A study on the simulation and prediction of land use change and carbon storage in Beijing under multiple scenarios based on the PLUS-InVEST model

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Introduction

Global warming has led to an increase in the frequency of extreme weather and climate events, posing a serious threat to human survival and development. Land use/cover change is the second largest source of carbon emissions and directly affects the carbon storage balance of terrestrial ecosystems. In this study, we used the PLUS-InVEST model to analyze the characteristics and driving mechanisms of land use change in Beijing from 2000 to 2020, taking Beijing as an example. Based on this analysis, we projected the spatial pattern of land use in Beijing in 2030 under the natural evolution scenario (NES) and ecological protection scenario (EPS). Then, we analyzed the impacts of land use/cover changes on carbon storage in terrestrial ecosystems from 2000 to 2020, and the spatial and temporal differences in carbon storage under different scenarios in 2030. This provides theoretical support for optimizing the land use structure and achieving carbon neutrality in Beijing in the future, and has important practical implications for guiding future urban planning and development trend.

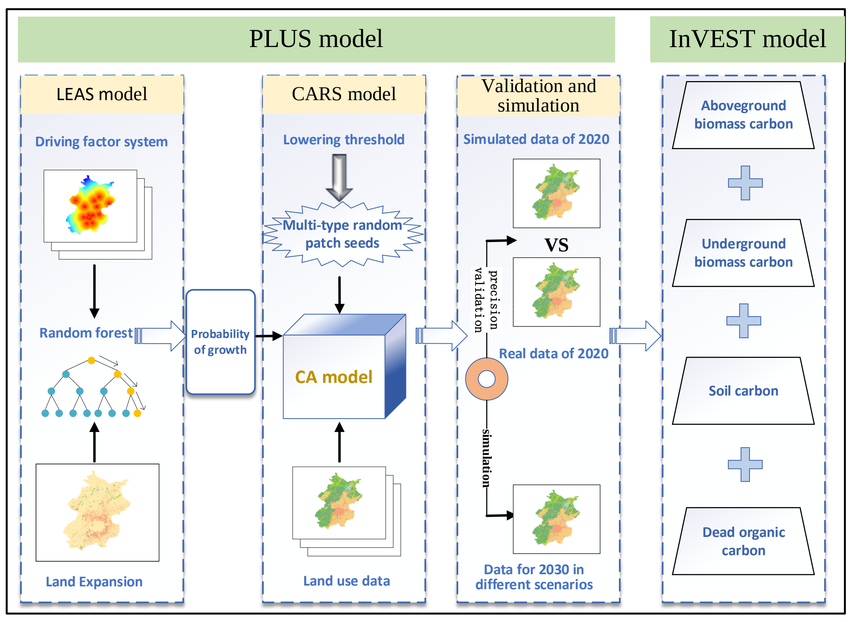


Figure 1. Graphical abstract.

Materials and Methods

Study Area

Beijing is the capital of China and an important political center of China. The center of Beijing is located at 116°20′ East longitude and 39°56′ North latitude. Beijing is located in the northern part of the North China Plain, The average elevation of Beijing is 43.5 m，showing a general topographic feature of towering in the northwestern part and low and gentle in the southeastern part.

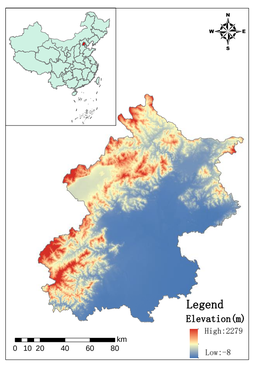


Figure 2. Location and DEM in Beijing.

Table 1. Data description table.

Type	Name	Source	Original Resolution
Natural environment data	Land use data	https://www.resdc.cn	30 m
	NDVI		
	Average annual rainfall		1000 m
	Average annual temperature		
	Soil type		-
	DEM	http://www.gscloud.cn	30 m
	Slope	-	
Socio-economic data	Population density	https://www.worldpop.org/	100 m
	GDP	https://www.resdc.cn	1000 m
	Roads, train stations, water systems, etc.	https://www.openstreetmap.org/	-

Data and Preprocessing

The geographic coordinate system of all data used in this study is set to GCS_WGS_1984, the spatial datum is WGS1984_UTM_ZONE_50N, and the spatial resolution is 30m×30m.

Methods

(1)The historical characteristics of land use changes in Beijing during 2000-2020 were studied.

(2)Analysis and simulation of land use changes in Beijing.

(3)The spatial distribution of land use in Beijing in 2030 is predicted under the NES and EPS.

(4)Using the InVEST model, the influencing factors and mechanisms of carbon stock changes under different scenarios were analyzed.

