Water Assessment based on AI-driven Multispectral Imaging

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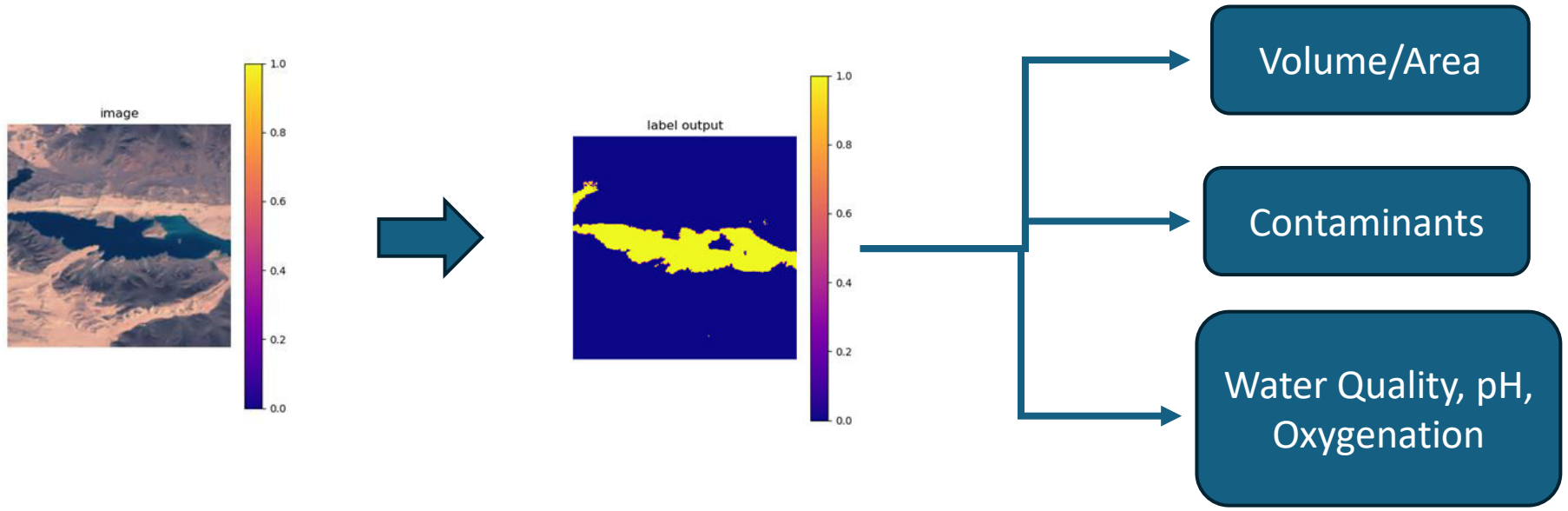
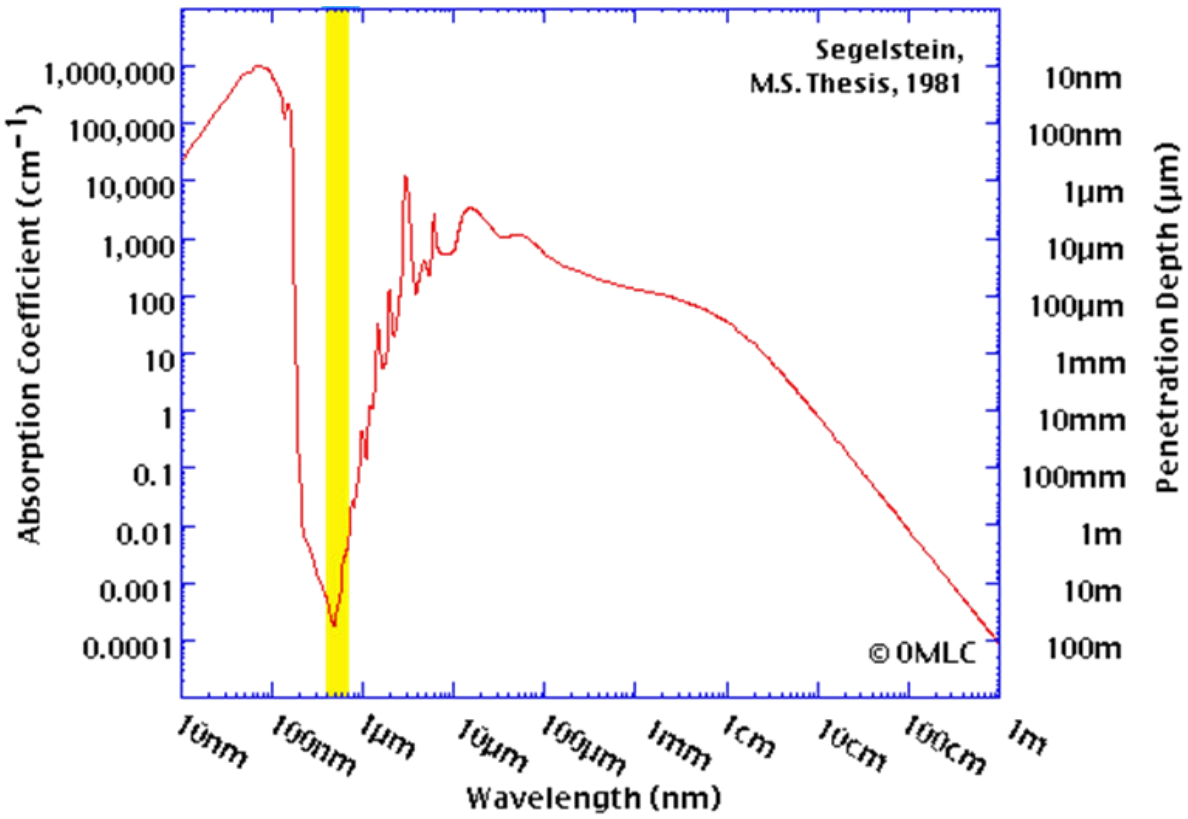
Objectives

