Improving Estimates and Change Detection of Forest Above-Ground Biomass Using Statistical Methods

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摘要	Forests store approximately as much carbon as is in the atmosphere, with potential to take in or release carbon rapidly based on growth, climate change and human disturbance. Above-ground biomass (AGB) is the largest carbon pool in most forest systems, and the quickest to change following disturbance. Quantifying AGB on a global scale and being able to reliably map how it is changing, is therefore required for tackling climate change by targeting and monitoring policies. AGB can be mapped using remote sensing and machine learning methods, but such maps have high uncertainties, and simply subtracting one from another does not give a reliable indication of changes. To improve the quantification of AGB changes it is necessary to add advanced statistical methodology to existing machine learning and remote sensing methods. This review discusses the areas in which techniques used in statistical research could positively impact AGB quantification. Nine global or continental AGB maps, and a further eight local AGB maps, were investigated in detail to understand the limitations of techniques currently used. It was found that both modelling and validation of maps lacked spatial consideration. Spatial cross validation or other sampling methods, which specifically account for the spatial nature of this data, are important to introduce into AGB map validation. Modelling techniques which capture the spatial nature should also be used. For example, spatial random effects can be included in various forms of hierarchical statistical models. These can be estimated using frequentist or Bayesian inference. Strategies including hierarchical modelling, Bayesian inference, and simulation methods can also be applied to improve uncertainty estimation. Additionally, if these uncertainties are visualised using pixelation or contour maps this could improve interpretation. Improved uncertainty, which is commonly between 30% and 40%, is in addition needed to produce accurate change maps which will benefit policy decisions, policy implementation, and our understanding of the carbon cycle.
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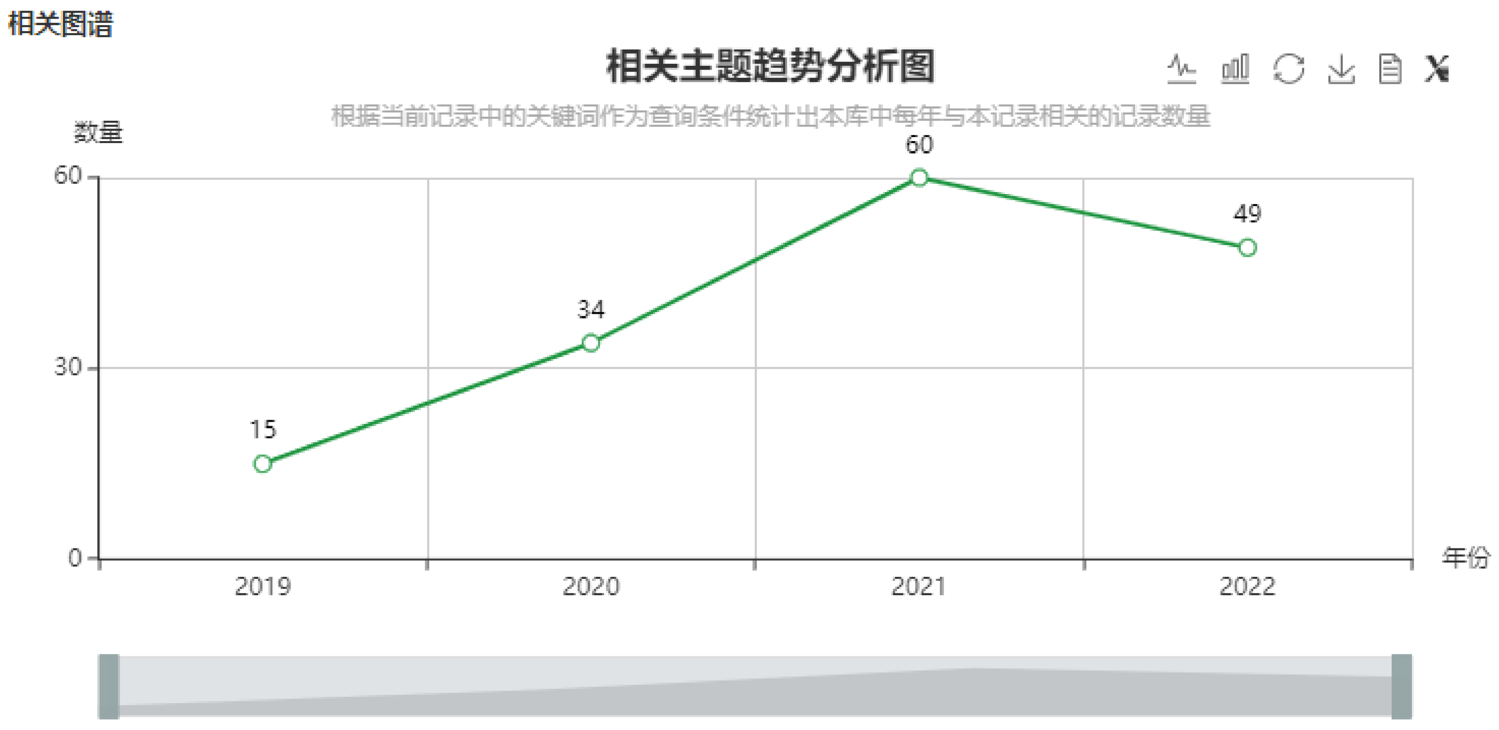

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