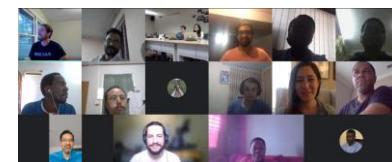
Jan 2020

2020 TensorFlow Virtual Technical
Exchange



Oct 2020

Session 6 SERVIR
Annual Global Exchange
(SAGE) 2021



SERVIR: Review of Efforts [in recent memory] in the ML, DL, & AI Sector



SERVIR



Geo For Good 2021



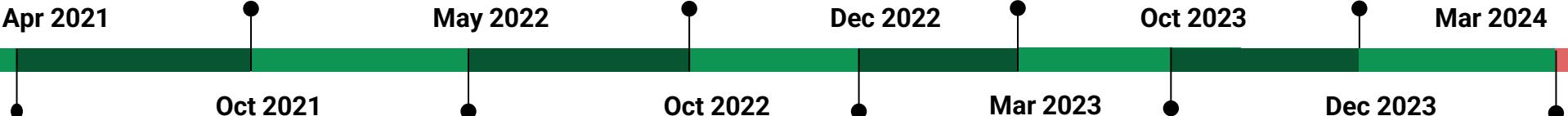
Geo For Good 2022



Geo for Good 2023



ML AGU Session



2021 AI/ML based
Cambodia Protected
Area Alerts System
for forest monitoring

SERVIR AMZ SME
for using ML for
Forest Monitoring

USAID AI Action Plan
Released

AGU ML Session

3rd NASA AI/ML Workshop

2023 SERVIR Global
Data Science
Technical Exchange

NASA
SMD
AI/ML
Workshop

SERVIR GEO-AI: Who Are We (to name a few)



RCMRD ICIIMOD

adpc

ICRISAT
INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

CIAT

UAH

THE UNIVERSITY OF
ALABAMA IN HUNTSVILLE

UNIVERSITY OF
SAN FRANCISCO



Deltares
Enabling Delta Life



Cloud to Street



Oregon State
University

Spatial
Informatics
Group

Radiant MLHub
EARTH IMAGERY FOR IMPACT

Google Earth Outreach

CSE
Centre de Suivi Ecologique

AIMS

AFRIGIST

COLUMBIA
UNIVERSITY

CERSGIS

CILSS

University of Florida
1853

ISETEL



T
THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

2023 SERVIR Global Data Science Technical Exchange



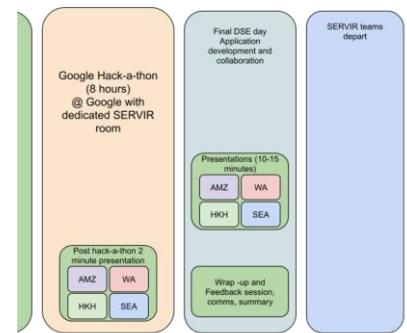
SERVIR Network Participants

- SEA: 2
- HKH: 0
- WA: 1
- AMZ: 4
- SIG: 6
- SCO: 7
- Partners:
 - McGill: 2
 - NASA IMPACT: 1
 - NASA IPI: 2
 - FAO: 3
 - Bhutan: 1

DSE

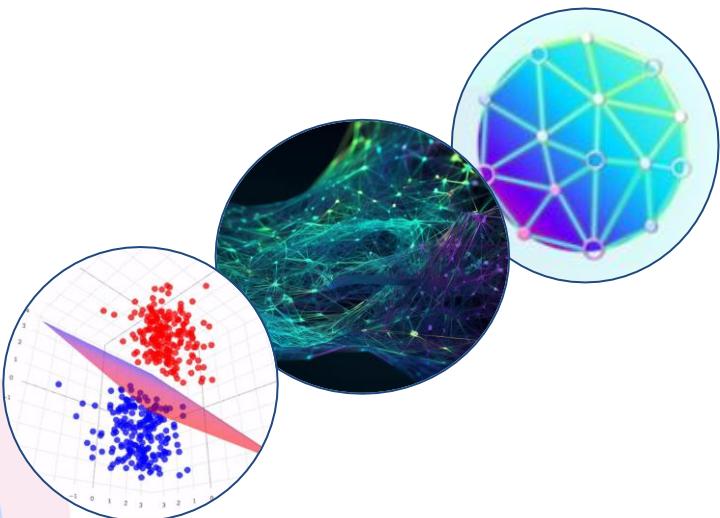
- AMZ, WA (both on illegal gold mining)
- SEA (crop mapping) had a good learning opportunity and progress on their services.
- Discussion on using cloud, resources, and the next steps for the SERVIR hubs.

