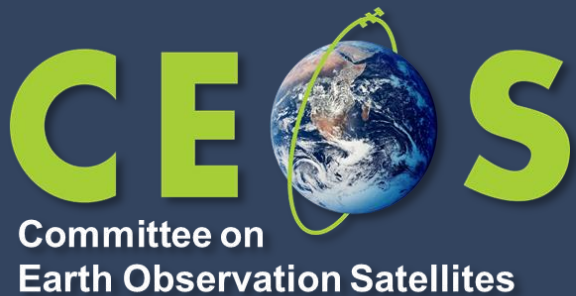


Enhancing EO Applications Using AI/ML



Nitant Dube, ISRO

Agenda ID: 2022.10.06_10.50

WGISS-54

Tokyo, Japan (JAXA)

3-7 October 2022

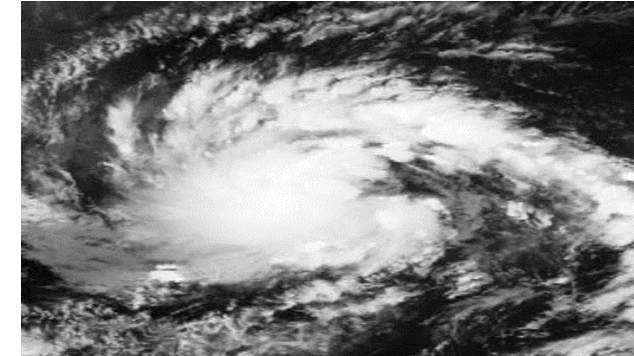
Executive Summary



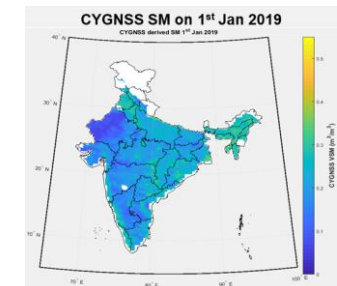
- ❖ Gartner report suggest maximum utilization AI/ML in the field of forecast and prediction for Earth Science Studies
- ❖ AI based prototype application is developed for Prediction and Intensity estimation of cyclones
- ❖ Soil Moisture is retrieved using AI based model which uses Space borne GNSS-R data
- ❖ Classification of Hyperspectral data (ROSIS) has shown a good accuracy of 96.93 %
- ❖ Deep learning techniques are used for Soil studies (un-mixing of red and black soil) for airborne hyperspectral data
- ❖ AI based forecasting of NDVI and wetland monitoring is operationally being used.
- ❖ Automatic Building Foot-print extraction and generation of 3D city model as part of Smart City Project is attempted using Deep learning Techniques
- ❖ DL plugin tools developed for AHYASS software for Hyperspectral data analysis
- ❖ **AI/ML helps in filling the Gap/ Enhancing the current understanding of Science to help Earth Observation Applications**



Building Foot-print and 3D city Model



Cyclone Detection and Intensity Estimation



Soil Moisture Retrieval

AI/ML in Earth Sciences

Gartner Hype Curve for machine learning in Earth Sciences



- ❖ Forecasting
- ❖ Nowcasting
- ❖ Downscaling
- ❖ Retrieval
- ❖ Decision Support
- ❖ Modeling
- ❖ Feature Engineering for generation of meaningful information from the data

❖ Urban Planning and Monitoring

- Automatic extraction of Building Footprint
- Urban Sprawl monitoring and growth prediction

❖ Agriculture

- NDVI (Normalized Difference Vegetation Index) Time Series Prediction using Recurrent Neural Network. NDVI can be used by crop insurance, Fertilizer and Horticulture and agriculture based industries.
- Crop discrimination/classification
- Crop Yield and Forecast

❖ Weather and Climate

- Nowcasting of Extreme weather events using AI techniques
- Climate predictions using AI

❖ Renewable Energy

- Forecasting of Energy Generation for Solar Power Plants
- Forecasting of Energy Generation for Wind Farms

❖ Disaster Mitigation and Recovery

- Landslide
- City Flooding
- Lightning

❖ Hydrology

- Water Level monitoring and forecasting of water levels in rivers
- Suitable sites for Underground water

