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The Ecosystem Carbon Storage Dataset in Tibet (2001−2010)

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Abstract: The ecosystem carbon storage dataset in Tibet (2001−2010) was developed following the procedures: (1) using MODIS MCD12Q1 (2001, 2005 and 2010) to get 16 land cover types in Tibet; (2) using monthly MODND1M NDVI data (June−October, 2001, 2005 and 2010) to get the average NDVI data for the 16 land cover types; (3) using the 1 km biomass carbon density data (2000) and the 10 km surface soil (0−30 cm) organic carbon density data, the relationship model between NDVI and biomass carbon density, as well as NDVI and biomass carbon density of 2001 for 16 land cover types were established, and the models was calibrated with the above-ground biomass, soil organic carbon, and other field data; (4) calculated the biomass carbon density and soil carbon density of 16 kinds of land cover type in 2005 and 2010; (5) based on the root to shoot ratio, biomass is divided into aboveground biomass and underground biomass, the carbon storage in 2001, 2005, and 2010 was calculated by inputting the land grid data and the four carbon library parameters (aboveground biomass, underground biomass, soil carbon and humus carbon) into InVEST model and (6) the carbon density and the changes of carbon accumulation in Tibet were obtained.

Keywords: ecosystem; carbon storage; Tibet; 2001−2010

1 Introduction

Land use change is one of the major factors leading to changes in ecosystem carbon storage. Tibet is a typical ecologically fragile and sensitive area[1−2]. In recent decades, due to global

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climate change and human activities, especially changes in land use/cover conducted by China's major ecological construction project, the ecosystem in Tibet has changed a lot. How has the carbon accumulation function changed in Tibet? what was the driven force for these changes, these are issues need to be further studied to provide reference for making decisions on ecological conservation and climate change responses in Qinghai-Tibet Plateau.

2 Metadata of Dataset

The metadata of the ecosystem carbon storage dataset in Tibet 2001−2010 is summarized in Table 1.

Table 1 Metadata summary of the ecosystem carbon storage dataset in Tibet 2001−2010

Items	Description
Dataset full name	Tibetan ecosystem carbon storage simulation and analysis dataset from 2001 to 2010[3]
Dataset short name	TibetanCarbon2001-2010
Authors	Zhao, Z. H. B-7520-2018, Institute of Geographic Science and Natural Resources Research, Chinese Academy of Science, zhaozh.16b@igsnrr.ac.cn Xu, Z. R. M-8190-2016, Institute of Geographic Science and Natural Resources Research, Chinese Academy of Science, xuzr@igsnrr.ac.cn Liu, G. H. B-7530-2018, Institute of Geographic Science and Natural Resources Research, Chinese Academy of Science, liugh@lreis.ac.cn
Geographical region	Tibet Autonomous region
Year	2001, 2005, 2010 Temporal resolution 5 years
Spatial resolution	418.5 m Data format .tif
Data size	30.00 MB (Compressed to 1 file, 15.1 MB)
Data files	Spatial distribution figure of carbon storage in Tibet in 2001, 2005 and 2010; Changes in carbon storage with changes in land use in Tibet from 2001−2010; Changes in carbon density causing the storage of carbon in Tibet from 2001−2010
Foundation(s)	Chinese Academy of Science (XDB03030000, KZZD-EW-08); Natural Science Foundation of China (41661144030, 41561144012)
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3 Methods

We used the dataset in 2000 to construct two regression models: one is NDVI and biomass, and the other one is NDVI and soil organic carbon. Then, based on the inversion of the models, biomass and soil organic carbon data in 2001, 2005 and 2010 were modeled. Based on the root to shoot ratio, biomass was converted into aboveground biomass and underground biomass. Because the humus carbon library is small and relatively stable[5], the humus carbon density data in this paper represent those collected in 2000. Then, the land cover and carbon density parameters were input into InVEST[6] model to determine the carbon storage in 2001, 2005 and 2010 in the Tibet.

3.1 Data Collection and Processing[6]

(1) Ecosystem carbon library simulation

InVEST was developed by Stanford University; it is a comprehensive ecosystem service evaluation model that can assess various ecosystem services, provide a comprehensive analysis for planning ecological restoration, pay ecosystem services (PES), and assess development effects and space permits. Cooperation risk management plays an increasingly important role in promoting biodiversity conservation, and the coordinated development of human well-being is of great significance[6]. Land cover and biomass data, as well as soil carbon and humus carbon data collected in 2001, 2005, and 2010 in the study area, were used as InVEST input data in order to simulate the carbon storage in corresponding years. Then, the behavior and spatial differentiation of carbon storage in Tibet from 2001−2010 was analyzed. The carbon computation formula in the carbon module in the InVEST model is described as follows:

$$C_{ZONE} = \sum C_i \times A_i \tag{1}$$

$$C = C_{\text{above}} + C_{\text{below}} + C_{\text{soil}} + C_{\text{dead}} \tag{2}$$

where A_i is the area of class *I*, C_i is the carbon density of class *I* (t C/ ha), C_{above} represents aboveground biomass, C_{below} represents root biomass, C_{soil} represents soil organic carbon, C_{dead} represents humus carbon.

