INDIAN INSTITUTE OF INFORMATION TECHNOLOGY

Dharwad

ज्ञानेन विकासः

TRACKING THE CHANGES IN WATER LEVEL IN LAKES OVER THE YEARS USING SATELLITE IMAGES

-Under the guidence of Dr.Utkarsh

PROBLEM STATEMENT

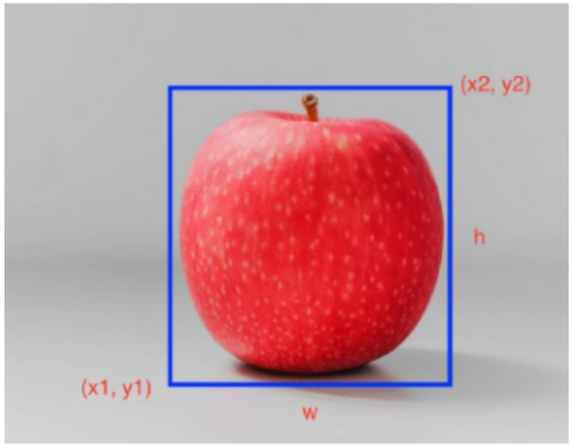
Project aim is to monitor the lake water level of different lakes using satellite imagery and deep learning algorithms.

LITERATURE SURVEY :

- Exploring Satellite Imagery by Girija Shankar Behera - link

DATA LABELING:

- Image Data Labelling and Annotation — Everything you need to know by Sabina Pokhrel
- Labeling Satellite Imagery for Machine Learning by By Niki LaGrone



BOUNDING BOXES -

POLYGONAL SEGMENTATION:

SEMANTIC SEGMENTATION:

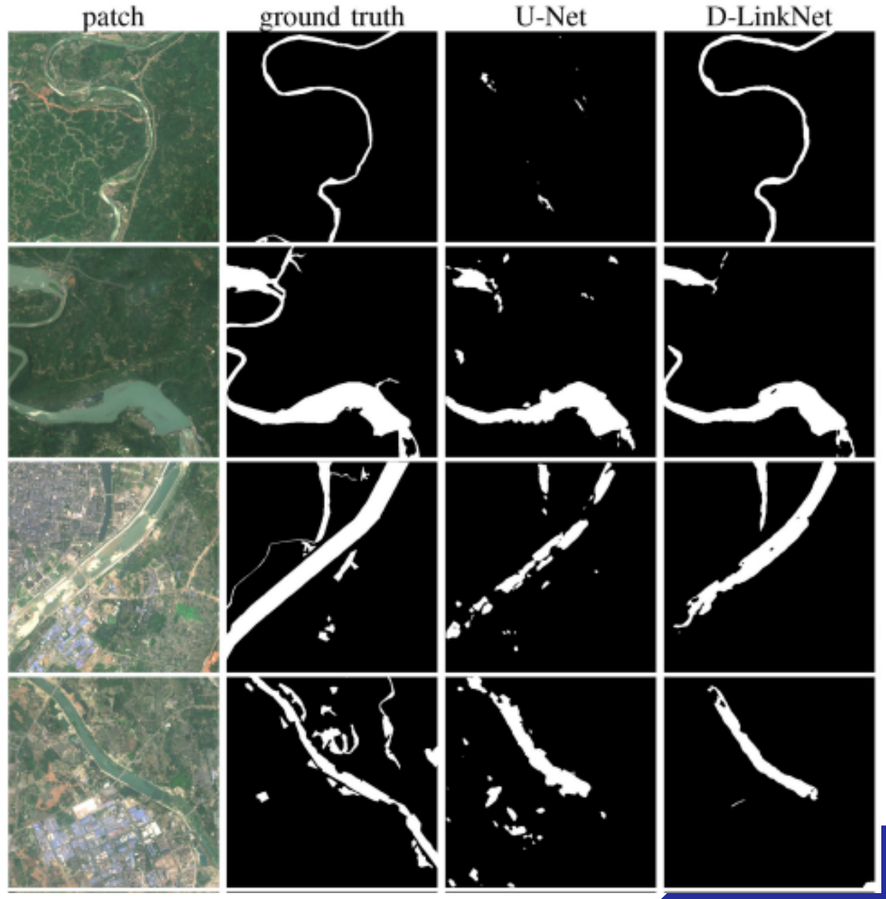
3D-CUBING:

KEY POINT AND LAND MARKING:

LITERATURE SURVEY :

SEMANTIC SEGMENTATION

- Detection of Water-Bodies Using Semantic Segmentation by Mina Talal, A. Panthakkan, Husameldin Mukhtar, W. Mansoor, S. Almansoori, Hussain Al Ahmad
- Deep-Learning-Based Multispectral Satellite Image Segmentation for Water Body Detection by Kunhao Yuan



LITERATURE SURVEY :

DATA AUGMENTATION:

- A survey on Image Data Augmentation for Deep Learning by Connor Shorten & Taghi M. Khoshgoftaar
- Five Simple Image Data Augmentation Techniques to Mitigate Overfitting In Computer Vision by Zoumana Keita

LITERATURE SURVEY :

ALGORITHMS

- A Study on Deep Learning Models for Satellite Imagery by M. P. Vaishnnave1 , K. Suganya Devi * , P. Srinivasan

CNN / AUTO ENCODERS

PROJECT MOTIVE

According to UNESCO

“Freshwater is the most important resource for mankind, cross-cutting all social, economic and environmental activities. It is a condition for all life on our planet, an enabling limiting factor for any social and technological development, a possible source of welfare or misery, cooperation or conflict.”

- WHY SATELLITE IMAGE PROCESSING?
- WHY DID WE CHOOSE LAKE WATER BODIES FOR SATELLITE IMAGE PROCESSING?

Technical Parts:

The techniques used in this project are:

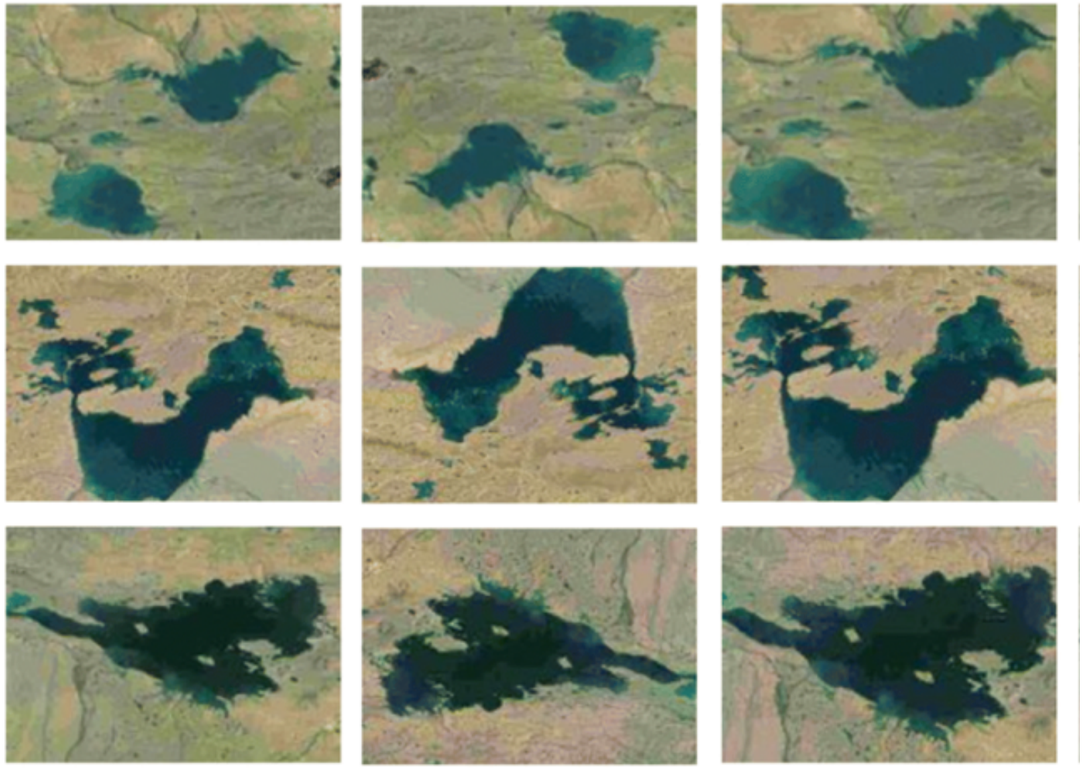
- Publicly available datasets for training and testing
- Data labeling for semantic segmentation
- Data augmentation for enlarging dataset
- U-Net architecture for semantic segmentation
- Metrics to evaluate semantic segmentation
- Dashboard application for displaying the model prediction

