Crop Yield Estimation Using Remote Sensing and GIS

VII-SEMESTER
Minor Project

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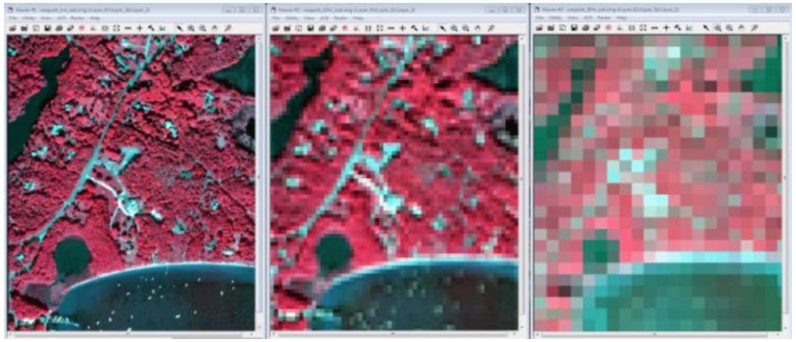
➢ INTRODUCTION

- With the advent of remote sensing and GIS technologies, it has become possible to estimate crop yields using various methodologies.
- Remote sensing is a powerful tool that can be used to identify and classify different crops, assess crop conditions, and estimate crop yields.
- Using data from GIS technologies and Remote sensing, indices like vegetation condition index (VCI) and temperature condition index (TCI), Normalized Difference Vegetation Index (NDVI) can be determined to analyse crop yield.
- With the help of GIS technologies, the project aims at spatially analysing the crop production in a particular region.

Spatial Resolution

- Resolution depends upon satellite orbit configuration and sensor design.
- Signifies the ground surface area that forms one pixel in the image.
- It is usually presented as a single value representing the length of one side of a square.
- The higher the spatial resolution, the less area is covered by a single pixel.



7 layers of the Landsat Dataset

Resolution(meter)	Wavelength(micrometre)	Band Name
30	0.45-0.52	Blue
30	0.52-0.60	Green
30	0.63-0.69	Red
30	0.77-0.90	NIR
30	1.55-1.75	SWIR 1
60*(30)	10.40-12.50	Thermal
30	2.09-2.35	SWIR2
15	0.52-0.90	Panchromatic