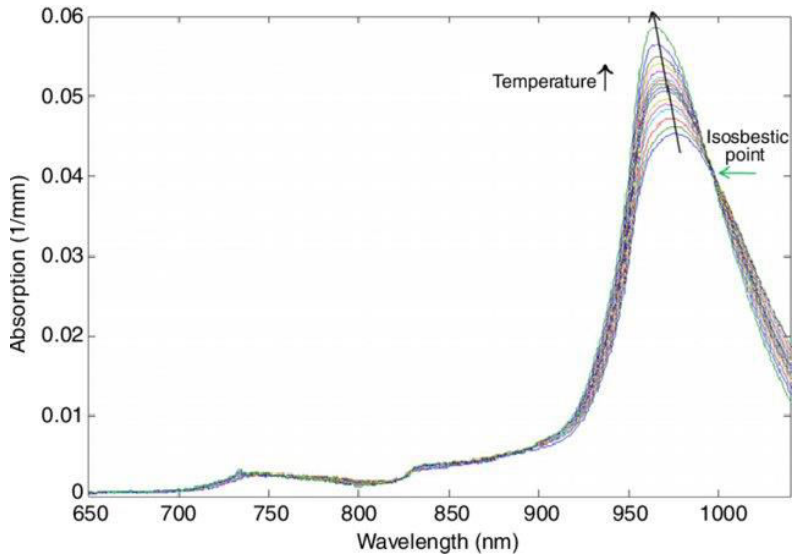
Propose AI-based Image Analysis for

- Body of water identification and segmentation
- Water quality analysis and quantifications



Water Absorption Spectrum

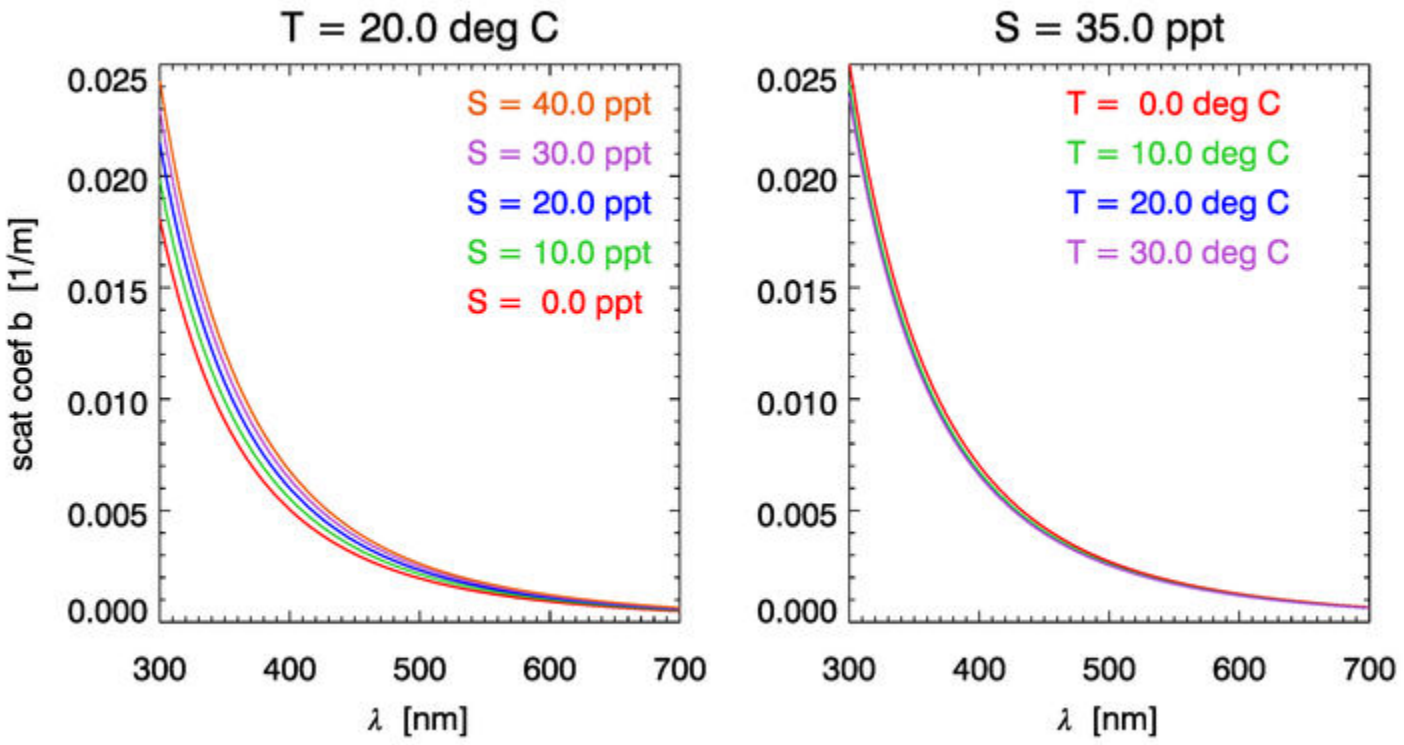




Pure water absorption spectra measured as a function of temperature (15-65 • C). The water peak around 970 nm increases in intensity, narrows in width and blue-shifts in wavelength as temperature increases. An isosbestic point at 996 nm is observed

