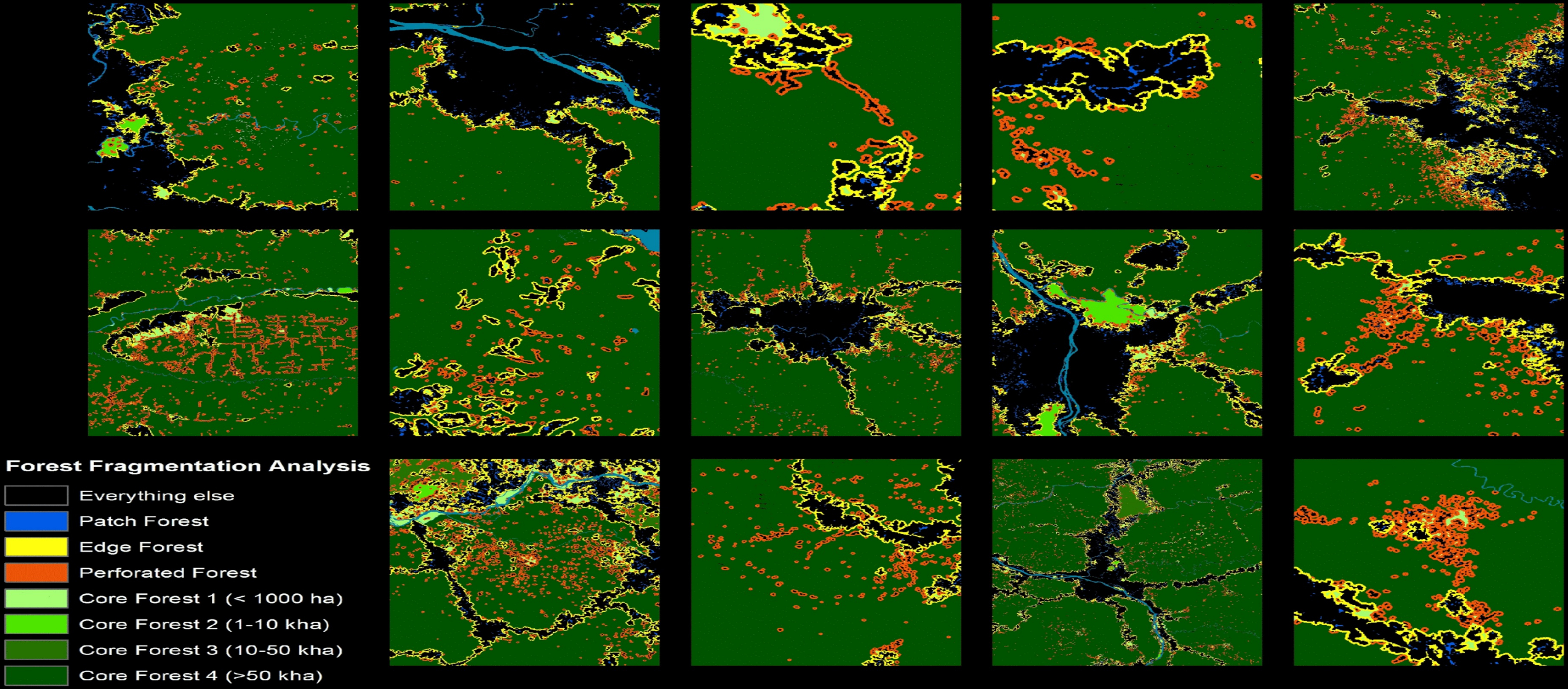
Detection and visualization of Shifting Cultivation

2000

SIH

2020



OUTLINE

- *Introduction*
- *Objectives*
- *Application*
- *Software Hardware Used*
- *Literature survey*
- *Scope of work*
- *Problem statement*
- *Existing block diagram*
- *Research Gape*
- *Dataset details*
- *Our Work flow*
- *References*

Registration Details

Category : Software

Problem Statement Title : Identify shifting cultivation location in dense temporal stacks

Problem Code : NM395

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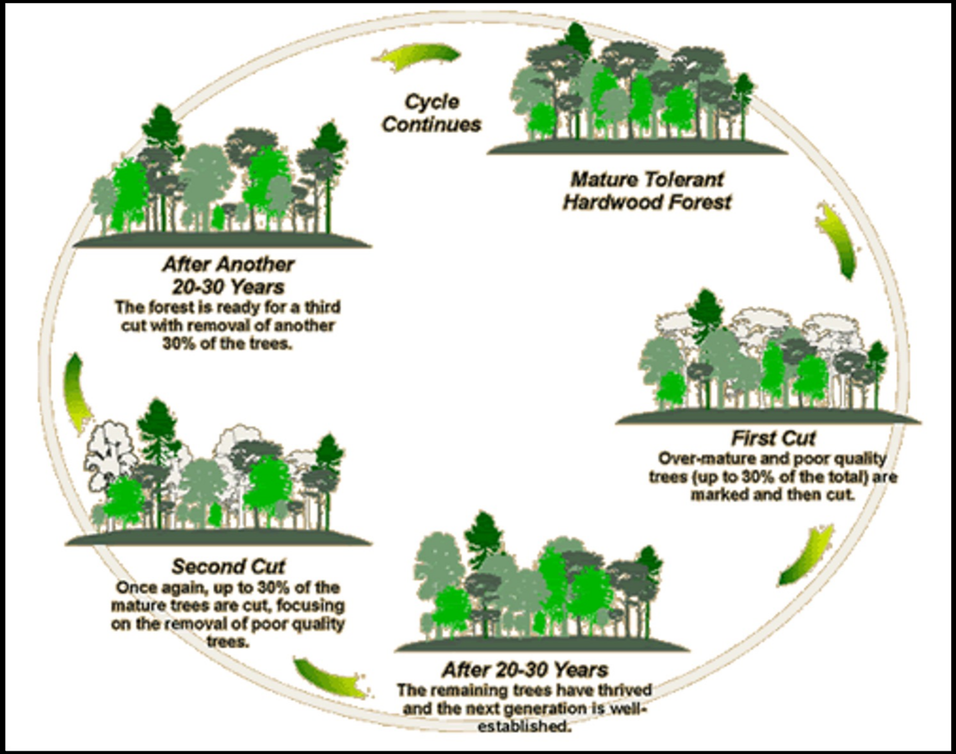
Dhanvi Acharya
Ayushi Pujara



College Name & Code : IITE - Indus University

Shifting Cultivation

Problem Description

Shifting cultivation is an agricultural system involving the clearing and burning of natural vegetation, followed by the cultivation of new fields for a few years. This is followed by a period of fallow during which the vegetation regenerates, after which the cycle begins all over again. This is typically followed in the hilly regions of the country. The cycle is likely to be over 7 to 20 years. Using multi-temporal satellite imagery. Develop AI/ML based software/algorithm to map/visualize/analyse

1. Areas exhibiting shifting cultivation.

2. Long-term changes.

Research Work till Date :

Here add some latest papers in table form paper name year adv disadv

No	Paper title	Author name	Journal name	Method used	Year	Advantages/Accuracy
1	Spatio-Temporal Monitoring of Shifting Cultivation Using Landsat Images: Soft Classification Approach	• G. Venkata Rao, • Anil Kumar, • A. Sentil Kumar & • M. Shashi	*Journal of the Indian Society of Remote Sensing*	Soft Classification	2018	Mapping and data pre-processing for shifting cultivation

2	Farms or Forests? Understanding and Mapping Shifting Cultivation Using the Case Study of West Garo Hills, India	Amit John Kurien , Sharachchandra Lel and Harini Nagendra	ATREE	MLC algorithm	2019	The data is classified using MLC algorithm with 80% accuracy.
3	Assessment of shifting cultivation fallows in Northeastern India using Landsat imageries	• S. V. Pasha, • Mukunda D. Behera, • S. K. Mahawar, • S. K. Barik & • S. R. Joshi	International Society for Tropical Ecology	NDVI	2020	Accuracy of 84.6% was achieved.

Impact of environment in the district observed during Field Study

1. Shifting cultivation has become unsustainable.

2. Increase in population and pressure on agricultural land has brought huge forest under shifting cultivation.

3. Mass destruction of forest cover leads to deforestation and loss of biodiversity on environment. 130

4. Burning of Jhum is one of the worst impacts on climate as it produce huge junks of smoke and released into the atmosphere.

Cont…

5. Rising of a temperature by a few degrees Celsius.

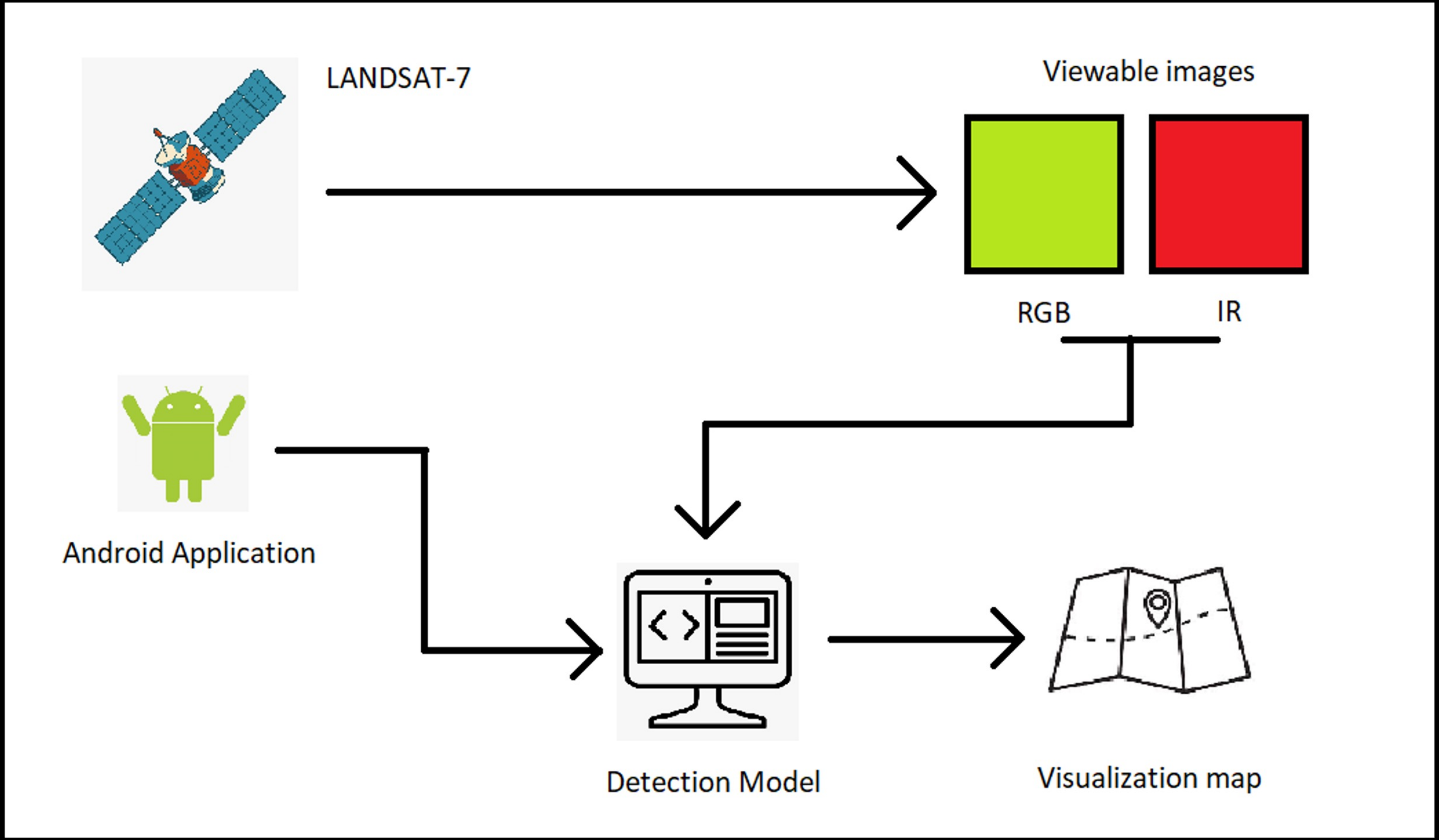
6. Decline in soil fertility with low yield is common in all the ranges.

7. Late monsoon and warm climate.

Using this algorithm and application one can know which places shifting cultivation is being done and can take precautionary steps to prevent the impact on the surrounding environment.

Goal

- Collect data from *Google Earth Engine.*
- Pre-process it to suitable, *visualizable* format so that anyone can visualize it.
- Make a software which *detects* the area exhibiting shifting cultivation.
- Make a application which is usable by normal people, who can *report recent activities* of shifting cultivation.
- Collect the reported data and *add it to pre-existing model* which is made by AI/ML. By doing so the prediction can be very accurate.
- Make another algorithm which *maps out* areas exhibiting shifting cultivation which uses the prediction done by the trained model.


