

# Radar Remote Sensing for Agricultural Applications

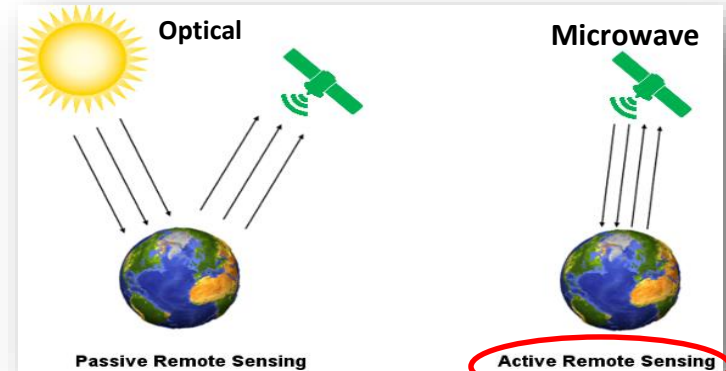
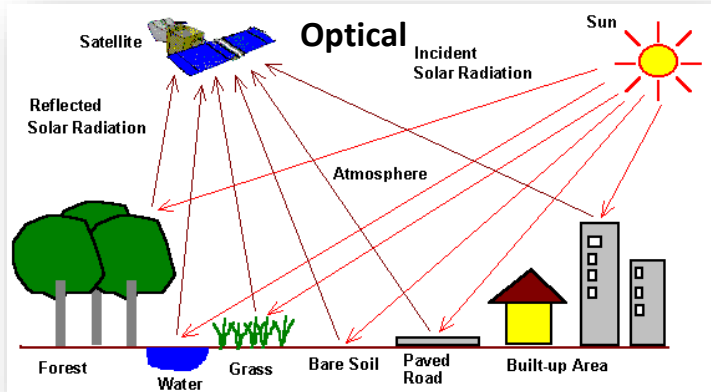
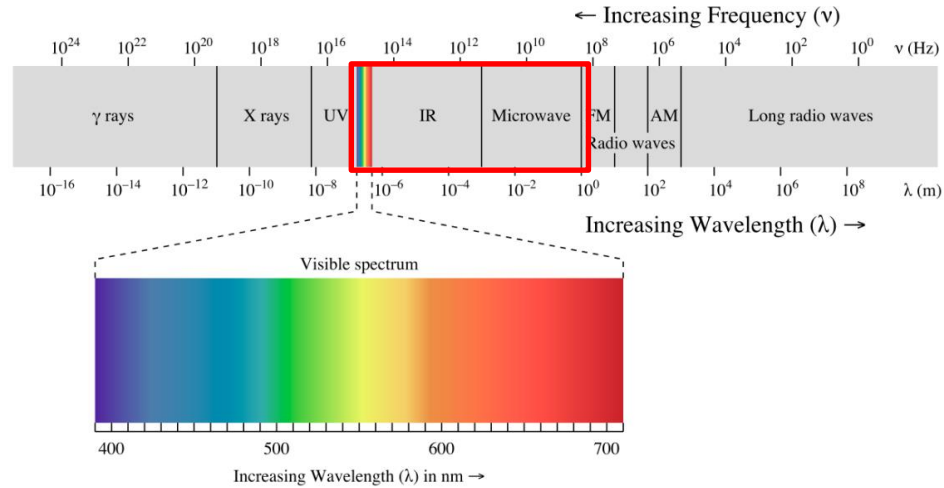
**Prof. Avik Bhattacharya**

Microwave Remote Sensing Lab  
Centre of Studies in Resources Eng.  
Indian Institute of Technology Bombay  
Mumbai-400076, India  
[www.mrslab.in](http://www.mrslab.in)



# Satellite Remote Sensing

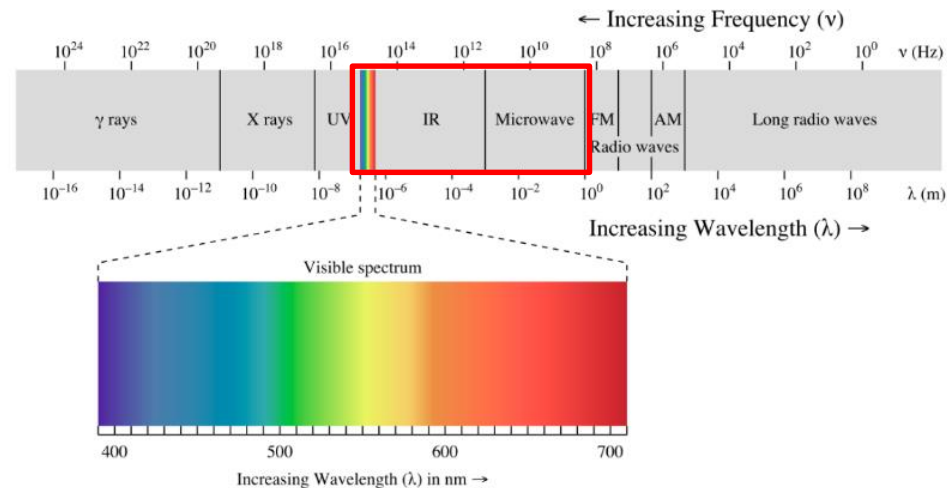
## Electromagnetic Wave Spectrum



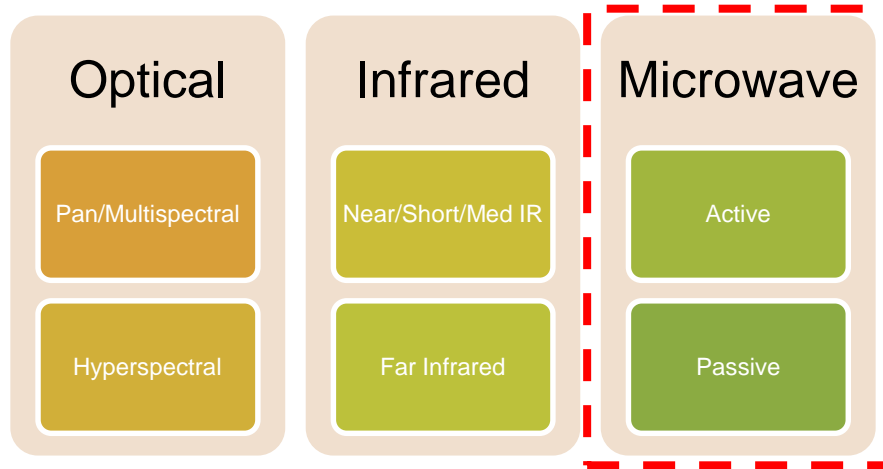
# Satellite Data Selection

## Major Applications

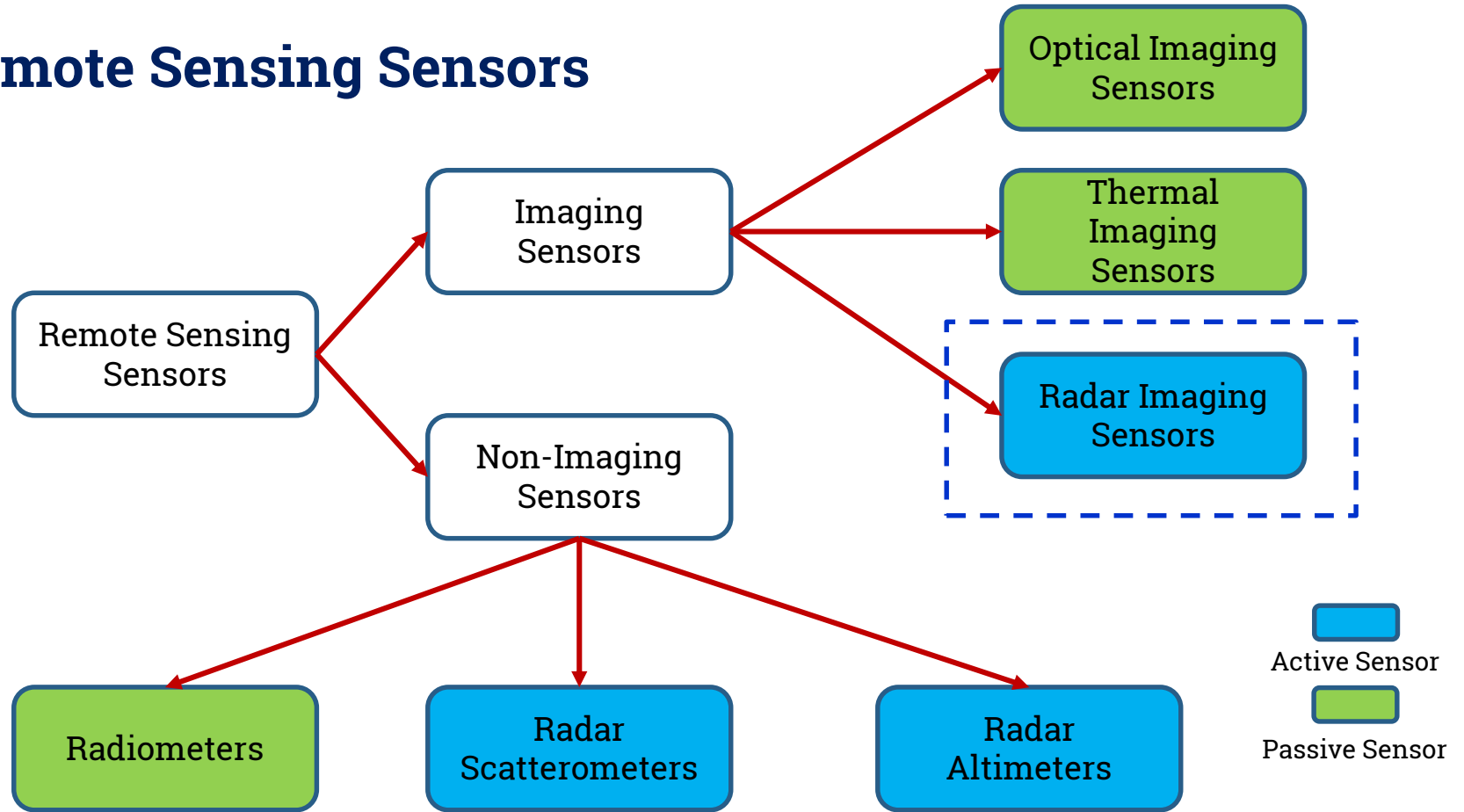
1. **Agriculture and Soil**
2. Forestry
3. Land Use and Land Cover
4. Geosciences
5. Urban and Infrastructure
6. Ocean, Atmosphere and Climate Science
7. Disaster Management Support