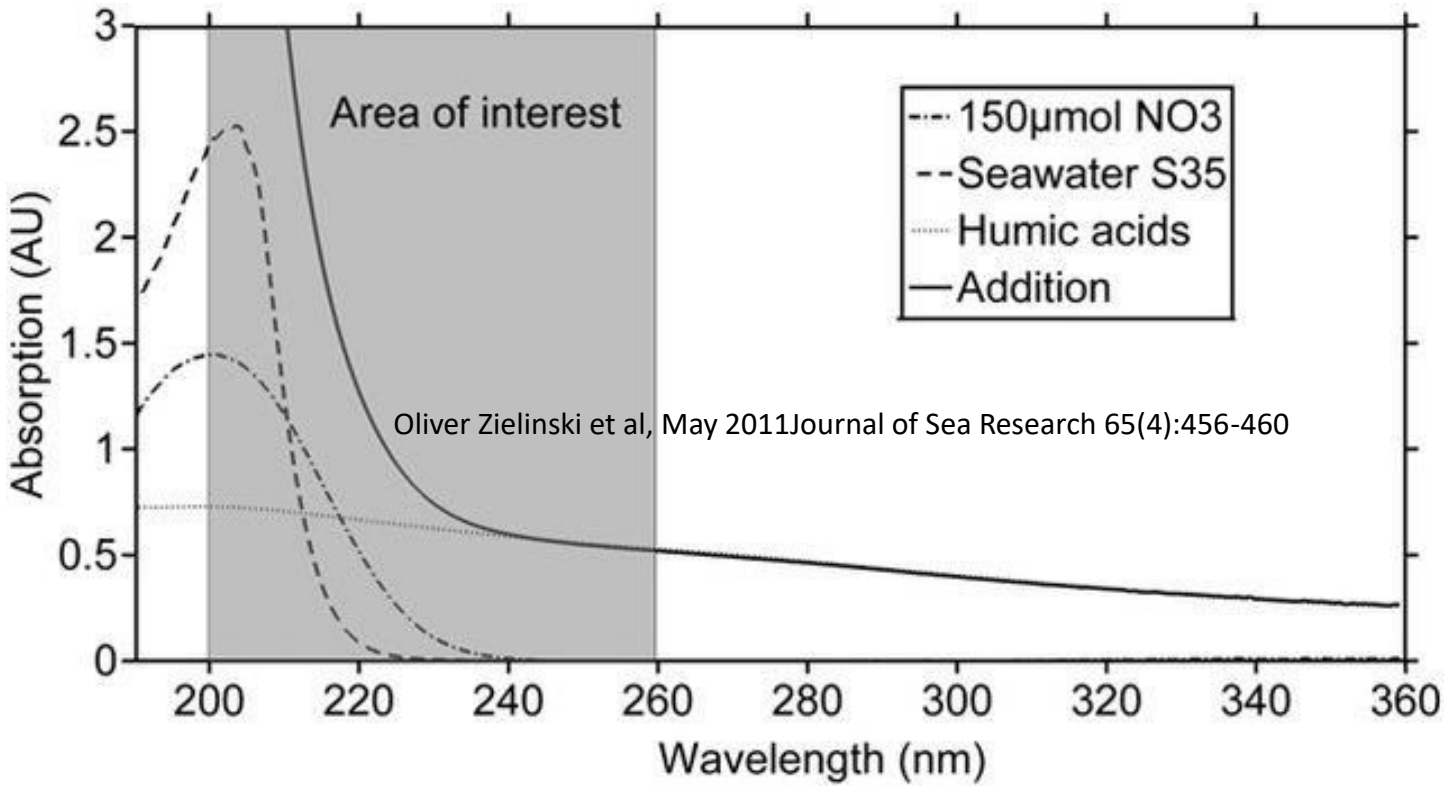
Copied from So Hyun Chung et al, Jul 2010 Physics in Medicine & Biology 55(13):3753-65

Water Salinity and Temperature



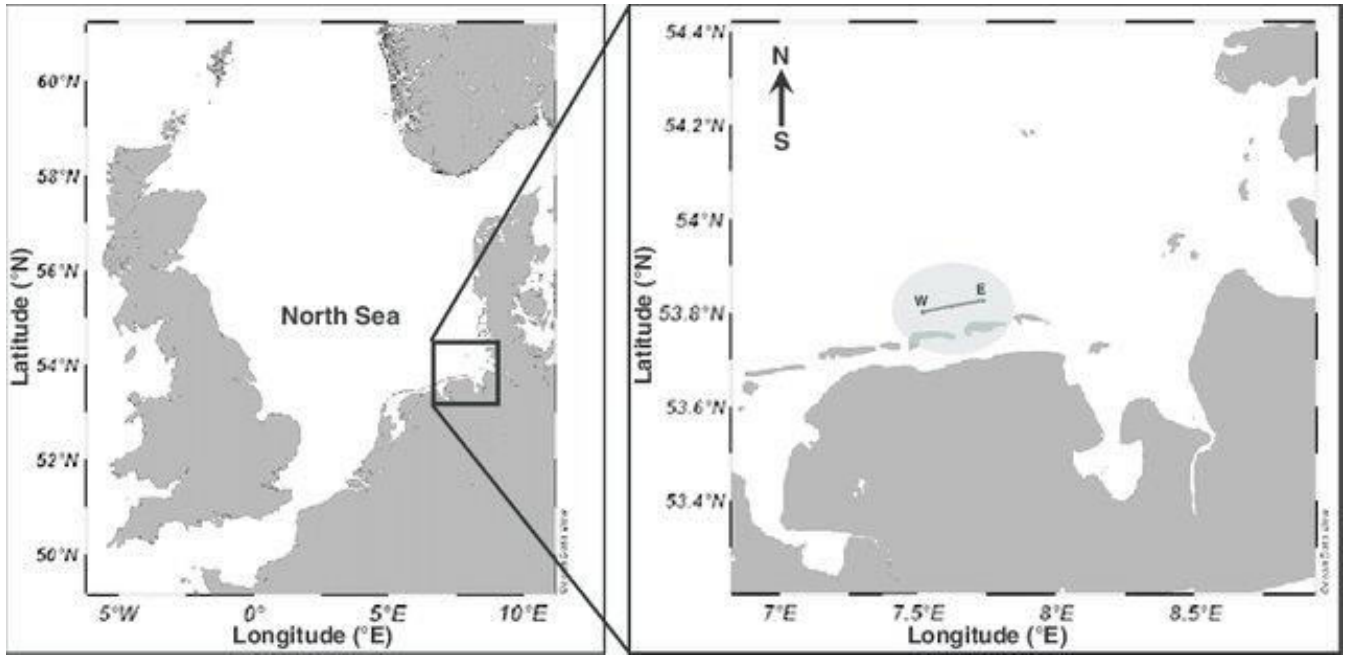
Dependence of the water scattering coefficient on temperature and salinity according to Zhang et al. (2009).