LANDSAT-7
Viewable images
RGB
IR
Android Application
Detection Model
Visualization map

Approach

1) *Gathering data from LANDSAT-7*
2) *Processing data for visualization.*
3) *Processing data for changes in vegetation.*
4) *Training model*
5) *Application for reporting areas (Professional required)*
6) *Retraining at specific interval (Reporting required)*
7) *Generating map of the classified data by the model*

Google Earth Engine

Earth Engine Google Earth Engine combines a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities and makes it available for scientists, researchers, and developers to detect changes, map trends, and quantify differences on the Earth's surface.

LANDSAT 7

- Landsat 7 is the seventh satellite of the Landsat program. Launched on 15 April 1999, Landsat 7's primary goal is to refresh the global archive of satellite photos, providing up-to-date and cloud-free images. The Landsat Program is managed and operated by the United States Geological Survey, and data from Landsat 7 is collected and distributed by the USGS.

Data Gathering

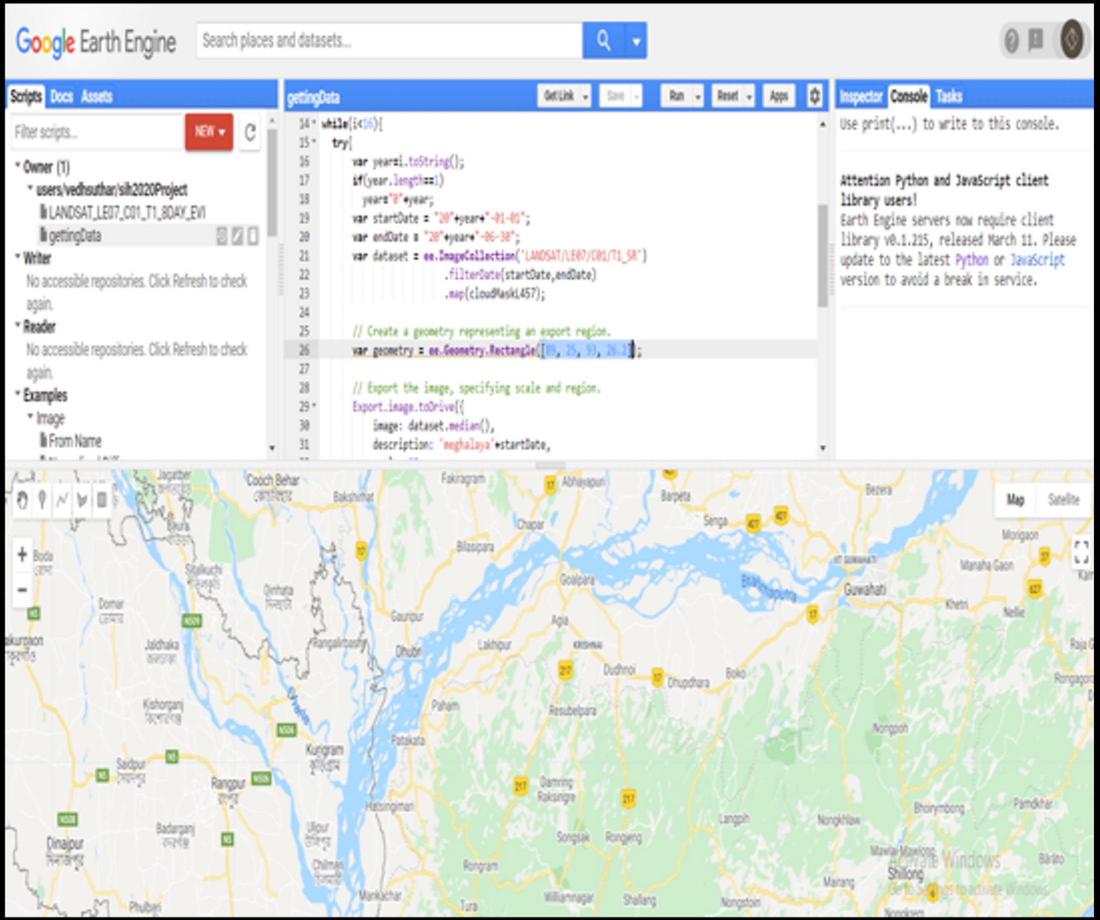
We first collected raw images from LANDSAT 7.

Region : [89, 25, 93, 26.2]

Data with no cloud-cover.

Interval : 6 months

Date range : From 2000 to 2019



Information about Data

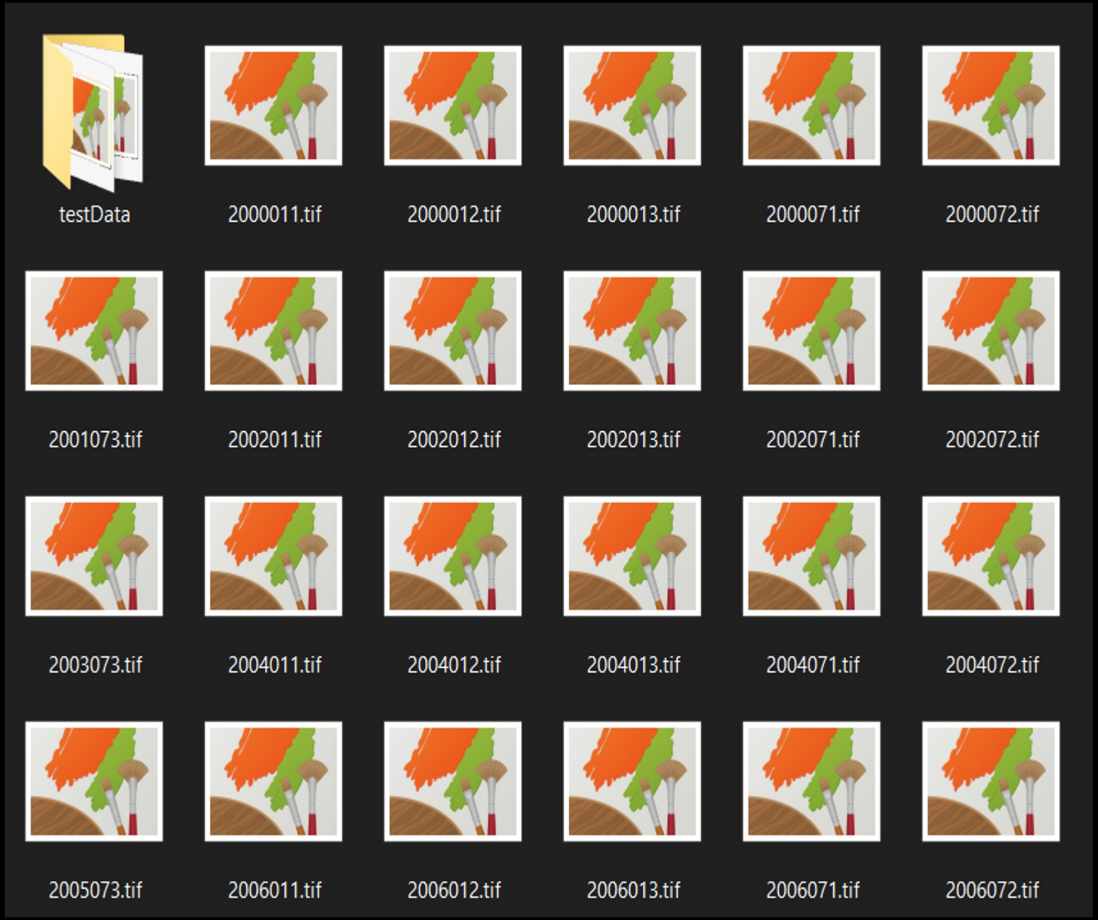
Downloaded and extracted all the data

Data Size : 55.9 GB

Extension : .tif

Bands : 1,2,3 for RGB

Bands : 4,5,7 for IR

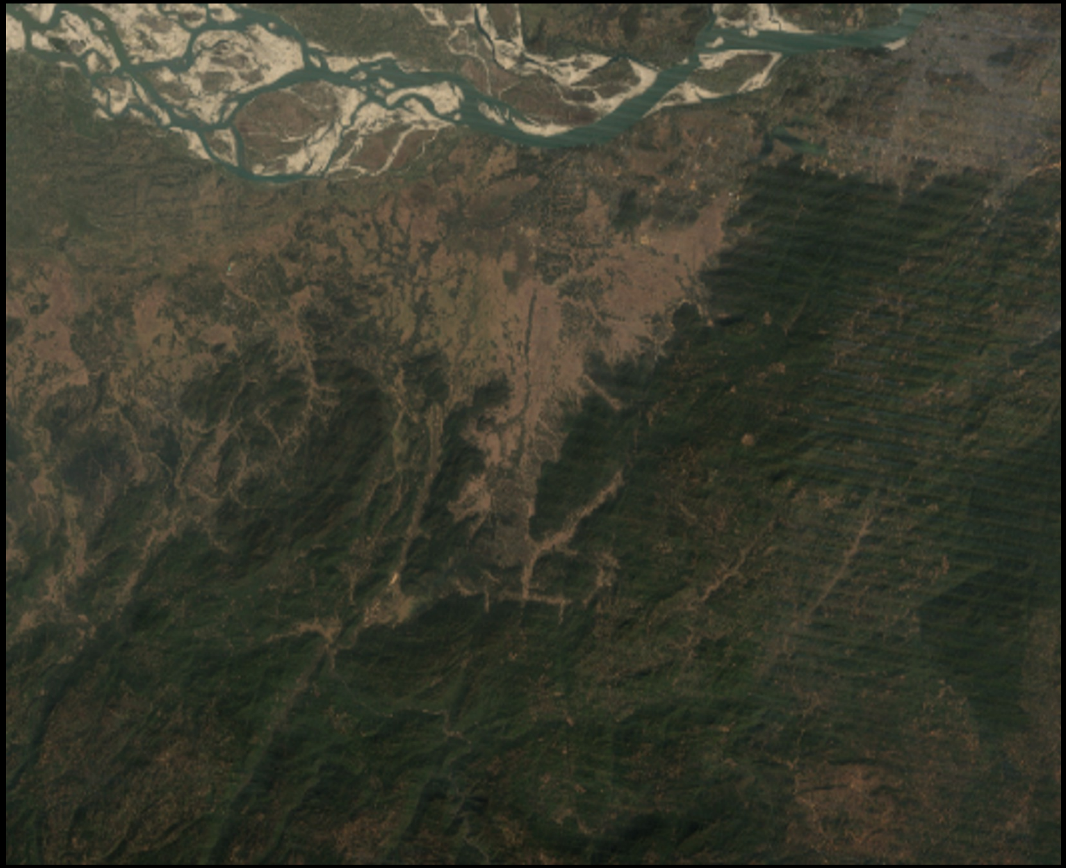


Processing data for changes in Visualization

Processed the raw data to make visualizable images

Bands used

- *Band 3 → Red*
- *Band 2 → Green*
- *Band 1 → Blue*
- *Band 7 → Fake red for IR*
- *Band 5 → Fake green for IR*
- *Band 4 → Fake blue for IR*



Sample RGB image

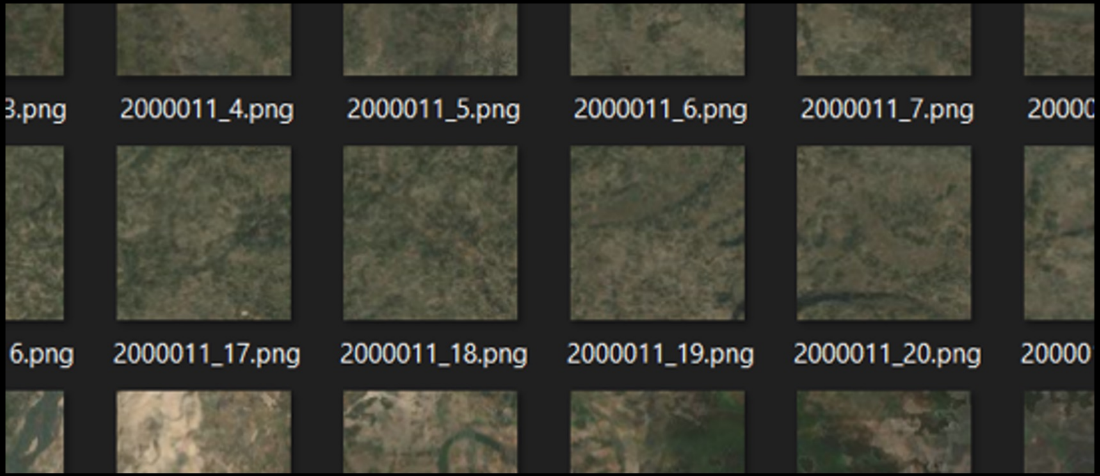
Processing data for changes in Visualization