## Major Remote Sensing Satellite data types



# Remote Sensing Sensors

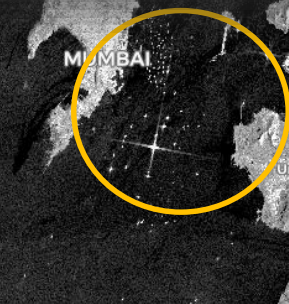
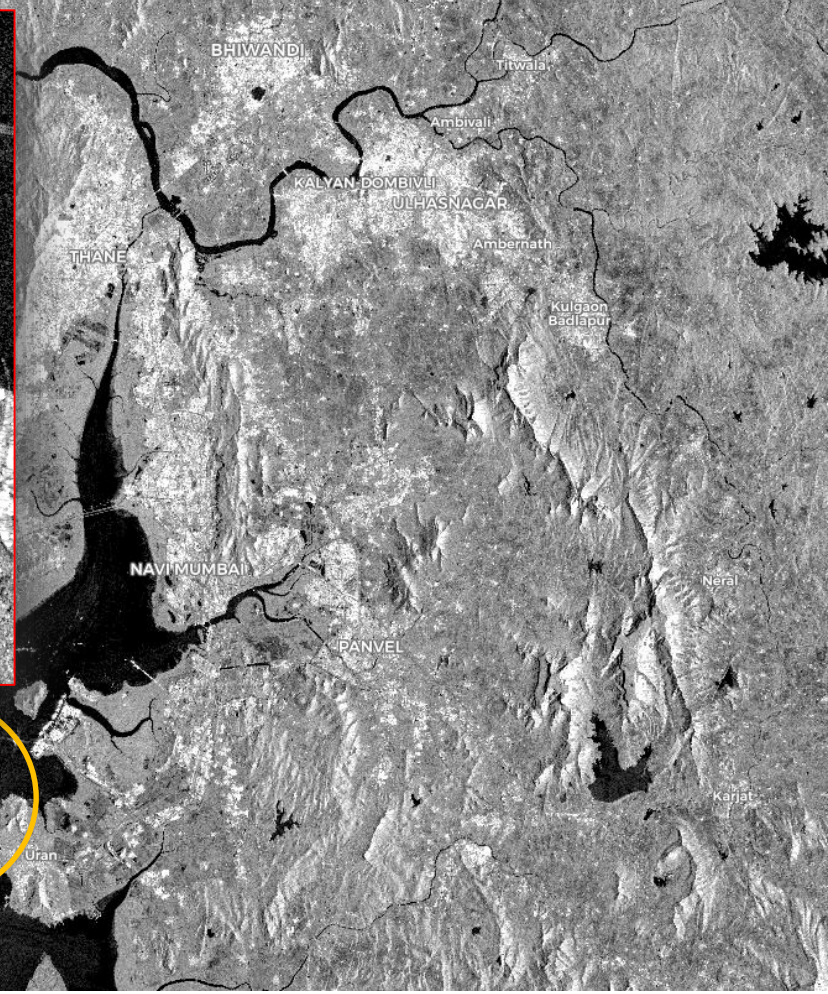
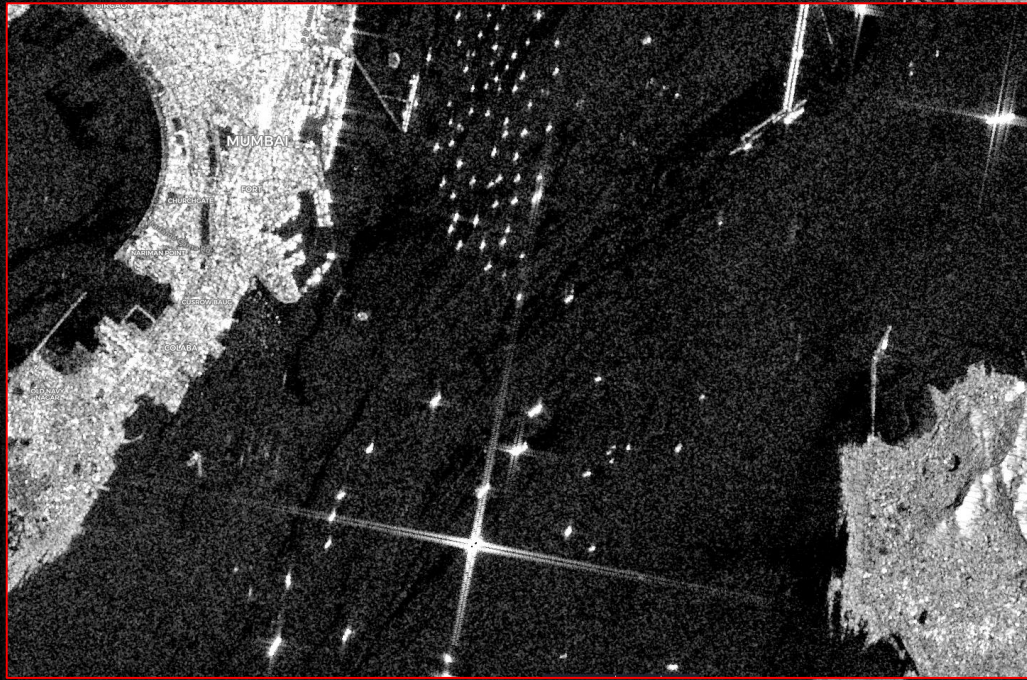


# Synthetic Aperture Radar (SAR) Imaging Satellites



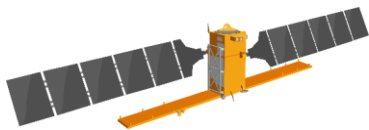
SENTINEL-1

# Synthetic Aperture Radar (SAR) Imaging Satellites: Images

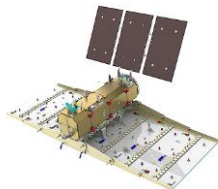


# Why Radar Remote Sensing ? Gaining attention/Challenges

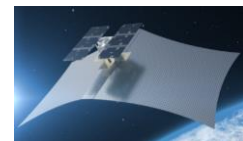
- Rapid expansion of constellations of SAR satellites