Water Contaminants and UV Spectrum

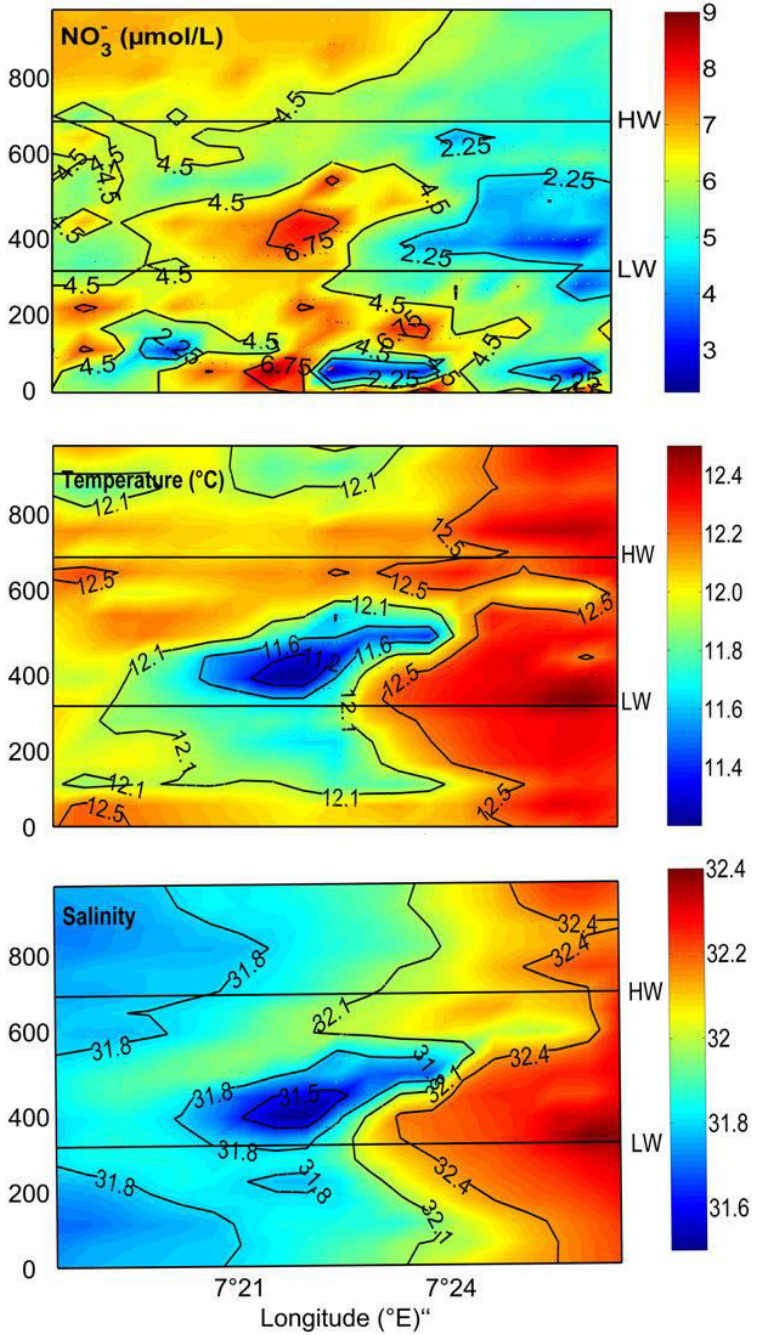


UV-spectrum of seawater. Principle absorption spectra of NO3−, seawater (salinity35) and humic acids, representing CDOM. Spectra are added up, resulting in a sumspectrum (solid line).