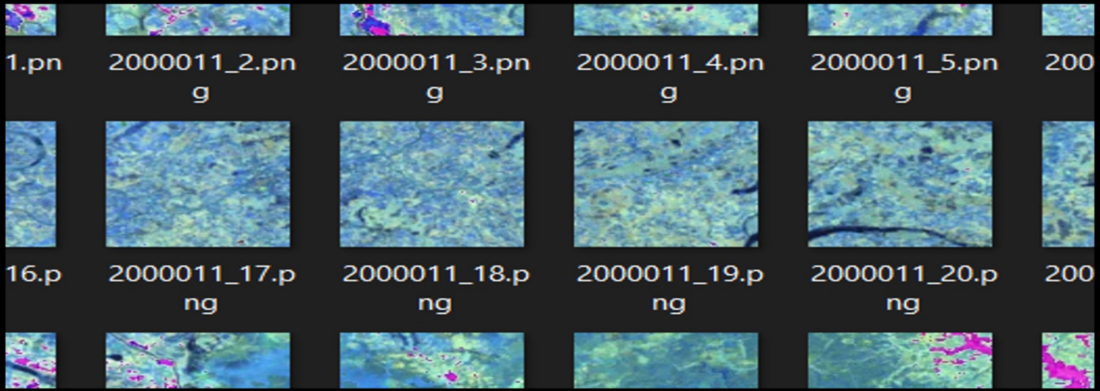
Processing images to be trainable by a Deep Learning model

Dividing images into 100x100 pixel

Resolution : 30m/pixel

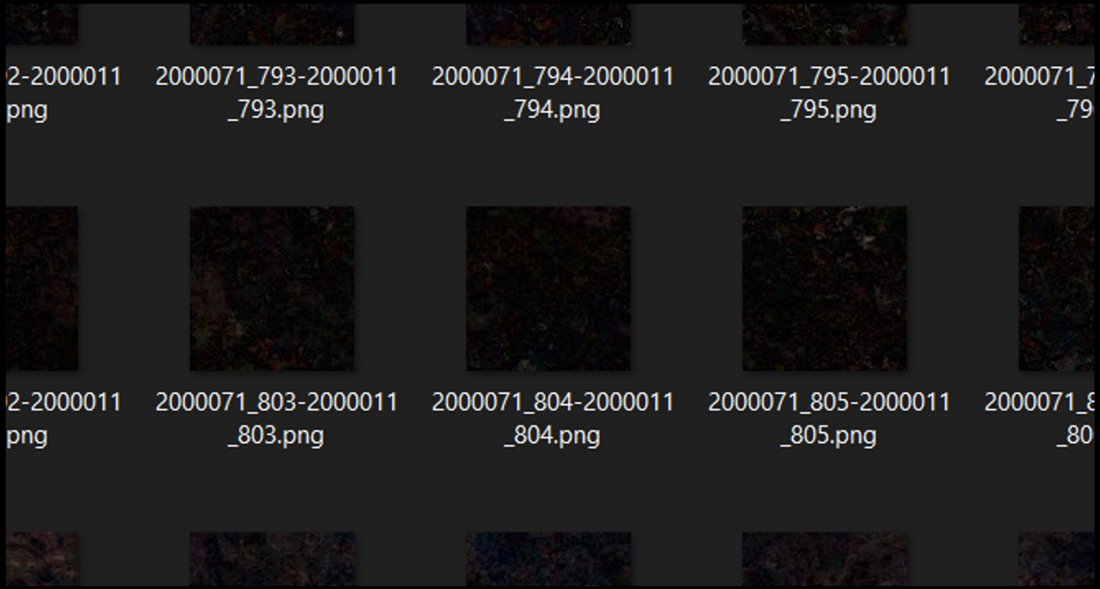
Size : 3km x 3km

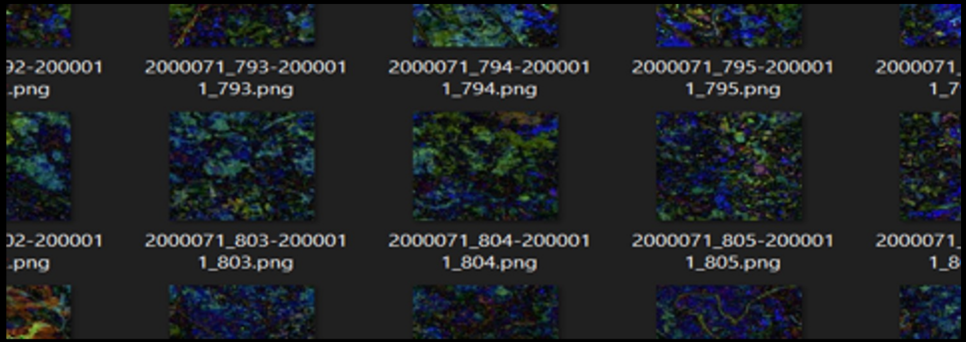




Found the difference between images of same area but at 6 months of interval.

By this images, we could check if there is a area with spots which could potentially mean that there was a farmland which is not present after 6 months.



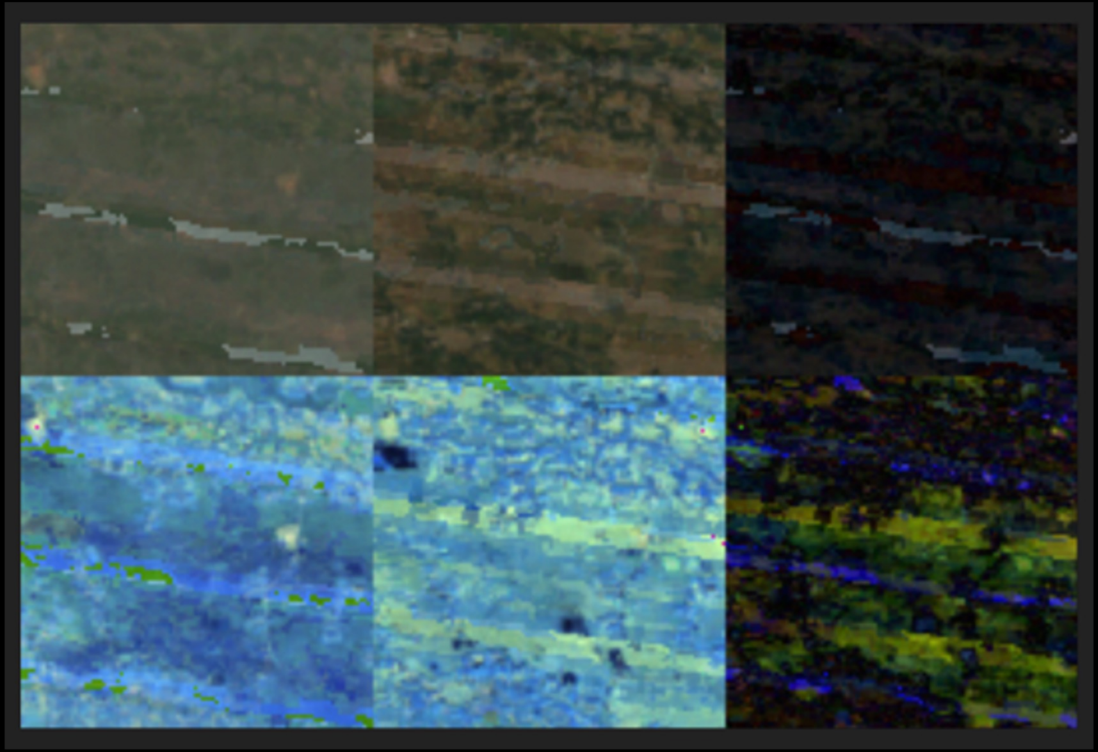


Processing data for changes in Visualization

A program which gives image in six month inerval, with its difference.

[RGB B, RBG A, RGB D]
[IR B, IR A, IR D]

B: Before
A: After
D: Difference



Processing Data for changes in vegetation

Removal of water bodies:

Using ratio for water index Green value/ NIR value

If there is a water body, NDWI > 1

B2	0.0001	0.52-0.60 µm	Band 2 (green) surface reflectance
B3	0.0001	0.63-0.69 µm	Band 3 (red) surface reflectance
B4	0.0001	0.77-0.90 µm	Band 4 (near infrared) surface reflectance

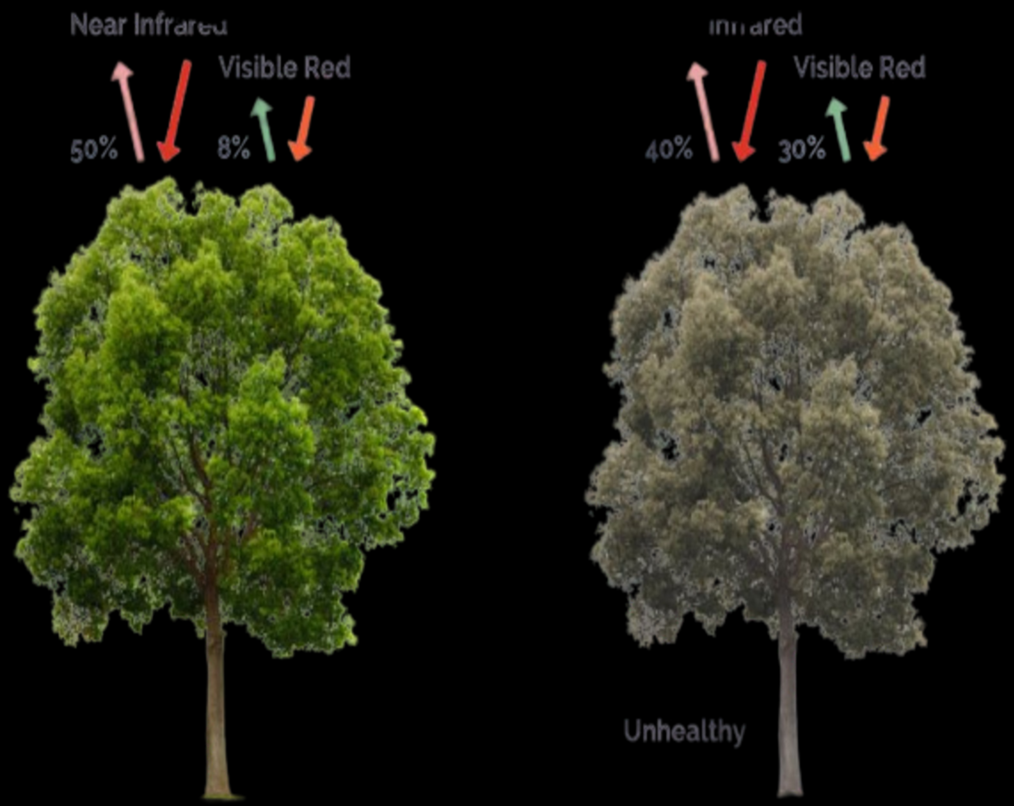
Processing Data for changes in vegetation

Getting the vegetation from the data:

Using modified normalized difference vegetation index
NIR value/(NIR value + Red value)

The resultant value is from [0,1]

Rice is the major crop grown in meghalaya
It's NDVI is from 0.4 to 0.9

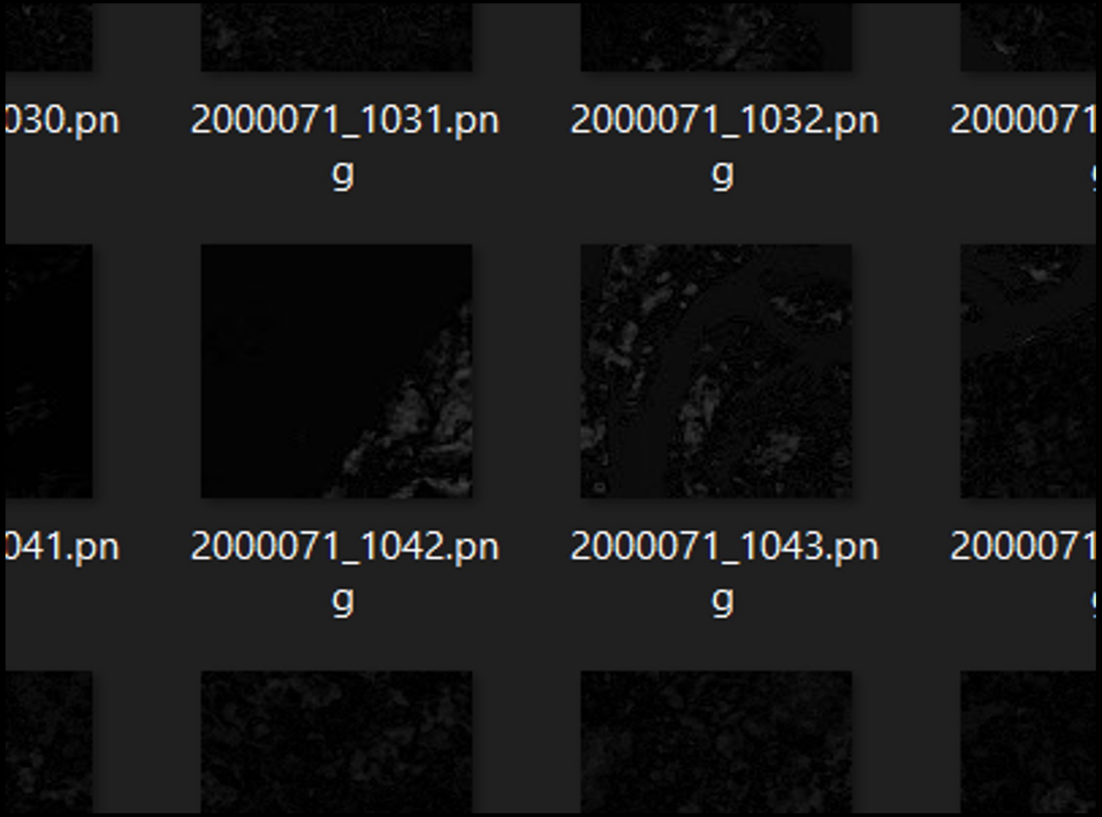


Processing data for changes in Visualization

Difference and dealing with noise and error reduction:

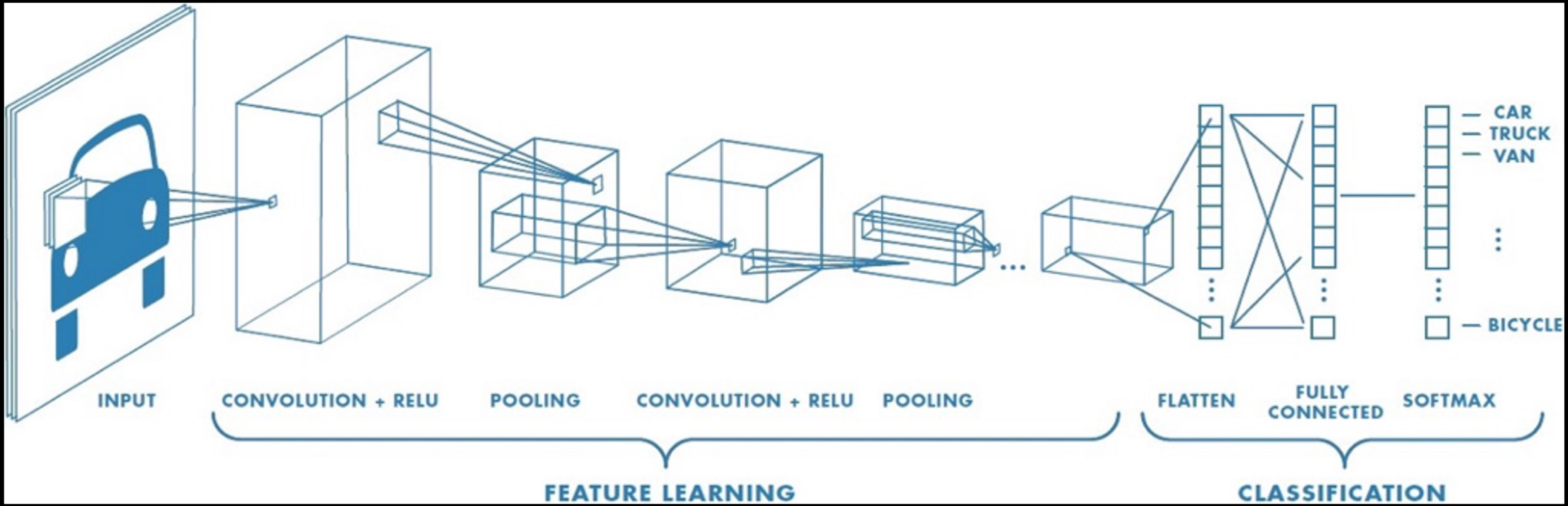
Using mean value of the processed image, we got minimum difference in change of vegetation in 6 months.

Furthur using the mean value of the change, we calculated variance to identify the change in the difference of ndvi.



Technology used for training [CNN]

In neural networks, Convolutional neural network (ConvNets or CNNs) is one of the main categories to do images recognition, images classifications. Objects detections, recognition faces etc, are some of the areas where CNNs are widely used.



Model Training

As we have the required inputs and required outputs, we started model training.

For input: Variance of difference of NDVI image

Output: Area of change in vegetation cover

```
model = keras.models.Sequential()
model.add(keras.layers.Conv2D(8, (3,3), input_shape=(100,100,1),padding='same'))
model.add(keras.layers.MaxPool2D((2,2),padding='same'))
model.add(keras.layers.Conv2D(5, (3,3),padding='same'))
model.add(keras.layers.MaxPool2D((2,2),padding='same'))

model.add(keras.layers.Flatten())
model.add(keras.layers.Dense(64, activation='relu'))
model.add(keras.layers.Dropout(0.3))
model.add(keras.layers.Dense(1,activation='relu'))

model.compile(optimizer=keras.optimizers.Adagrad(lr=0.0005),loss=keras.losses.mean_squared_error)

for i in range(50):
    x,y=get_batch(500,250)
    model.fit(x,y,epochs=(i*100)+100,shuffle=True,batch_size=5,initial_epoch=i*100)
```

Model Training

As there was huge data, around 250k images.
Batch execution was done.
We seperated training and testing data.
From training data, we got a batch with 250 images where shifting cultivation was done and 250 without it.
We formed 50 random batches and trained the model over it.

Training accuracy: MSE of 9-11
Test set accuracy: MFE of 10-14

Note*: This accuracy is on the first batch, once the accurate data is reported, accuracy can increase.

Mapping and visualization

Once the model is trained, we could predict it and map it back onto the RGB image from the LANDSAT-7.

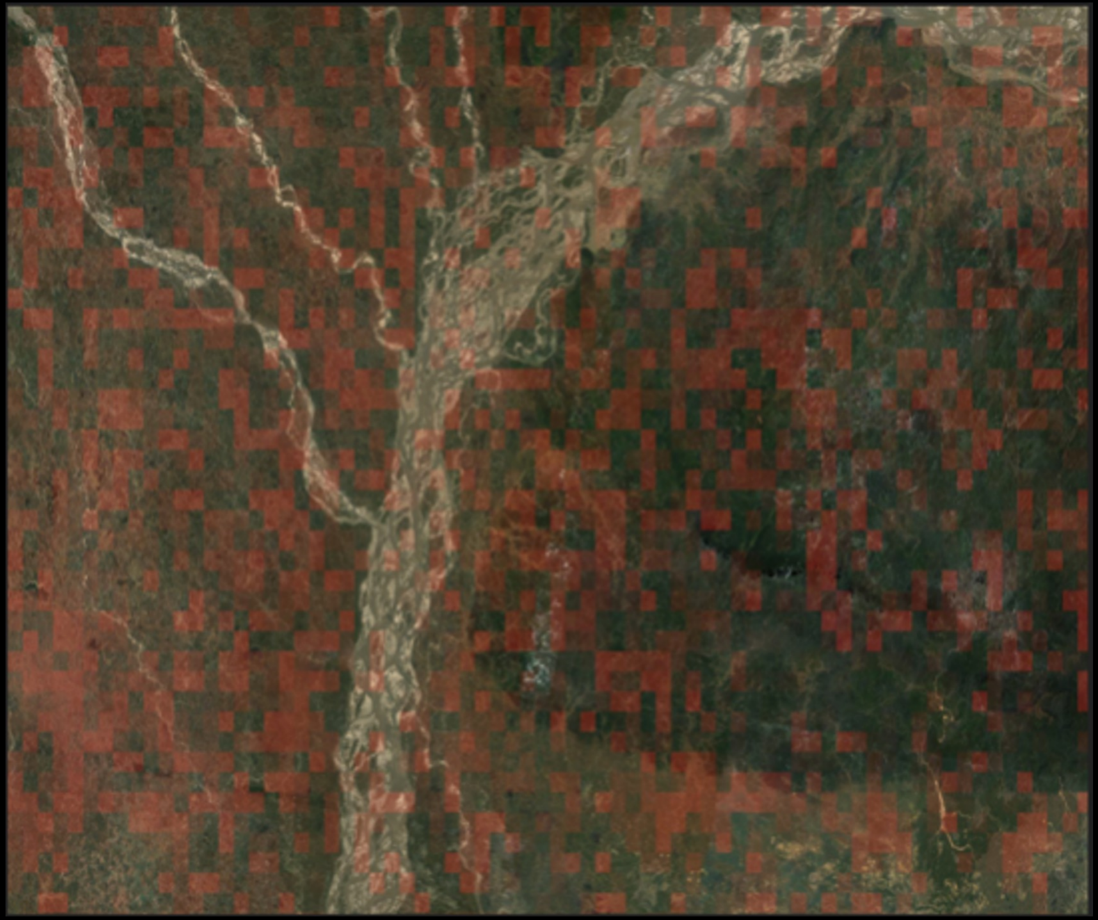
From our research, the average size of farm in meghalaya is 2100 sq. m.

So when a single farm is shifted, there would be average change of this much area.

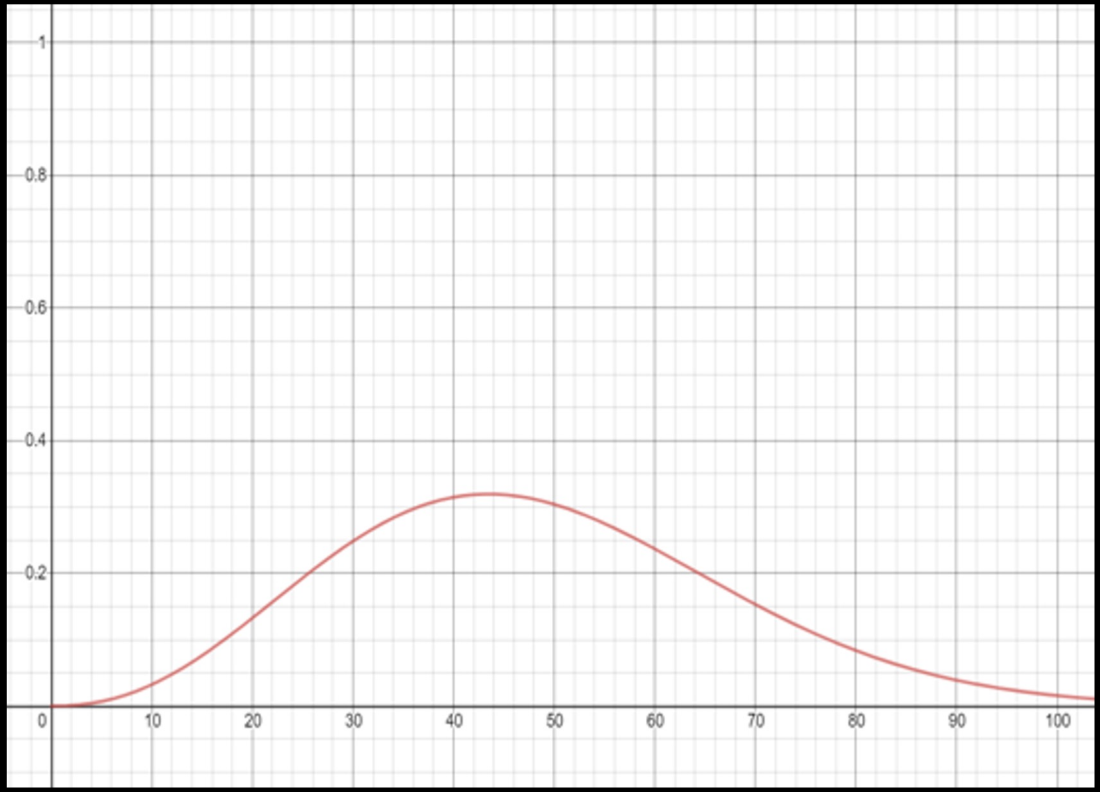
From the predicted value of area changed by the CNN model, we could visualize different area.

```
predX=np.zeros((1,100,100,1))
sec=diff[i:i+100,j:j+100]
predX[0,0:len(sec),0:len(sec[0]),0]=sec
predX=abs(np.array(predX,dtype=np.float64)-predX.mean())
predicted=model.predict(predX)[:,0]
uptoi=0
uptoj=0
if i+100>=len(imgl):
    uptoi=len(imgl)-1
else:
    uptoi=i+100
if j+100>=len(imgl[0]):
    uptoj=len(imgl[0])-1
else:
    uptoj=j+100

opacity = (0.43*(predicted**2.3))/(7.6**(0.27*(predicted**2)))
imgl[i:uptoi,j:uptoj,0] = [[ imgl[x,y,0]*(1-opacity)+(255*opacity) for y in range(j,uptoj)]for x in range(i,uptoi) ]
```