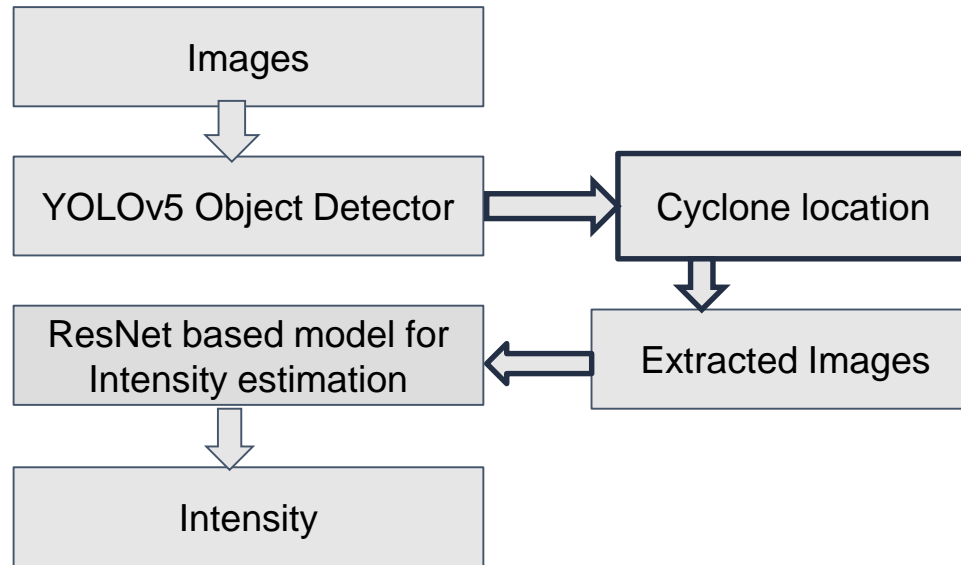
❖ Ocean and Marine Ecosystem

- PFZ forecast
- Bleaching of Coral Reefs
- Oil Spill track prediction

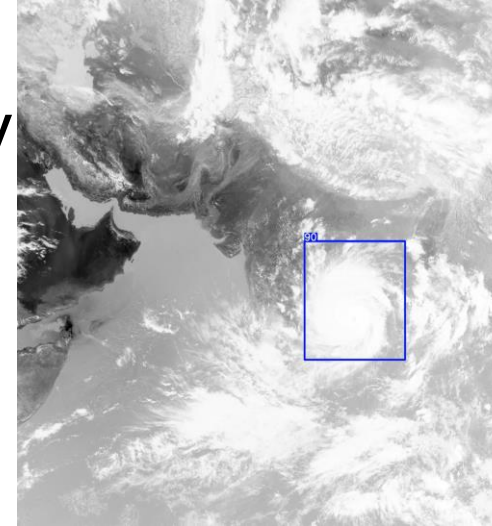
❖ Environment

- Forecasting of Aerosol load due to Stub burning
- Forecasting of city pollution levels
- CRZ monitoring

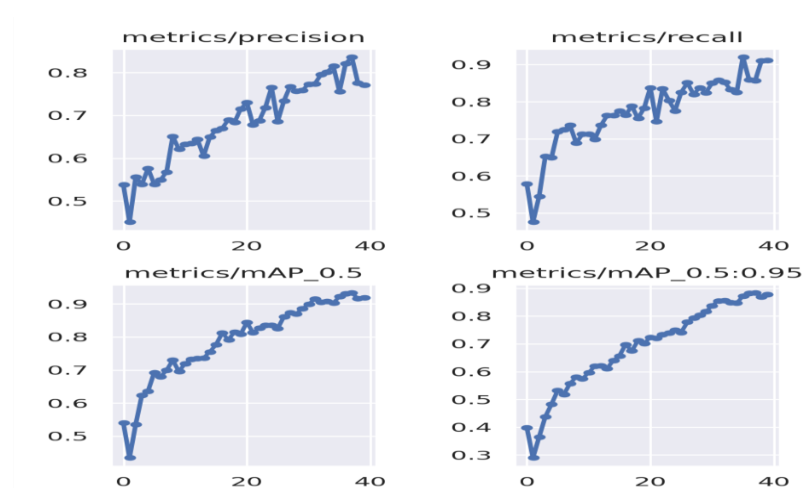
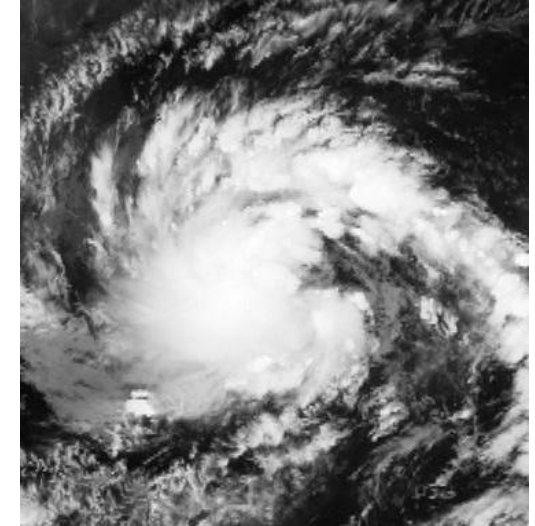
❖ AI based model for Detection of Cyclone in an image and its Intensity Estimation



Detection



Intensity Estimation



Machine Learning based Soil Moisture Retrieval over Indian Cropland using CYGNSS (Space borne GNSS-R mission)