(2) Carbon storage function change analysis of the impact factor and its attribution

In general, changes in land use can be divided into changes of land cover types (land conversion) and changes of internal quantity of a specific land cover type (land modification). Accordingly, changes in the regional carbon storage function involve changes in the land cover type and carbon density, and they involve the contribution of different factors that affect the carbon storage function. The model of this process is described as follows: changes in regional carbon storage function based on two carbon available libraries using the ΔC characteristic:

$$\Delta C = \sum_{i=1}^{n} (A_2 D_2 - A_1 D_1) \tag{3}$$

where A_1 and A_2 are the areas of class I before and after the change, respectively, and D_1 and D_2 are the carbon densities of class I before and after the change, respectively.

We assume that the carbon density of same land use/land cover type is constant, the changes in carbon storage (ΔC_l) are only caused by the change in land use/land cover change. ΔC_l can be characterized as:

$$\Delta C_1 = \sum_{i=1}^{n} (A_2 D_1 - A_1 D_1) \tag{4}$$

Assuming that land use/land cover is constant, the changes of carbrn storage ΔC_d only caused by carbon density change, the ΔC_d can be characterized as:

$$\Delta C_d = \sum_{i=1}^{n} (A_1 D_2 - A_1 D_1) \tag{5}$$

The contribution rate of the change in land use/land cover types to carbon storage (A_1) and the contribution rate of the change in carbon density to carbon storage (A_d) can be calculated using the following formulas:

$$A_1 = \Delta C_1 / (\Delta C_1 + \Delta C_d) \tag{6}$$

$$A_d = \Delta C_d / (\Delta C_1 + \Delta C_d) \tag{7}$$

3.2 Procedure of Data Processing

Based on land use/cover data, carbon density, NDVI and field survey data, a regression model of NDVI and carbon parameter was developed, and further developed carbon density and carbon storage model (Figure 1). After verification of InVEST model, the impacts of land use change and geographical factors on carbon density and carbon storage was studied.

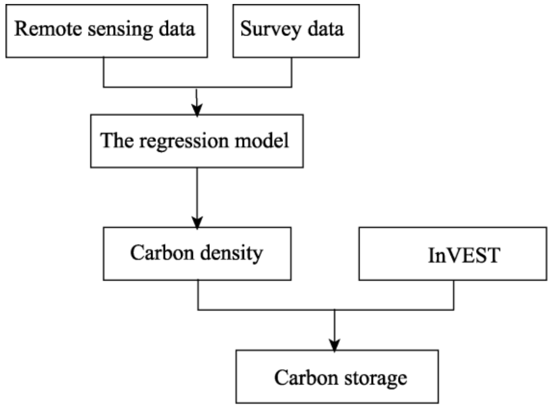

Figure 1 Flow chart of data processing

4 Results and Validation

4.1 Data Products

From 2001−2010, the carbon storage in Tibet exhibited overall stability and growth. In 2001, 2005 and 2010, the total carbon storage values were 11,642, 11,667, and 11,692 million t C, respectively. Over 10 years, an increase of 50 million t C occurred. From southeast to northwest, Tibet features the distribution of forest, grass, alpine meadow, alpine steppe and alpine desert. Consistent with this natural distribution, the carbon volume in 2001, 2005 and 2010 decreased from southeast to northwest, exhibiting minor changes in different years. From 2001−2010, the carbon library has changed greatly in southeast and northwest Tibet, it was relatively stable in north Tibet Plateau and south Tibet Lake Basin[7].

If we assume that the carbon density of each land use type is constant and assume that only changes in land cover type induce changes in carbon storage, carbon storage increased by 126 million tons in the Tibet in 2001−2010, and changes in land cover type contributed to the carbon storage was about 269% (Figure 3).