Visualization



Mapping of the output



Curve used for generating image

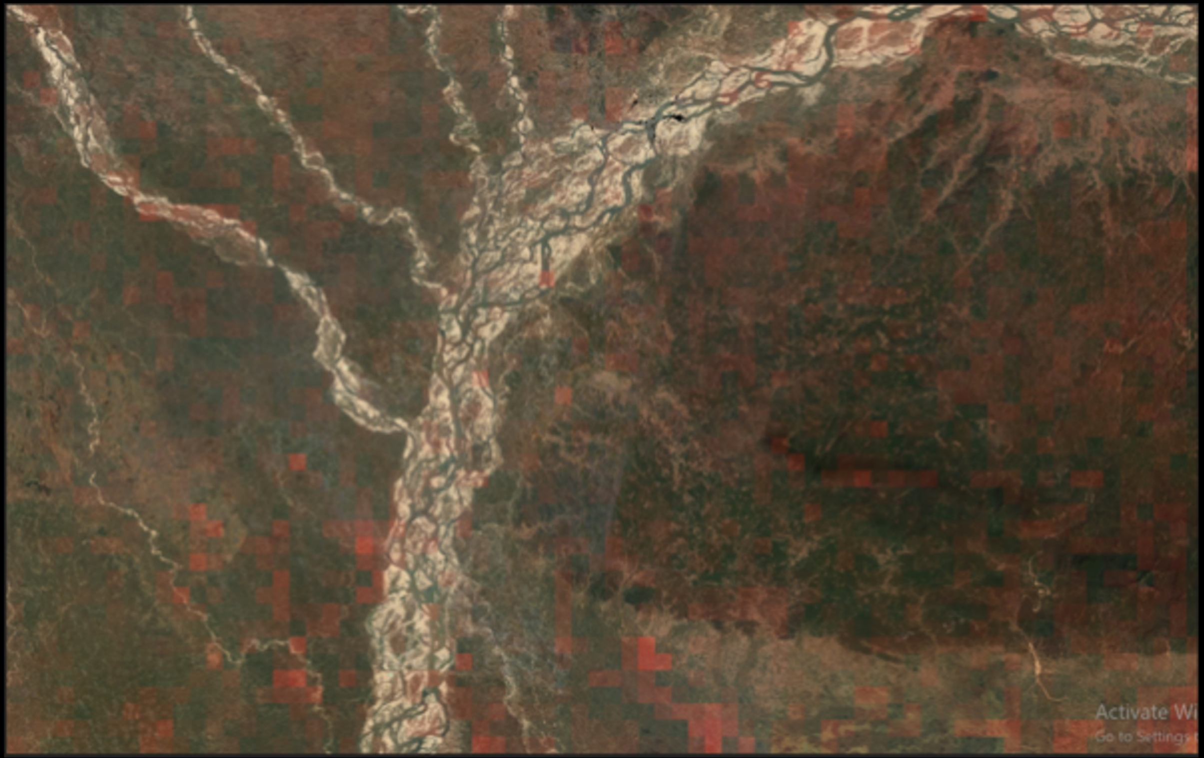
Using multi-temporal data

Used the prediction of model from 8 years of data.

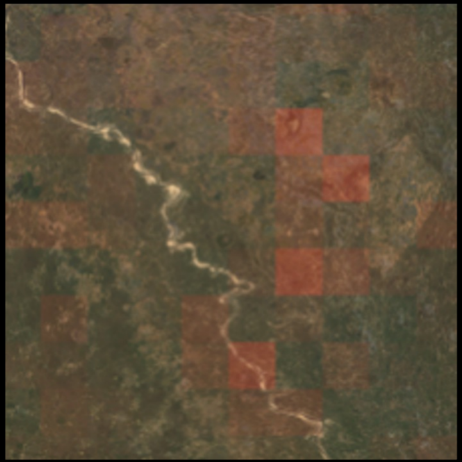
If there is a yearly periodic pattern of agriculture,

variance(change in vegetation)=0

Over the 8 years.



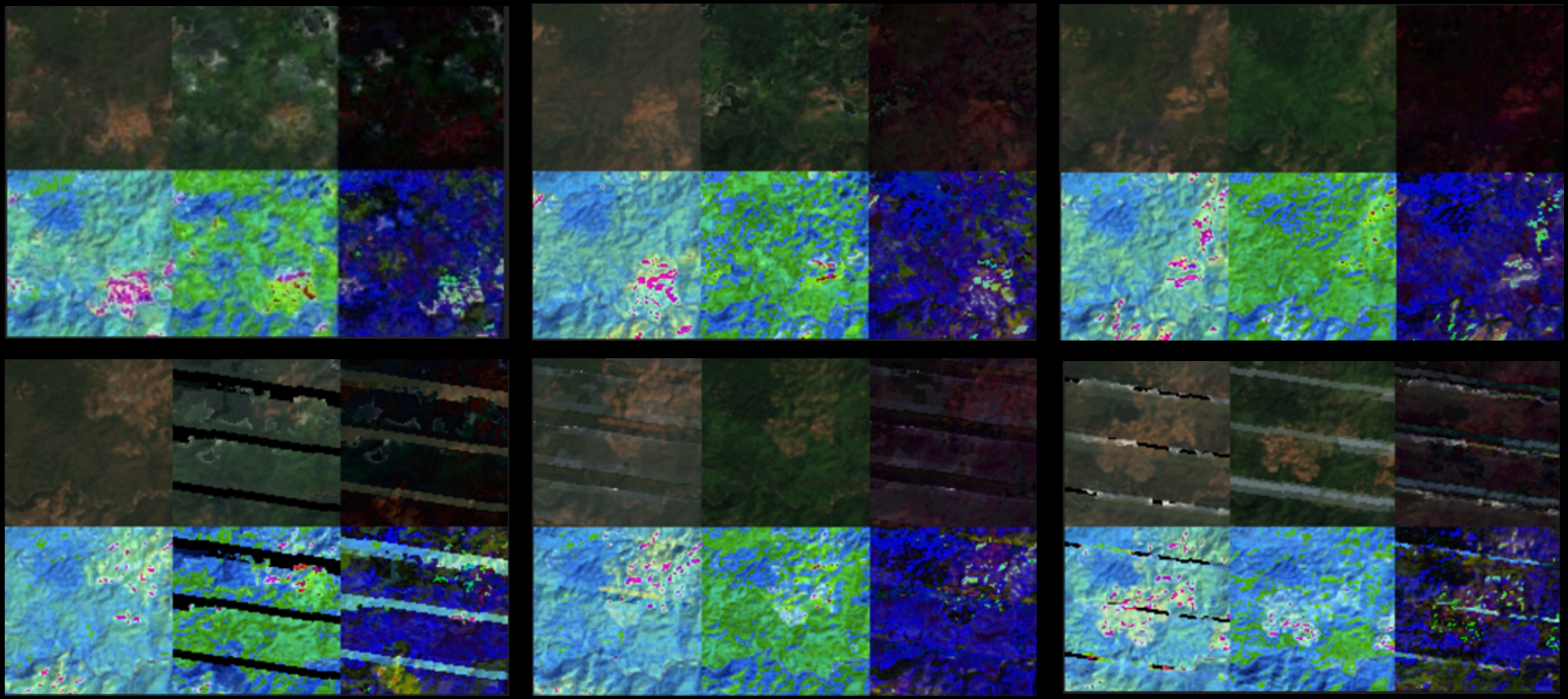
Cont.



Checking the prediction [1]

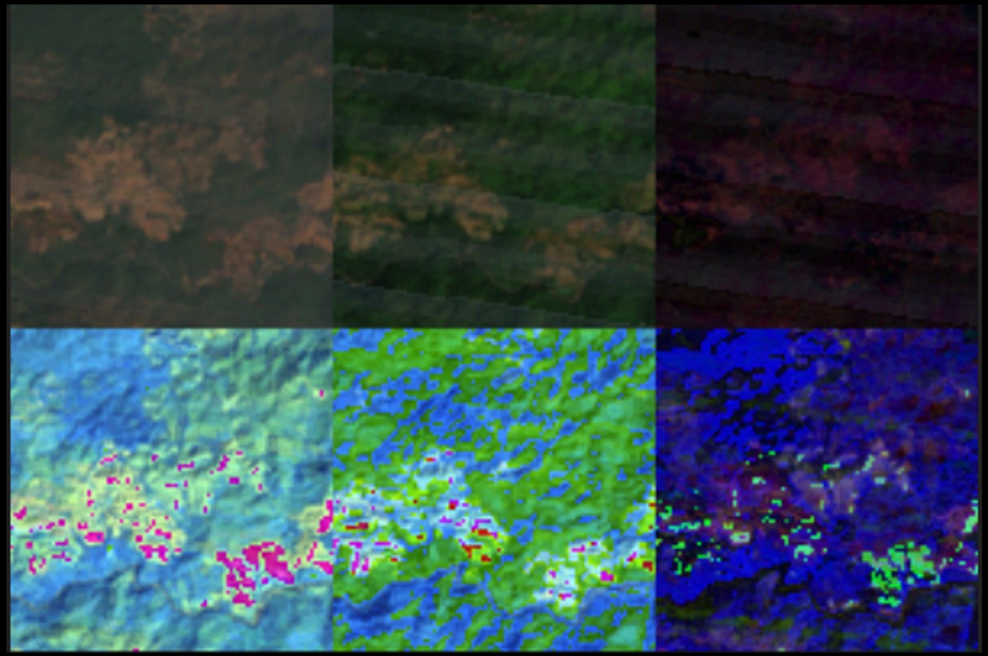
```
In [41]: var[32][21]
Out[41]: 0.483336454674989

In [42]: (32*46)+21
Out[42]: 1493
```

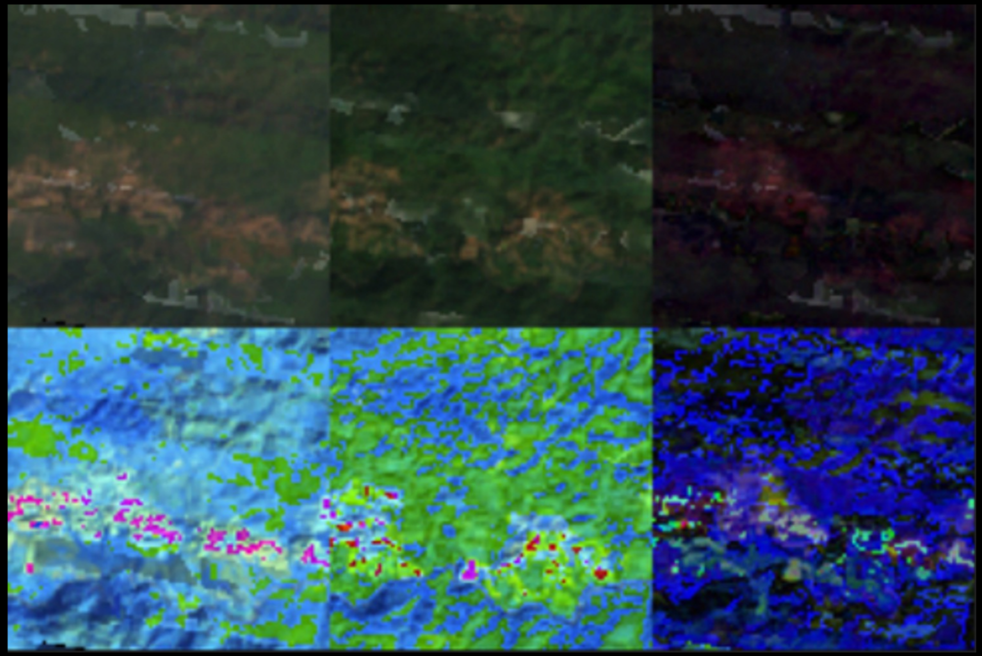
```
array([0.09771143, 0.15139378, 0.19092293, 0.13221811, 0.10414862,
       0.05051057, 0.09017028, 0.15386817])
```



Checking the prediction [1]

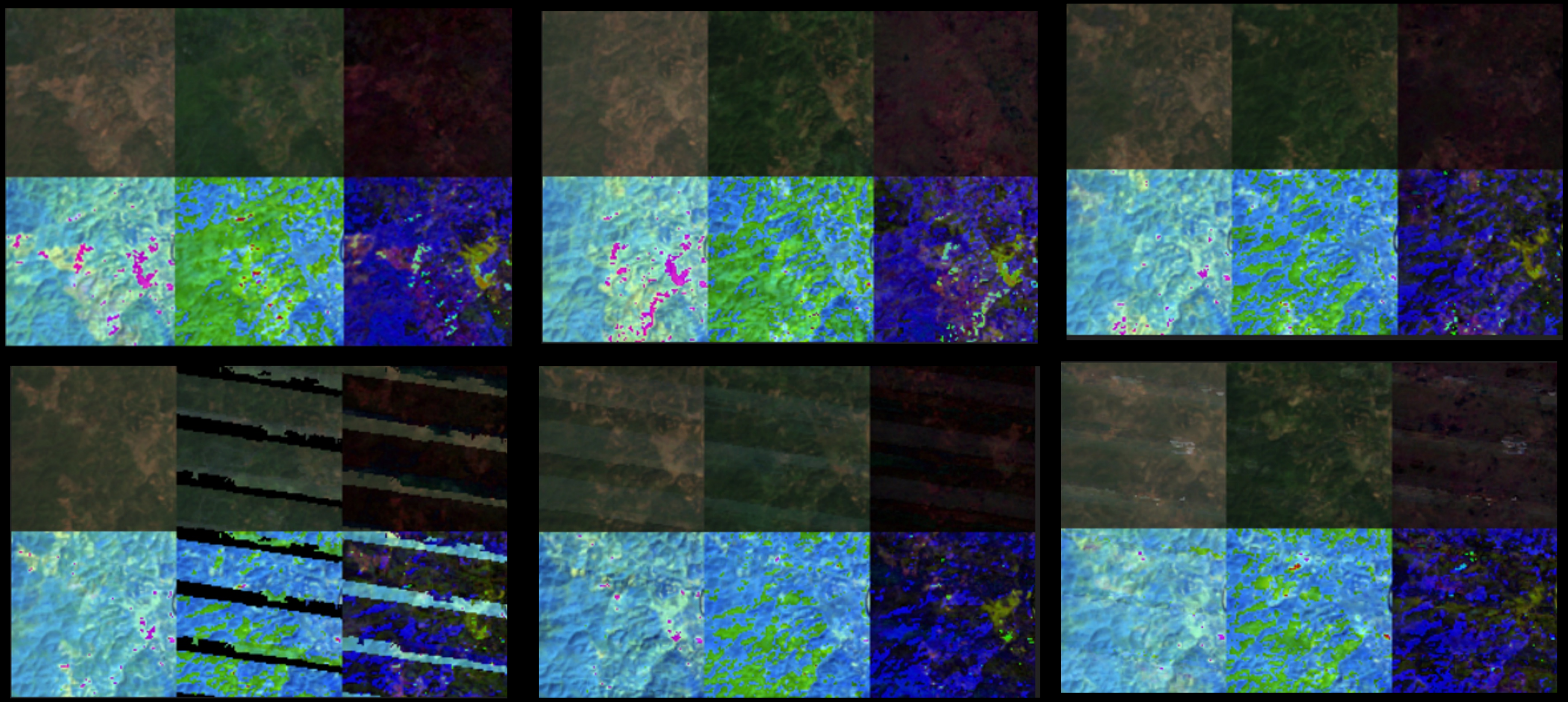
```
In [41]: var[32][21]
Out[41]: 0.483336454674989

In [42]: (32*46)+21
Out[42]: 1493
```