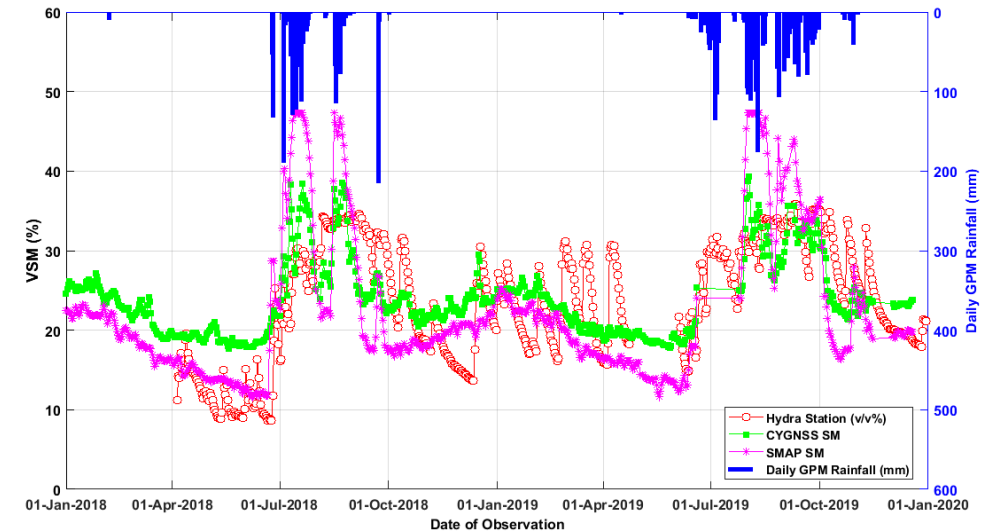
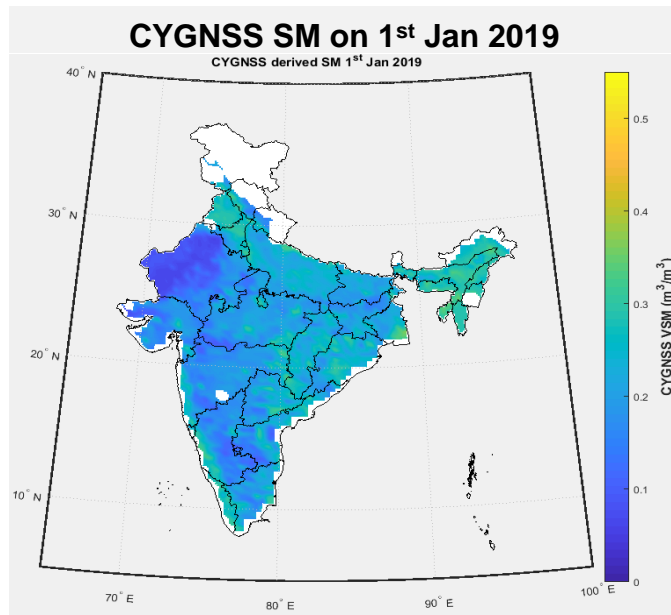
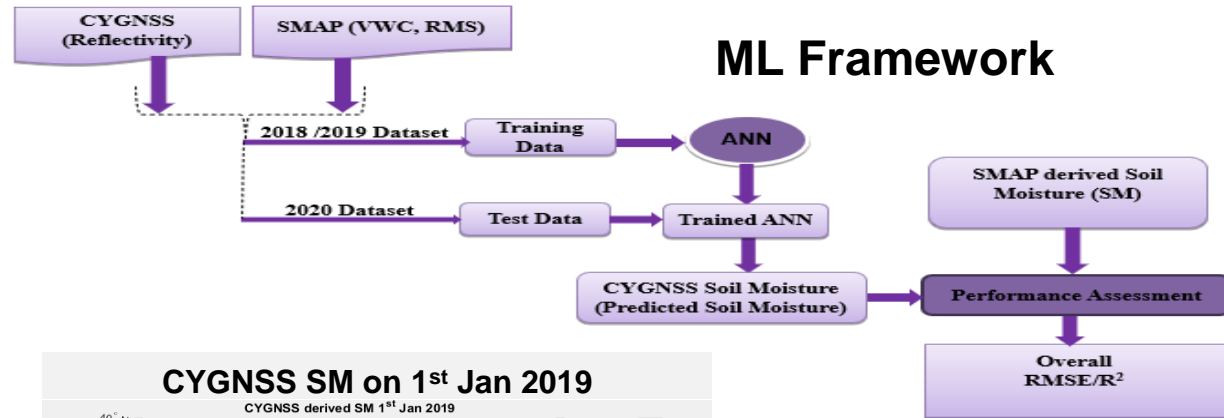


Fig. Temporal Analysis of CYGNSS derived SM over Anand Station (Gujarat)