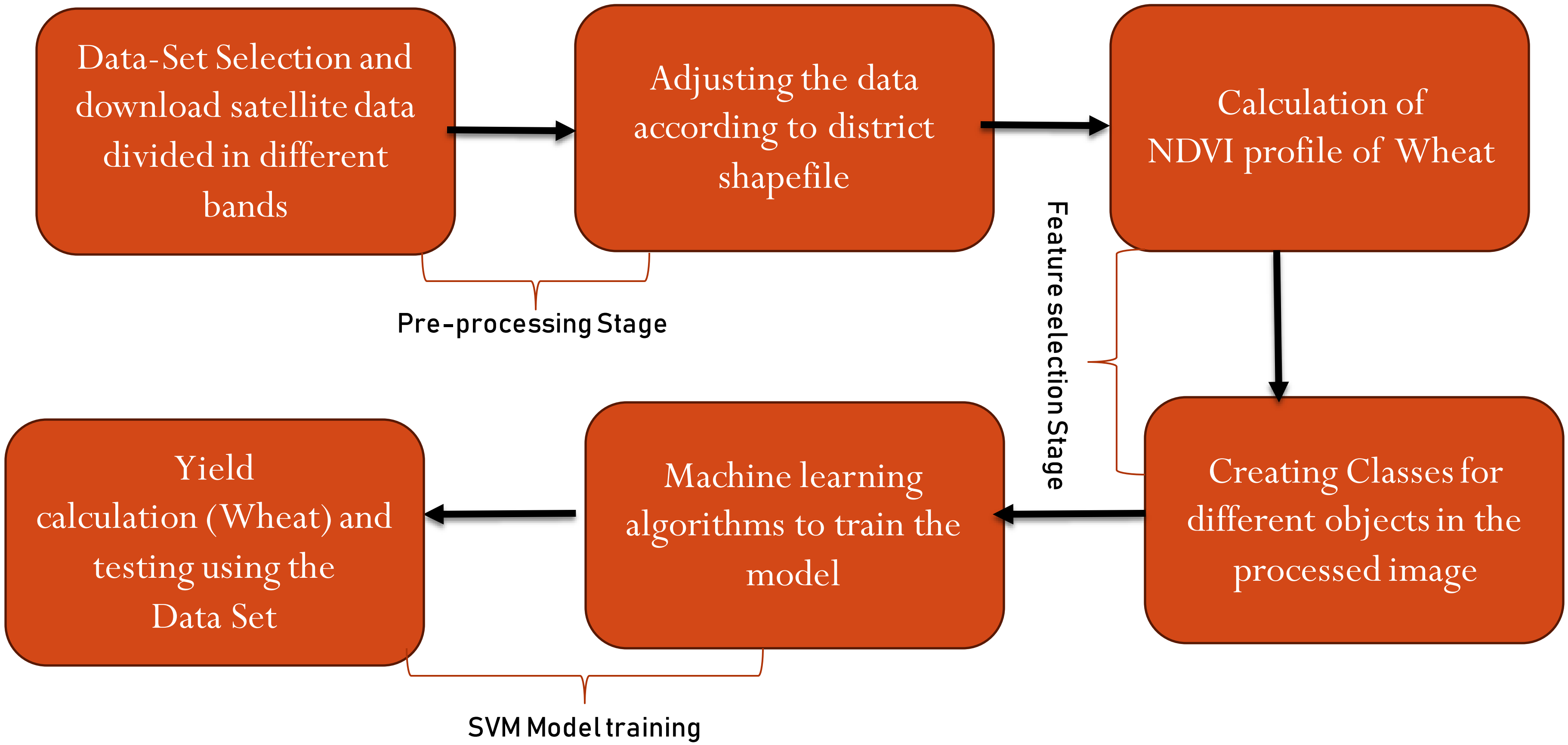
FACTORS AFFECTING WHEAT YIELD

- The soil type in Patiala is sandy loam, prone to erosion and salinity.
- Wheat is susceptible to various pests and diseases, such as rusts, blights, bunts, smuts, aphids, hoppers, borers, and nematodes causing significant losses in yield and quality.
- According to the experts, the recent drop in wheat production in India is linked to climate change, which is projected to reduce wheat yield by **6-23% by 2050** in India

Data-Set and Software used

- USGC Earth explorer Landsat-8 satellite data (divided into 7 bands)
- The crop yield data-set over the years
- ArcGIS for image processing.
- Python to train the Data-Set & Machine Learning Models

Methodology of the Project



Methodology of Image: Pre-processing Stage

Data Acquisition: Download Landsat-8 data from the USGS Earth Explorer

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Stacking Bands: Landsat-8 captures data in multiple spectral bands. Stack bands together to create a multispectral image.

