Flood Monitoring using SAR and Optical Satellite data

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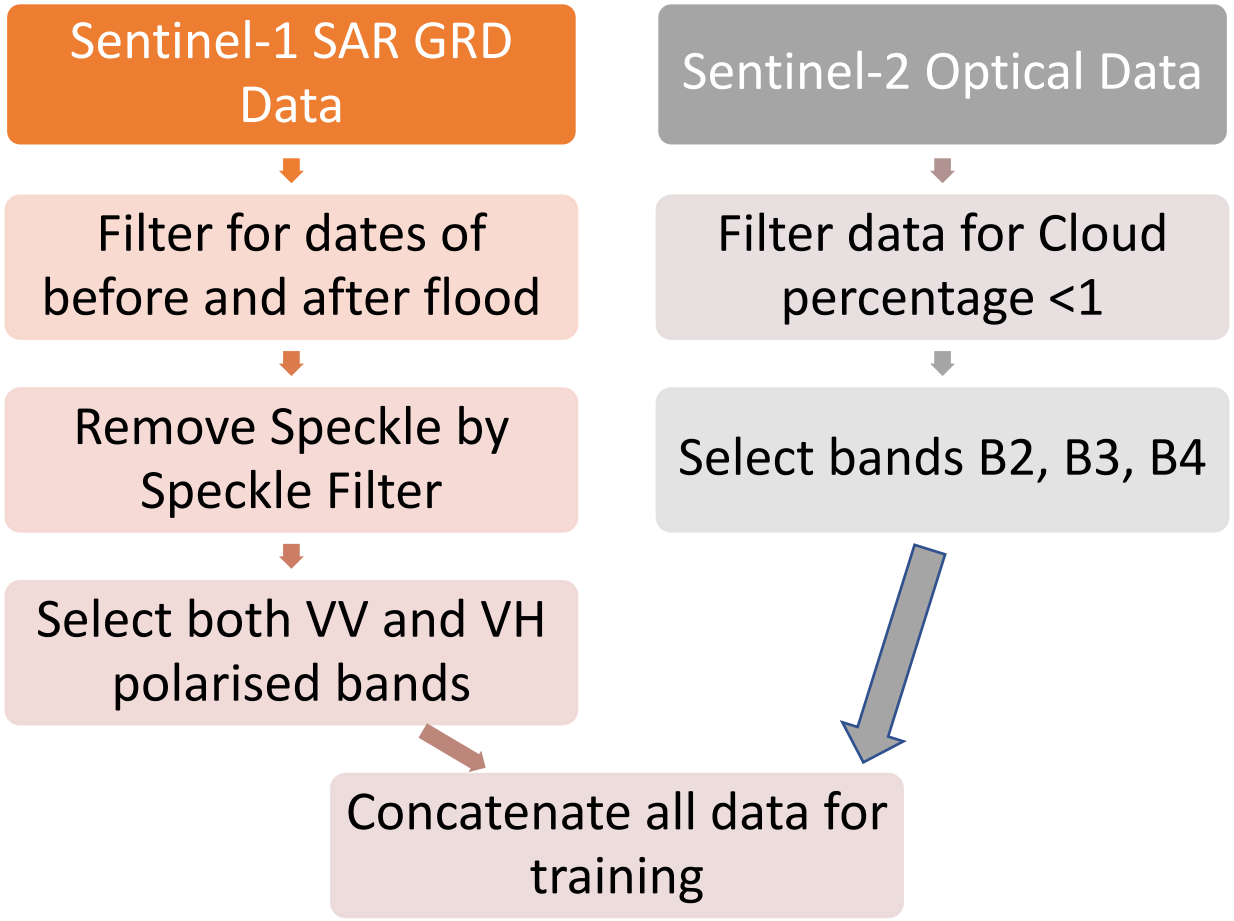
Motivation

- Emergency managers responders frequently request satellite-based crisis information for flood monitoring to target the often-limited resources and to prioritize response actions throughout a disaster situation.
- This project aims at improving existing satellite-based emergency mapping methods based on Synthetic Aperture Radar (SAR) data by training, testing and validating novel machine learning algorithms for the extraction of water bodies in case of flood situations.
- Particular focus is to automate the visual image analysis process by deploying Convolutional Neural Networks (CNNs) for semantic segmentation of systematically acquired Sentinel-1A/B SAR data at high spatial (20m) and temporal (3-5 days) resolution, including using information from polarimetry and Optical data.