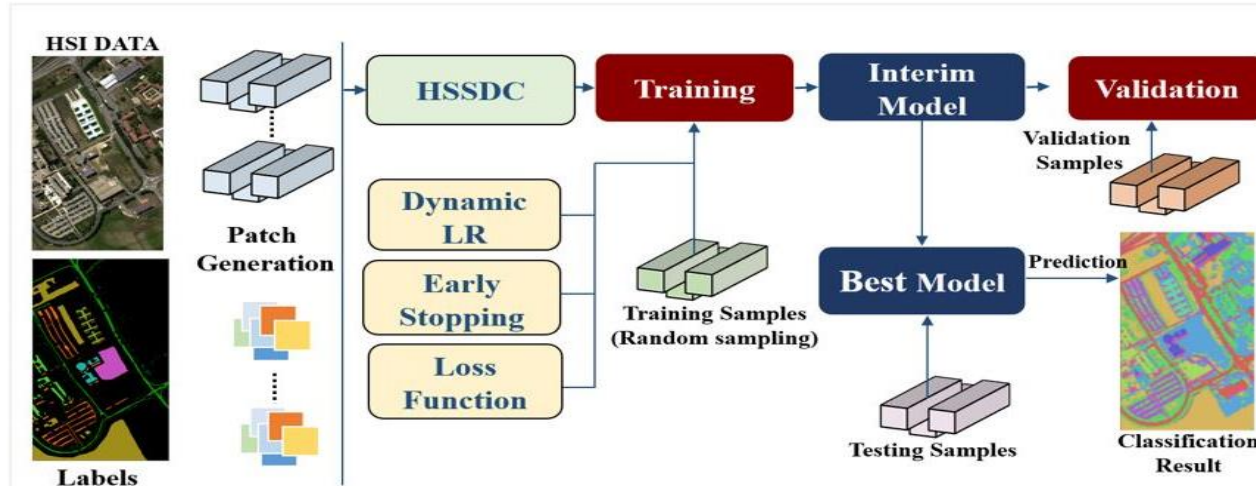
Contributions:

- Developed Machine learning based Soil Moisture retrieval algorithm using CYGNSS (Spaceborne GNSS-R mission) data.
- Tested CYGNSS derived SM along with SMAP SM over multiple agriculture sites using In-situ station datasets.

Linkages: Enhancing spatial & temporal frequency of current operational SAC SM products at MOSDAC and VEDAS & future ISRO spaceborne GNSS-R mission

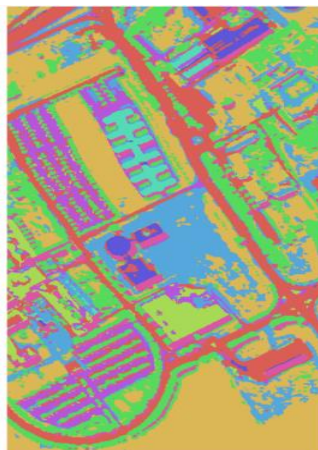
Shivani Tyagi et. al (2021), IGARSS 2021 (Accepted); Tyagi et. al (2019), IEEE TENCON

Hyperspectral Image Classification



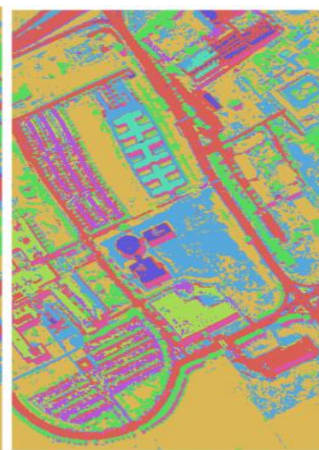
Data: ROSIS Hyperspectral Image – 103 bands, 1.3 m

- Classify pixels in a Hyperspectral image having ground truth available using Convolutional Neural Network (CNN).



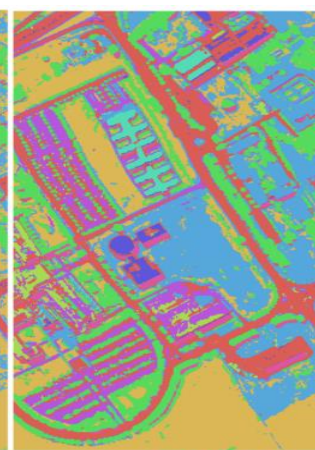
Li et.al.(2017)

▪ 94.45 %



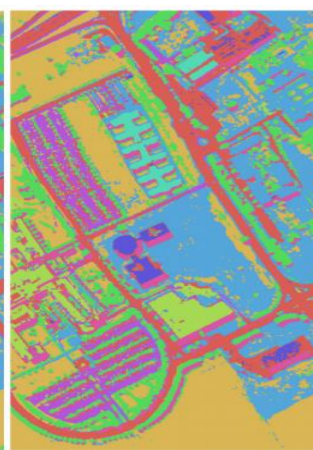
He et.al. (2017)

▪ 94.09 %



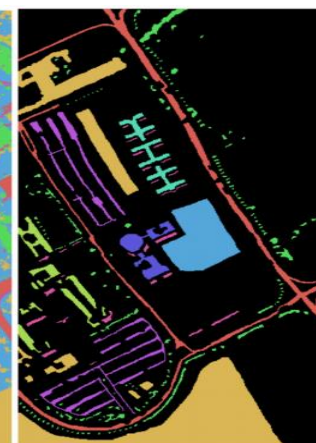
Lee et.al. (2016)

