

# Tourist boats traffic

## Problem description

Recreational ecosystem services are essential for human well-being and often support local economies through nature-based tourism. Monitoring these activities, specifically small recreational boat traffic on lakes, is crucial for sustainable regional development. However, traditional methods of monitoring, such as field surveys, are often labor-intensive and may not provide comprehensive spatial and temporal coverage. Remote sensing offers a promising alternative, but detecting small boats (<10m) on lakes remains challenging due to factors like image resolution and environmental conditions.

## Proposed solution

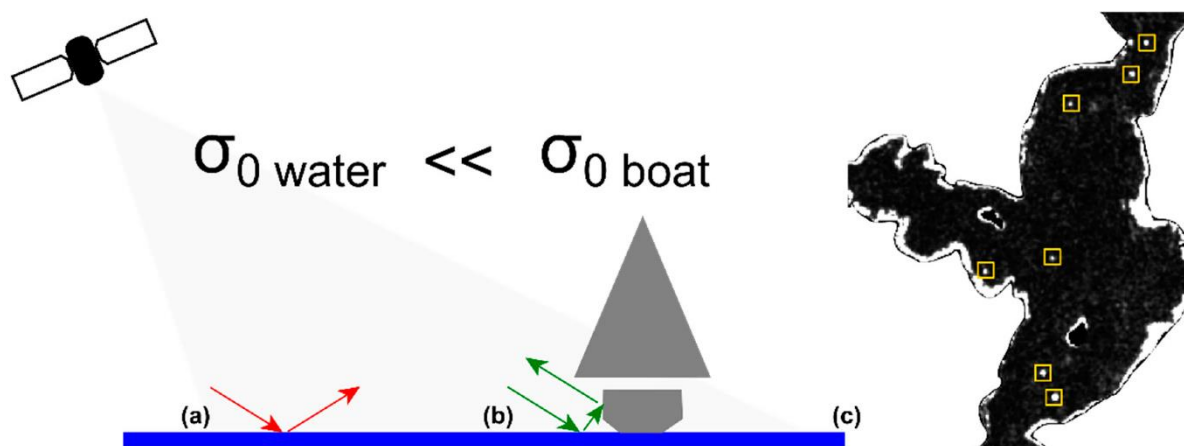


Fig 1. Boat detection method: (a) a single specular bounce from the water, (b) a double bounce from the boat, and (c) a sample radar satellite image (yellow squares represent boats). Total burned area (BA) in years 2002 - 2021 classified using MODIS surface reflectance images.

A novel method for detecting small recreational boats using Sentinel-1 radar images has been developed. This approach leverages satellite-based radar data to monitor boating activities, providing a comprehensive and efficient alternative to traditional methods.

The method involves analyzing Sentinel-1 radar images, which are captured over the Great Masurian Lake District in Poland, a region well-known for its recreational boating. The detection process utilizes a sophisticated algorithm comprising adaptive thresholding and mathematical morphology operators. Adaptive thresholding is employed to differentiate boats from the surrounding water in the radar images, while mathematical morphology operators enhance the detection accuracy.

The detection algorithm has been meticulously validated, achieving an impressive overall accuracy rate of 88.17%. This high level of accuracy was corroborated through a validation process involving field data, where the results showed a strong correlation coefficient of 0.76. This validation underscores the method's robustness and reliability, confirming its potential as a viable tool for monitoring recreational boating activities.

