Optimal deployment of cultivated land quality monitoring points based on satellite-driven cultivated land quality and improved spatial simulated annealing

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Abstract

The deployment of scientific and reasonable cultivated land quality (CLQ) monitoring points can provide timely and accurate information on the current situation and changes in CLQ, which is highly important to protect national food security. The conventional methods of selecting CLQ monitoring points are based on the CLQ of land use patches. As there may be different grades of large patches, being selected as monitoring points reduces the reliability of monitoring CLQ. Moreover, the conventional monitoring point deployment method mainly considers only CLQ and ignores road accessibility and terrain as factors, resulting in the inaccessibility of some monitoring points. Therefore, to improve the reliability of CLQ monitoring, this study presented a novel approach for deploying CLQ monitoring points. First, the pixel-scale CLQ was estimated using the genetic algorithm-back propagation neural network (GA-BPNN) model based on the Landstat8 data with 30 m spatial resolution. Second, the stratified sampling model was used to determine the optimal sample points. Finally, the improved spatial simulated annealing algorithm (ISSA), considering both slope and road accessibility, was applied to optimize the location of monitoring points. This study was conducted in the Conghua District of Guangzhou, Guangdong Province, China. The results highlighted that (1) compared to the accuracy of measured CLQ, the accuracy (R^2 = 0.63, RMSE = 79.32, and NRMSE = 13.77%) of CLQ estimated using the remote sensing technique was reliable, and the pixel-scale CLQ data was more reasonable than the patch-scale CLQ data with different grades. (2) A total of 132 monitoring points were finally identified in the study area based on the stratified sampling model. (3) When compared with those of the spatial simulated annealing algorithm (SSA) and the standard grid method, the approach proposed in this study had a higher total score (F = 94.61). Moreover, the obtained sample points were mainly located near roads and flat terrain. This can effectively avoid the inaccessible places. Thus, the results based on the novel approach proposed in this study provide a scientific basis and technical support for obtaining the optimal CLQ monitoring points.

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