▪ 93.27 %



Squeezenet

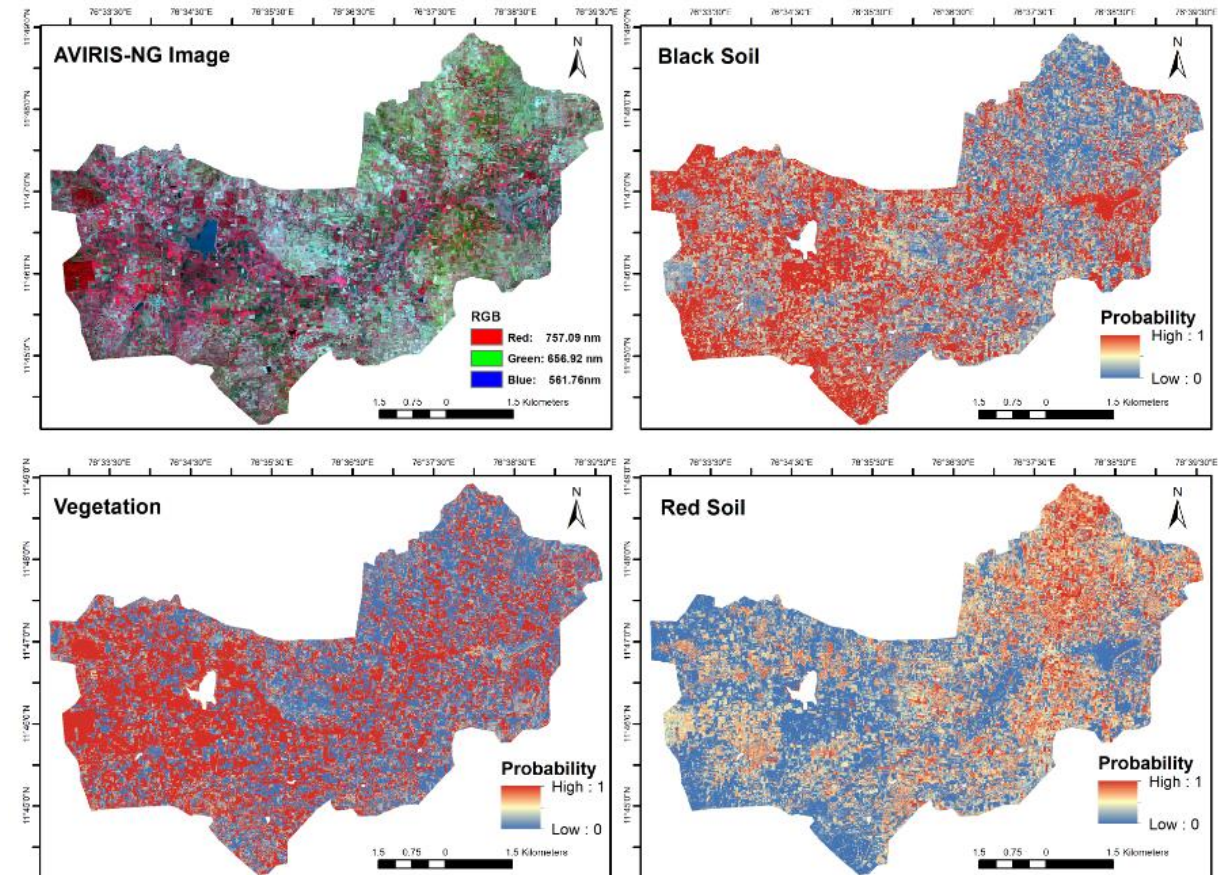
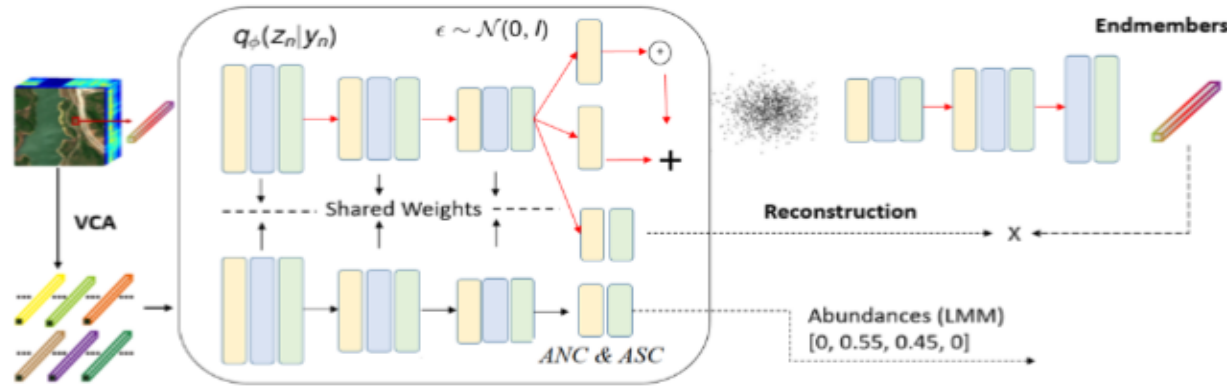
▪ 96.93 %