Preprocessing



Generating training data

- For supervised classification, the first step is to collect training data to “train” the classifier – This involves collecting representative samples of backscatter for each landcover class of interest.
- 4 classes: Permanent water, Flooded Open water, Urban area, Lowland area
- For Permanent water, Urban area and Lowland area, samples were drawn of areas which remained unchanged before and after flood, with respect to backscatter values in the SAR image as well as similarly in the Optical image.
- The Flooded Open water sample was selected based majorly on change on considerable change in backscatter values of SAR image and also on visual effect from the Sentinel-2 images.

Training the model

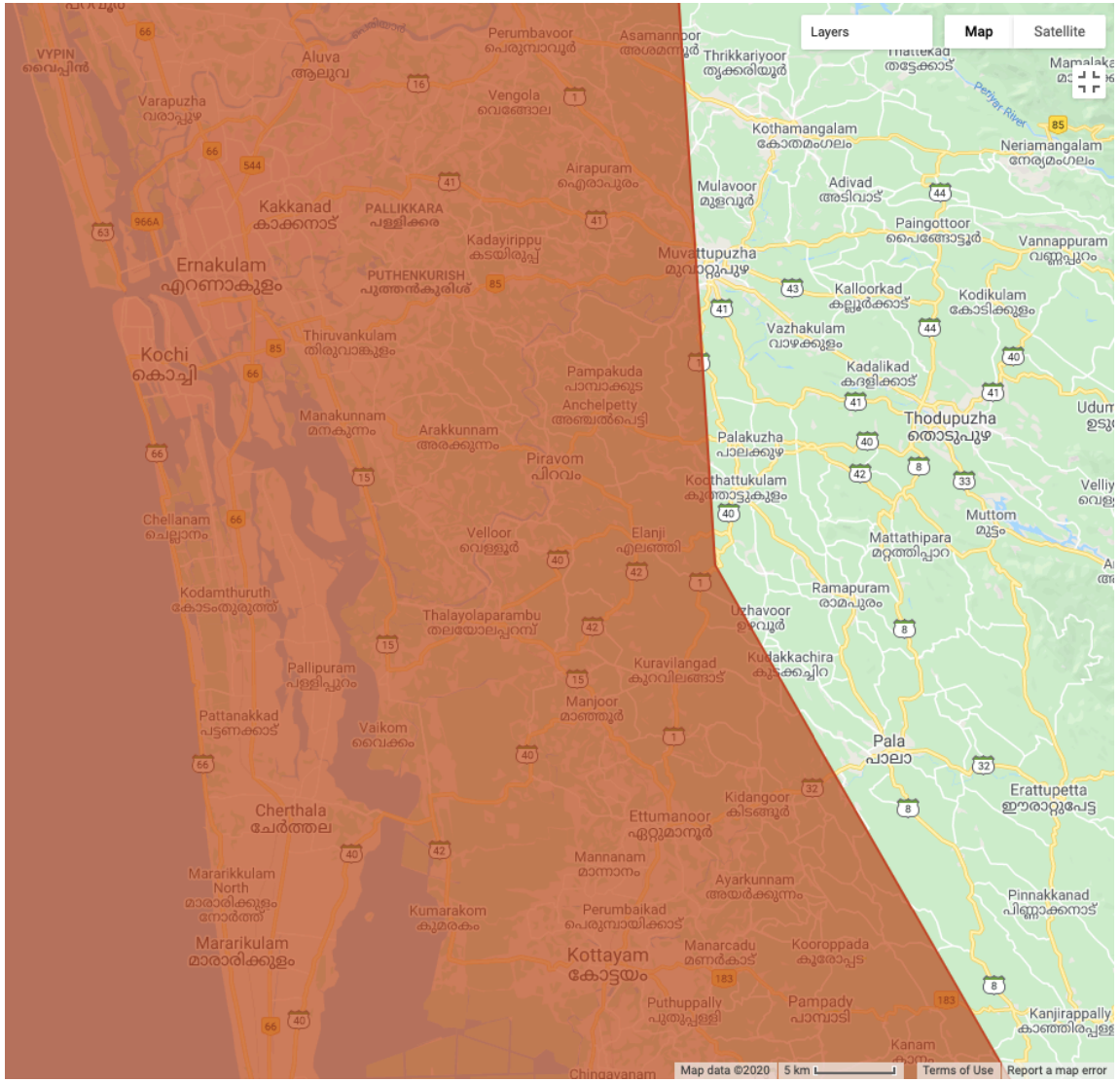
- The concatenated labeled data was divided into training and test data based on random sampling.
- The training data was now used to train a model using a neural network for classification.

