

Ao Chen¹, Jialu Yu², Junbo Zhang^{1,3,*}, Gangyi Yu¹ and Rong Wan^{1,3,*}

¹Shanghai Ocean University, Shanghai 201306, China

²Shanghai Fisheries Research Institute, Shanghai Fisheries Technical Extension Station, Shanghai 200433, China

³National Engineering Research Center for Oceanic Fisheries, Shanghai 201306, China

 jb_zhang@shou.edu.cn; rongwan@shou.edu.cn

1. Abstract

This study proposes a new model (MROIC) for the accurate extraction of coastal fish cage and raft information from satellite imagery, crucial for understanding mariculture patterns. Integrating spatial-spectral enhancement (SSE) and object-based image analysis (OBIA), the MROIC model leverages advanced techniques to achieve robust classification in complex environments, even under the influence of clouds and vessels. Demonstrating high extraction accuracy (90.43% and Kappa 0.80), the MROIC model offers significant technical support for government planning, risk assessment, and management efficiency in fishery facility areas.

2. Study Areas



Sansha Bay, Ningde, Fujian, China

3. Formulas of SEE and OBIA Techniques

$$R1 = \frac{G}{NIR}; R2 = \frac{R}{NIR}; R3 = \frac{NIR-R}{NIR+R}; R4 = \frac{NIR-G}{NIR+G}; R5 = \frac{R-G}{R+G};$$

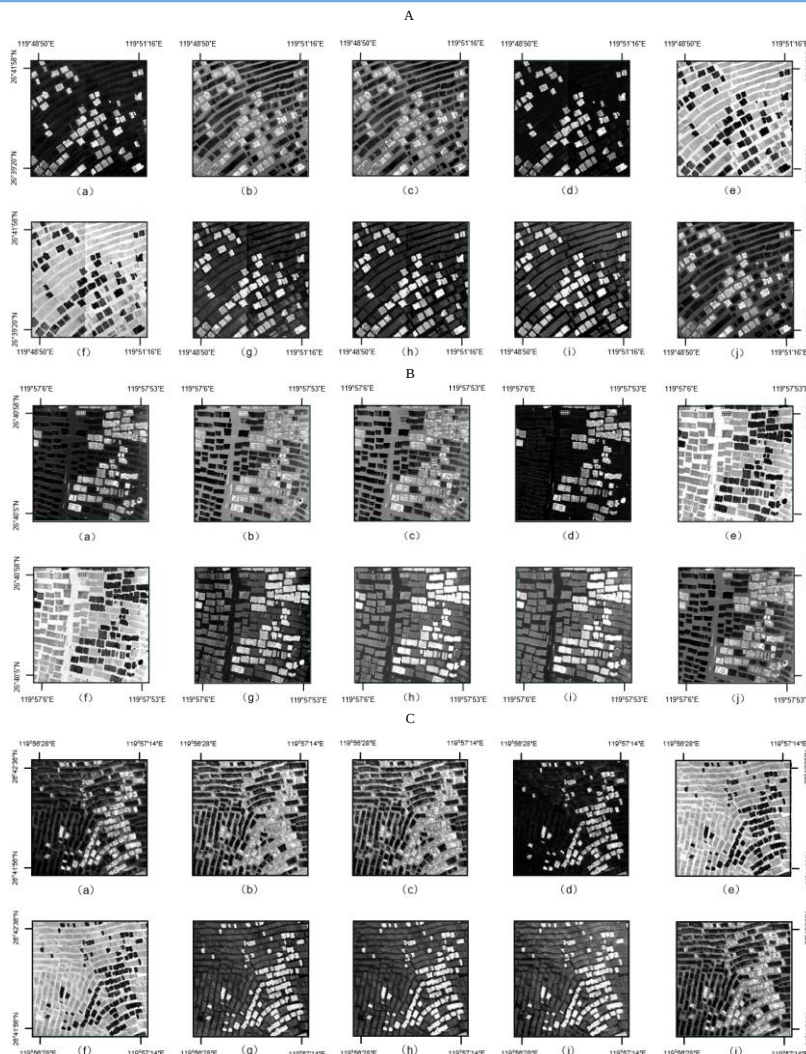
$$R6 = 0.028 \times G + 0.019 \times R - 5.13 \times \frac{R}{G} + 0.537;$$

$$BD = \frac{1}{4} \times \frac{(\mu_1 - \mu_2)^2}{\sigma_1^2 + \sigma_2^2} + \frac{1}{2} \log \left(\frac{\sigma_1^2 + \sigma_2^2}{2\sigma_1\sigma_2} \right);$$

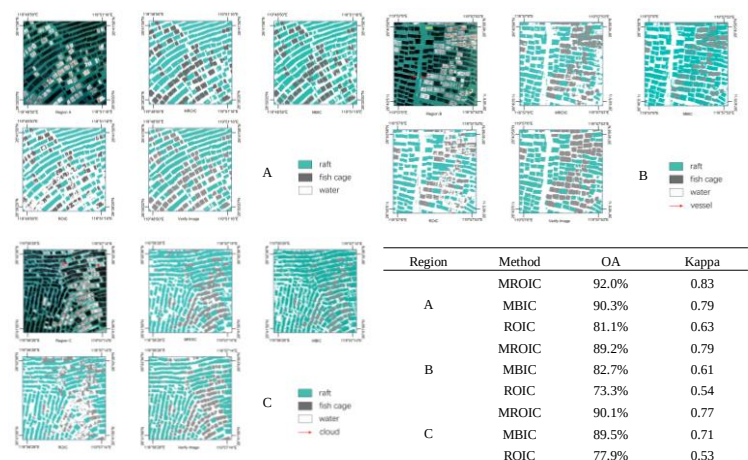
$$t_{ij} = \frac{\frac{|o_i| \times |o_j|}{|o_i| + |o_j|} \|U_i - U_j\|^2}{L}; L = \text{length}(\sigma(o_i, o_j));$$

$$U_i = \frac{1}{N_i} \sum_{k=1}^N P_i(k); U_j = \frac{1}{N_j} \sum_{k=1}^N P_j(k)$$

4. SEE Results



5. OBIA Classification Results



6. Discussion and Conclusion

- The SEE results show that bands R1–R6 enhance color saturation, target distinction, and image layering, with the green and NIR-derived R4 band proving most effective in identifying fishery facilities and mitigating vessel and cloud interference. The OBIA results demonstrate clear boundary delineation and reduced noise, effectively capturing the spatial structure and geometric characteristics of fish cages and rafts.
- The MROIC model, integrating SEE and OBIA, accurately extracted fish cage and raft information from GF-2 satellite imagery in Sansha Bay. The model demonstrates high extraction accuracy (90.43% overall, Kappa 0.80) and low errors, providing a robust tool for coastal fishery facility management in complex environments.

7. References

- Long et al. Offshore aquaculture in China. Review in Aquaculture. 2023. <https://doi.org/10.1111/raq.12837>.
- Cheng et al. Research on a novel extraction method using Deep Learning based on GF-2 images for aquaculture areas. International Journal of Remote Sensing. 2020. <https://doi.org/10.1080/01431161.2019.1706009>.
- Zhang et al. Coastal Oyster Aquaculture Area Extraction and Nutrient Loading Estimation Using a GF-2 Satellite Image. Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 2020. <https://doi.org/10.1109/JSTARS.2020.3016823>.