10/13 Post G4G Hack-a-thon
10/14 DSE Final Day
10/14 SERVIR teams depart



SERVIR's Geo-AI WG Goals

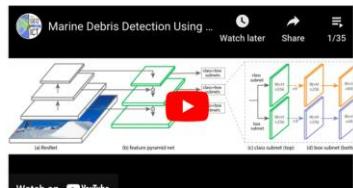
1. Build capacity
2. Applications
3. Knowledge sharing



Geo-AI Working Group Efforts and Examples



See the [website](#) for resources and training material (prerequisites)



[GEO-AI WG Playlist in Youtube](#)



GEO-AI@ 2023 Data Science Exchange and G4G meeting

To add the GEO-AI Calendar
[Click Here](#)

TensorFlow Working Group Event Calendar

Today | Friday, March 29 | Week | Month | Agenda

Wednesday, April 3
10:00am TensorFlow Working Group Bi-Weekly Meeting

Wednesday, April 17
10:00am TensorFlow Working Group Bi-Weekly Meeting

Wednesday, May 1
10:00am TensorFlow Working Group Bi-Weekly Meeting

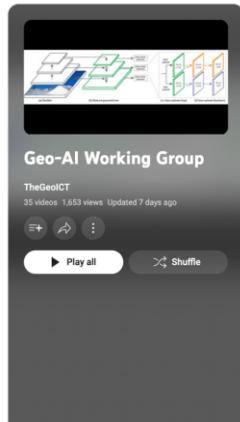
Wednesday, May 15
10:00am TensorFlow Working Group Bi-Weekly Meeting

Wednesday, May 29
10:00am TensorFlow Working Group Bi-Weekly Meeting

Show events until 5/31. [Look for more](#)

31

[Youtube video channel](#) of past Geo-AI WG presentations



- 1 Marine Debris Detection Using Planet Data
TheGeoICT · 566 views · 1 year ago
48:12
- 2 Using Very High-Res Satellite Imagery and Deep Learning/Machine Learning to detect African Elephants
TheGeoICT · 1.6K views · 1 year ago
49:27
- 3 Using Machine Learning for Spatio-temporal modeling of Landslides: Case Study in Nepal
TheGeoICT · 777 views · 1 year ago
44:58
- 4 Deep Learning Approach for Monitoring Trees outside of Forests
TheGeoICT · 339 views · 1 year ago
55:50
- 5 Using LSTM to predict hydrologic extremes under climate change and landuse scenarios in Mekong Basin
TheGeoICT · 358 views · 1 year ago
46:20
- 6 Mapping Aquatic Vegetation in Lake Tahoe, California using UNET
TheGeoICT · 69 views · 1 year ago
36:53



[Geo-AI Working Group](#)

GEO-AI Working Group Efforts and Examples



And
many
many
more!

- Ben Weinstein University of Florida Deep Forest: [Video](#)
- Osmar and Marvin Selective Logging using Deep Learning and Earth Observation in the Peruvian Amazon: [Video](#)
- John Brandt WRI Deep Learning Approach for Monitoring Trees outside of Forests: [Video](#)
- Lilly and Ankur Marine Debris Detection Using Planet Data: Slides | [Video](#)
- 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 Stratman (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 Stratman (NASA SERVIR SCO): [Colab Pro](#)
- Abena & Modou (SERVIR WA): Illegal Mining [Slides](#)
- Louis & Thibaud (SERVIR AMZ) : Tree crops [Slides](#); [Video](#)
- Katie Stratman (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](#)

2024 schedule of speakers

Date	Meeting Description	Speaker	Theme/Tag
1/10/24	TFWG coordination	N/A	N/A
1/24/24	Google Operational FF Model	Frederik Kratzert (Google Research)	Water
2/7/24	Dev Seed and Radiant Earth native tools potential	Jed Sundwall (Radiant Earth), Vincent Sarago (DevSeed)	Cloud
2/21/24	Discussion on DL Book	TFWG Admin	N/A
3/6/24	half-meter tree height product with MAXAR and DeepForest	John Brandt (WRI)	Ecosystem/Landcover
3/20/24	Earth Index, an example of the future foundation model powered geospatial data	Ben Strong (Earth Genome)	Ecosystem/Landcover
4/3/24	GEO-AI WG Admin	N/A	Ecosystem/Landcover
4/17/24	Training Data Sampling Best Practices for Modeling	Micky Maganini (SCO)	Methods
5/1/24	The Pretrained Remote Sensing Transformer (Presto)	Gabriel Tseng (NASA-Harvest), Hannah Kerner (ASU)	Agriculture
5/15/24	AI Downscaling	Romitha Neelam	Methods
5/29/24	Hold for FlexibleNet: A New Lightweight Convolutional Neural Network Model for Estimating Carbon Sequestration Qualitatively Using Remote Sensing	Alzahra Sayeed	AQ/Health
6/12/24	A Phenology-guided Bayesian-CNN (PB-CNN) framework for yield estimation and uncertainty analysis	Mohamad M. Awad	Ecosystem/Landcover
6/26/24		Chishan Zhang, University of Illinois at Urbana-Champaign	Agriculture
7/10/24	Hold Arif Albayrak (AST-Meyer)	Arif Albayrak Biospheric Sciences Lab, NASA Goddard Space Flight Center	Water
7/24/24	Deploying Robust Deep Learning Hydrologic Models: Opportunities and Lessons From HydroForecast's Operational Experience	Alden Keeffe Sampson (Upstream Tech)	Water
8/7/24	NAME TBD	Sujit Roy	Weather
8/21/24	Predicting Soil Nutrients Using Hyperspectral Data and Machine Learning	Gayathri Damaria	Ecosystem/Landcover