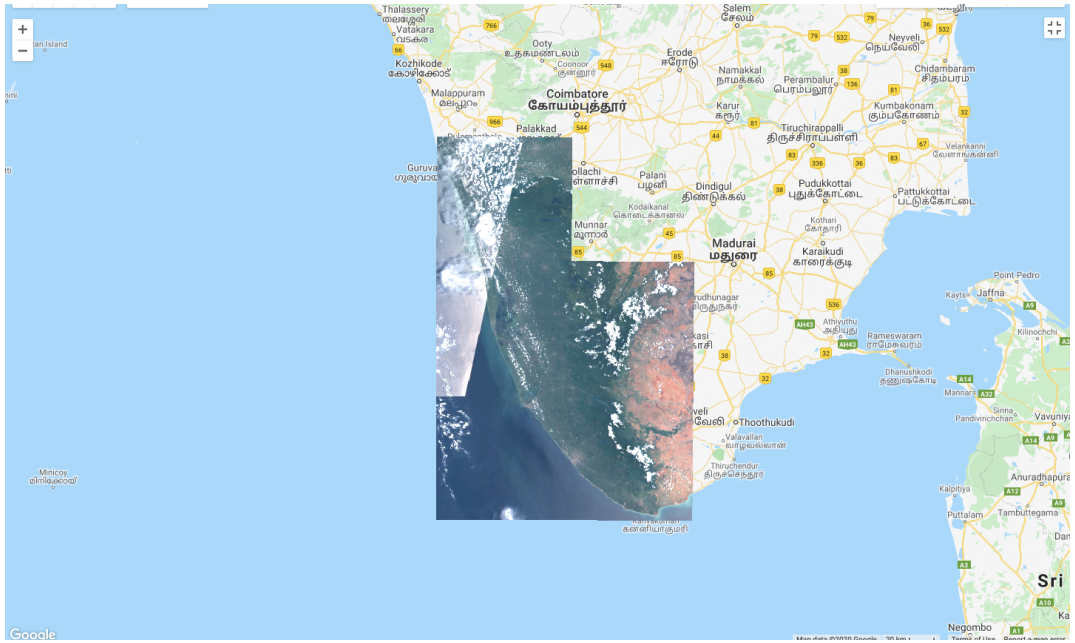
Sequential Neural Network Classifier

- Platforms used: Google Earth Engine, Tensorflow v2.2, Keras
- The model had a 64 node hidden layer, a dropout layer and an output layer, with Softmax activation layer and using Adam optimizer.
- The model was trained for 10 epochs and evaluated on the test data set.