Results

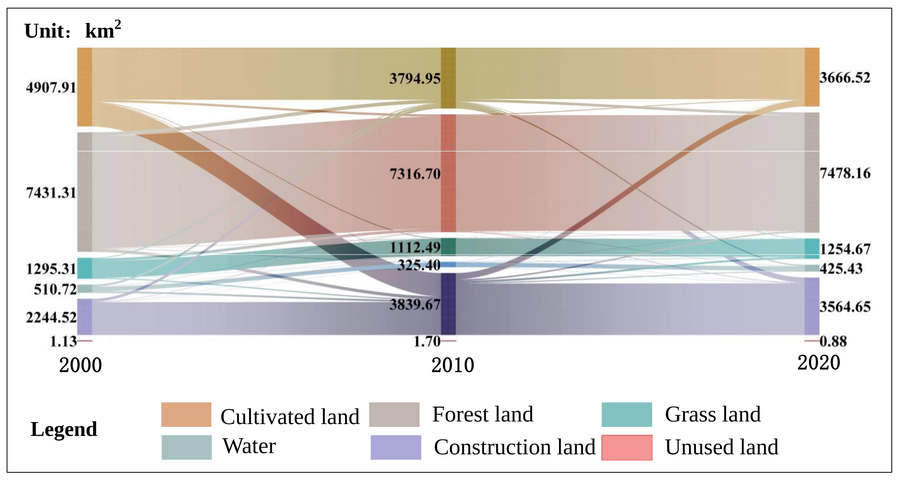


Figure 3. The Sankey diagram of land use change from 2000 to 2020.

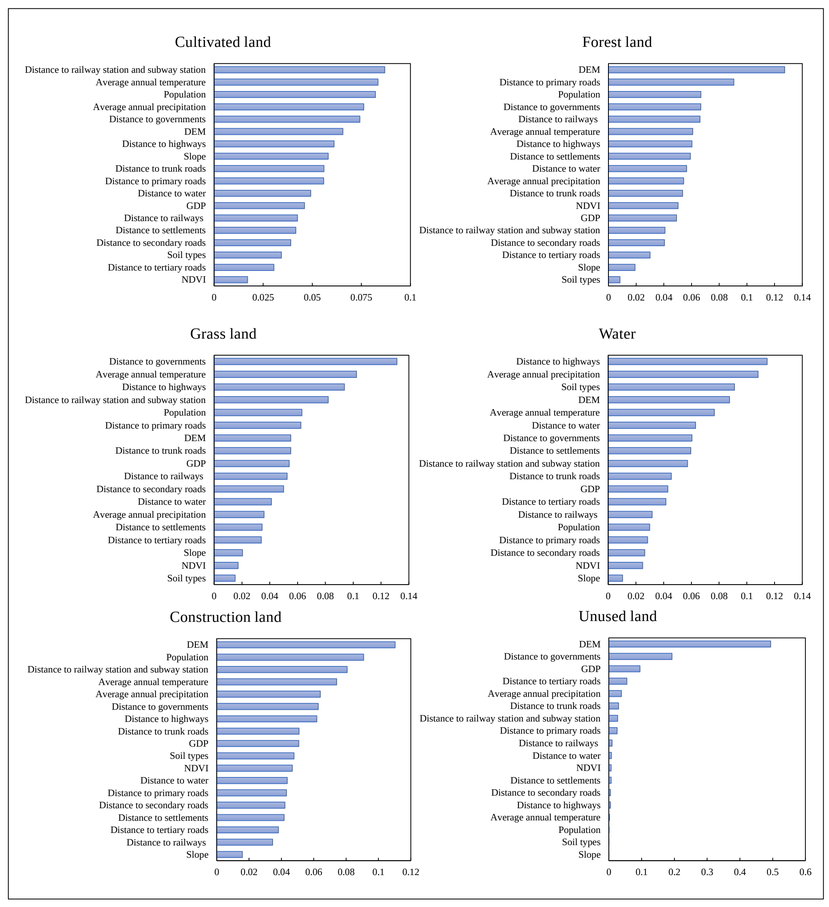
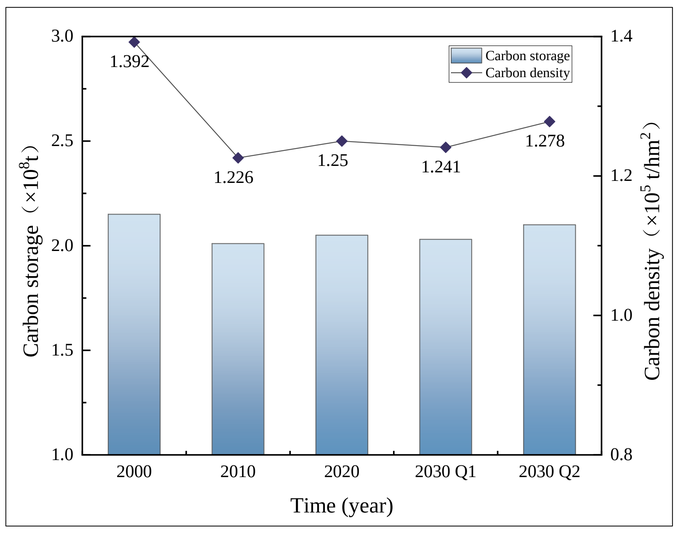


Figure 4. Contribution of each driving factor.



Carbon storage

Carbon density

change trend

Figure 5. Trend of carbon storage in Beijing from 2000 to 2030.

Conclusions

(1) Forest land is the largest land use type with about 45%.

(2) During 2000-2020, the carbon stock is characterized by a "rapid decrease and slow increase".

(3) In 2030, the carbon stock in Beijing will decrease by 1.6×10^6 t under NES and increase by 4.6×10^6 t under EPS.