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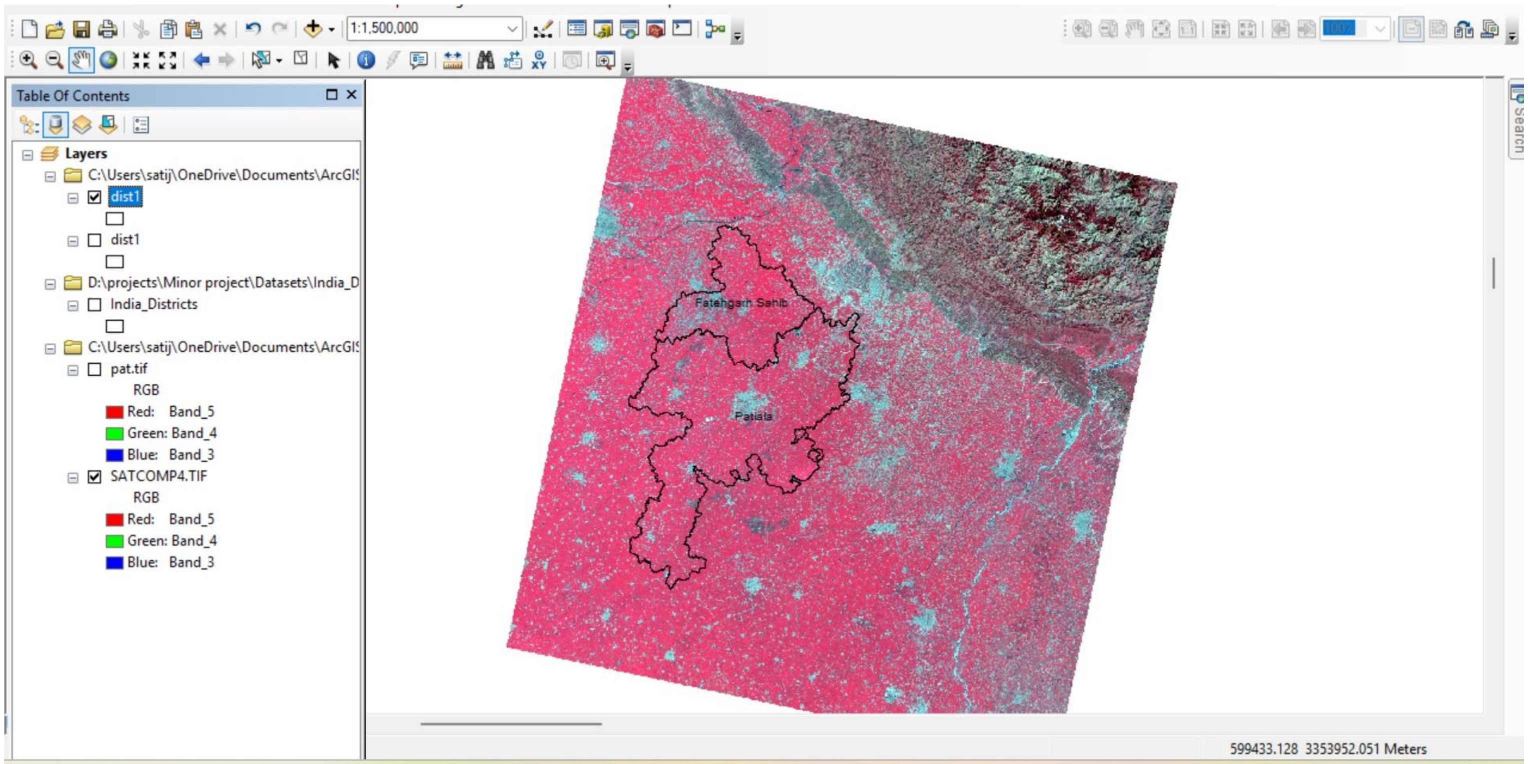
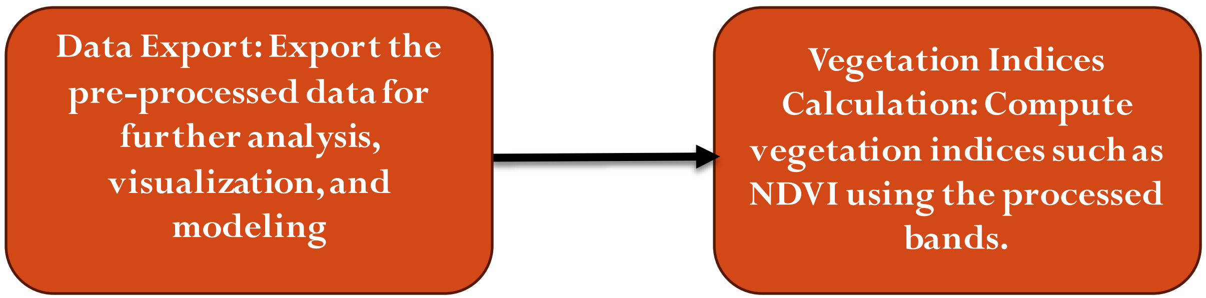
Subset and Clip Data: Use QGIS to subset the data to your specific study area. Remove unnecessary areas

LANDSAT IMAGE



LANDSAT-8 image for the Patiala district downloaded from United States Geological Survey (USGS) in the month of March 2022.