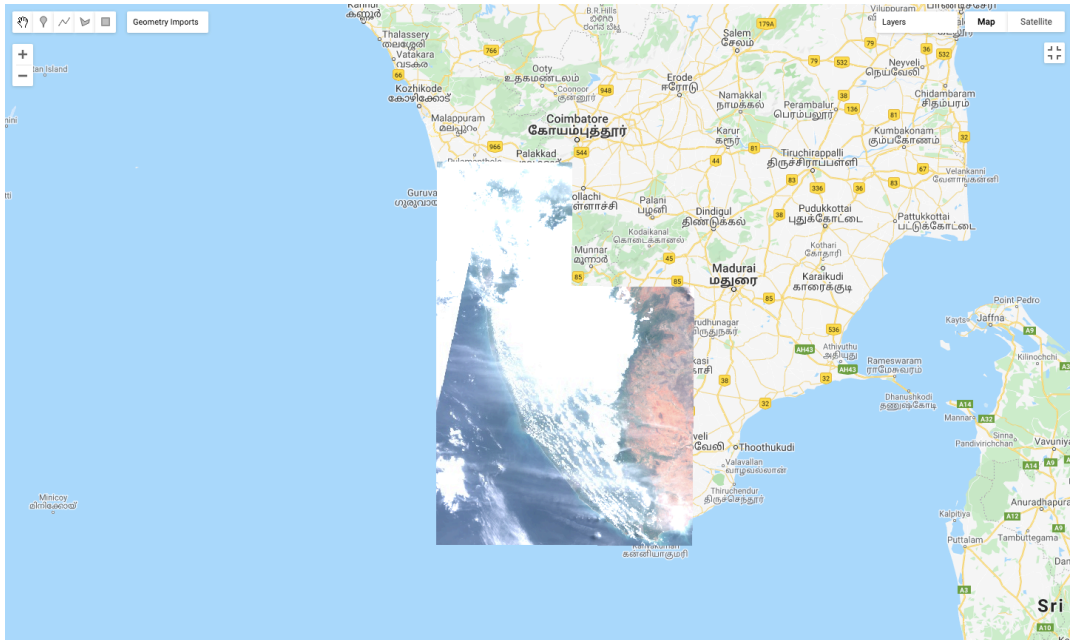
Region of Interest: Kerala Floods, India, 2018

- Kerala Floods in Southern India from July 2018 – August 2018.