Ground truth

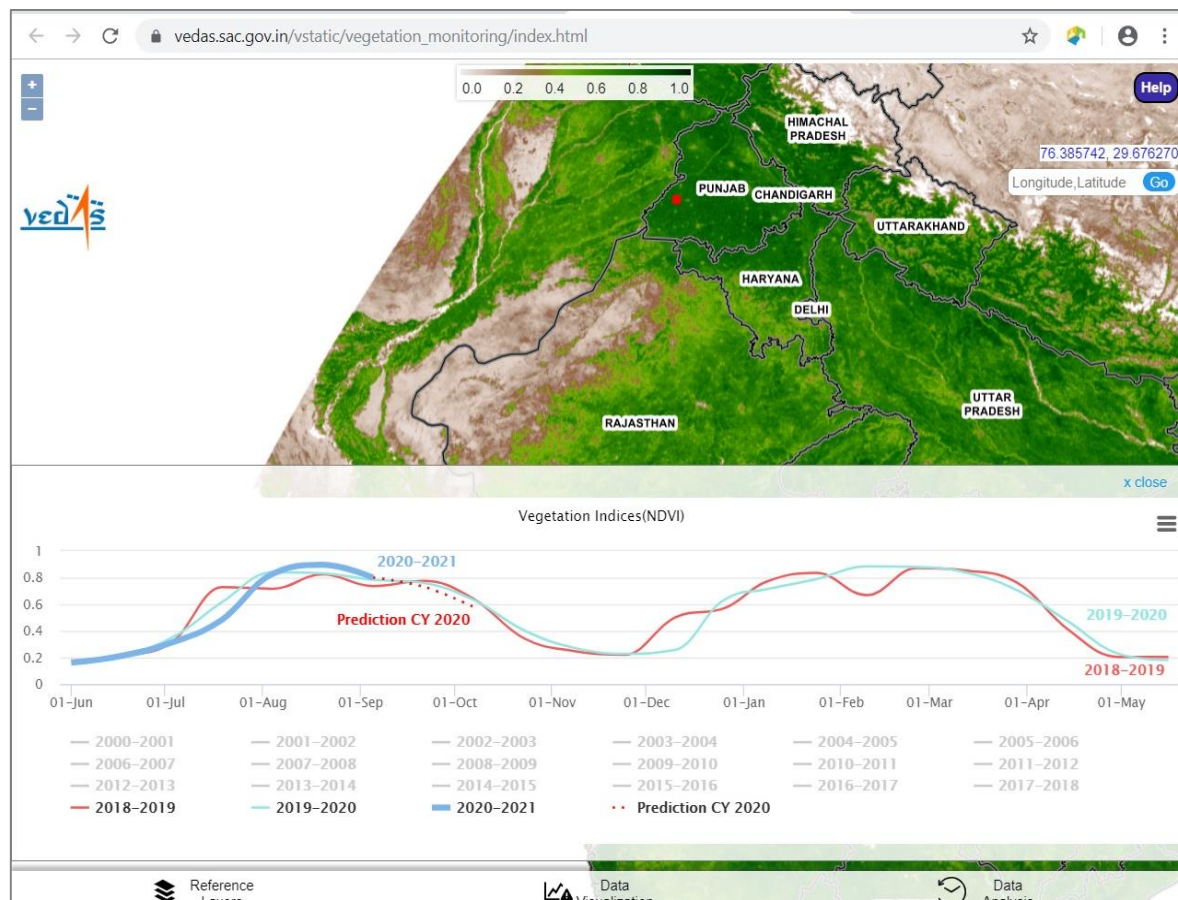
- Unclassified
- Asphalt
- Meadows
- Gravel
- Trees
- Painted Metal Sheets
- Baresoil
- Bitumen
- Self-Blocking Bricks
- Shadows