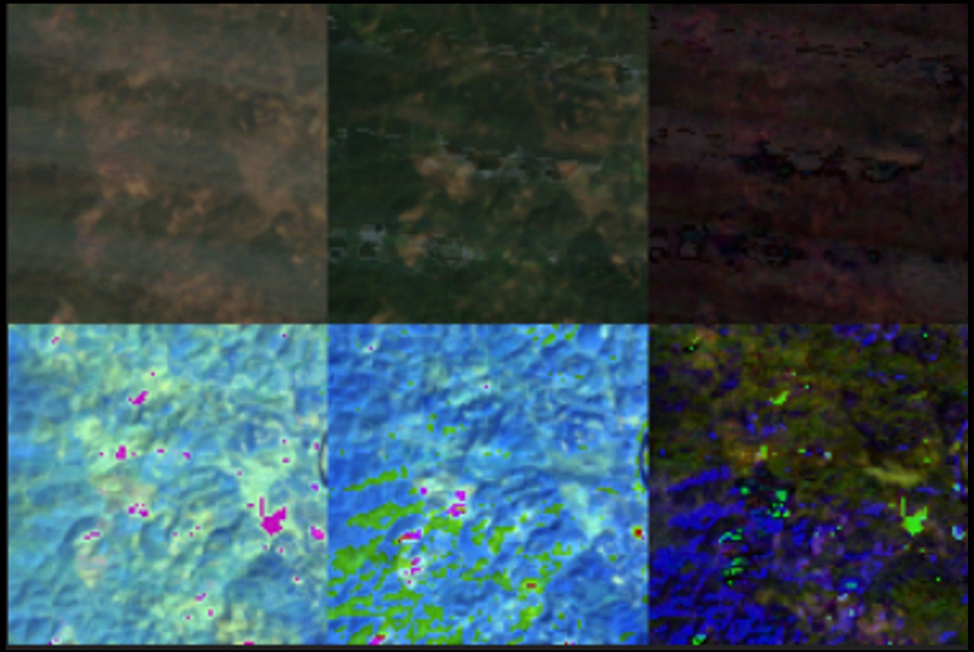
Checking the prediction [2]

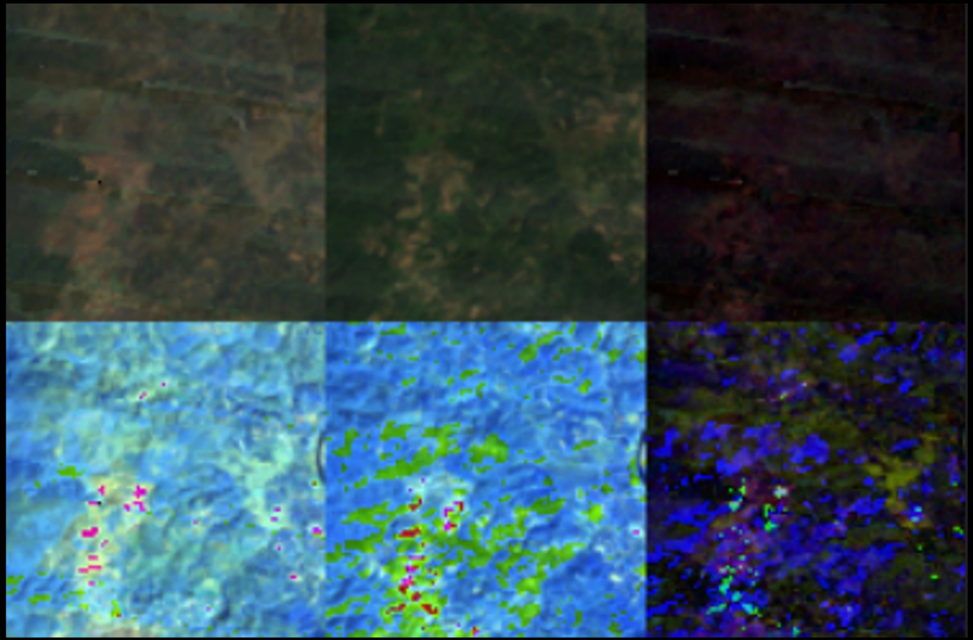
```
In [52]: var[28][51]
Out[52]: 0.2696312832492602

In [53]: (28*46)+51
Out[53]: 1339
```



Checking the prediction [2]

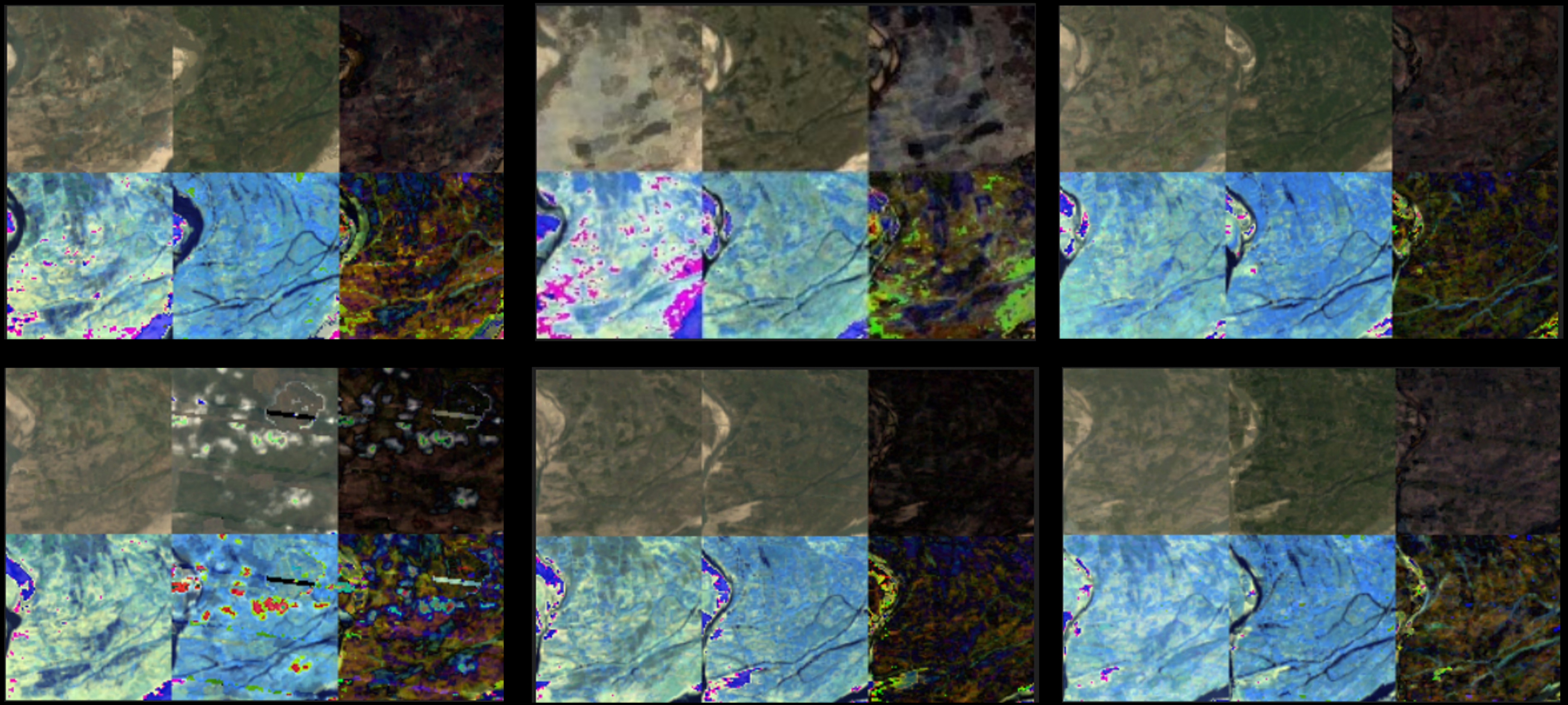
```
In [52]: var[28][51]
Out[52]: 0.2696312832492602

In [53]: (28*46)+51
Out[53]: 1339
```





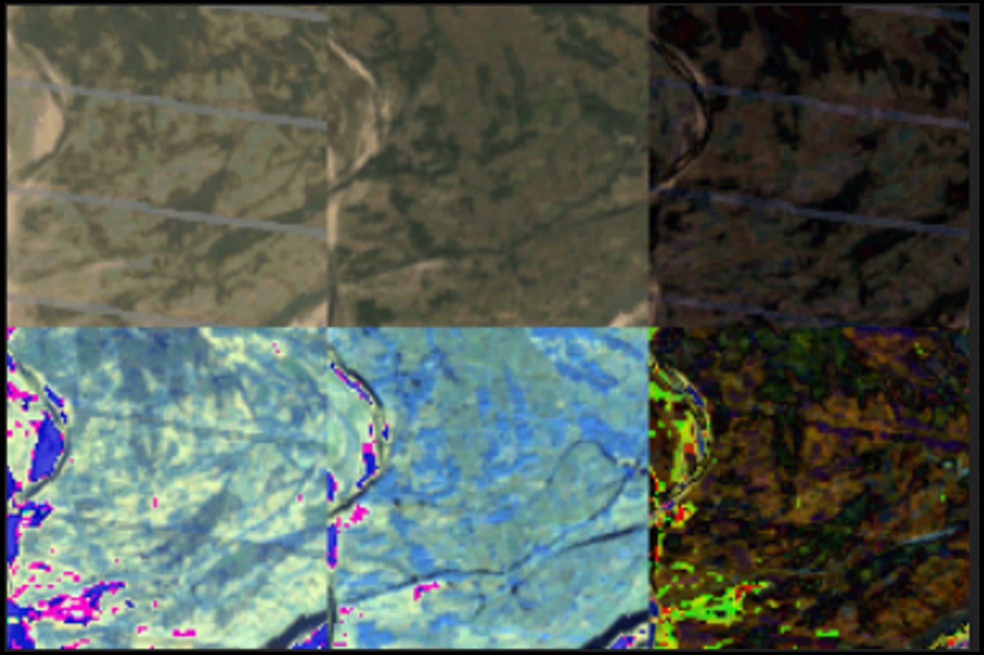
Checking the prediction [3]

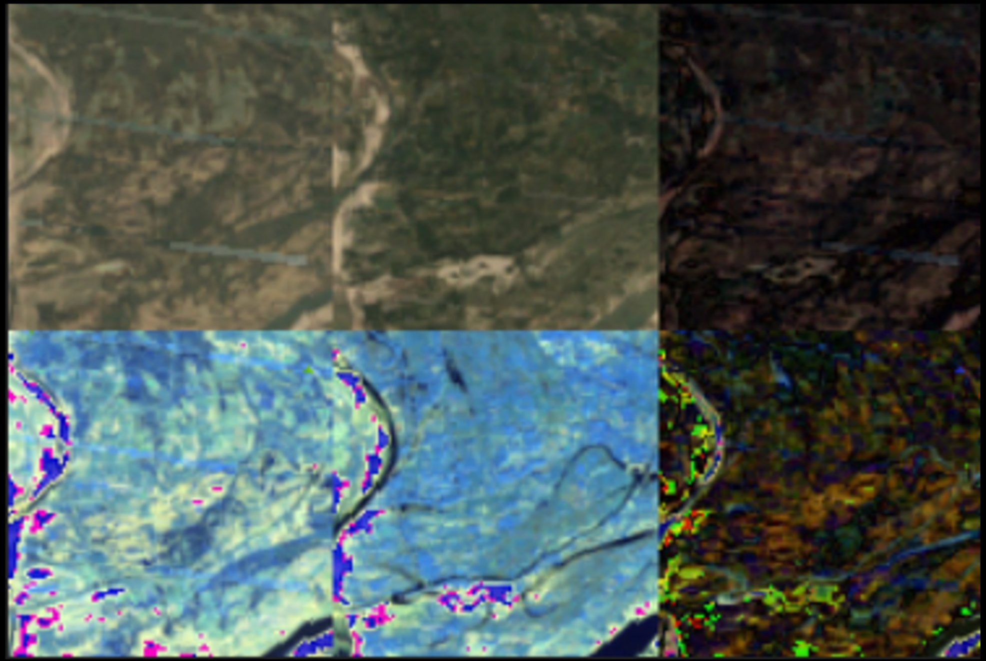
```
In [64]: var[18][58]
Out[64]: 8.744609008705726e-05

In [65]: (18*46)+58
Out[65]: 886
```