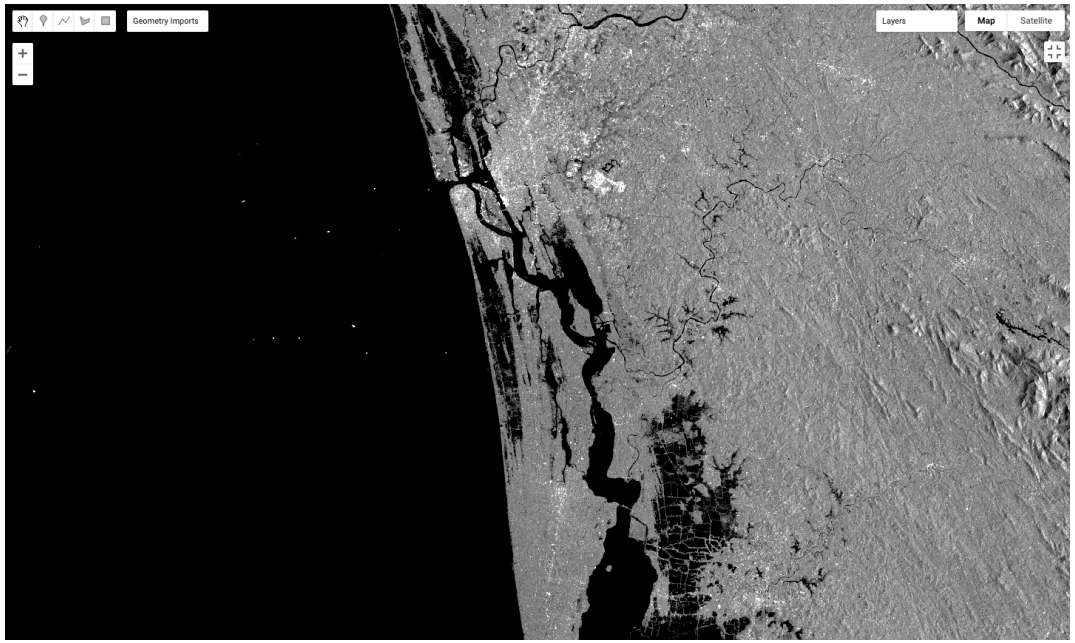




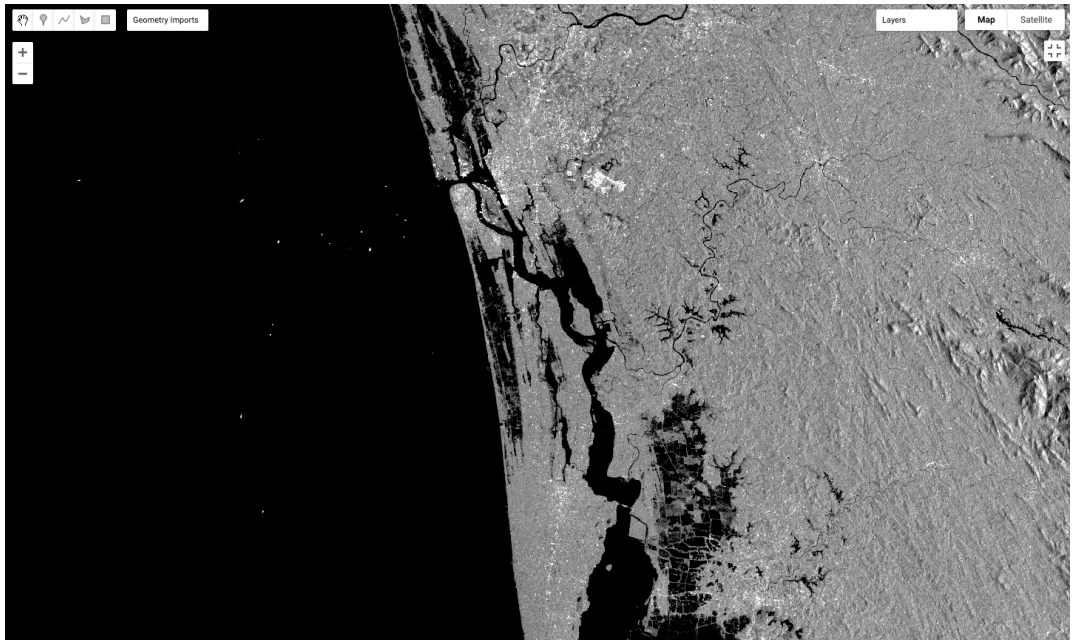
Sentinel-2 image before floods
31.07.2018



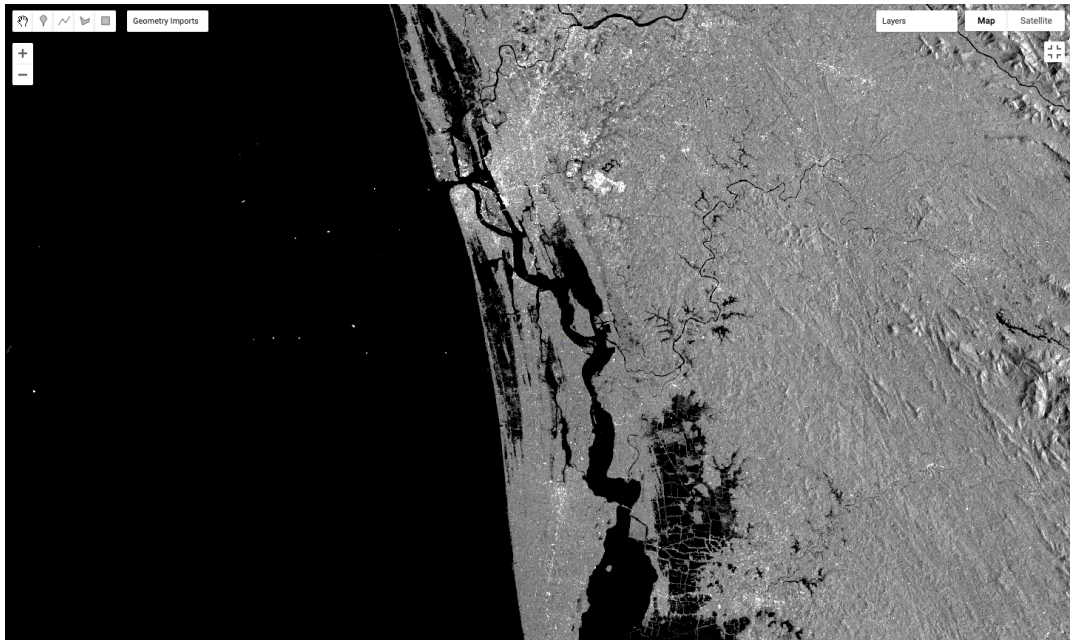
Sentinel-2 image during floods
15.08.2018