➢ Feature Selection Stage



SVM and Training Stage

Land Cover Classification: Performed supervised classification to categorize land cover types.

Masking: masks to exclude non-agricultural areas or areas with cloud cover, shadows, or water bodies.

Support Vector Machine(SVM) Model

- SVM(Support Vector Machine) is used with GIS software to analyse spatial data and create maps.

- Handles both linear and non-linear relationships between variables and is a powerful algorithm used for a wide range of applications, including image classification, text classification, and bioinformatics.

- The best hyperplane is selected that separates the data into different classes.

➢ Accuray Detection stage

Integration with Field Data: Integrate remote sensing data with ground-based data, such as crop yield samples, to calibrate and validate your models.

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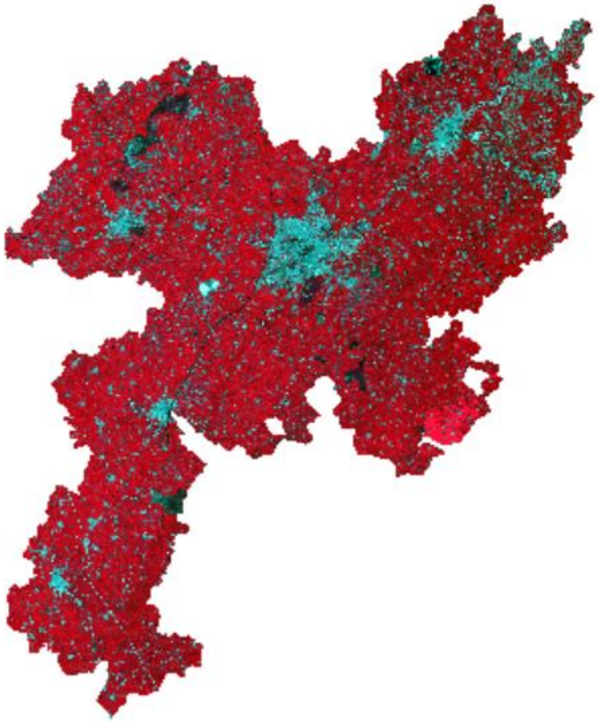
Validation and Accuracy Assessment: The processed data is compared with ground truth data. Assess the accuracy of your classification results.

PATIALA DISTRICT SHAPEFILE



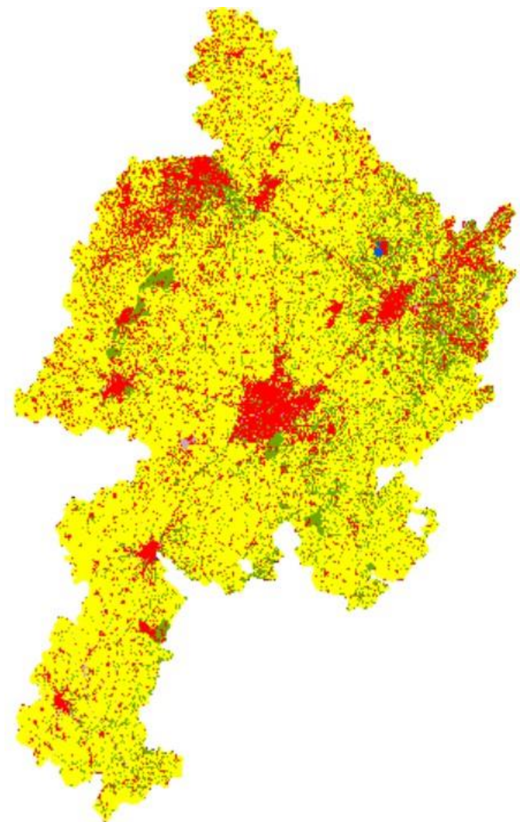
Selected and separated from the undesired area for more accuracy during image processing.

