Assessment of Carbon Storage from Past and Future Perspectives on Hainan Island, China

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Abstract

Land use changes affect the carbon cycling process in terrestrial ecosystems. As a key conservation area in China, the impact of land use changes on carbon storage (CS) in Hainan Island is not yet known. Revealing the spatiotemporal patterns of CS under land use changes offers a reference for regional carbon management. This study couples the InVEST and GeoSOS-FLUS models to map historical and future CS spatial patterns, integrating optimal parameter geographic detectors and multi-scale geographically weighted regression models to reveal the driving forces of CS spatial pattern. Key findings include: (1) Hainan Island's land use is predominantly cropland and woodland. From 1990 to 2020, construction land increased by 668.25 km ^{2}, extensively encroaching on woodland and cropland, resulting in a cumulative decrease in CS by approximately 229.54×10^4 t, with especially notable declines in rapidly developing coastal regions. (2) Both natural and anthropogenic factors determine the spatial pattern of CS, with natural factors playing a dominant role. The interaction between natural and anthropogenic factors significantly enhances their impact, resulting in both bivariate enhancement and nonlinear enhancement. (3) The expansion of construction land will continue in the future. By 2050, under natural development and rapid development scenarios, CS is projected to decrease by 183.16×10^4 t and 283.09×10^4 t, respectively. However, in the ecological protection scenario, restrictions on the expansion of construction land and an increase in woodland areas will result in a carbon storage increase of 87.66×10^4 t. In the future land use planning for the Hainan free trade port, it is crucial to enhance the protection of key ecological areas such as the central mountainous regions and nature reserves, optimize the land-use pattern, strictly control the conversion of woodland and cropland to construction land, improve carbon sequestration capacity, and achieve regional sustainable development.

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