Opportunities and Discussion



SERVIR's The Applied Deep Learning Book

Please use this form to express your interest to contribute to the forthcoming Practitioner Focused SERVIR's Applied Deep Learning Methodology and End-To-End Workflows Book

The SERVIR Science Coordination Office (SCO) at the Marshall Space Flight Center in Huntsville, Alabama. SERVIR is a joint NASA / U.S. Agency for International Development (USAID)

program focused on improving environmental decision-making using Earth observations and geospatial technologies. SERVIR, a program within the Capacity Building program of NASA's Applied Sciences Program (ASP), focuses projects thematically in specific geographic regions to develop science applications that meet the needs of decision-makers in the SERVIR regions. SERVIR is active in the following regions: West Africa (WA), Hindu Kush-Himalaya (HKh) and SouthEast Asia (SEA), Amazonia (AM2). The regional organizations are known as SERVIR Hubs and are operated by technical institutions.

Specifically, Deep Learning (DL) and Artificial Intelligence (AI) approaches have been crucial in co-developing decision-making oriented services. The challenge in applying DL and AI in the limited knowledge and accessible workflows for application and adoption. This has led the SERVIR SCO to envision the co-development of a knowledge product 'The Applied Deep Learning Book' that is Practitioner Focused Applied Deep Learning Methodology and End-To-End Workflows.

This book will span thematic (Agriculture & Food Security, Ecosystem & Carbon Management, Air Quality and Health, Weather & Climate Resilience, Water Security) and regional (Central America, West Africa, South America, South East Asia, and Hindu Kush Himalaya) foci. Each module/chapter will be structured on a DL problem sets/application, listed below. Additionally each chapter will contain sub-chapters wherein authors will contributions. This includes theoretical text and background as well as hands-on jupyter notebook based modules.

- Heuristics of Data Science and DL data preparation,
- Image Classification,
- Image Segmentation,
- Instance Segmentation,
- Image/Object Recognition,
- Time series analysis,
- Process based simulation using ecological and hydrological model,
- Transfer Learning,
- Fusion techniques,
- Downscaling,
- Foundational Models and Large Language Models.

We welcome author and co-author interest in developing and providing chapter/sub-chapters to The Applied Deep Learning Book.

Thank you
Editors - Tim Mayer and Biplov Bhandari

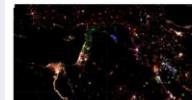
bb0134@uah.edu Switch account

- SERVIR GEO-AI WG is in the early stages of developing a practitioner and user focused book on leaving Deep Learning approaches to Earth observation based environmental challenges.
- This book will be similar to the SAR Handbook (2019) and GEE Book (2022)

Book Sections and Chapters

Click on the sections below to access the book chapters

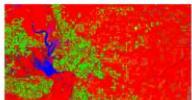
Part 1: Fundamentals



Section F1
Programming and Remote Sensing Basics



Section F2
Interpreting Images



Section F3
Advanced Image Processing

- F1.0 JavaScript and the Earth Engine API
- F1.1 Exploring Images
- F1.2 Survey of Raster Datasets
- F1.3 The Remote Sensing Vocabulary

- F2.1 Image Manipulation: Bands, Arithmetic, Thresholds, and Masks
- F2.2 Interpreting an Image: Classification
- F2.3 Accuracy Assessment: Quantifying Classification Quality

- F3.0 Interpreting an Image: Regression
- F3.1 Advanced Pixel-based Image Transformation
- F3.2 Neighborhood-based Image Transformation
- F3.3 Object-based Image Analysis



The Applied
Deep Learning
Practitioner Focused Applied
Deep Learning Methodology
and Workflows

Capacity: Power & Depth of the SERVIR Network



2020 SERVIR Annual Global Exchange, Siem Reap, Cambodia

Thank You.



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