Sentinel-1A/1B



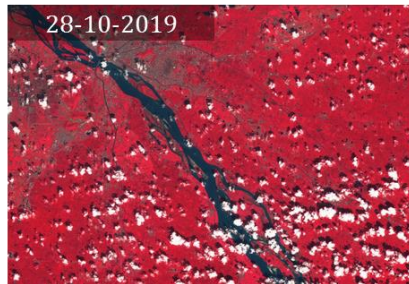
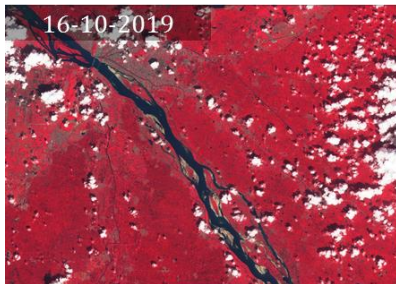
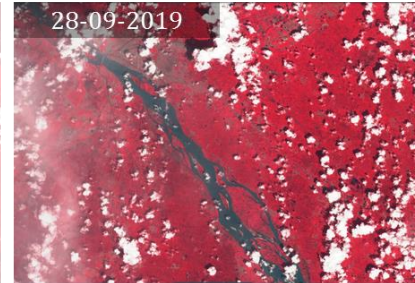
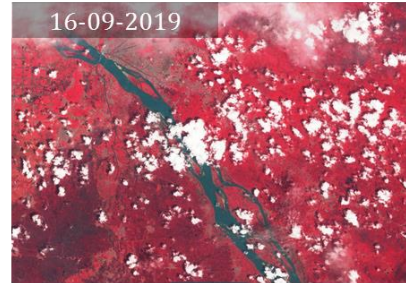
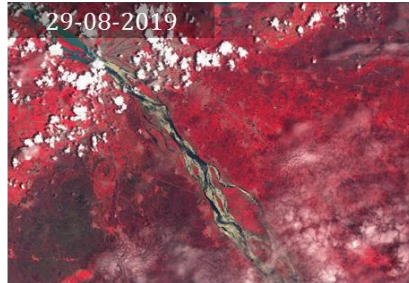
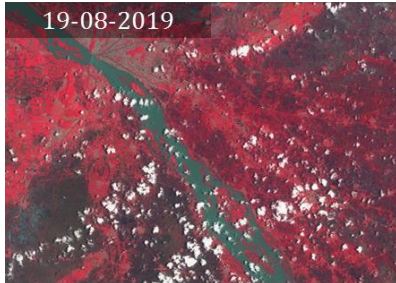
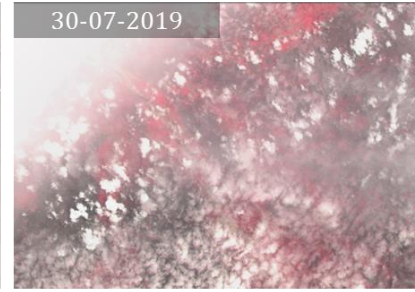
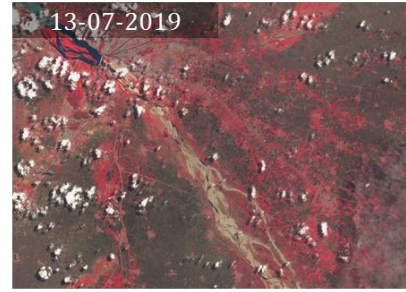
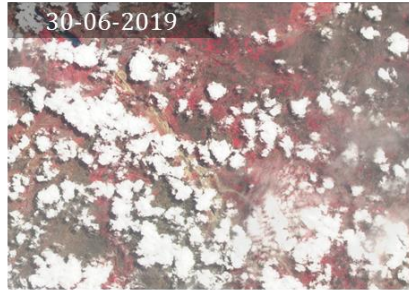
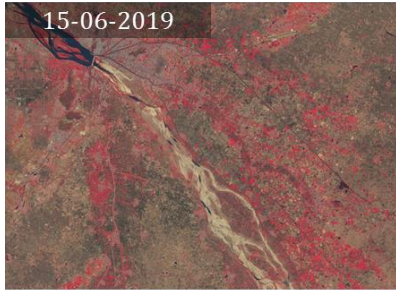
SAOCOM 1A/B



Capella X-SAR

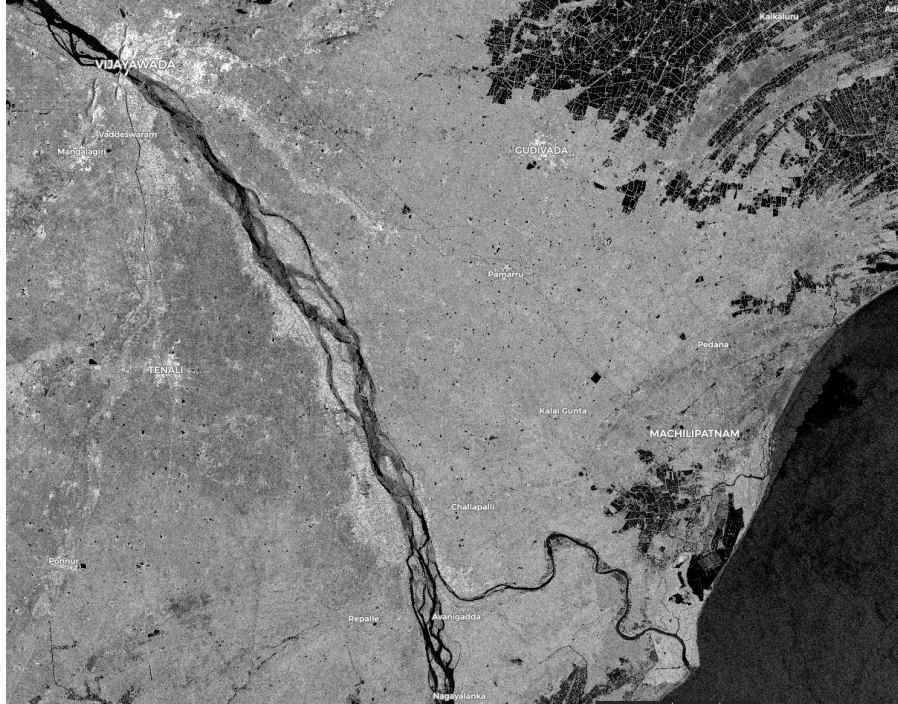
- Provide **wide-swath coverage and all-weather monitoring**
- There is an increased need to explore the potential for quantitative estimation of **bio/geo-biophysical parameters** using SAR data
- No proven **single best inversion approaches** for the estimation of biophysical parameters from vegetation models using full and dual polarimetric SAR data
- Due to the **large data volume** of new dual-pol SAR systems, exploration of processing chains for crop inventory map generation at a larger scale is limited.
- **New generation dual and compact-pol SAR** systems provide an opportunity to develop improved algorithms for parameter estimation

# Sentinel-2 FCC (843) – Vijayawada, India



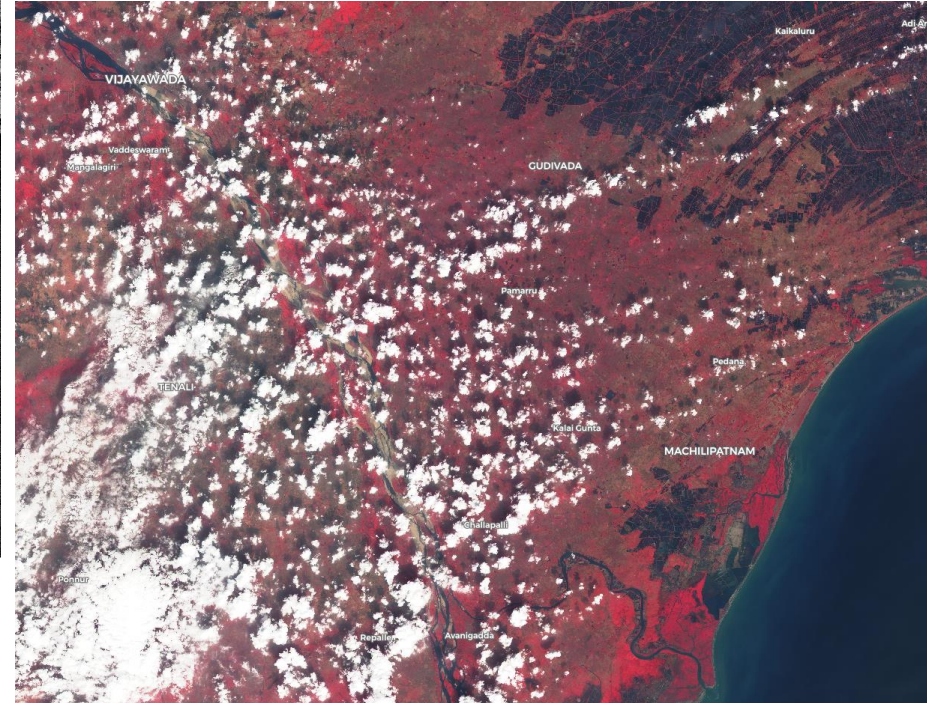


# Monitoring **Kharif** season (June – October) crops !



**Sentinel-1 SAR image (VV Polarization)**

**Sentinel-2 Optical Image (FCC)**



**Advent of the south-west monsoon season**

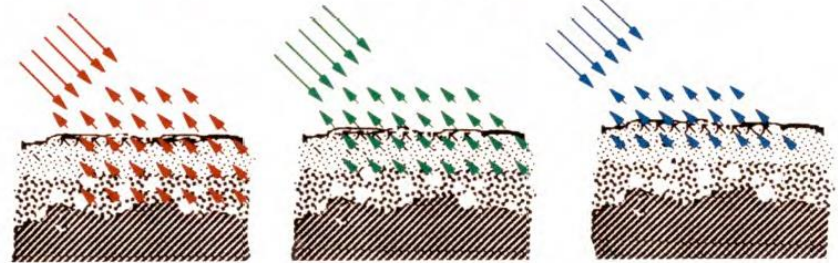


# Generic Scattering Properties

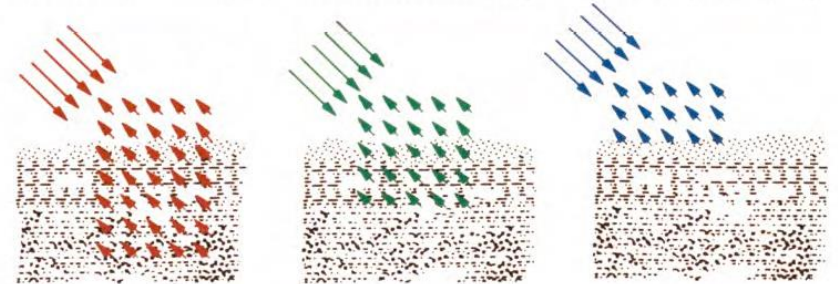
**Forest:** Leaves interacts with **X-band**, **C-band** can penetrate through the foliage, and **L-band** can possibly see the ground-trunk.



**Dry Soil:** Surface looks rough with **X-band**, moderate to less rough with **C-band** and **L-band** respectively.



**Snow/Ice:** Depending on the wetness, the three wavelengths can penetrate to a certain extent in the snow pack. Surface and layering looks rough with **X-band**, moderate to less rough with **C-band** and **L-band** respectively.