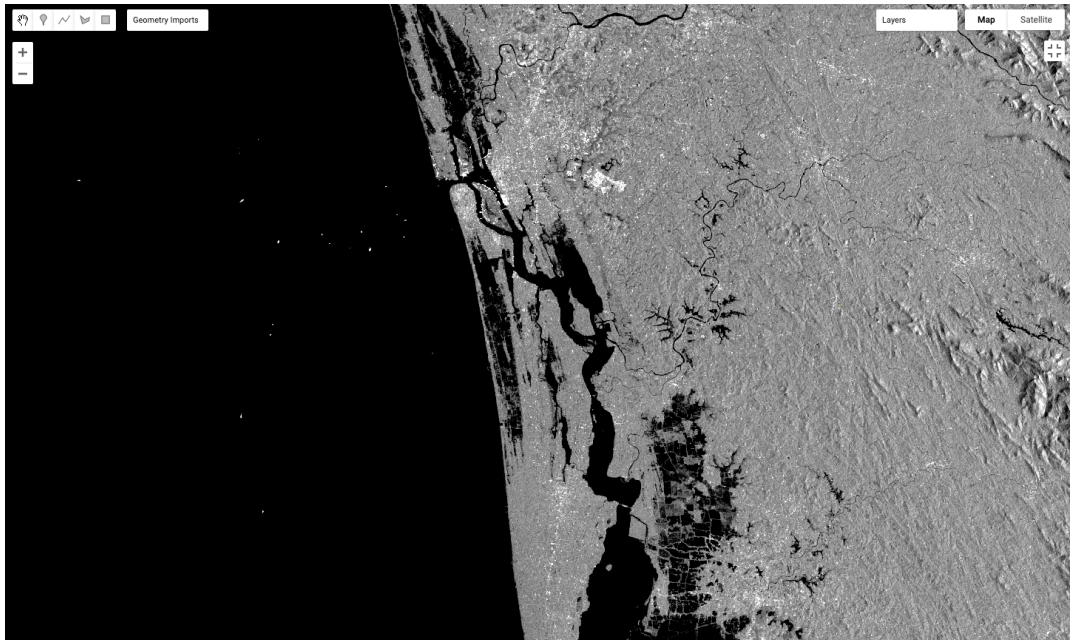
Sentinel-1 SAR image before floods 31.07.2018