Datasets

- **NWPU-Resic-45:** There are 700 photographs in each of the 45 scene classifications represented in our dataset's 31,500 total images.
- **Sentinel-2 :** Many lakes were available, following are the endangered lakes, the required dataset for our project.
  - Lake Poopo, Bolivia;
  - Lake Urmia, Iran;
  - Lake Mojave, USA;
  - Aral sea, Kazahkstan;
  - Lake Copais, Greece;
  - Lake Ramganga, India;
  - Qinghai Lake, China;
  - Salton Sea, USA;
  - Elephant Butte Reservoir, USA
  - Lake Faguibine, Mali;
  - Mono Lake, USA;
  - Walker Lake, USA;
  - Lake Balaton, Hungary;
  - Lake Koroneia, Greece;
  - Lake Salda, Turkey;
  - Lake Burdur, Turkey;
  - Lake Mendocino, USA;

Data Augmentation

- Height shift up to 30%;
- Horizontal flip;
- Rotation up to 45 degrees;
- No shear;
- Vertical flip;
- Width shift up to 30%;
- Zoom between 75% and 125%

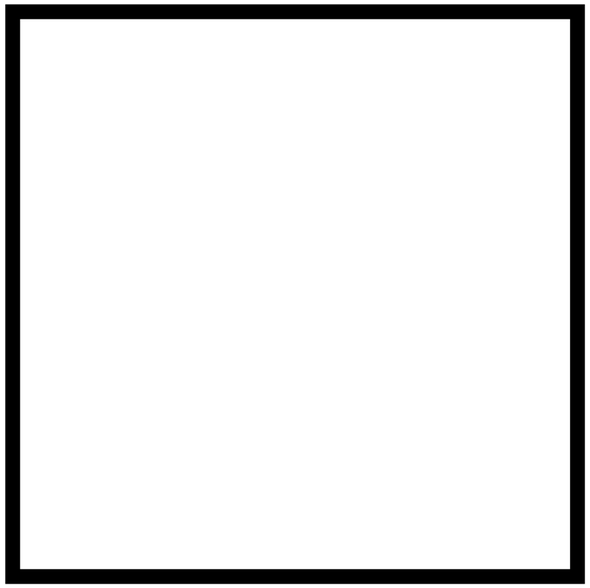


Data labeling for semantic segmentation:

-MakeSense

Metrics:

Original image



After segmentation

After segmentation

Metrics:

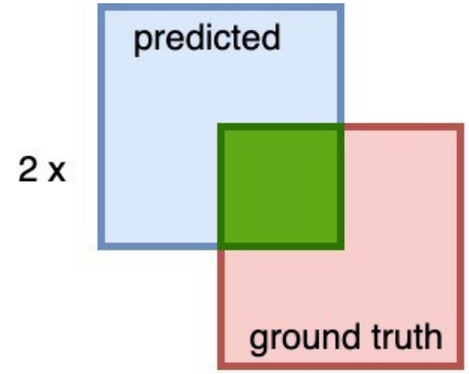
The following metrics have been used to evaluate the semantic segmentation model:

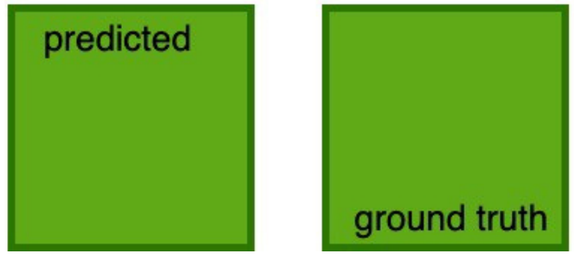
01 Jaccard Index

$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$

02 Dice Coefficient

$$\text{Dice coefficient} = \frac{\text{2x area of overlapped (green)}}{\text{total area (green)}} = \frac{\text{2 x}}{}$$