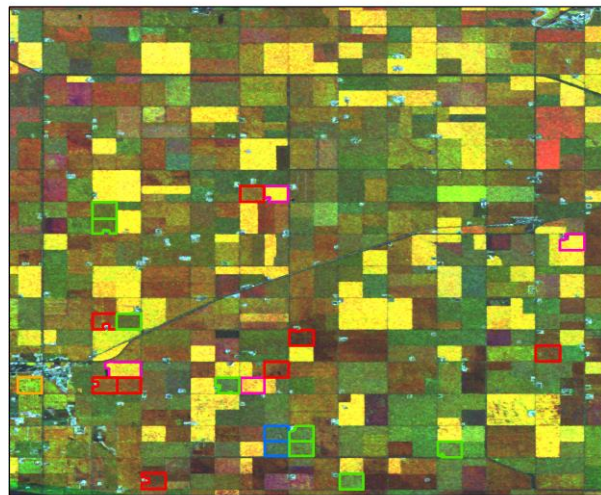


# Temporal Variation in SAR Backscatter Intensity

Temporal variation in HH



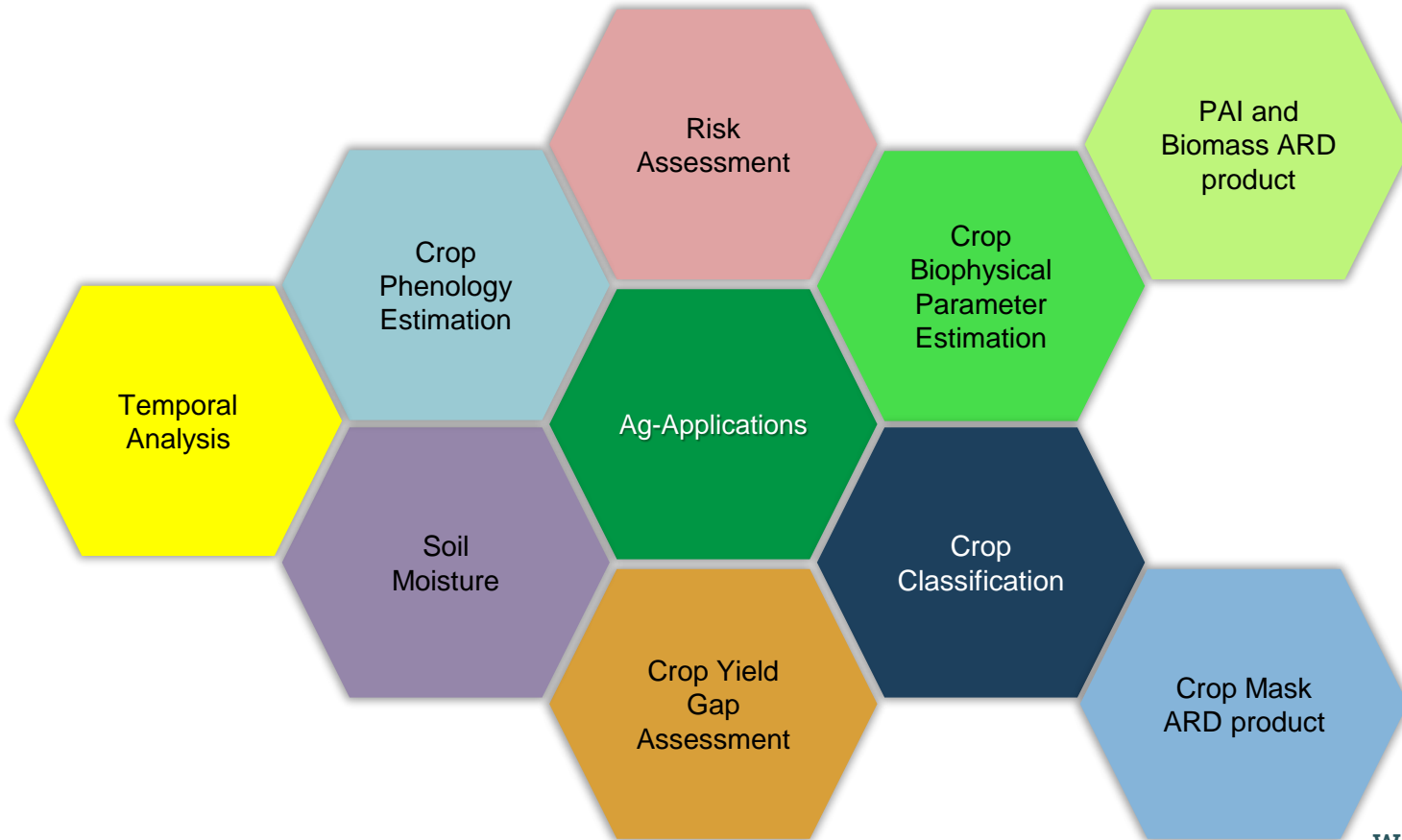
Temporal variation in VH



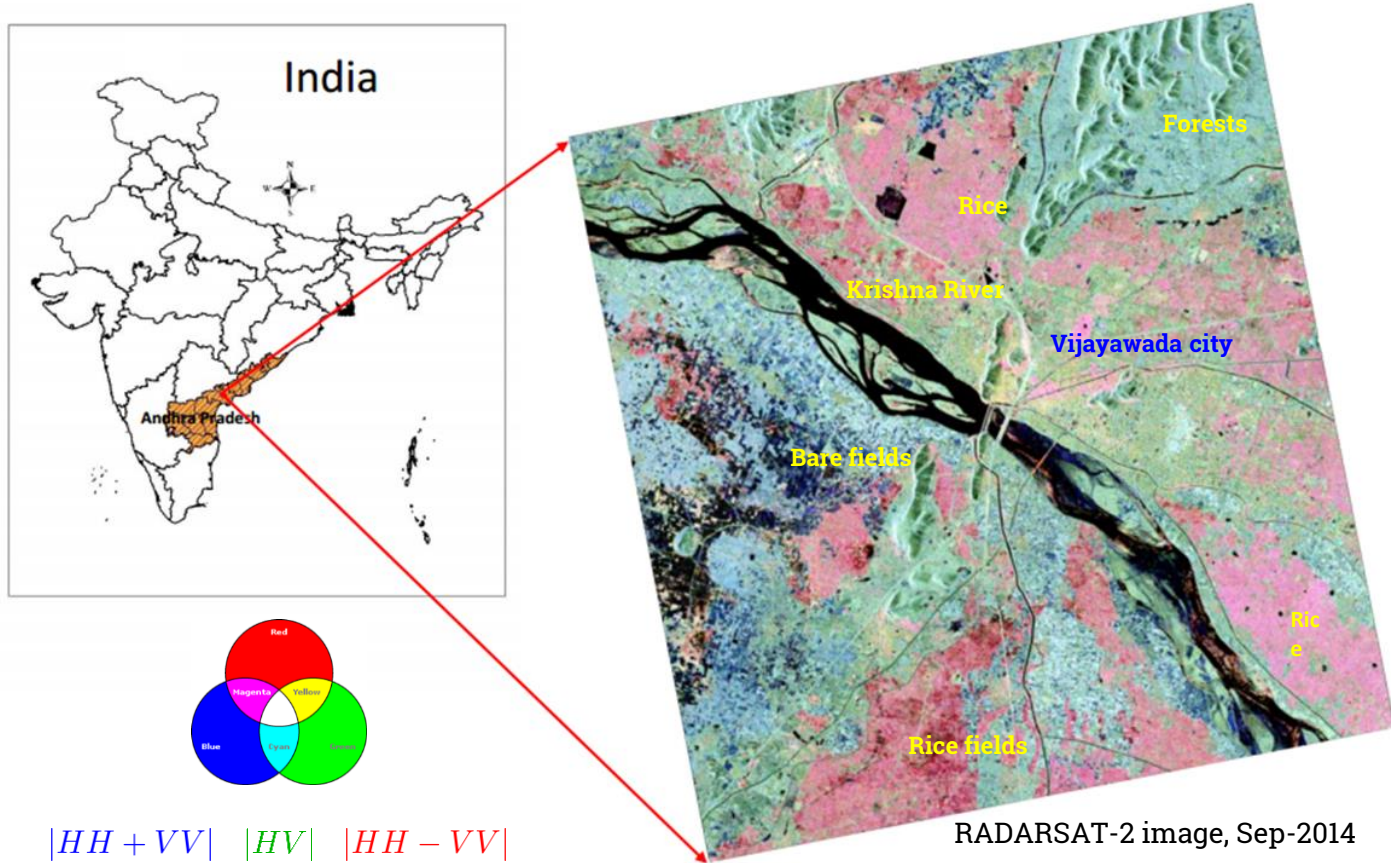
Temporal variation in VV



# Research Components in SAR Agriculture

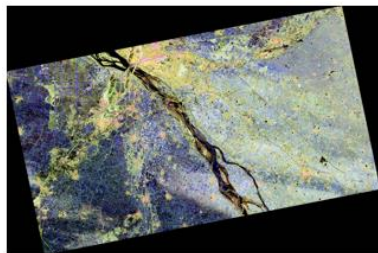


# Vijayawada, India: SAR Image Visualization

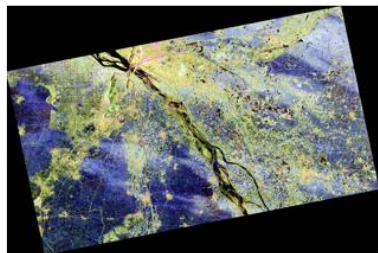


RADARSAT-2 image, Sep-2014

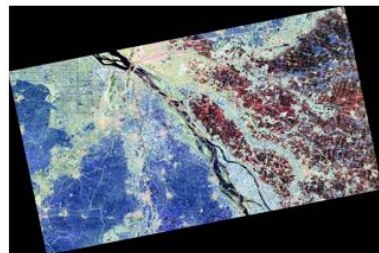
# GRVI, Vijayawada, India



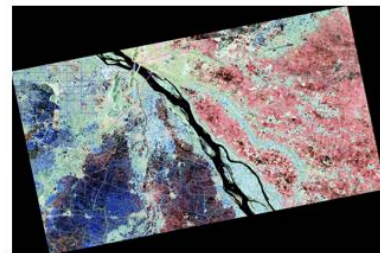
2018/06/11



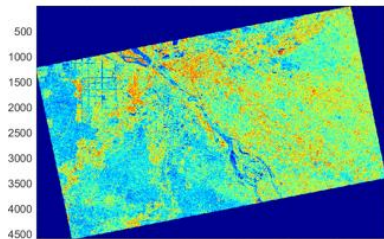
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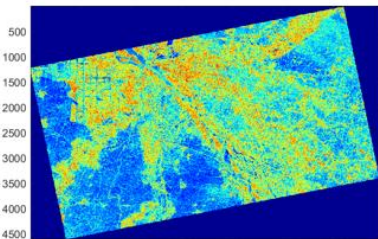
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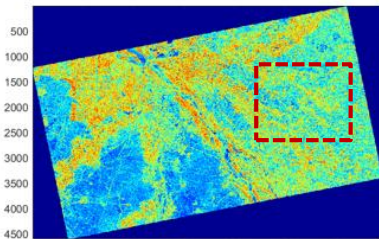
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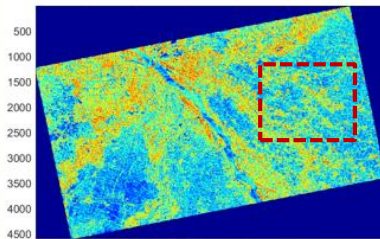
RVI



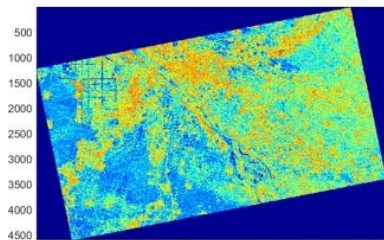
RVI