DEEP LEARNING FOR THE UNMIXING OF RED AND BLACK SOIL in AVIRIS-NG Image



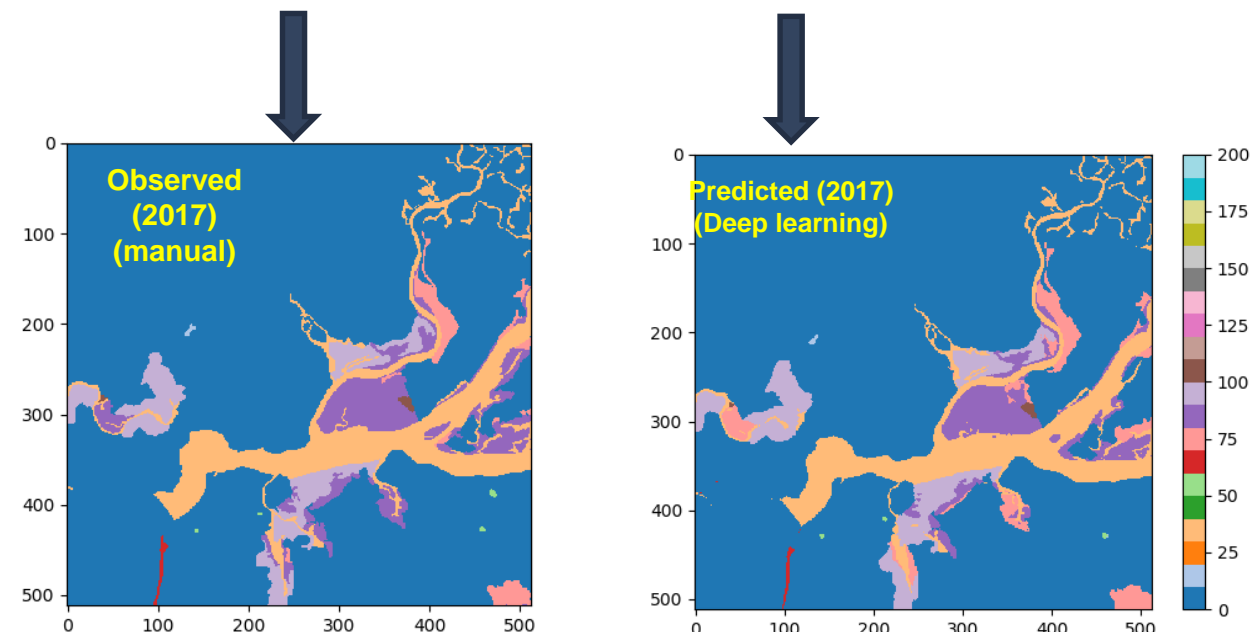
[IGARSS 2022]

AI based NDVI Time Series Forecasting



AI based Automated procedure for Wetland Monitoring

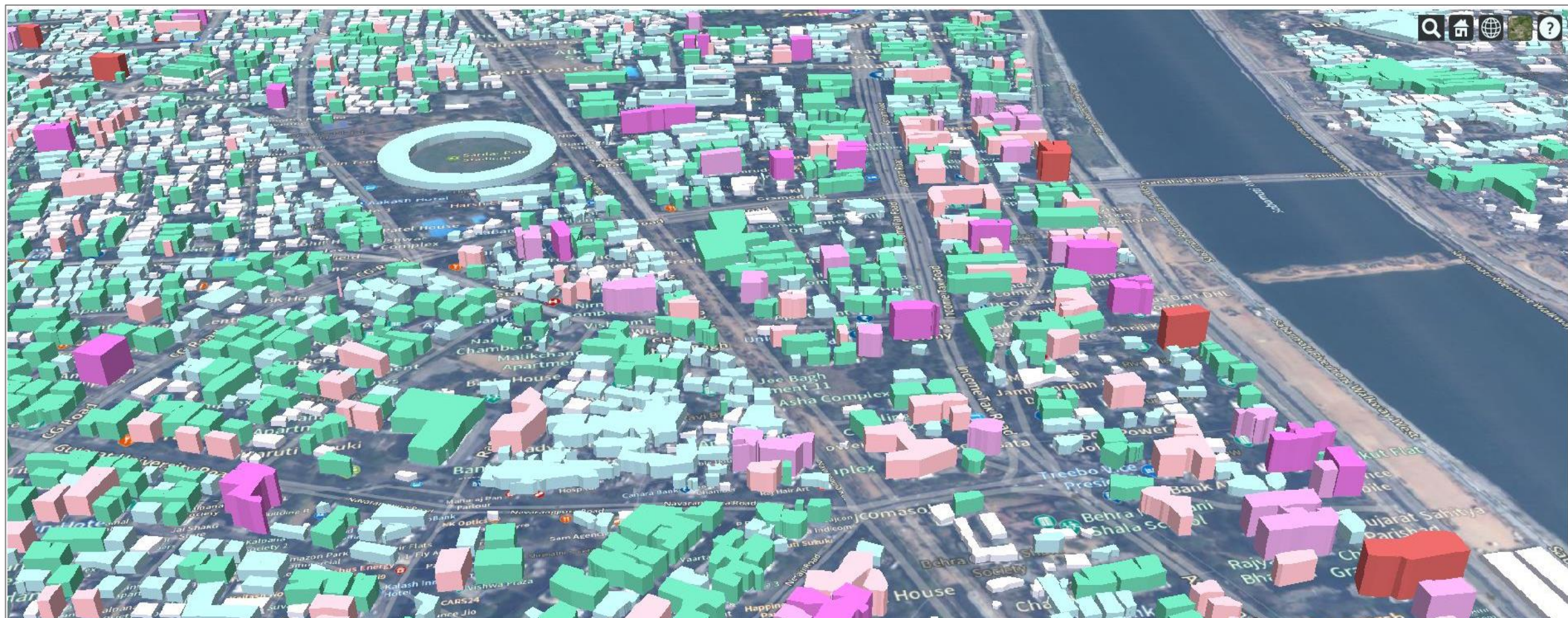
- CNN based architecture (Deep learning)