IMAGES

Training Sample Manager

ID	Class Name	Value	Color	Count
1	Wheat	1		1718
2	vegetation	9		293
3	residential	17		835
4	Barren	23		316
5	water	25		85

Attribute Table including pixel count of each class



SVM classified image

CALCULATION OF NDVI PROFILE

- NDVI profile is calculated to assess the health of the wheat crops, identifying areas with high vegetation density.

- **NDVI = (NIR – Red) / (NIR + Red)**
- For Landsat 8 data,

  NDVI = (Band 5 – Band 4) / (Band 5 + Band 4)

- The NDVI value varies from -1 to 1.
- Generally, we obtain following result:

  NDVI = 0.2 to 0.5 represent Shrubs and grasslands

  NDVI = 0.6 to 1.0 represents Dense vegetation or tropical rainforest

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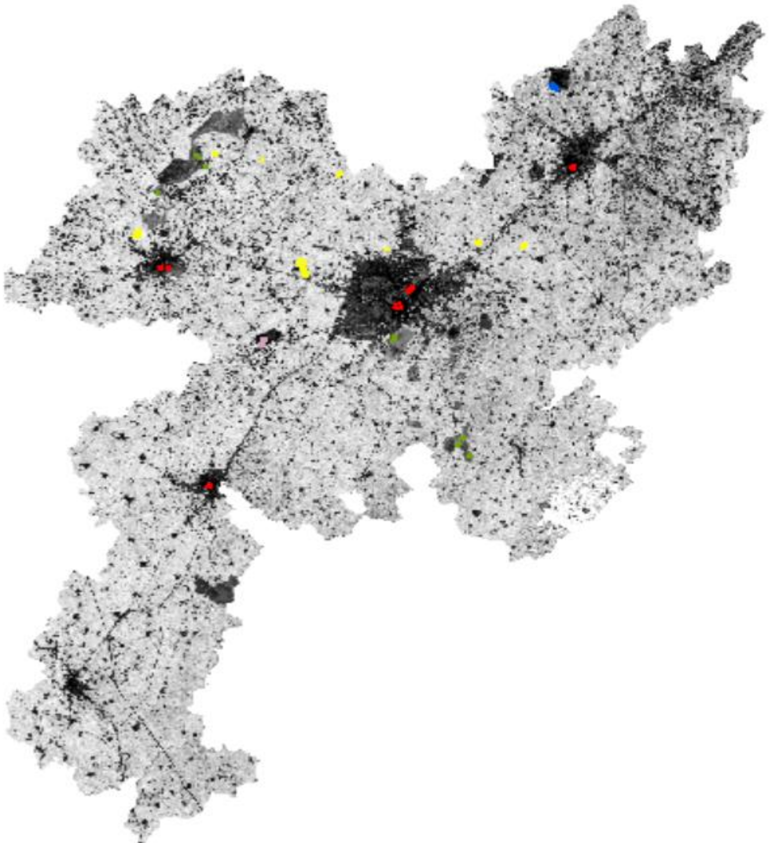
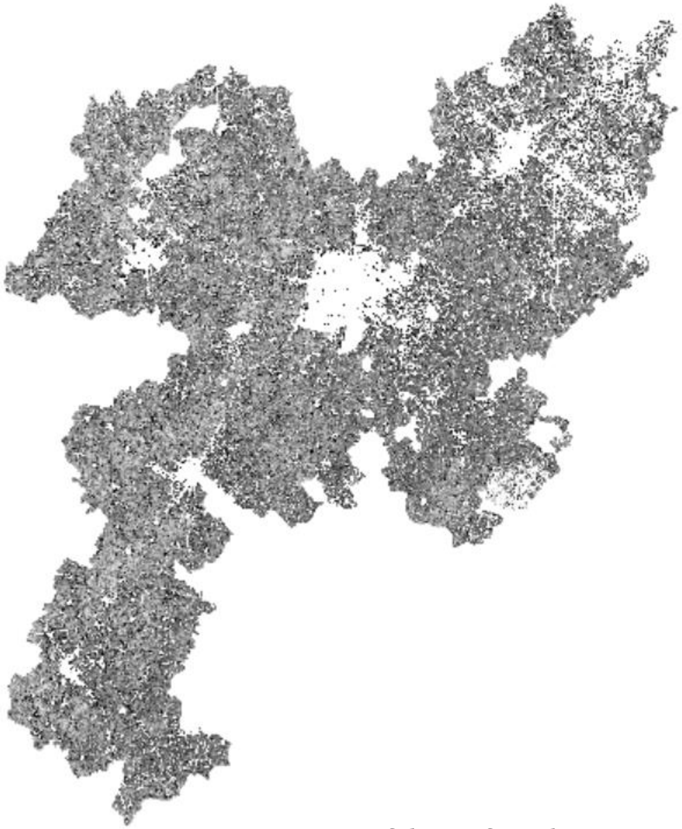
➢ NDVI PROFILE