Metrics:

$$a = TP, \quad b = TP + FP + TN$$

$$IoU = \frac{TP}{TP + FP + TN} = \frac{a}{b}$$

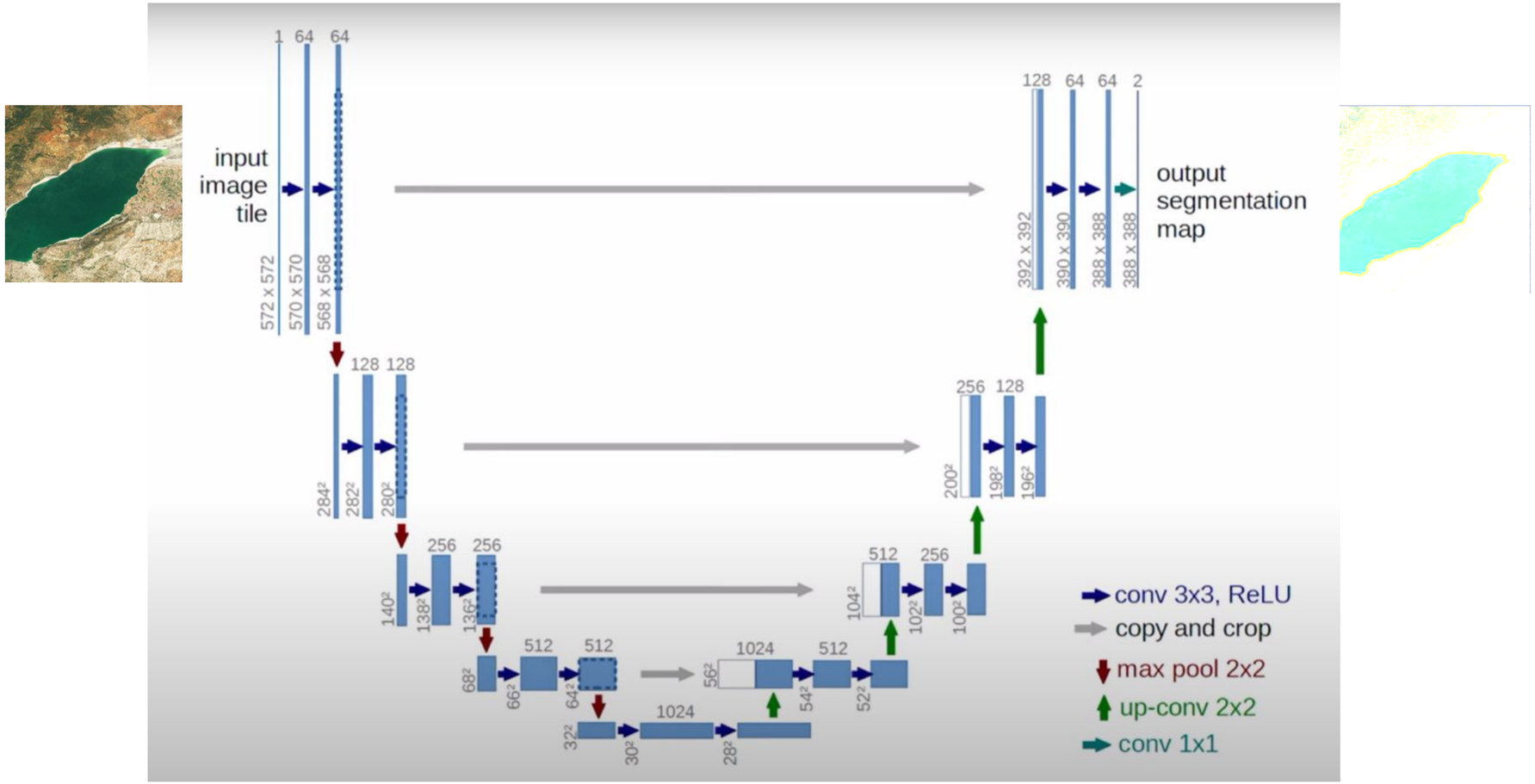
$$Dice = \frac{TP + TP}{TP + TP + FP + TN} = \frac{2a}{a + b}$$

$$Dice = \frac{\frac{2a}{b}}{\frac{a+b}{b}} = \frac{2 \cdot \frac{a}{b}}{\frac{a}{b} + 1} = \frac{2 \cdot IoU}{IoU + 1}$$

ref:https://stats.stackexchange.com/questions/273537/f1-dice-score-vs-iou/276144#276144

U-Net model architecture:

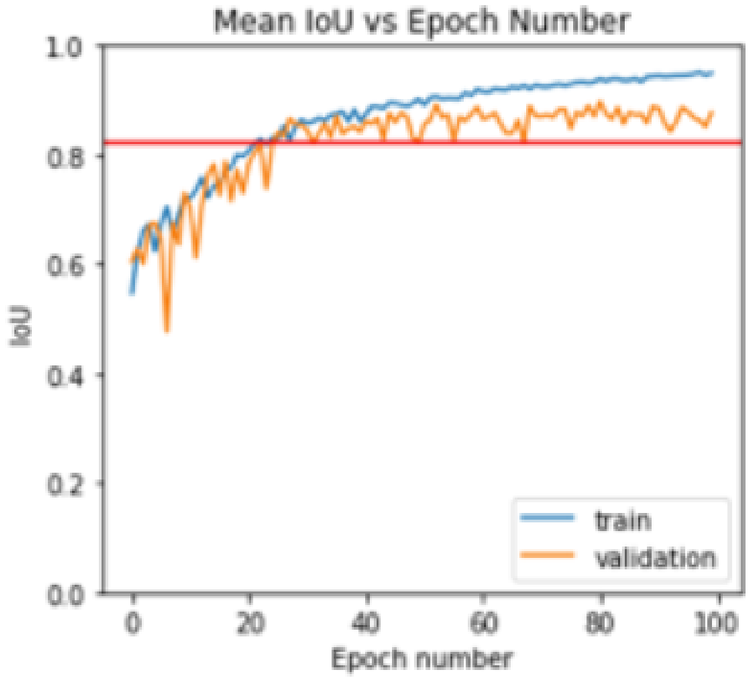
It's a semantic segmentation technique. The model architecture is fairly simple: an encoder for downsampling and a decoder for upsampling with skip connections.



Without Data Augmentation

Train/Validation/Test splits based on Resic-45 dataset only:

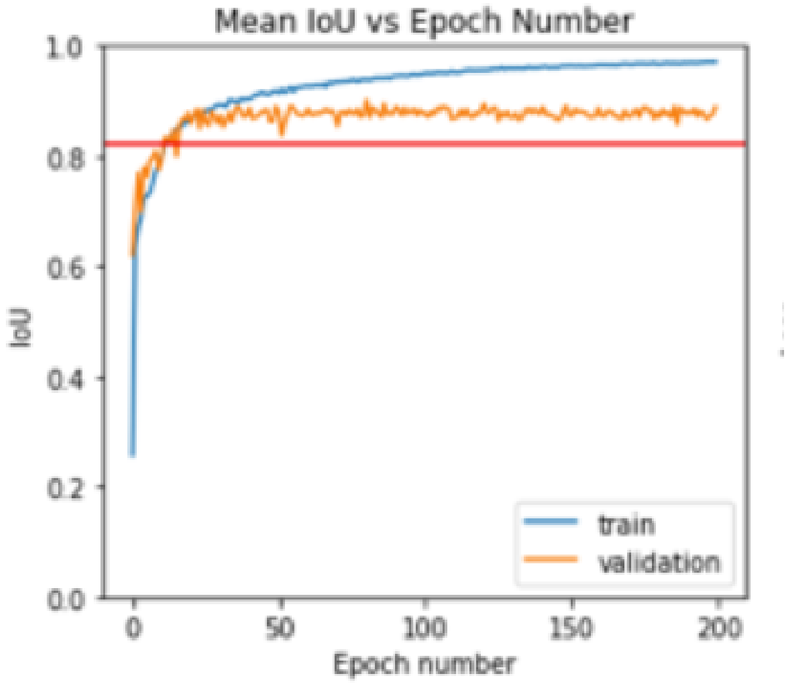
- training set: 489 images.
- validation set: 140 images.
- test set: 71 images.



With Data Augmentation

Train/Validation/Test splits based on Resic-45 dataset only:

- training set: 979 images;
- validation set: 280 images;
- test set: 122 images.