Checking the prediction [3]

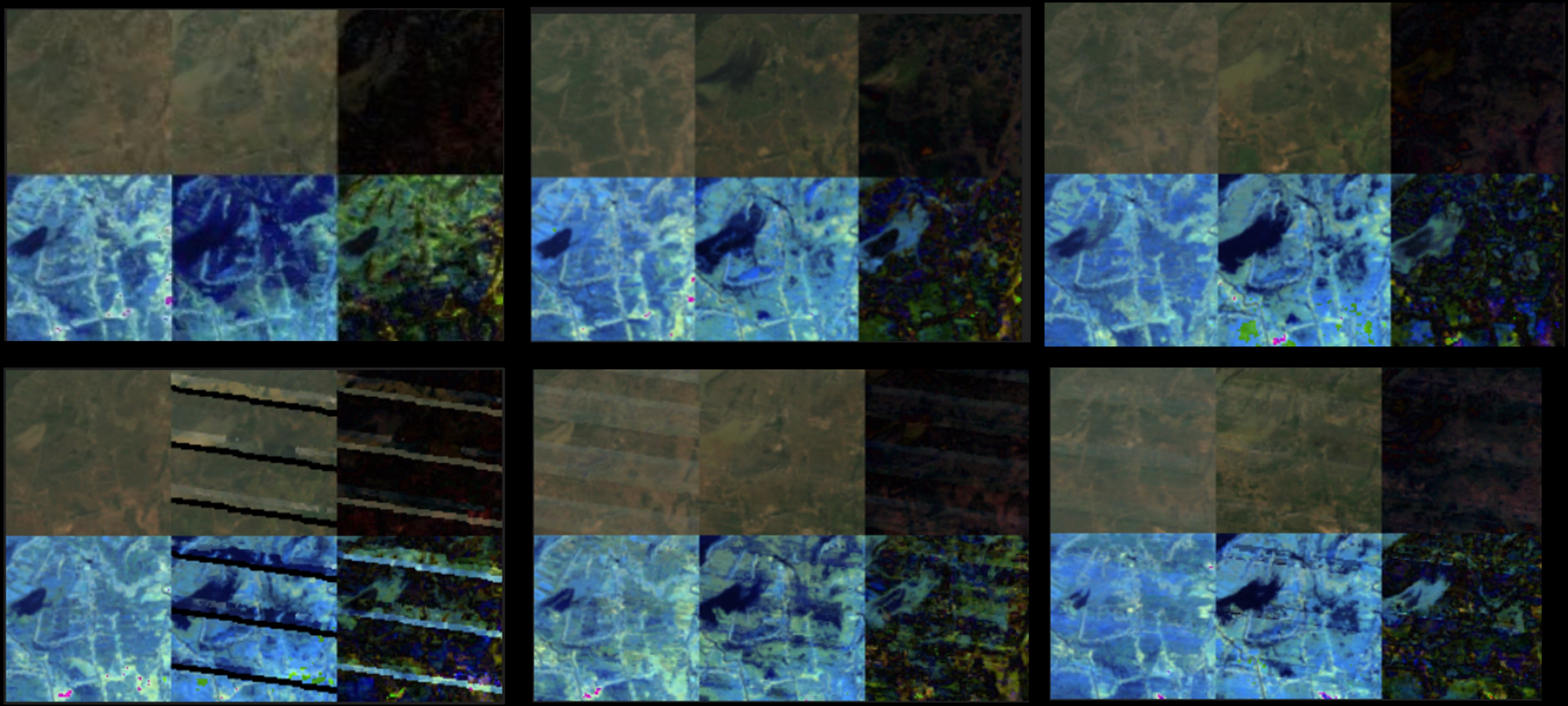
```
In [64]: var[18][58]
Out[64]: 8.744609008705726e-05

In [65]: (18*46)+58
Out[65]: 886
```





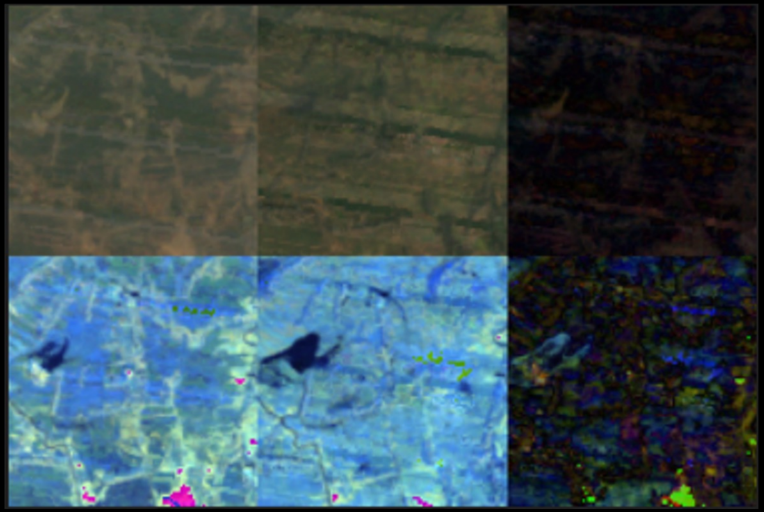
Checking the prediction [4]

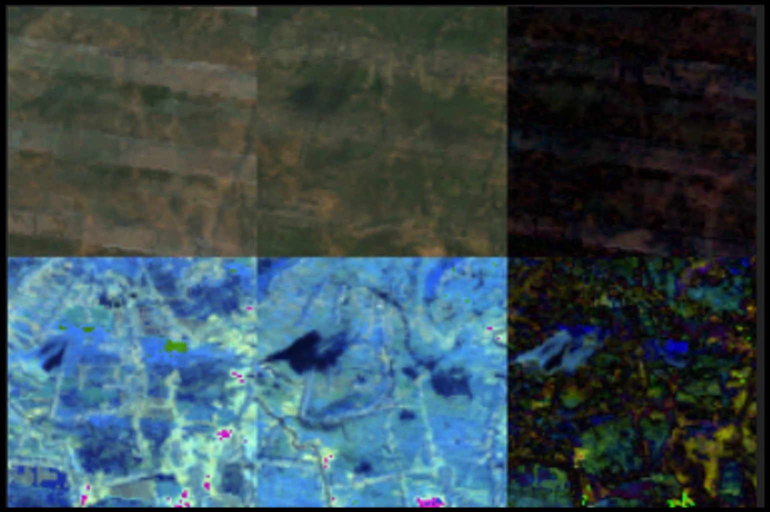
```
In [95]: var[13,22]
Out[95]: 0.06013884498993642

In [96]: (13*46)+22
Out[96]: 620
```



Checking the prediction [4]

```
In [95]: var[13,22]
Out[95]: 0.06013884498993642

In [96]: (13*46)+22
Out[96]: 620
```





Classification of different areas

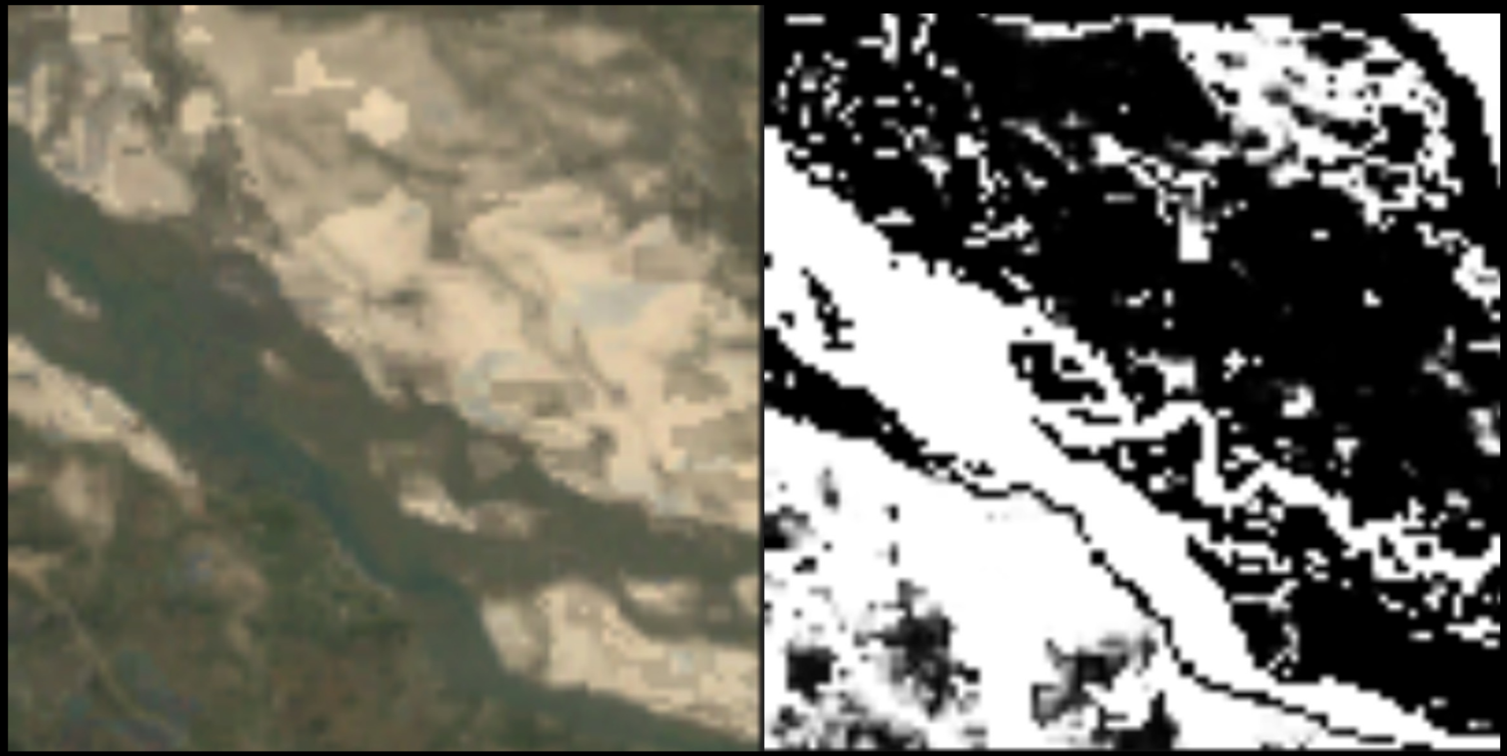
We used the NDVI value and the Burn index to classify the land cover.

