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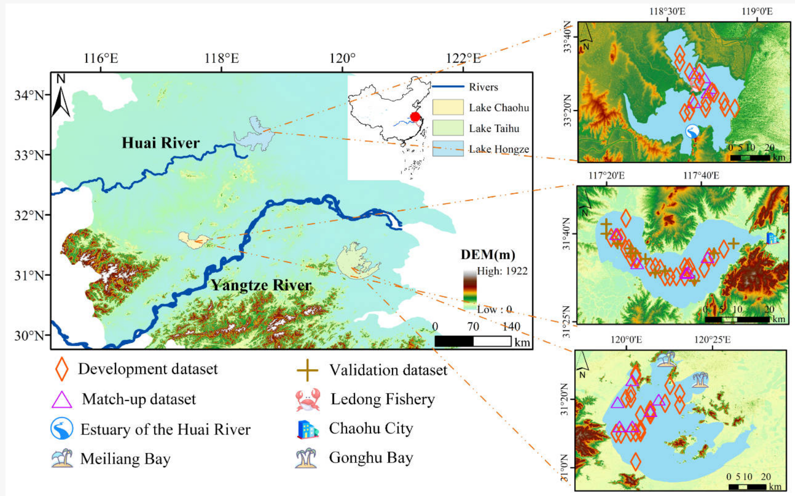
How satellites can save our lakes

GA, UNITED STATES, March 1, 2025 /EINPresswire.com/ -- Since the Holocene epoch, global changes have been remarkable and human activities have been intense. The lake environment in China has undergone drastic changes, with frequent algal blooms. A new remote sensing algorithm has been developed to significantly enhance the accuracy of algal biomass monitoring in lakes. By integrating satellite data with field measurements, researchers have introduced a novel method that estimates column-integrated algal biomass, offering a more comprehensive view of algal distribution throughout the water column. This advancement addresses the limitations of traditional methods, which typically measure only surface algal concentrations, often missing the full extent of algal biomass. The new algorithm provides a more reliable tool for assessing lake eutrophication and ecological health, enabling better-informed management strategies to mitigate the impacts of algal blooms and improve water quality.



Study areas and sampling locations. Subplots on the right side are Lake Hongze, Lake Chaohu, and Lake Taihu, respectively.

Lakes serve as vital freshwater resources, supplying drinking water, supporting fisheries, and sustaining local economies. Yet, more than half of the world's lakes are impacted by eutrophication—an excessive nutrient buildup that triggers harmful algal blooms, degrades water quality, and threatens aquatic ecosystems. While traditional remote sensing techniques have long been used to monitor these conditions, they often focus solely on surface algal concentrations, overlooking the vertical distribution of algae throughout the water column. This limitation prevents a complete understanding of algal biomass, resulting in incomplete assessments of lake health. Given these challenges, the need for a more precise and comprehensive approach to monitor algal biomass is clear.

On February 4, 2025, a research team from the Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, published an innovative study (DOI: 10.34133/remotesensing.0436) in Journal of Remote Sensing, introducing a new algorithm designed to improve lake algal biomass monitoring. This method overcomes the limitations of conventional remote sensing techniques by providing a more accurate tool for lake ecological management and controlling eutrophication.

The researchers developed a novel three-step framework to estimate algal biomass more precisely. The process begins with the inversion of surface chlorophyll a (Chla) concentrations, followed by estimating the diffuse attenuation coefficient of photosynthetically active radiation [Kd(PAR)]. Finally, a generalized additive model (GAM) is used to estimate column-integrated algal biomass (CAB) based on these initial steps. The method was validated using data from three major lakes in China—Taihu, Chaohu, and Hongze—and demonstrated impressive results. The root mean square error (RMSE) values were significantly lower than those of existing methods, with RMSEs of 8.21, 3.90, and 5.09 mg/m^2 for Taihu, Chaohu, and Hongze lakes, respectively. Furthermore, the study revealed that the peaks of total algal biomass (Btot) do not always align with surface Chla peaks, emphasizing the importance of considering the entire water column for accurate assessments.

To achieve these results, the team conducted extensive field sampling campaigns and laboratory analysis to measure Chla concentrations at various depths. They also used high-quality satellite data from the Ocean and Land Colour Instrument (OLCI) to develop and validate their algorithm. By combining these datasets, the researchers produced detailed maps of algal biomass distribution and identified trends over time. This comprehensive approach not only enhances the accuracy of algal biomass estimation but also provides critical insights into the dynamics of algal blooms, paving the way for more effective lake management strategies.

"This study offers a more accurate method for monitoring lake algal biomass and reveals the dynamic changes in algal biomass throughout the water column," said the lead researcher. "This is crucial for lake ecological management and controlling eutrophication. Moving forward, we plan to further refine the algorithm and apply it to more lakes worldwide, contributing to global lake ecological monitoring."

The research team's fieldwork in Taihu, Chaohu, and Hongze lakes included measuring Chla concentrations at multiple depths, combined with satellite-based remote sensing data from OLCI for inversion. By integrating both field data and satellite data, the team successfully developed a column-integrated algal biomass estimation algorithm using a generalized additive model, overcoming the limitations of traditional methods.

The success of this technology offers new opportunities for lake ecological monitoring. With further optimization, the algorithm is poised for global application, helping countries better monitor and manage their lake ecosystems. As remote sensing technology continues to evolve, this algorithm could be integrated with other ecological monitoring techniques, providing more comprehensive support for global water resource protection and ecological governance.

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