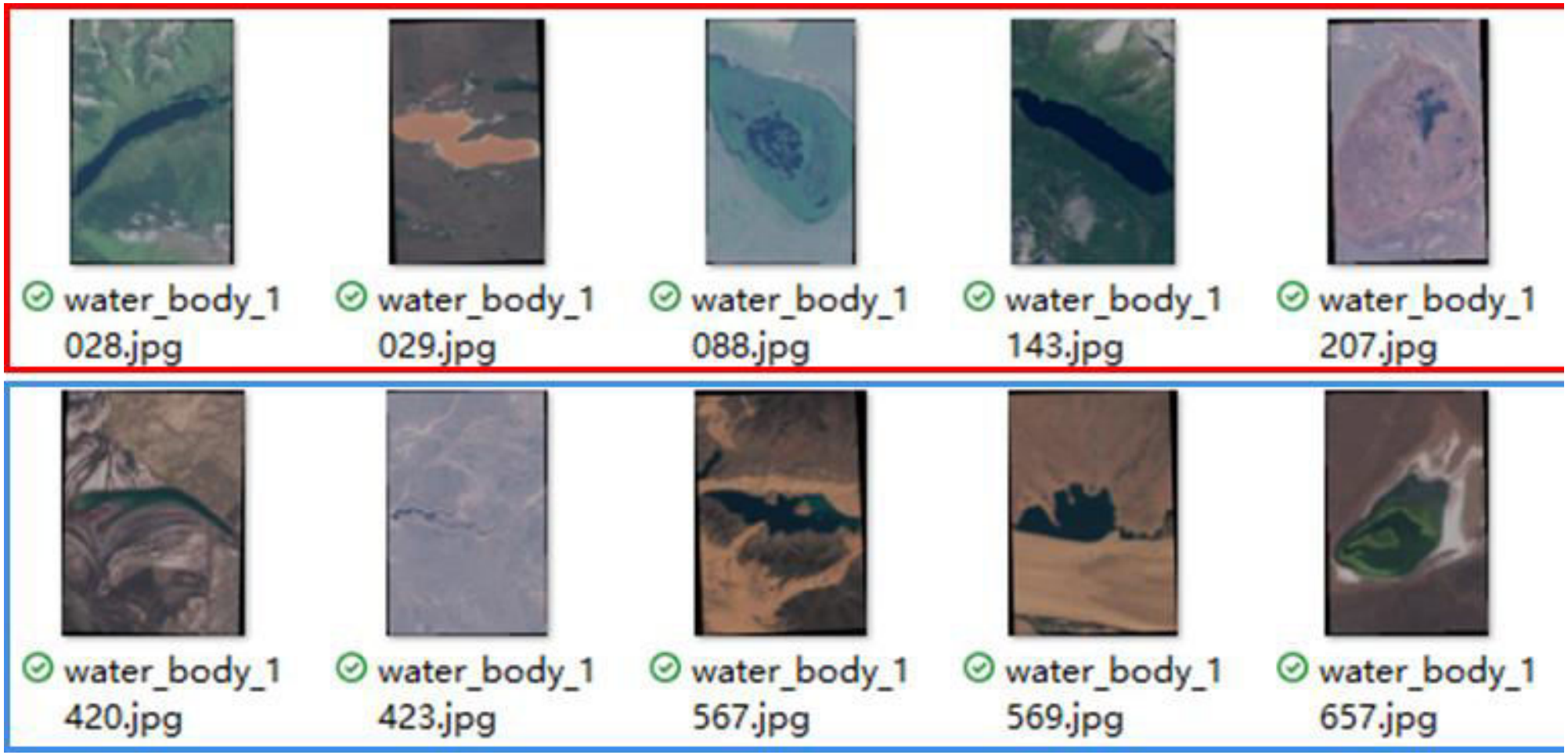
Example of a Boby of Water Analysis



Observation area. Map of the study site situated in the southern North Sea (left). The detailed map (right) shows the observed area, north of the Wadden Sea in the German Bight

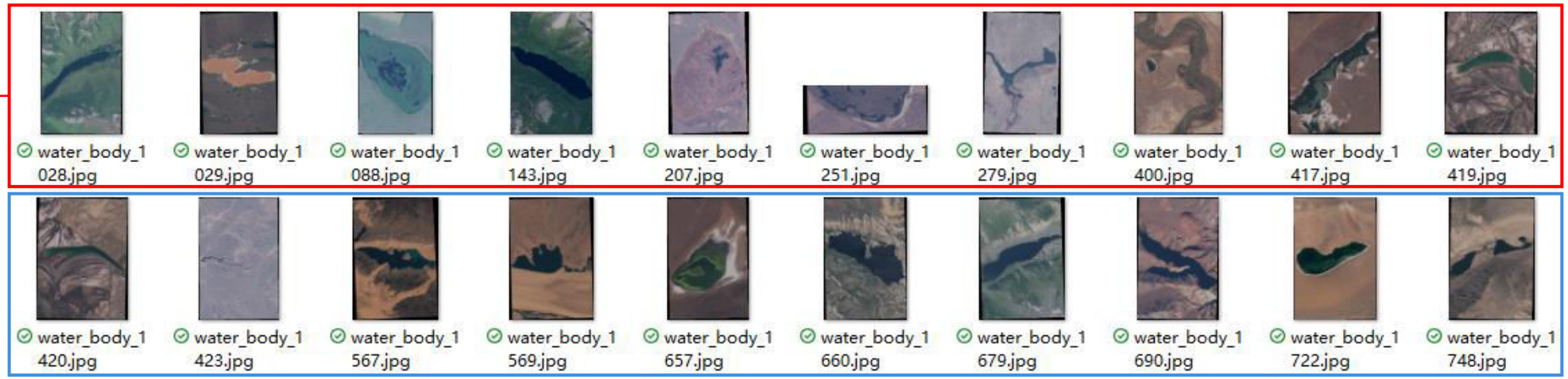


Satellite Images of Water Bodies



https://www.kaggle.com/datasets/franciscoescobar/satellite-images-of-water-bodies