Output classes

- Barren Land
- Crop/Vegetation
- Forest
- Burnt vegetation
- Other

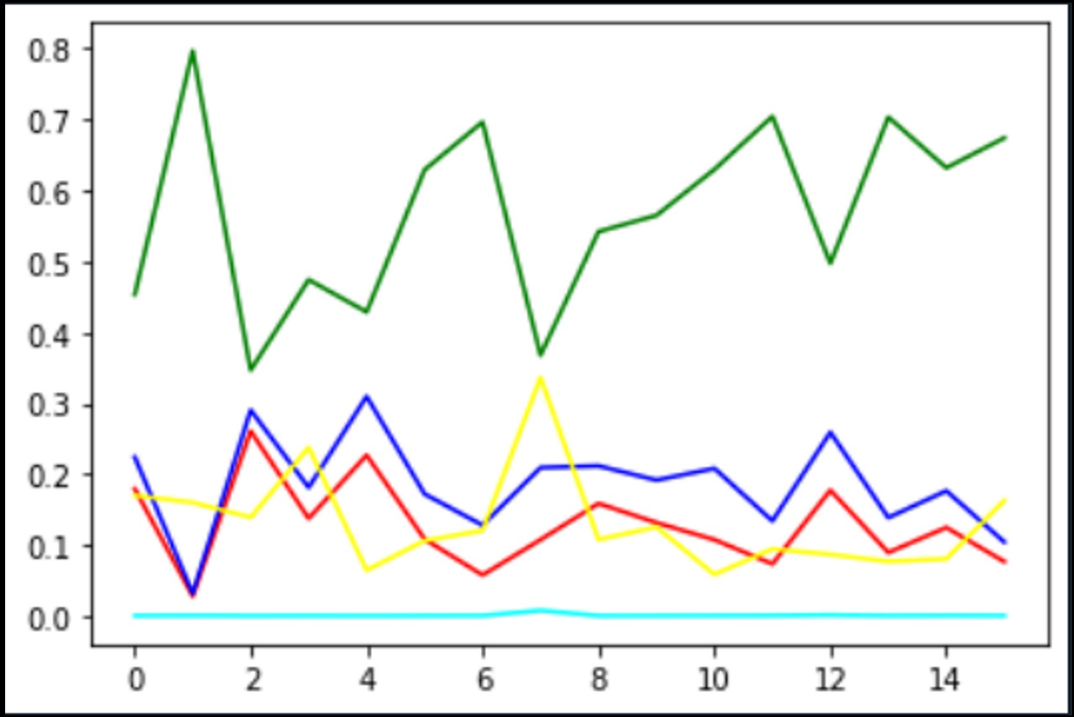
```
model = keras.models.Sequential()
model.add(keras.layers.Dense(10,input_shape=(2,),activation='relu'))
model.add(keras.layers.Dense(50,activation='relu'))
model.add(keras.layers.Dense(50,activation='relu'))
model.add(keras.layers.Dense(10,activation='relu'))
model.add(keras.layers.Dense(5,activation='sigmoid'))

model.compile(optimizer=keras.optimizers.Adagrad(lr=0.0005),loss=keras.losses.Bina
```

Visualization of the result



Multi-temporal analysis

```
plt.plot(a,"red") #barren
plt.plot(b,"blue") #crop
plt.plot(c,"green") #forest
plt.plot(d,"cyan") #burnt
plt.plot(e,"yellow") #other
```

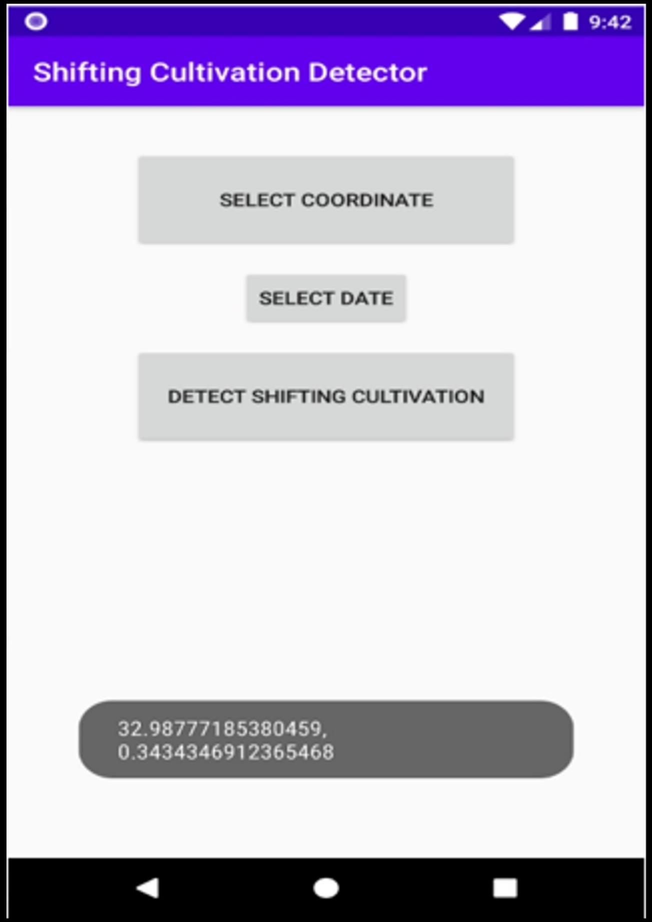


Android Application

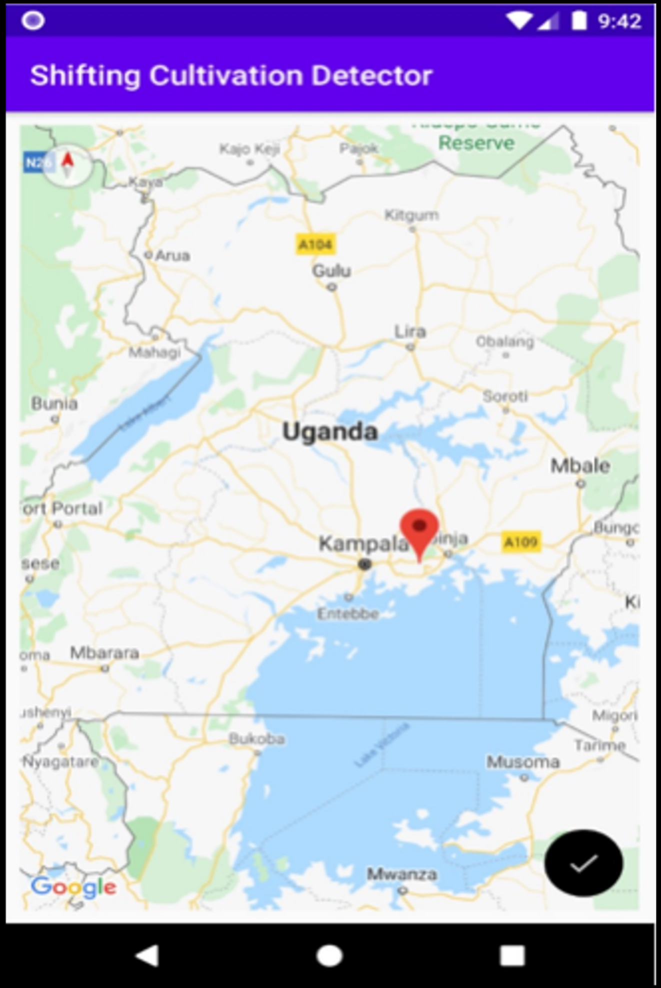
A application where user can report the area exhibiting shifting cultivation.

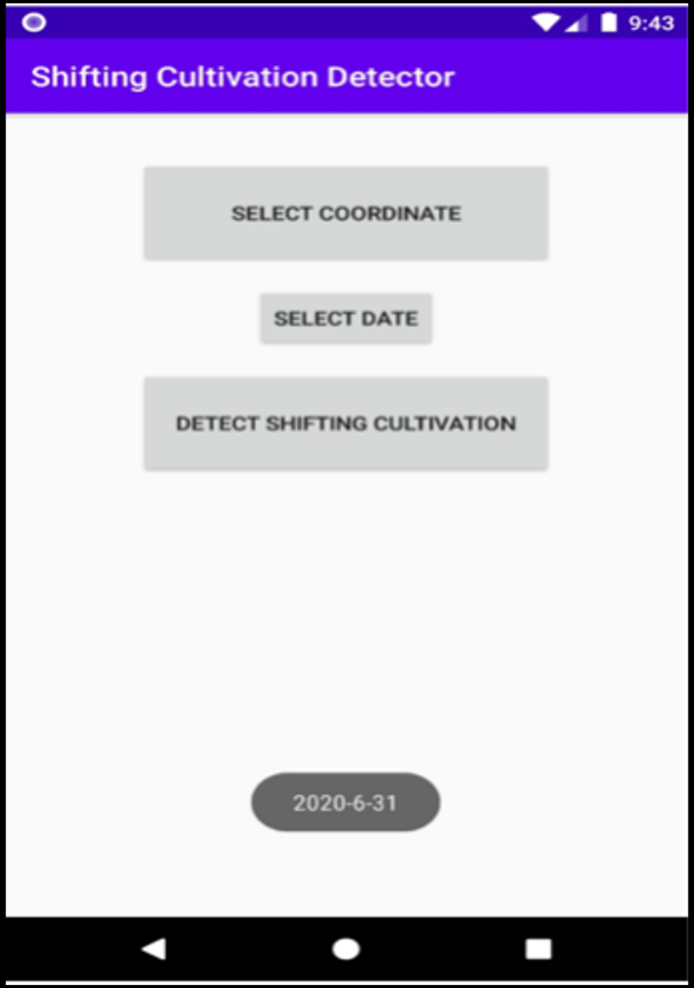
This data can be used so that our data can be classified with higher accuracy.

Retraining the model within regular interval with the new reported data.



Android application





Changes done on the base of comments

- Used the data of 8 years from the LANDSAT-7 to differentiate between regular cultivation and the shifting cultivation.
- Generated new model to classify land areas.
- Support to view photo of a particular area on the android while reporting.
- Analysis of the data from multiple years.

Bibliography

Effects on LANDSAT images: Spatio-Temporal Monitoring of Shifting Cultivation Using Landsat Images: Soft Classification Approach

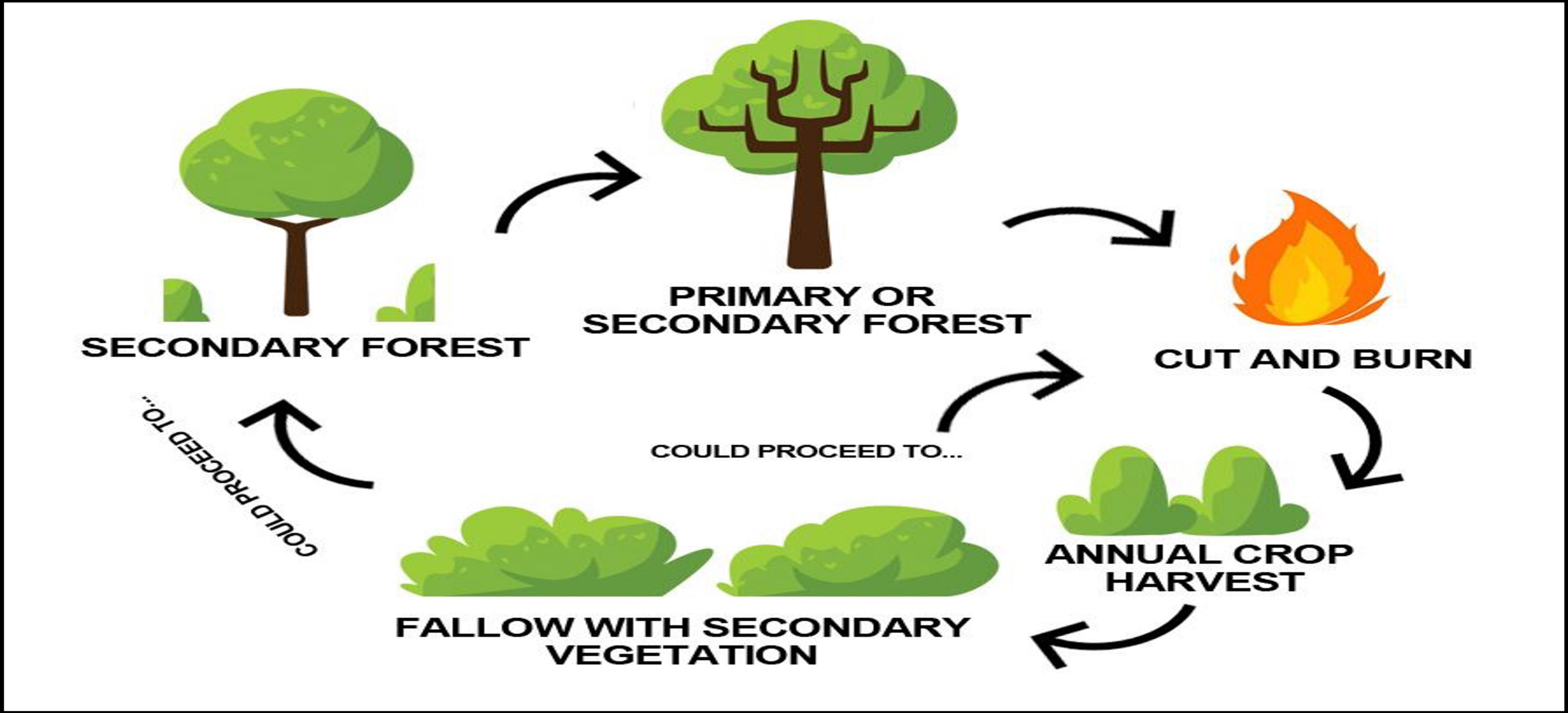
Vegetation constant : Mapping Rice Cropping Systems in Vietnam Using an NDVI-Based Time-Series Similarity Measurement Based on DTW Distance

Water bodies detection : Identification of Water Bodies in a Landsat 8 OLI Image Using a J48 Decision Tree

Crop study of meghalaya:
https://en.wikipedia.org/wiki/Meghalaya#:~:text=Meghalaya%20has%20predominantly%20an%20agrarian,%2C%20papayas%2C%20spices%2C%20etc.

Size of farms: https://www.zizira.com/blogs/people-and-process/farmers-leaving-farming-in-meghalaya#:~:text=Is%20there%20a%20criterion%3F,in%20Meghalaya%20is%200.21%20hectare.

conti.....



PRIMARY OR
SECONDARY FOREST
CUT AND BURN
ANNUAL CROP
HARVEST
FALLOW WITH SECONDARY
VEGETATION
COULD PROCEED TO...
SECONDARY FOREST
COULD PROCEED TO...

Thank You...!!