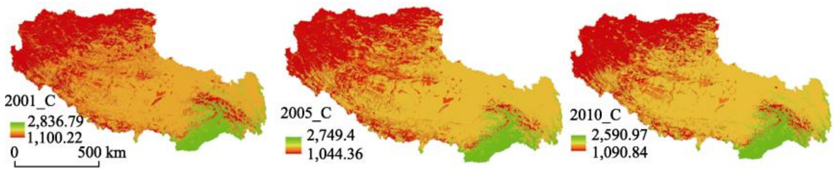

Figure 2 Spatial distribution of carbon storage in the Tibet in 2001, 2005 and 2010 (Unit: t C/grid)[7]

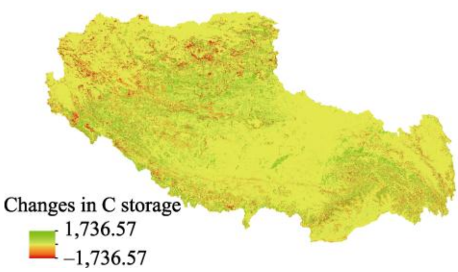

Figure 3 Changes in carbon storage with changes in land cover in Tibet from 2001−2010 (Unit: t C/grid)[7]

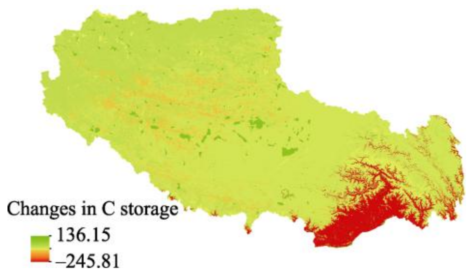

Figure 4 Changes of carbon storage caused by changes of carbon density from 2001−2010 (Unit: t C/grid)[7]

Carbon density in the Tibet decreased from 2001 to 2010. The average carbon density in the area in 2001, 2005 and 2010 were 120.2, 116.9 and 116.6 t C/ha, respectively. Assuming that the land cover types were stable and that only changes in carbon density induced changes in the storage of carbon, the decline in the carbon intensity in 2001−2010 yielded an increased volume of 79 million tons of carbon, and the contribution rate of changes in carbon density to carbon storage was about −169% (Figure 4).

4.2 Validation

Aboveground biomass and soil organic carbon were measured by field sampling data. The soil samples were collected by the quartering method, and the soil samples were screened by 2 mm after air drying, and the soil organic matter was measured by the external heating method with potassium dichromate [8]. An area of 50 cm x 50 cm was used to collect the grass samples, and each sample was repeated three times. Biomass samples were also obtained for areas that were mowed, cleaned, and dried; then, their ANPP dry weight was acquired, thus, we got the carbon weight with carbon content rate as 0.47. After this, the carbon density parameter obtained by regression model can be used for further simulation and analysis.

5 Conclusion

The carbon storage in Tibet increased from 2001 to 2010. The volumes of carbon in Tibet in 2001, 2005 and 2010 were 11,642, 11,667, 11,692 million t C, respectively. The carbon library has changed greatly in many places of Tibet accept eastern. Land cover change has contributed to carbon storage change in the recent decades, if we assume that the carbon density of each land use type was constant and the changes in land cover type from 2001 to 2010 caused the carbon volume increase by 126 million tons; thus, changes in land cover type contributed to a carbon storage contribution rate of 269%. If we assume that the land cover types are stable, the decline of the carbon intensity of Tibet from 2001−2010 yielded decreased volume of 79 million tons of carbon, and the contribution rate of changes in carbon density to carbon storage is about −169%.

Author Contributions

Xu, Z. R. and Liu, G. H. designed the algorithms of dataset. Zhao, Z. H. contributed to the data processing and analysis. Zhao, Z. H. wrote the data paper.

References

[1] Zhang, Y. L., Li, B. Y., Zheng, D. Datasets of the boundary and area of the Tibetan Plateau [DB/OL]. Global Change Research Data Publishing & Repository, 2014. DOI: 10.3974/geodb.2014.01.12.V1.

[2] Zhang, Y. L., Li, B. Y., Zheng, D. Datasets of the boundary and area of the Tibetan Plateau [J]. *Acta Geographica Sinica*, 2014, 69(Suppl.): 164−168.

[3] Zhao, Z. H., Xu, Z. R., Liu, G. H. Tibetan ecosystem carbon storage simulation and analysis dataset from 2001 to 2010 [DB/OL]. Global Change Research Data Publishing & Repository, 2018. DOI: 10.3974/geodb.2018.01.05.V1.

[4] GCdataPR Editorial Office. GCdataPR Data Sharing Policy [OL]. DOI: 10.3974/dp.policy. 2014.05 (Updated 2017).

[5] Zhang, H. Distribution characteristics of soil organic carbon and its composition under erosion environment in different vegetable regions of Loess Plateau [D]. Yangling: Northwest A&F University, 2013.

[6] Sharp, R., Tallis, H. T., Taylor R., *et al*. InVEST 3.1.2 User's Guide [M]. The Natural Capital Project. Stanford, 2015.

[7] Zhao, Z. H., Xu, Z. R., Cheng, S. K., *et al*. Analysis on dynamic of carbon storage in Tibet attributable to land use and land cover change [J]. *Journal of Natural Resources*, 2016, 31(5): 755−766.

[8] Bao, S. D. Soil Agrochemical Analysis [M]. Beijing: China Agriculture Press, 2000.