

An Integrated Geospatial Framework for Sustainable Aquaculture Monitoring and Development

Loucel Cui¹, *Decibel Villarisco Faustino-Eslava¹, Moises Dorado², Danilo III Gonzales¹, Rosemarie Laila Areglado-Dimasuay¹, Ericha Montecillo-Amante¹, Donald Luna¹, Sofia Alaira¹, Concepcion Khan³, Maria Regina Regalado¹, Leo Neil Viado²

1. School of Environmental Science and Management, University of the Philippines Los Baños, Philippines, 2. Institute of Agricultural and Biosystems Engineering, College of Engineering and Agro-industrial Technology, University of the Philippines Los Baños, Philippines, 3. Institute of Computer Science, College of Arts and Sciences, University of the Philippines Los Baños, Philippines

Aquaculture is a critical component of food security, livelihoods, and regional economic development in the Philippines, yet its effective management is constrained by the limited availability of spatially explicit and up-to-date information. This study demonstrates an integrated geospatial framework for nationwide aquaculture monitoring, with a pilot application in three municipalities in Quezon Province. Freely available satellite data from Sentinel-1 (SAR), Sentinel-2 (MSI), and Landsat missions were combined with GIS-based analysis and manual digitization to map aquaculture ponds and cage structures and to assess temporal changes in their spatial extent.

Satellite-derived products were further used to generate high-resolution spatial indicators of water quality, including surface water temperature, turbidity, and chlorophyll-a concentration. Results reveal pronounced spatial variability in these parameters across aquaculture sites, underscoring the influence of localized environmental conditions and the need for site-specific management interventions. The integration of multi-sensor remote sensing data with field observations provides a cost-effective, scalable, and repeatable approach for monitoring aquaculture systems, particularly in data-limited settings.

The proposed framework supports evidence-based decision-making, strengthens policy and regulatory planning, and enhances the capacity of local communities and institutions to respond to environmental variability and climate-related pressures. By demonstrating the utility of integrated geospatial systems for aquaculture assessment, this study contributes to advancing sustainable aquaculture development at both local and national scales.

Keywords: aquaculture, remote sensing, GIS, Philippines