

Optimization of Sishui Science and Technology New Town's low-carbon spatial planning by urban carbon source and carbon sink

Shilei Fu^{1, a}, Tiemao Shi^{1, b *} and Tingting Xu^{2, c}

¹Shenyang Jianzhu University, China

²Institute of Applied Ecology Chinese Academy of Sciences, China

^afsl116@163.com, ^btiemaoshi@163.com, ^c304799385@qq.com

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Abstract. Rising CO₂ is predicted to impact global warming, and the city is the most important carbon source. Based on the theory of urban carbon sink, we surveyed the the most important carbon source and sink infect factor, and take them as the constraint conditions of urban ecological space by calculating different kinds of carbon sink. Depended on the spatial analysis of GIS, we form the whole low-carbon network of the green city with the source of oxygen outside, greenbelt-greenheart inside and neighbor-greenland by the qualitative and quantitative analysis method. At the end, optimize the urban ecological spatial pattern in urban low carbon, which is conducive to help urban to become more perfect on planning and development.

Introduction

On the background of climate changes and global reducing exhaust, the low-carbon development have been the most important contents of global reducing carbon emission[1]. Urban spatial pattern have some locking effect on urban operation and other important factors, which is the core means of urban planing[2]. Therefore, the research of realation between urban spatial pattern and carbon emission become hotspot gradually now. As the accelerating development of urbanization in our country, the landuse expansion of urban have unprecedent development in our country. Although the land use expansion of urban can make the population and economy fast growth, but there also appears kinds of social ecological environment problems such as pollution and farmland shortage and so on, which affect the sustainable development of social economic and ecological environment.

Methods and data

GIS Space superposition method

Image area shape are obtained from remote sensing and the urban statistical unit of the social and economic data is the main data sources[3], using data to spatial overlay analysis will make the space planning resonable[4].

Constitute and correlate method of index factor on calculation

Through the analysis of the mechanism of high carbon emissions in shenyang, we analyzes its of the main problems in the field of low carbon, and Put forward the method to calculate the cindex factor on calculation of carbon emission and absorption for the local terminal metering plate(Tab.1) [5].

Tab.1 Constitute and correlate method of index factor on calculation of caebron emission and absorption

Carbon emissions type	Impact factors	Carbon emissions targets	Equations
Carbon emissions of buildings	Climate conditions, regional energy structure, living/public building energy consumption per unit area	Living/public area, all kinds of buildings total carbon emissions, per capita/to carbon emissions	$FA = \sum A \times EA_i \times K$ A: Building Area EA_i : energy consumption value per unit area K: emission coefficient
Carbon emissions of industries	Energy consumption per unit GDP / Energy consumption per unit value added of industry, energy emission coefficient	Industry total industrial added value, energy consumption, total carbon emissions	$FI = \sum A \times VA \times EVA_i \times K$ A: Different kinds of land area VA: Unit of land for industrial EVA_i : Unit energy consumption of industrial production K: emission coefficient
Carbon emissions of traffic	Unit mileage fuel consumption, transportation structure and transportation mode, fuel emission coefficient	All kinds of motor transportation total mileage, total carbon emissions	$FT = \sum L \times EL_i \times K$ L: Different kinds of motor transportation total mileage EL_i : Unit mileage of carbon emissions
Sum	Total carbon emissions, per capita carbon emissions, carbon emissions (carbon density)		$F = FA + FI + FT + FR + FG$

The calorific value of the different energy and conversion of carbon emission as the table 2.

Tab.2 calorific value of the different energy and conversion of carbon emission

Energy type	unit	heat value (kcal/per)	Unit of calorific value conversion (TJ)	emission coefficient (T-C/TJ)	Carbon emissions (kg-CO2/per)
Coal	Kg	7000	0.000029302	29.45	3.16
Natural gas	m3	8900	3.73E-05	15.3	2.04

Note: kcal=4.186J

Dates from "IPCC Guidelines for National Greenhouse Gas Inventors"

General transportation consists of outdoor public transport and private transport. Carbon emissions are main public transport buses, taxis. By shenyang development plan, and the current traffic situation, the current can be calculated surabaya new motor vehicle ownership is about 4100 vehicles in the city, we can work out the carbon emissions units area in the planning area ,which is 147.41t/102km.