NDVI profile of Patiala District (-0.08 - 0.54)



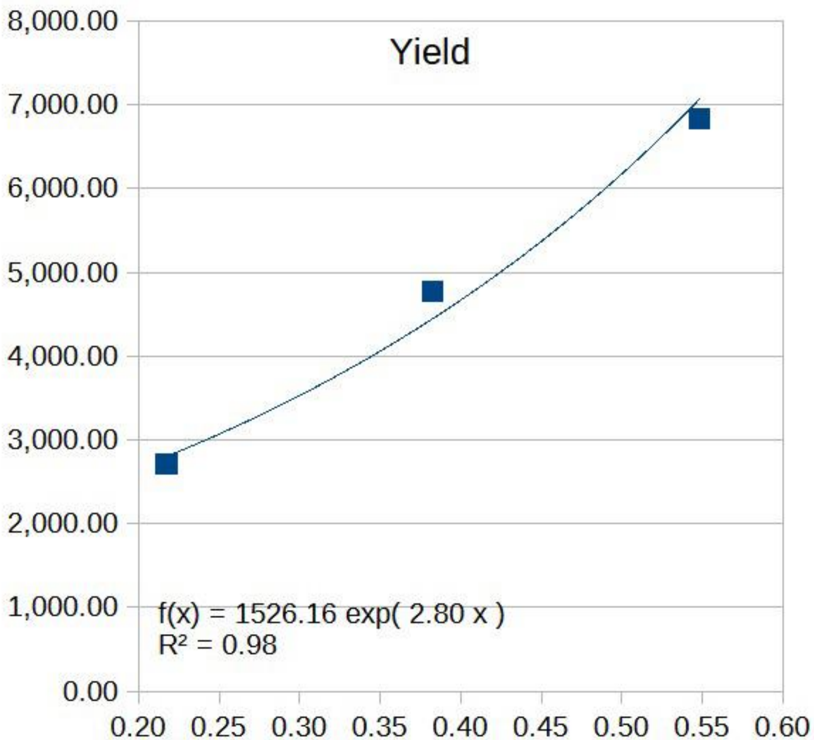
NDVI profile of Wheat (0.22- 0.55)

YIELD OF WHEAT

Calculation of wheat yield for different zones within the study area is done by:

- yield estimation algorithms w/ factors such as NDVI, soil properties, and meteorological data.
- Integrating ground truth data, agricultural records, and soil data to calibrate the model and validate the accuracy of the wheat crop classification.