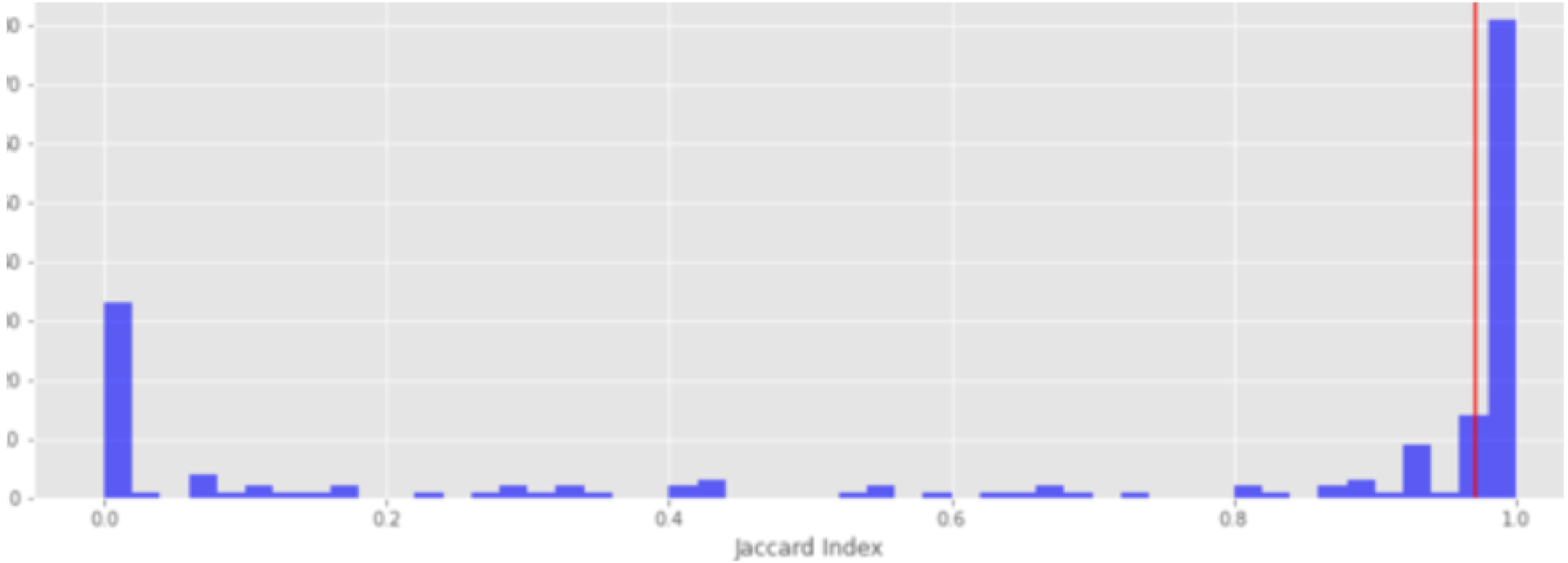


Model Results:

Min: 0.0000

Meadian:0.9715

Max:1.0000



Water level prediction

Select a water body and the desired year.

Burdur, Turkey

2018

Mask Opacity:

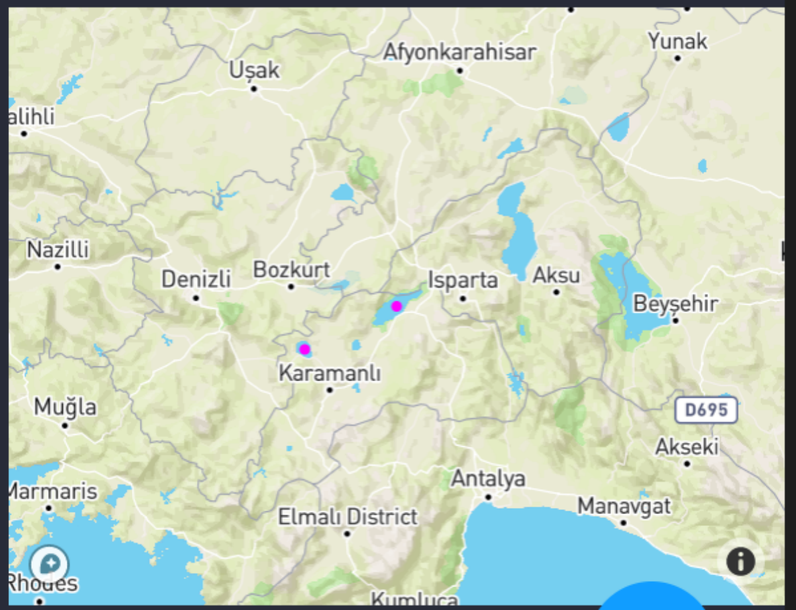
0.2 0.4 0.6 0.8

Design by: iiitdwd- final year (mini project)

Model Prediction

Surface Area (square kilometer)

Geolocation



Water Surface (%)

Thank you!

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