The index of CO₂ emission on kinds of transportation means is shown in the table 3.

Tab.3 the index of CO2 emission on kinds of transportation means

CO ₂ emission index	Bus	Taxi	Car	motorcycle
CO2 emissions per Hundreds of kilometers (kgCO2/102km)	88.1	28.3	22.3	5.1
CO2 emissions per capita gCO2/ (person km)	55.5	227.2	96.8	129.8

IPCC The IPCC default carbon sink coefficient method

When calculating the carbon sequestration of cities, urban carbon resource estimation mainly adopts the IPCC default carbon sink coefficient method [6], according different land use types to calculate ,such as forest land, garden green land, wetlands, and agricultural land area [7].Equations is shown in (1):

$$C_s = \sum_{i=1}^n C_{si} = \sum_{i=1}^n \beta_i A_{CSi} \quad (1)$$

Explanation: Cs is the total carbon sink, 104t; Csi is the class I carbon sequestration of carbon sink, 104t; β_{iis} is Coefficient of carbon sink (CO_2e), $\text{t}/(\text{hm}^2 \cdot \text{a})$; ACSiis the area of carbon sink, km^2 .

The coefficient of carbon sink is shown in the table 4.

Table 4 The coefficient of carbon sink about main land-use types in Northeastern

Land-Use Type	woodland	grassland	farmland	wetland
Coefficient of carbon sequestration ($\text{C t}/(\text{hm}^2 \cdot \text{a})$)	210.83	29.78	37.18	18.03
Coefficient of carbon sink ($\text{CO}_2 \text{ t}/(\text{hm}^2 \cdot \text{a})$)	780.85	110.30	137.71	66.76

Results

From the point of carbon source distribution, urban carbon emissions mainly concentrated in the industrial, construction, transportation and other industries(Tab.5). Industrial areas, industrial development is given priority to with eye health care and medical instrument processing industry, unreasonable industrial structure and industrial layout; Building area, residential land area per capita, seriously over standard, national and local land building high carbon emissions;due to the existence of urban spatial structure is not reasonable factors, there are bottlenecks in a local region between the new and the old city traffic, which affects efficiency of city traffic, and increase transport carbon emissions. In addition, the urban transit network layout form a single, lack of parking facilities is also the city traffic fields such as one of the main factors of carbon emissions (Fig.1).

According to the above soil conditions, carbon source, carbon sink factor analysis of the elements such as carbon sinks elements is given priority to with urban carbon source for urban spatial extension of low carbon constraints(Tab.6), by elevation, slope, forest carbon sinks coverage, soil erosion and other ecologically sensitive factors for ecological suitability analysis [8], the formation of multistage low carbon support level of spatial pattern of natural low carbon elements (Fig. 2).

Tab.5 the quantitative of carbon source on influencing factors

unit: 10^4t			
Carbon emissions type	carbon source of buildings	carbon source of traffic	carbon source of person
Coal	34.8		
Natural gas	0.49		
Total	35.29	0.46	0.89