Analysis of the Satellite Images of Water Bodies-Dataset



for Training

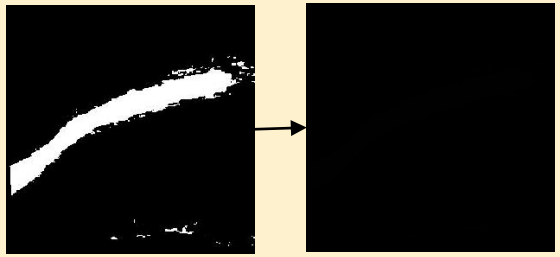
for Testing

Preprocessing Steps of Training Dataset

1. Original Image & Mask

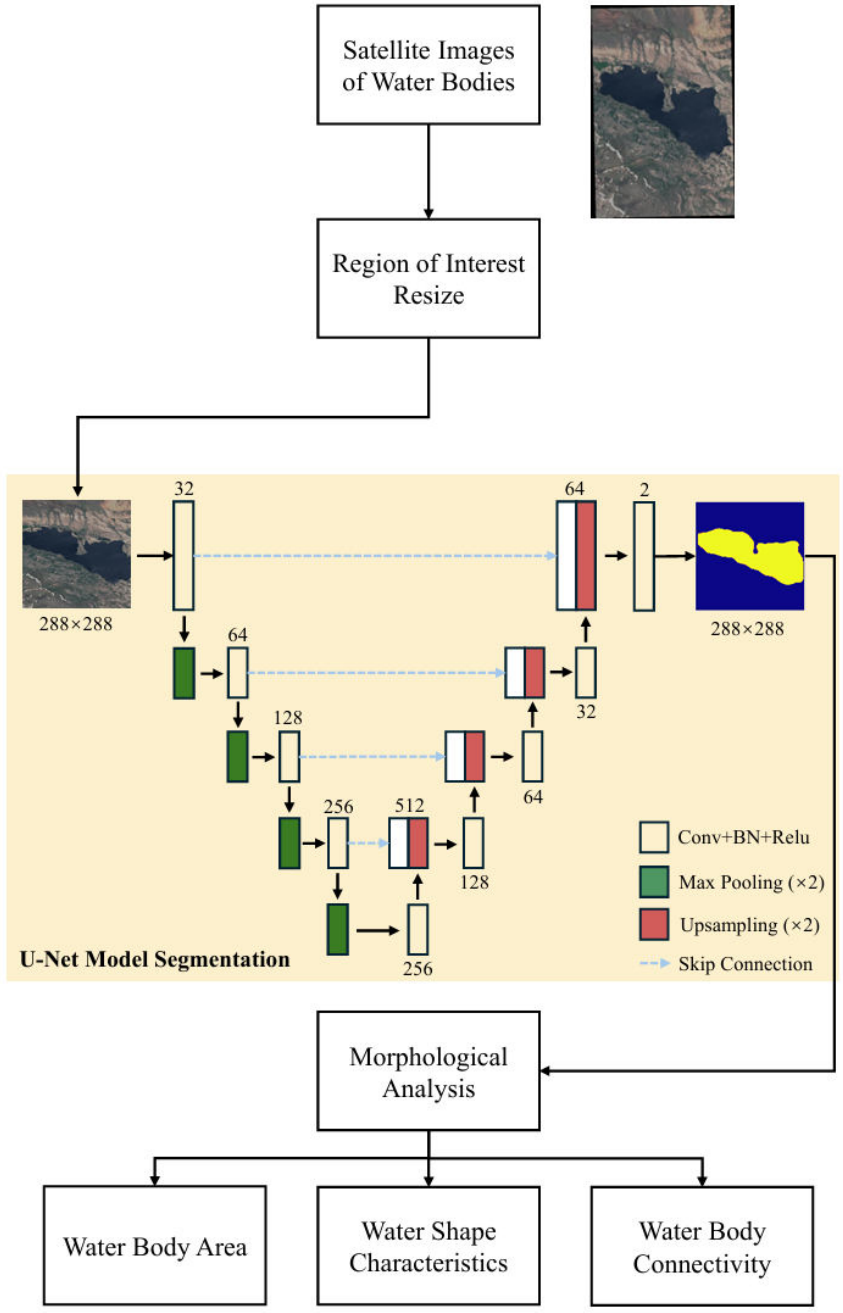
2. Resized Image & Mask

3. Data Augmentation (from 10 to 50 images)

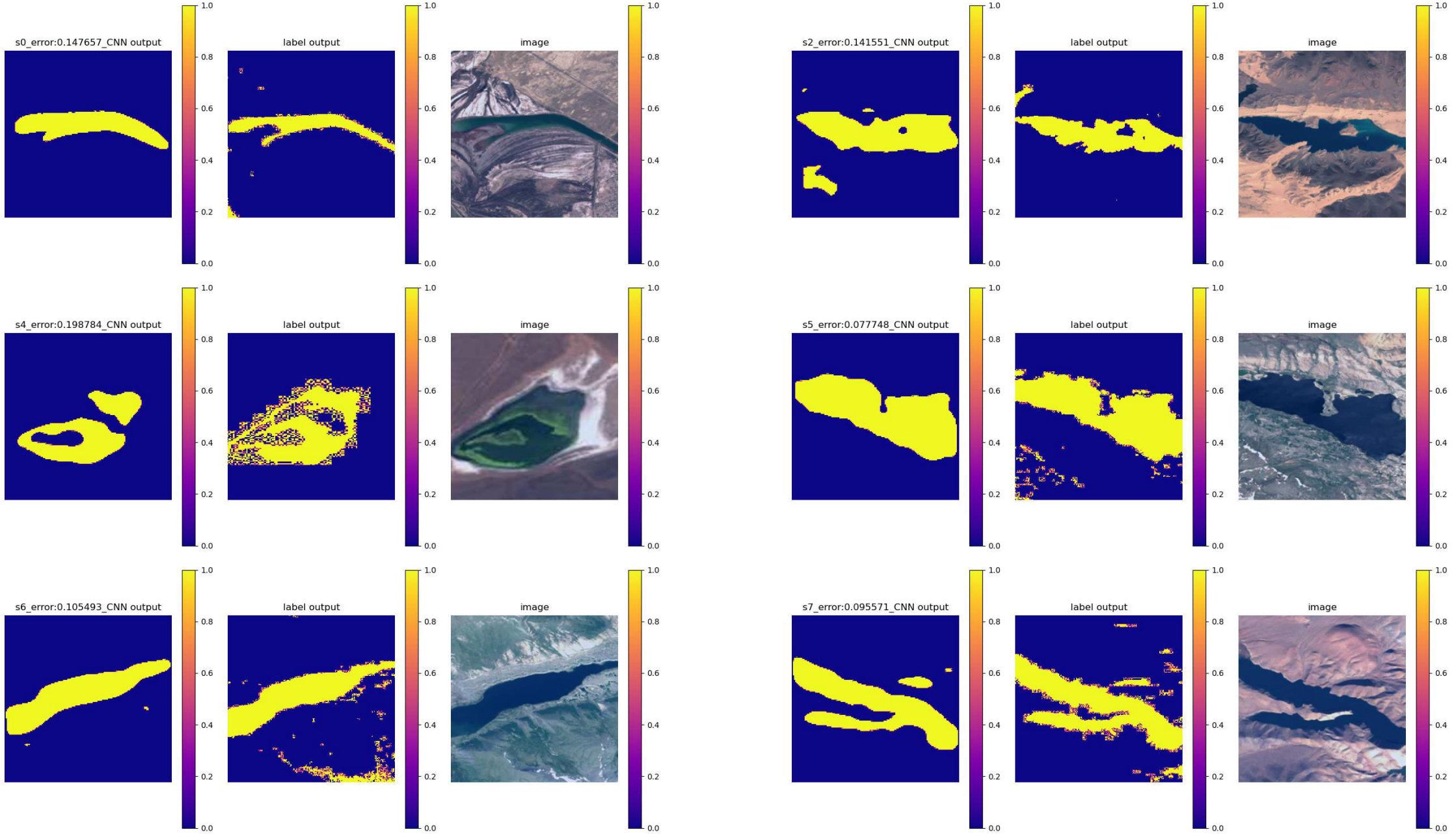


4. Binary Mask Generation (0 & 1)

Analysis of the Satellite Images of Water Bodies-Flowchart



Analysis of the Satellite Images of Water Bodies-Result