## Main features

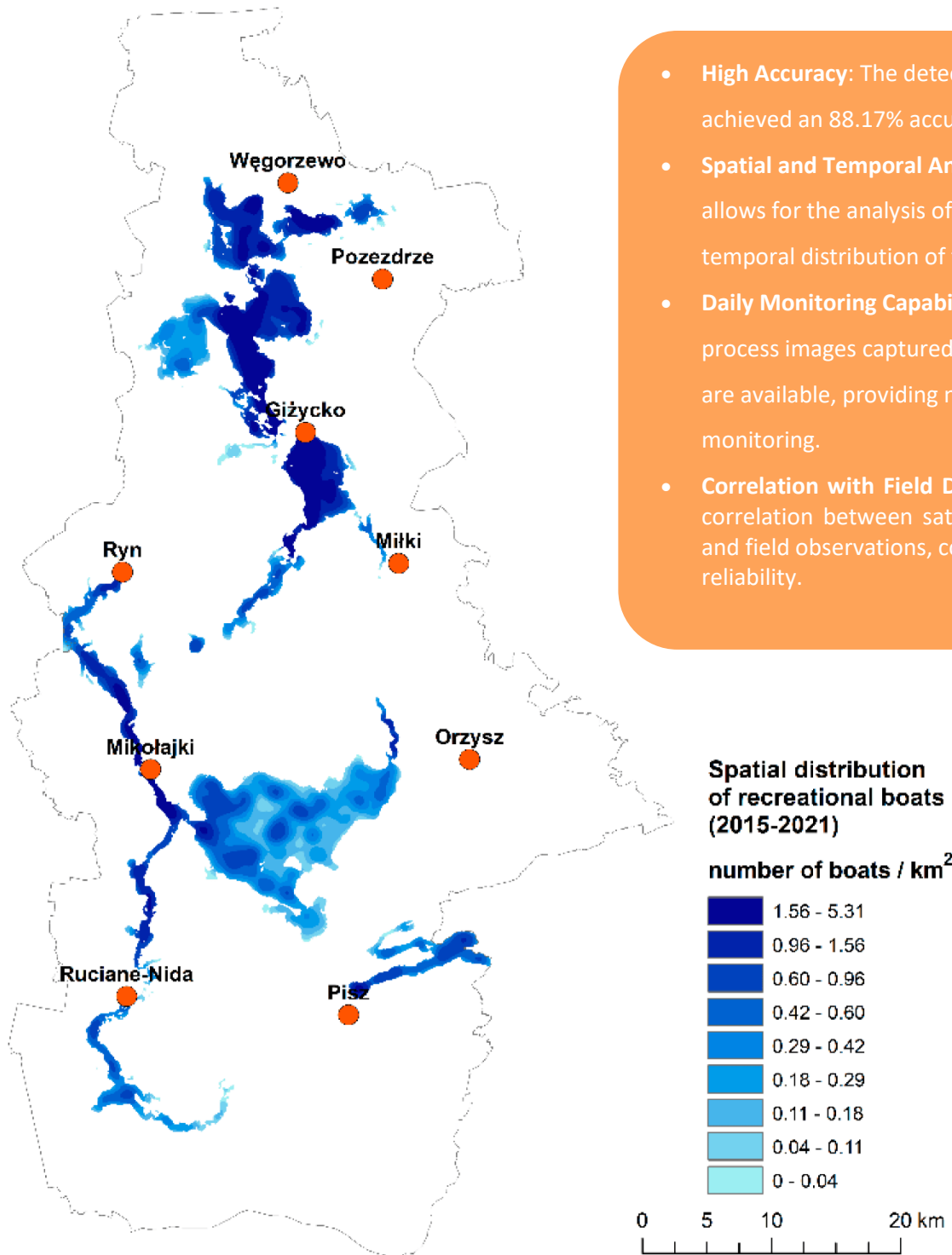


Fig 2. Spatial and temporal distribution of detected recreational boats for the period 2015–2021.

- **High Accuracy:** The detection algorithm achieved an 88.17% accuracy rate.
- **Spatial and Temporal Analysis:** The method allows for the analysis of both spatial and temporal distribution of tourist boat traffic.
- **Daily Monitoring Capability:** The algorithm can process images captured daily, whenever they are available, providing near real-time monitoring.
- **Correlation with Field Data:** There was a 0.76 correlation between satellite-based detections and field observations, confirming the method's reliability.

## References

Detailed description of proposed algorithm can be found in the paper:  
Ruciński M., Woźniak E., Kulczyk S., Derek M. Small Recreational Boat Detection Using Sentinel-1 Data for the Monitoring of Recreational Ecosystem Services. Remote Sensing (2023). DOI: [10.3390/rs15071807](https://doi.org/10.3390/rs15071807)