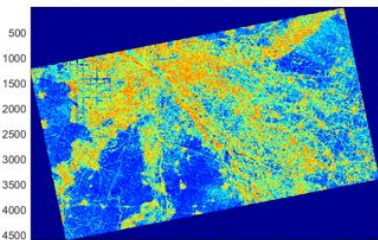
RVI



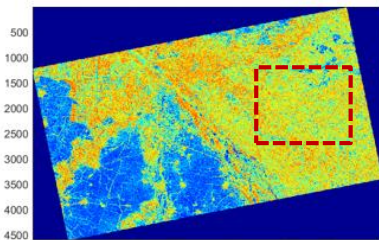
RVI



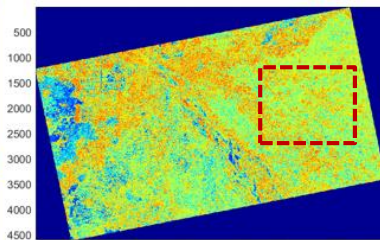
GRVI



GRVI



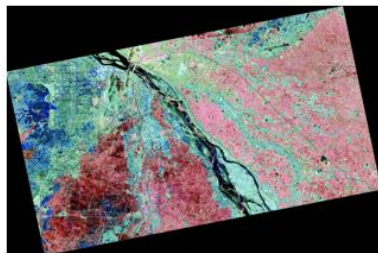
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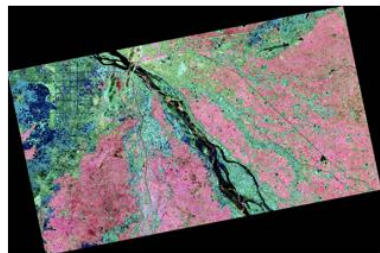
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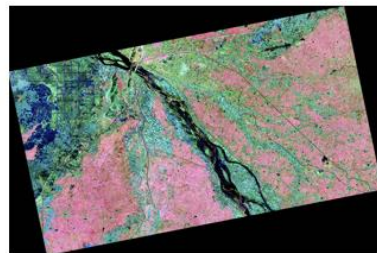
# GRVI, Vijayawada, India



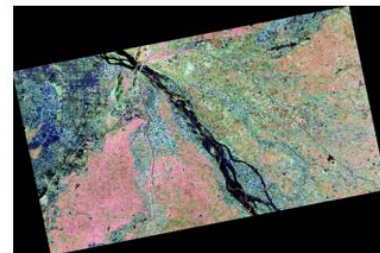
2018/09/15



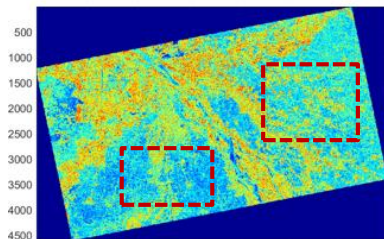
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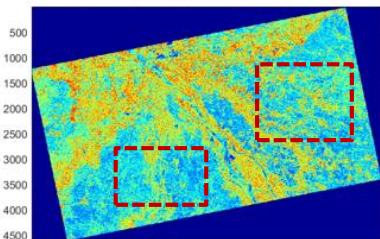
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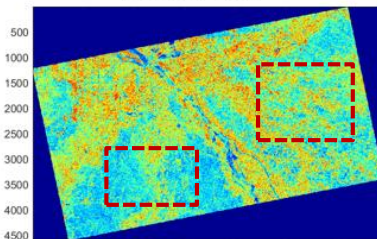
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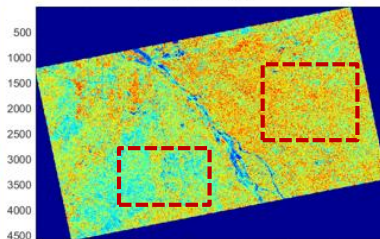
RVI



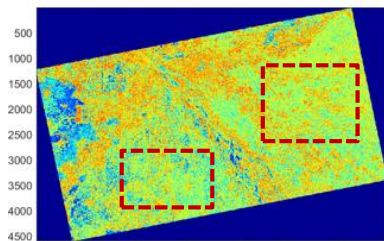
RVI



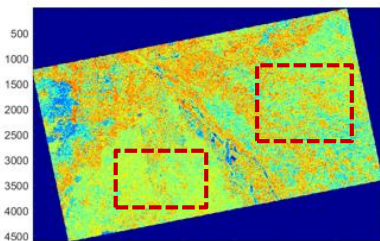
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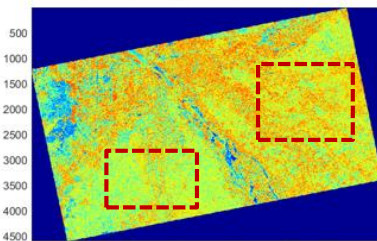
RVI