Analysis of the Satellite Images of Water Bodies-Morphological Analysis

Assume pixel resolution = 1 (1 pixel = 1 meter square)

```
Total water area: 8845.00 square meters
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Main Water body region 1:
Area: 8845.00 square meters
Aspect ratio: 5.61
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Number of total water body regions: 3
Number of isolated water bodies: 1
```
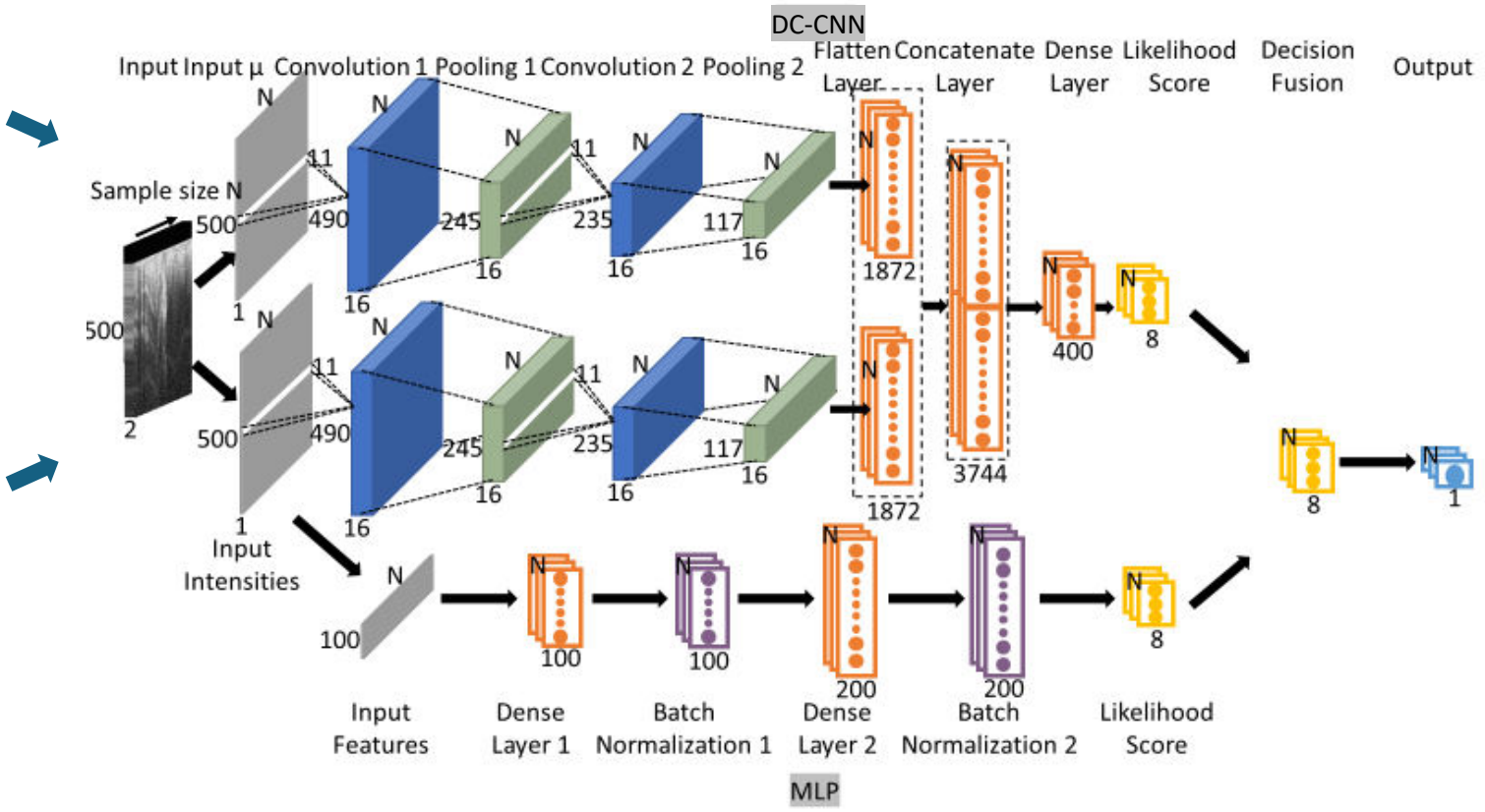