Sentinel-1 SAR image during floods 15.08.2018



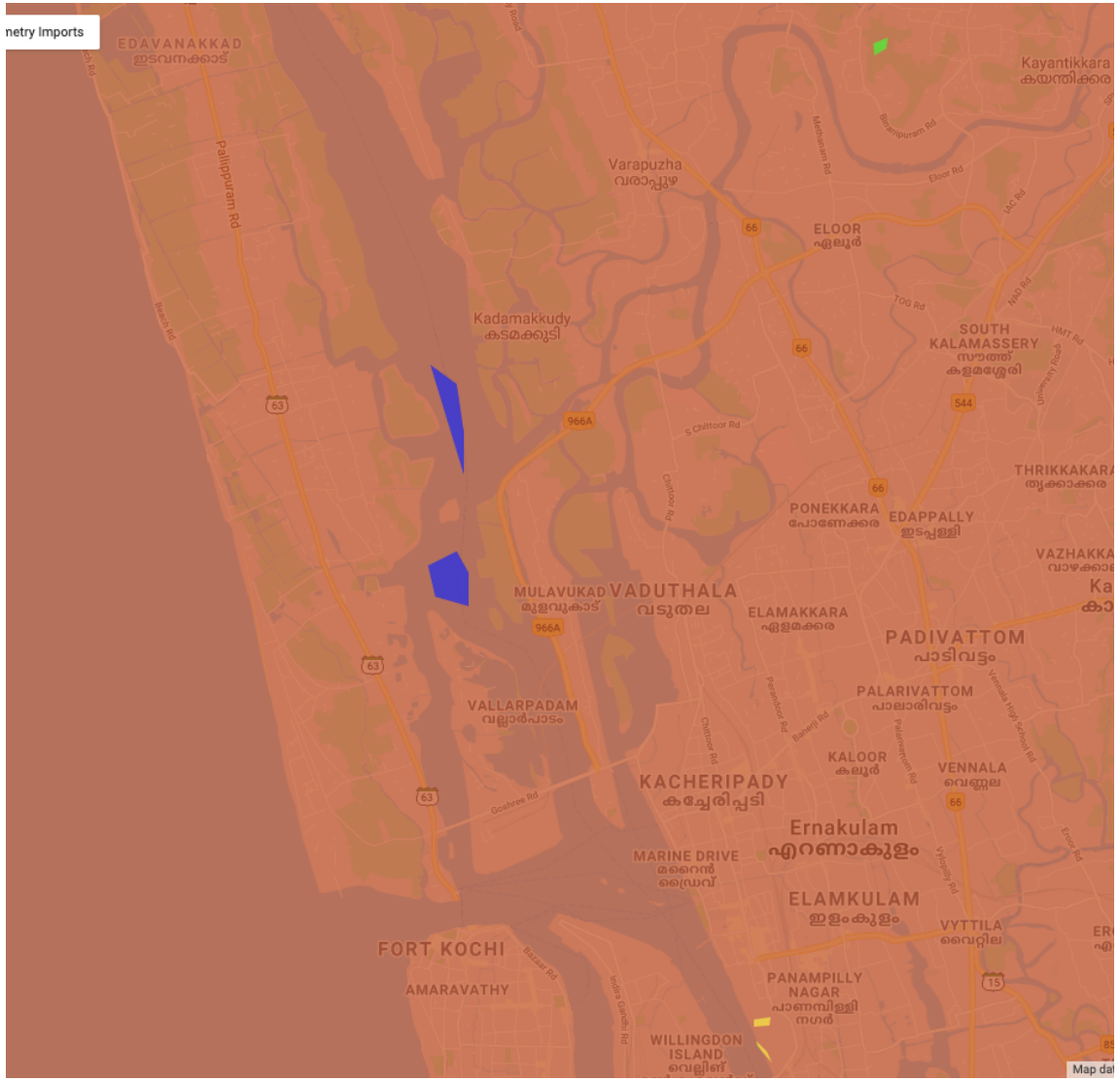
Sentinel-1 SAR image before floods 31.07.2018 after applying speckle filter