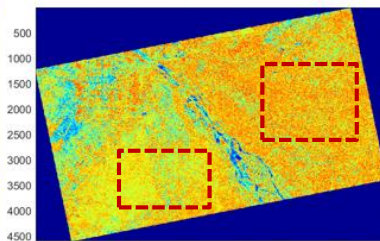
GRVI



GRVI

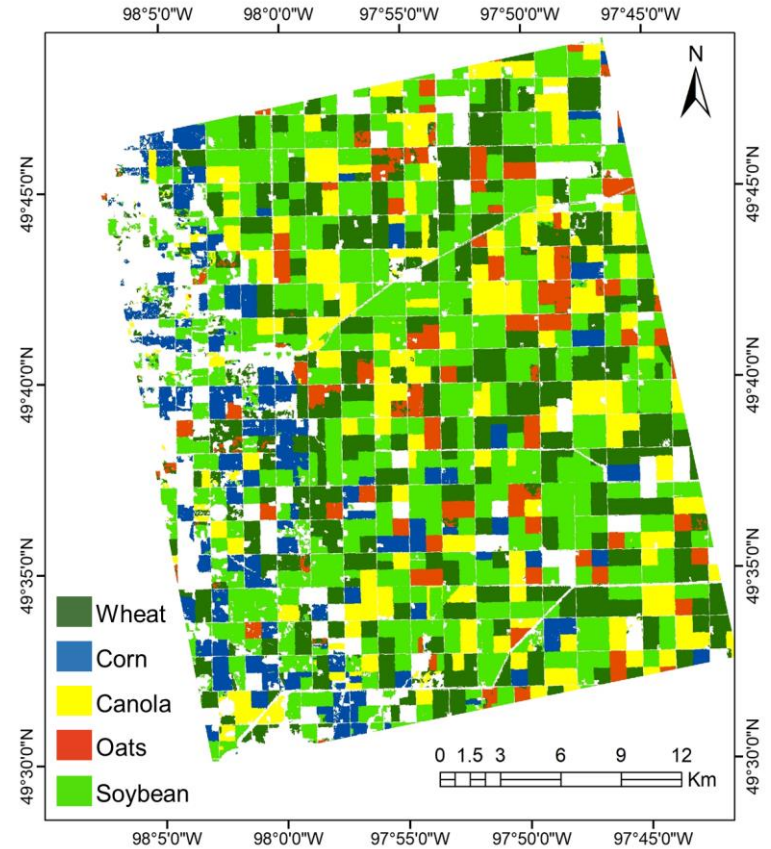
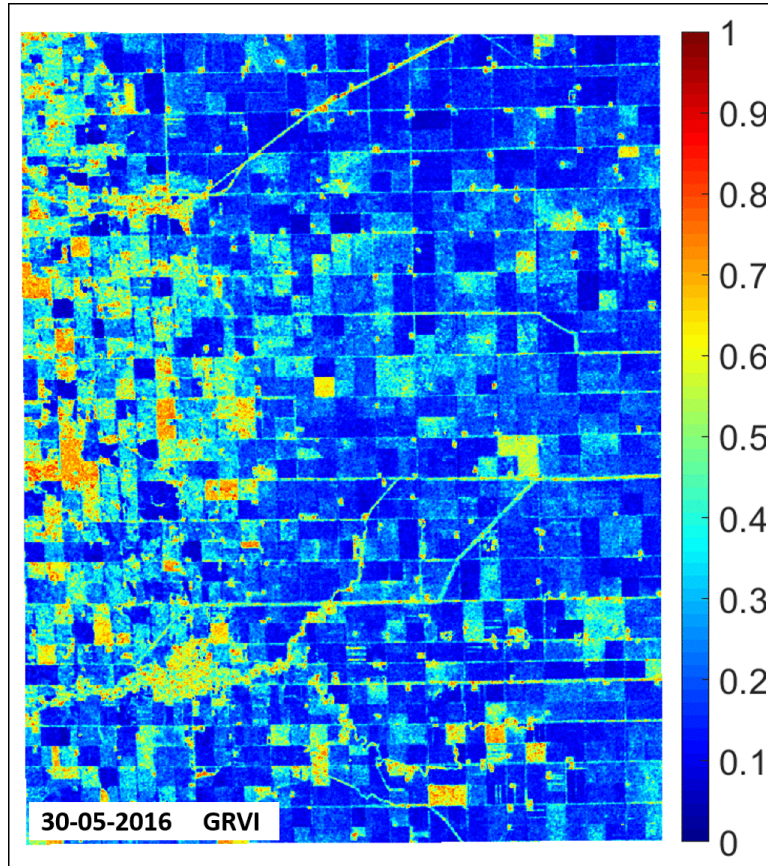


GRVI



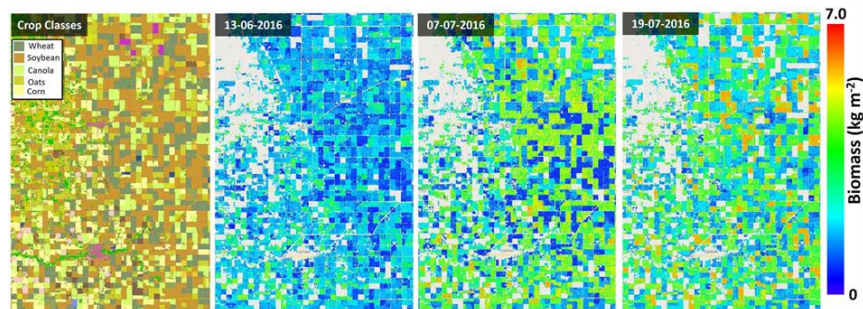
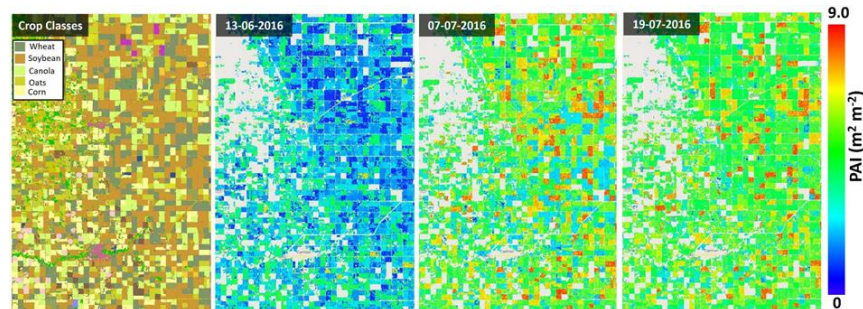
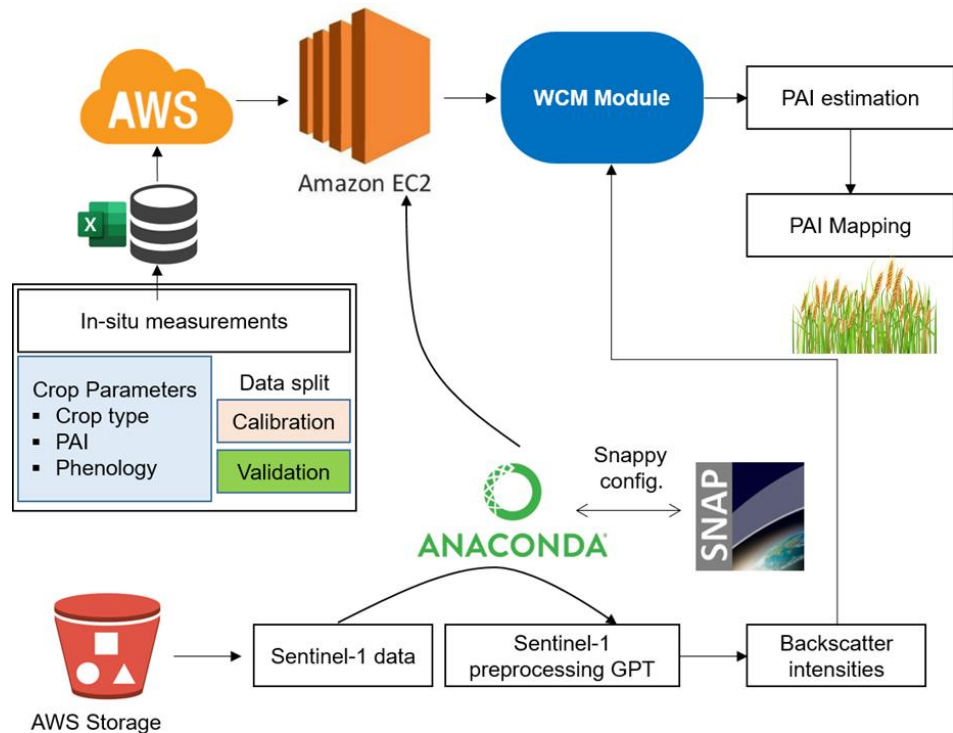
GRVI







# Analysis Ready Data (ARD): PAI and Biomass maps



Sample workflow to generate crop biophysical parameters from **Sentinel-1** data on **AWS cloud platform**

# Codes & Software Availability



The codes are available through this link:

<https://github.com/Subho07?tab=repositories>

The offline version of the code is available from **PolSARTools** QGIS based plugin

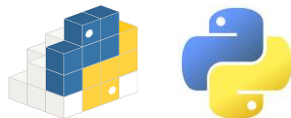


[https://plugins.qgis.org/plugins/polsar tools/](https://plugins.qgis.org/plugins/polsar%20tools/)

ESA **SNAP** functionalities



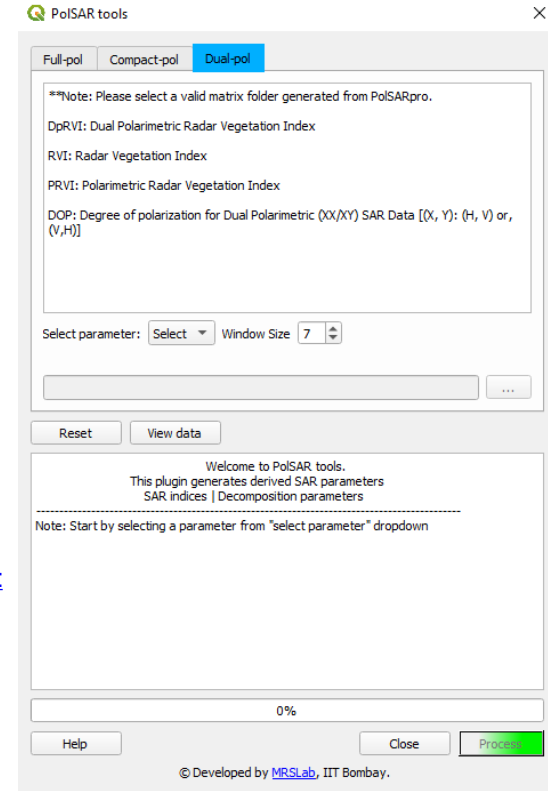
PyPI packages



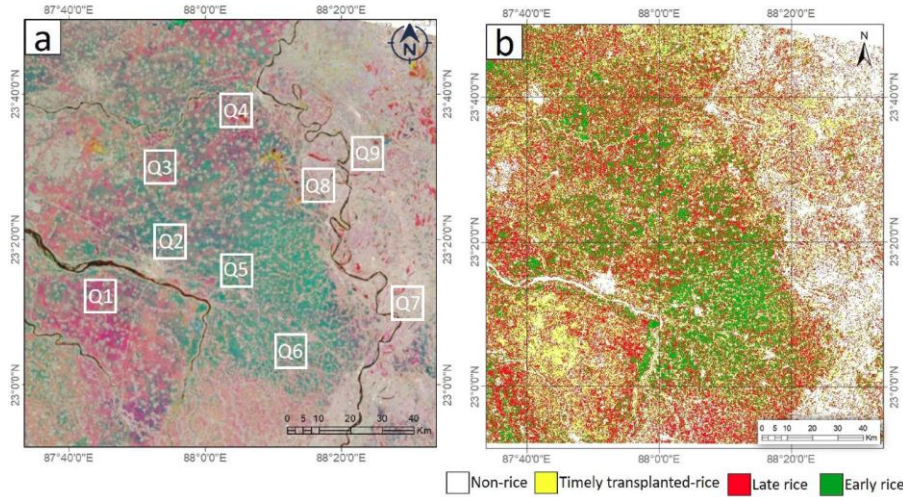
- Vegetation Indices :  
Generalized Radar Vegetation Index (GRVI)  
Dual-pol Radar Vegetation Index (DpRVI)  
Compact-pol Radar Vegetation Index (CpRVI)
- Model-free (MF#Components) Decomposition Techniques :  
MF3CF, MF4CF for full-pol SAR data  
MF3CC for compact-pol SAR data