Hybrid multilayer perceptron dual-channel convolutional neural network (MLP-DC-CNN) classifier

Intensity Image

Spectra



Input feature vector of multilayer perceptron model

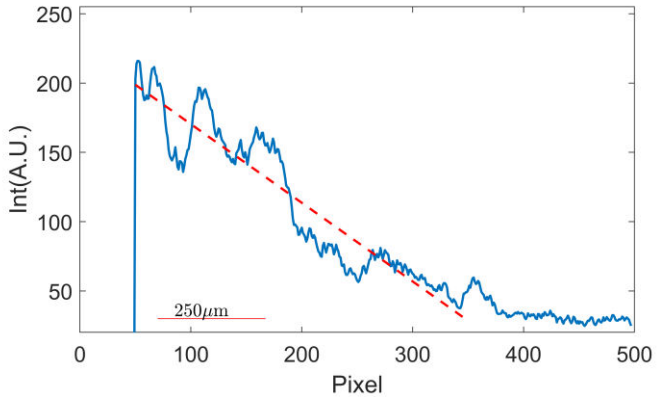
Global Features (180)

Local Features (1680)

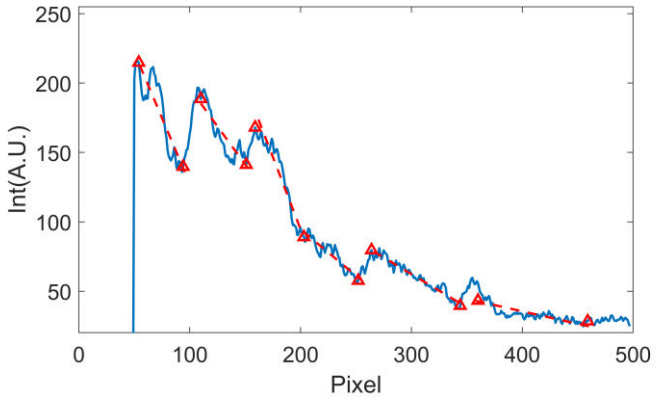
Crossing Intermediate Features (94)

Average Backscattering Terms (1)

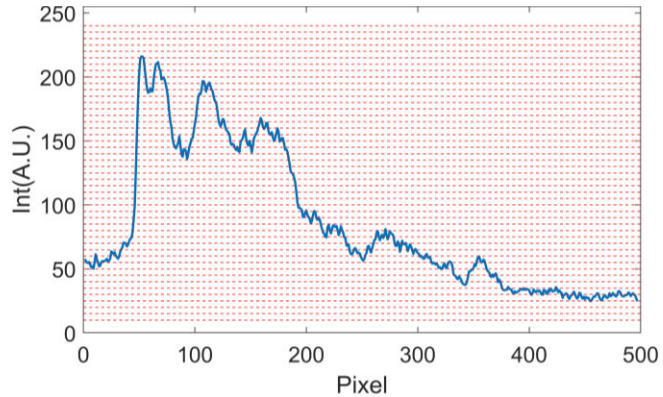
Minimum Redundancy Maximum Relevance (mRMR) algorithm → Input Features (100)



Calculation of global features



Calculation of local features

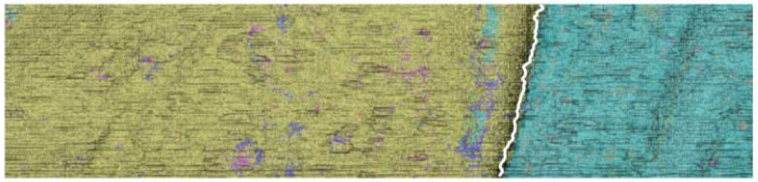


Calculation of crossing intermediate features

Boundary and labeling accuracy

The comparative results of different models on test dataset

Methods	Accuracy	Precision	Specificity	F1	AUC
MLP	0.8636	0.8472	0.9782	0.8310	0.9827
Atten-based 1C-CNN	0.8605	0.8270	0.9731	0.8293	0.9817
Intensity-based 1C-CNN	0.8578	0.8184	0.9718	0.8269	0.9825
Dual Channel(DC)-CNN	0.8787	0.8503	0.9772	0.8511	0.9860
MLP-DC-CNN (ours)	**0.9006**	**0.8834**	**0.9828**	**0.8781**	**0.9862**



Summary

Deep Learning can be used to accurately identify bodies of water and analyze their characteristics such as size, temperature, salinity and contaminants