➢ WHEATYIELD

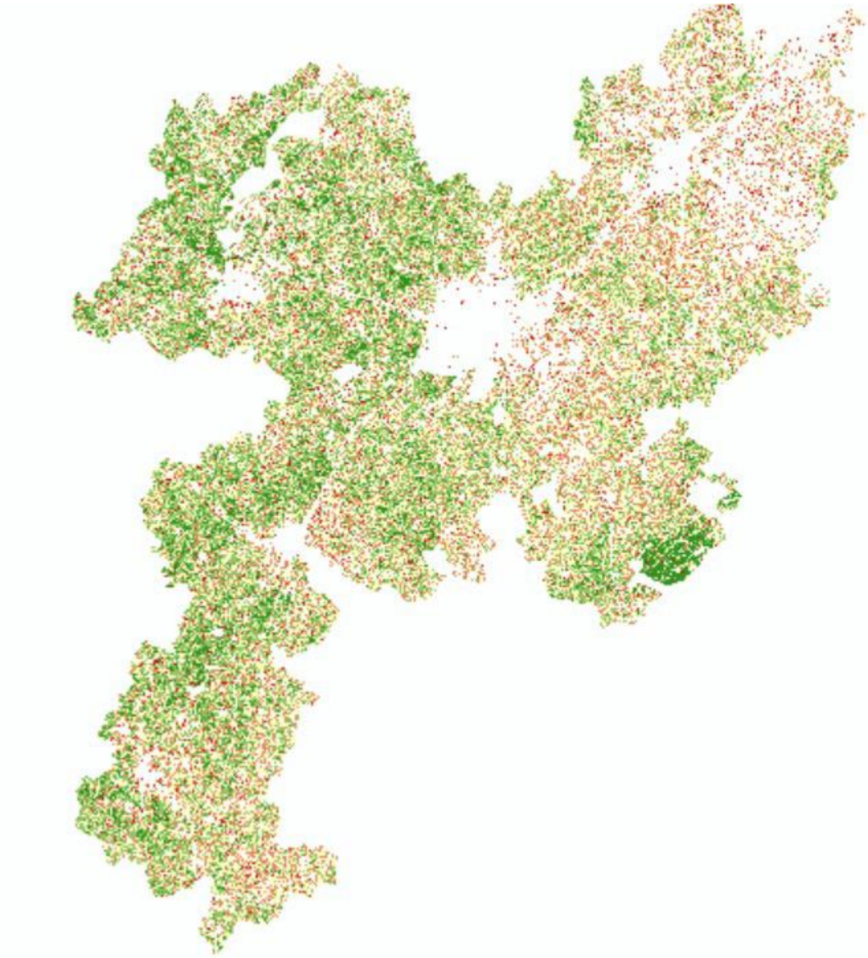


Yield Equation: $f(x)=1526.16 \exp(2.80x)$

Govt. Wheat Yield:
4.77 tonnes/hecatre

NDVI		
Range	NDVI	CropYield
High	0.55	6,831.60
Low	0.22	2,706.86
Average	0.38	4,769.23

Re-Classification of Wheat Yield



Accuracy

Area (Hectare)	
Observed	319000
Simulated	306007
% Accuracy	95.93

Production (Tonnes)	
Observed	1116000
Simulated	1123490.072
% Accuracy	99.32

HIGHLIGHTING THE FINDINGS

Once the yield is calculated:

- Areas with high and low yield are highlighted and studied.
- Created spatial maps visualizing the distribution of wheat crops and yield variations across the study area using QGIS.
- Generate maps highlighting areas requiring improvements in agricultural practices.
- Outlining key findings, challenges encountered, and recommendations for future research or agricultural management strategies.

➢ CONCLUSION

- A significant stride in the agriculture domain, employing advanced remote sensing technologies and machine learning algorithms to determine wheat crop yield in Patiala, India is made through this project.
- This project not only advances the methodology for crop yield estimation but also underscores the importance of integrating diverse datasets and cutting-edge technologies for sustainable agricultural practices.
- As technology continues to evolve, this adaptable approach to crop monitoring contributes to global efforts to enhance food security and agricultural sustainability.

THANK YOU!