MF3CF: <https://pypi.org/project/mf3cf/>

MF3CC: <https://pypi.org/project/mf3cc/>



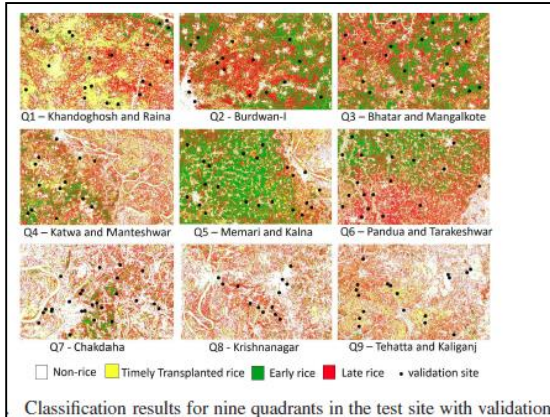
# Sen4Rice: Google Earth Engine



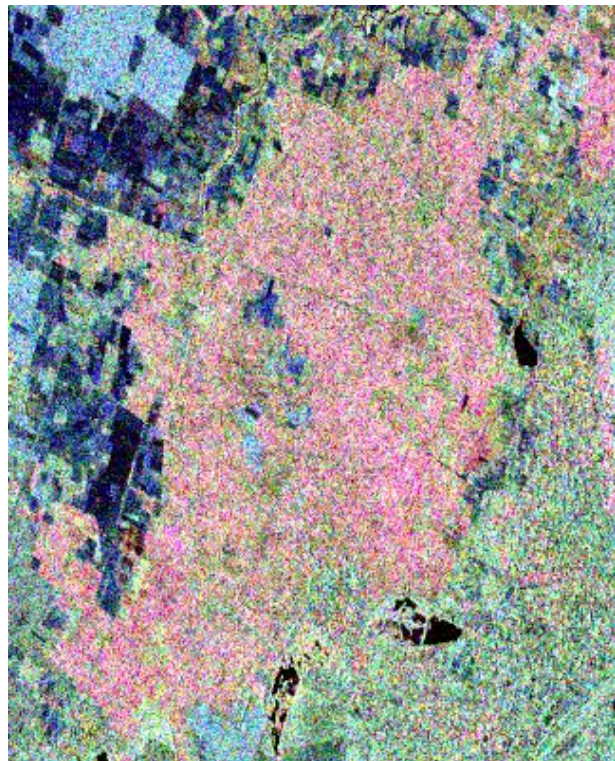
IEEE GEOSCIENCE AND REMOTE SENSING LETTERS

## Sen4Rice: A Processing Chain for Differentiating Early and Late Transplanted Rice Using Time-Series Sentinel-1 SAR Data With Google Earth Engine

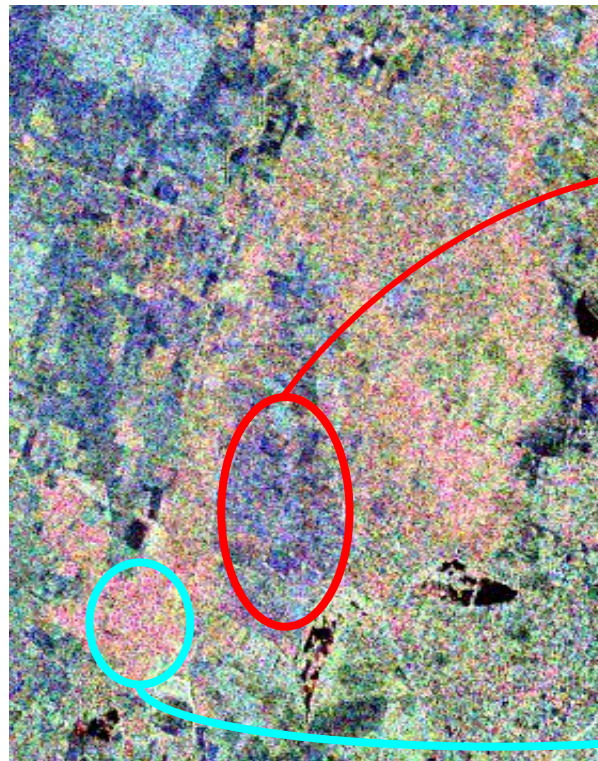
Dipankar Mandal<sup>1</sup>, Student Member, IEEE, Vineet Kumar<sup>2</sup>, Student Member, IEEE,  
 Avik Bhattacharya<sup>3</sup>, Senior Member, IEEE, Yalamanchili Subrahmanyeswara Rao,  
 Paul Siqueira<sup>4</sup>, Member, IEEE, and Soumen Bera



# Harvested & Non-Harvested Rice areas Vijayawada, India



16-Nov-2014



10-Dec-2014



Harvested Rice



Non-Harvested Rice



# PolSAR tools



A plugin to generate polarimetric descriptors  
is now available for **QGIS**

**Developer: MRSLab, IIT Bombay**



Microwave  
Remote Sensing Lab



[www.mrslab.in](http://www.mrslab.in)



[mrslab](https://www.linkedin.com/company/mrslab)



Microwave Remote Sensing Lab-IIT Bombay

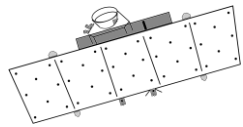


[@mrslab\\_iitb](https://twitter.com/mrslab_iitb)

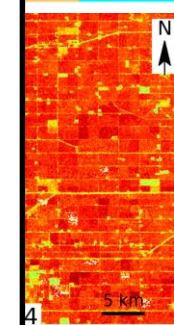
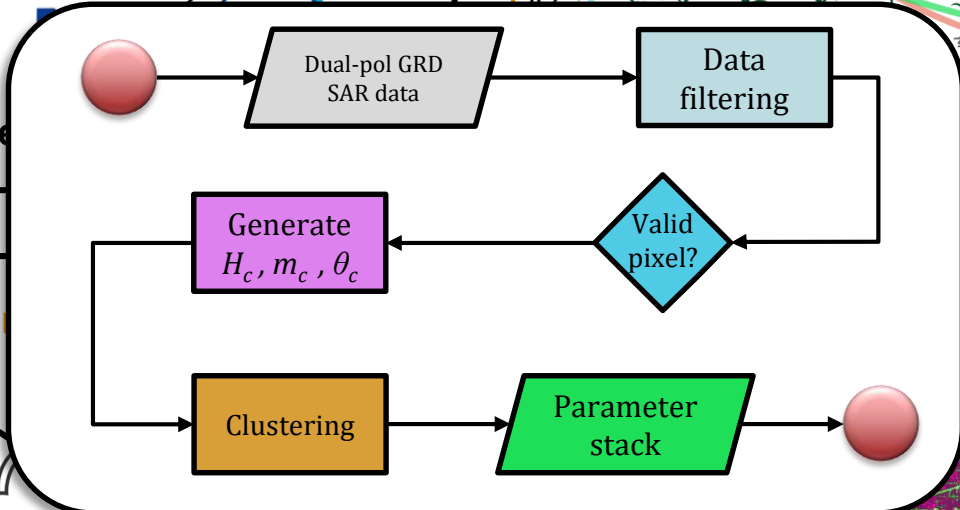
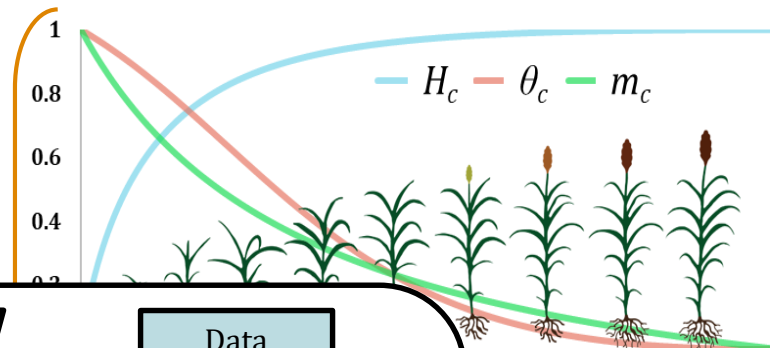
ALOS-4