Sentinel-1 SAR image during floods 15.08.2018 after applying speckle filter

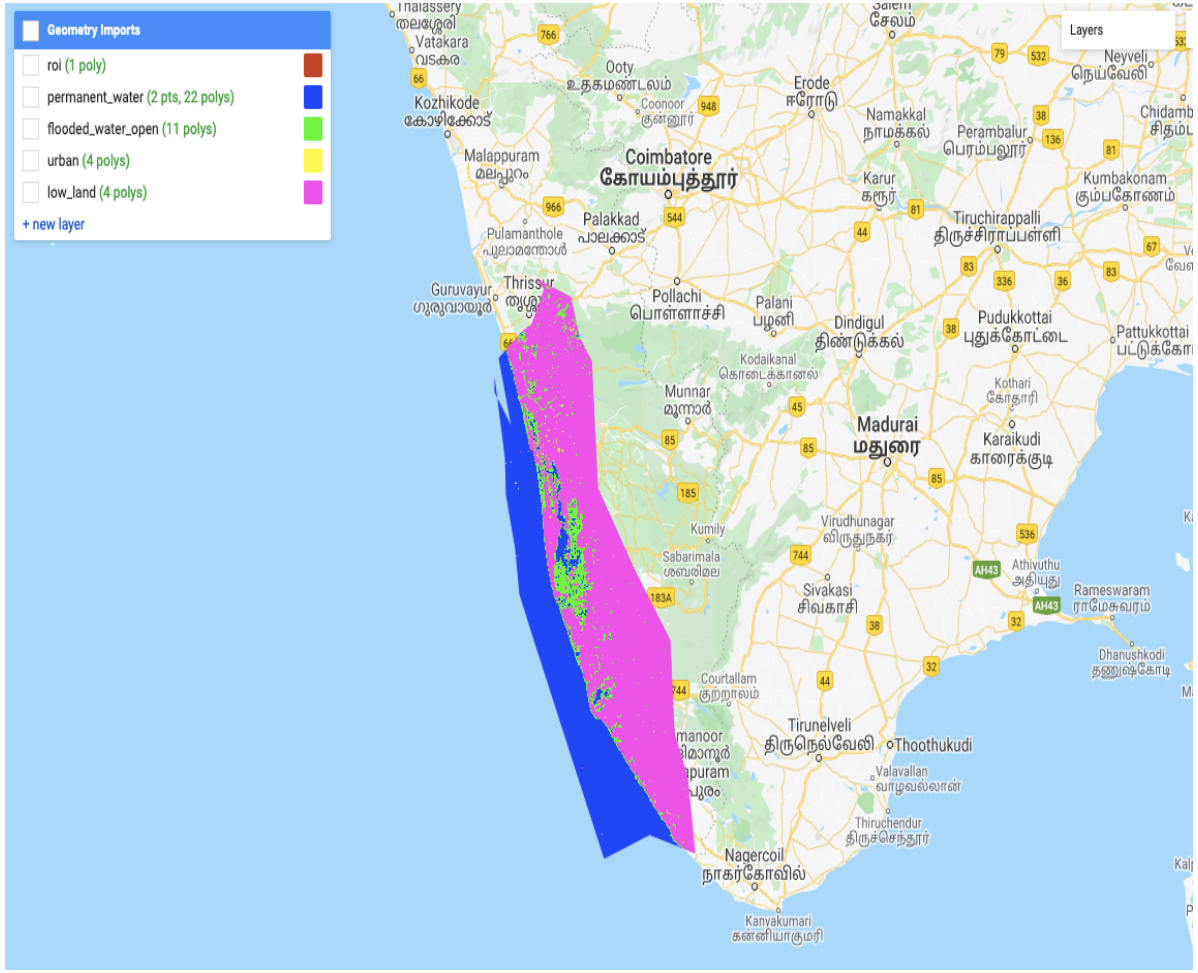
Sampling training areas

- Training areas were sampled belonging to 4 classes: Permanent water, Flooded Open water, Urban area, Lowland area



Classification results

- The trained model was used to classify the validation dataset, with an accuracy of 94%.
- The test data which comprised of the rest of the points from the region of interest was also classified.



Future work

- Our aim is to automate the entire process for rapid flood detection using Machine Learning.
- The idea is to incorporate data from all sources including SAR backscatter, coherence, polarimetry, and Optical data.
- Our future goal is to construct a streaming data pipeline which can be used to rapidly monitor flood situations as well train models for real-time detection of floods.

Thank You