10 = Lakes, 20 = Waterlogged, 30 = River/Stream, 40 =Reservoirs/Barrages, 50 = Tanks/Ponds, 60 = Sand/Beach, 70 = Salt Pans, 80 = Mangroves, 90 Pans, 100 = Aquaculture Ponds

AI based Building Footprint Extraction

3D City Model of Ahmedabad



Building footprint from Carto-3 (AI based) and height from Carto-1 data

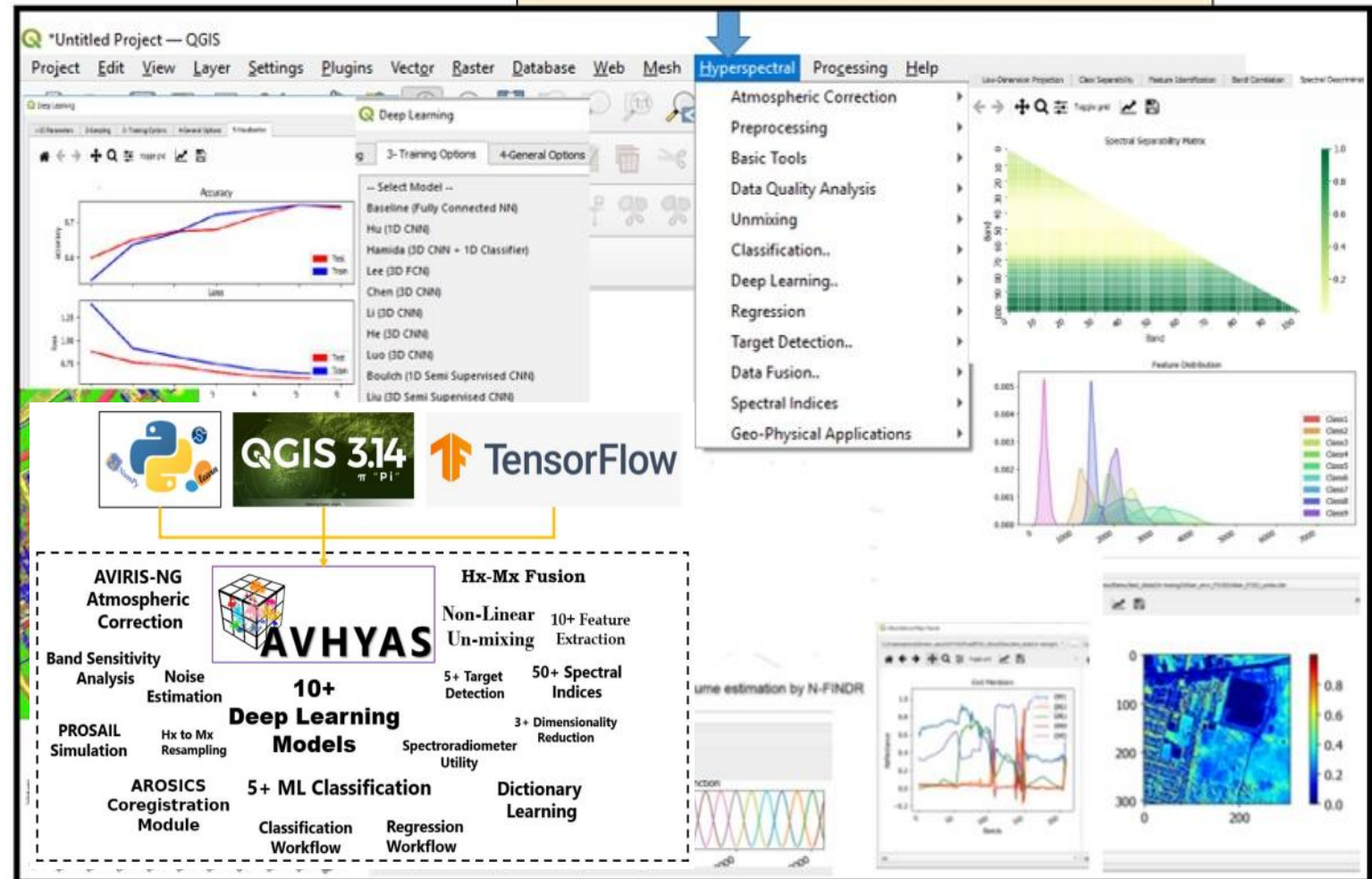
DL tools for Hyperspectral Data Analysis



- QGIS plugin
- 50+ Functionalities
- Deep learning
- PROSAIL Simulation
- Bilinear Unmixing
- Hx+Mx Fusion

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AVHYAS plugged into QGIS as "Hyperspectral" tool





Thanks

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Space Applications Centre
Indian Space Research Organisation