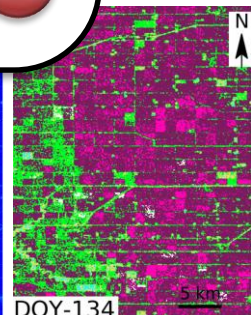
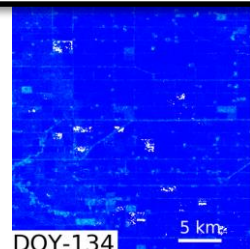
Sentinel-1A, 1B, 1C, 1D



ESA ROSE-L (S)



New Dual-Pol GRD Product Descriptors

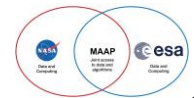


$H_c/\theta_c$  Clusters



Google Earth Engine

MAAP



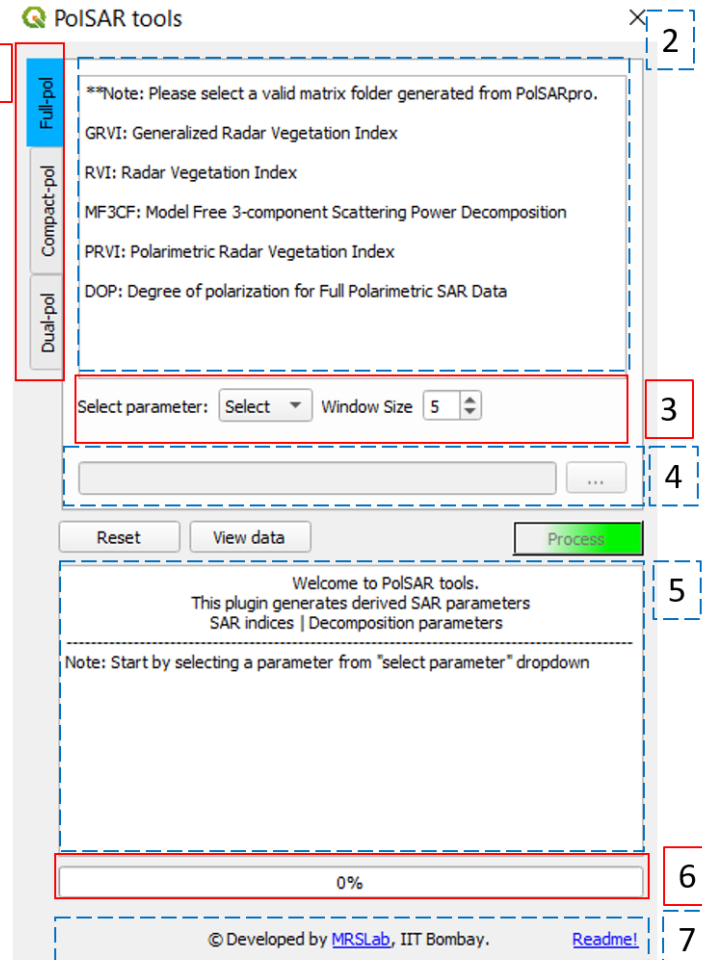
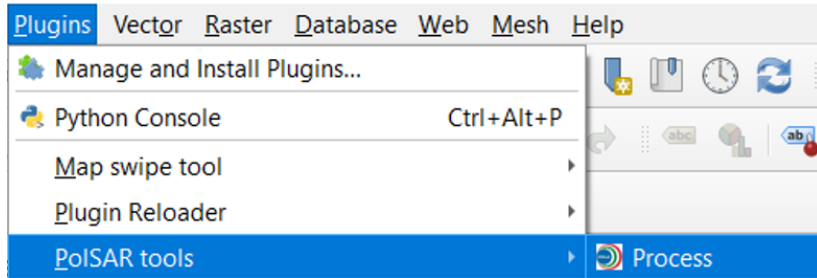
Google Earth Engine App @ MRSLab  
URL: <https://bnarayanarao.users.earthengine.app/view/dpgrd>

www.mrslab.in





# Contributions using QGIS





# Contributions using QGIS

PolSAR tools

Full-pol

Compact-pol

Dual-pol

\*\*Note: Please select a valid matrix folder generated from PolSARpro.

GRVI: Generalized Radar Vegetation Index

RVI: Radar Vegetation Index

MF3CF: Model Free 3-component Scattering Power Decomposition

PRVI: Polarimetric Radar Vegetation Index

DOP: Degree of polarization for Full Polarimetric SAR Data

Select parameter: Select Window Size 5

Reset View data Process

Welcome to PolSAR tools.  
This plugin generates derived SAR parameters  
SAR indices | Decomposition parameters

Note: Start by selecting a parameter from "select parameter" dropdown

0%

© Developed by [MRS Lab](#), IIT Bombay. [Readme!](#)

PolSAR tools

Full-pol

Compact-pol

Dual-pol

\*\*Note: Please select a valid matrix folder generated from PolSARpro.

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DOP: Degree of polarization for Full Polarimetric SAR Data

Select parameter: Select Window Size 5

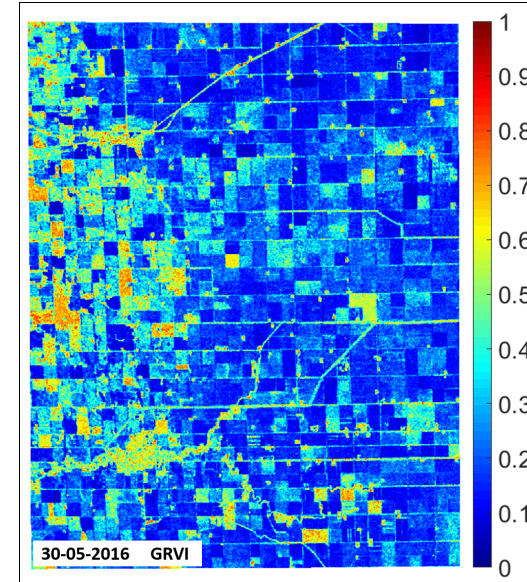
Reset View data Process

Welcome to PolSAR tools.  
This plugin generates derived SAR parameters  
SAR indices | Decomposition parameters

Note: Start by selecting a parameter from "select parameter" dropdown

0%

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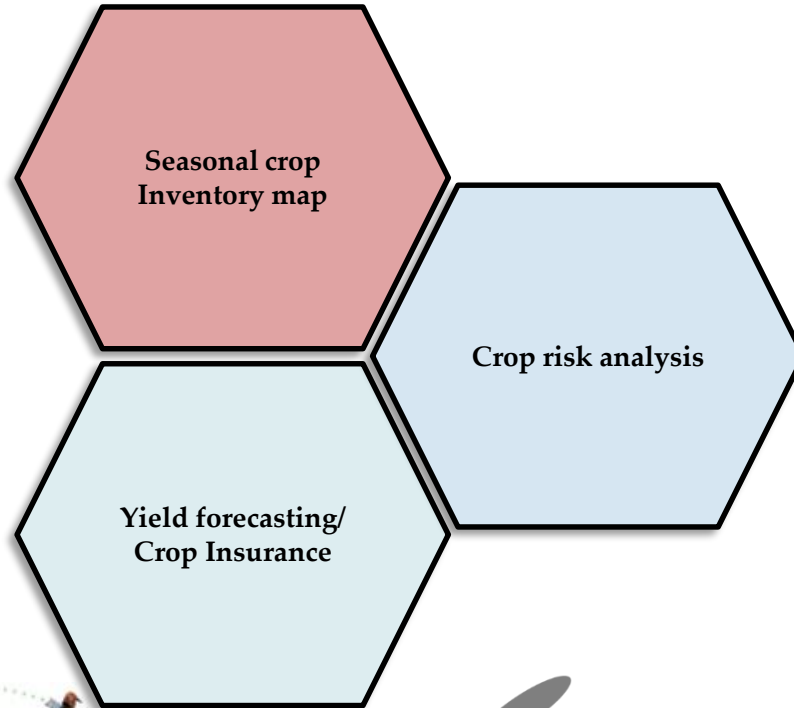
# The Present & Future of EO



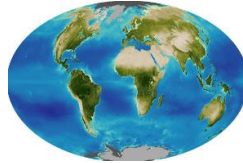
L A N D S A T



[www.mrslab.in](http://www.mrslab.in)



Contact us: <http://mrslab.in/>



## Strengthen Global Agricultural Monitoring

The screenshot shows the MRSLab website interface. At the top left is the MRSLab logo, a stylized globe with the text "MRSLab" and "Microwave Remote Sensing Lab". To the right of the logo is a navigation menu with links for "Home", "People", "Research", "Publication", and "News and Events", followed by a search icon. The main content area features a large banner with two side-by-side satellite images of agricultural fields. The left image is a false-color composite of Sentinel-2 and RISAT-1 data, showing a grid of red, green, and blue patches. The right image is a PolSAR image of the same area, showing a grid of purple, blue, and green patches. A dark blue text box in the center of the banner reads "Crop characterization using PolSAR". Below this, a white text box contains the text "Sentinel-2 False Color Composite & RISAT-1 Raney RGB Image over Manitoba, Canada". At the bottom left of the banner is the Sentinel-2 logo, and at the bottom right is the RISAT-1 logo. The website URL "www.mrslab.in" is visible in the bottom right corner of the screenshot.

# Thank You