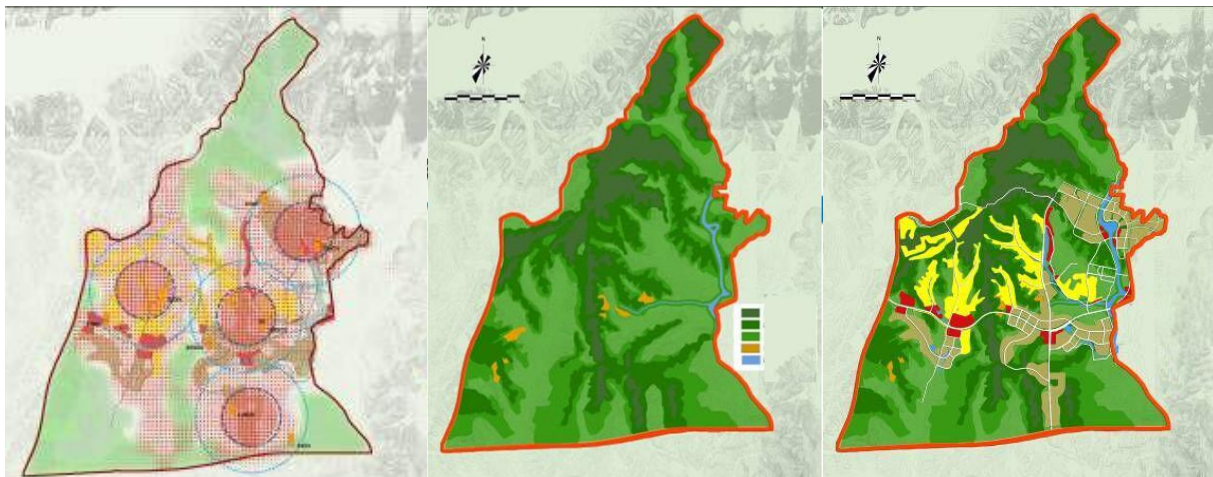


Fig. 1 Spatial energy consumption of urban Fig. 2 Distribution of carbon sink from urban Fig. 5 Optimization of the urban spatial pattern

Tab.6 the quantitative of carbon sink on different landuse type factors

unit: t

Carbon sink type	Carbon sink of woodland	Carbon sink of grassland	Carbon sink of farmland	Carbon sink of wetland
Coefficient of carbon sequestration	5.77	0.34	0.21	2.01
Total of carbon absorb	5520.85	40.72	0.27	92.52
				5653.51

Urban greenbelt of urban development pattern is inspired by Howard "garden city" theory, banded oxygen source of green space in city construction, thus a circular carbon sinks as far as possible to keep the city state of carbon balance, this kind of layout is mainly effected by the city green space around [9]. The city group layout structure forming ring green belt, and combined with large ecological forest, city, forest blend of circumferential layout structure [10] (Fig.3).

This model plays a very important role on green space of urban ecological function and maintain the ecological balance of the city, regulating urban carbon balance.

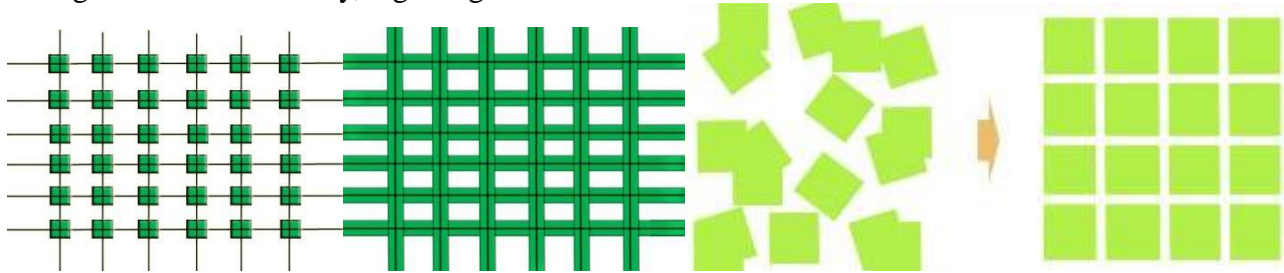


Fig.3 layout of greenbelt-greenheart inside

Fig.4 The integration schemes of greenland

The Urban green core layout pattern is known as the corridor network. General the main road's green belt in the city will be connected with the green patch and forest surrounding the city together to form a network. Combining the characteristics of good carbon reserves in the new city, the ribbon green space combined with dot points can strengthen the integrity and completeness of the urban space, and form the complete urban ecological system. Urban infrastructure corridor, shelter belt, parks and other linear and blocky green space, will form a multi-level and multi-function complex network system of ecological corridors(Fig.4).

The layout of Sishui New Science and Technology Town Surabaya new town of science and technology of ecological space will be in a buildup of plaque and node location at the same time, build the green corridor, ultimately form a complete ecological green space system, build the chessboard hill scenic area, and chessboard hill reservoir headwater surabaya river system, ribbon park landscape zone, ecological landscape nodes, and the wedge green space as part of the forest ecological skeleton, closely connect with the surrounding natural ecological environment, on the basis of protecting biodiversity organically separating the functions of the urban space, make the ecological environment and urban function space close union, the regularity of distribution, and finally reached surabaya new town of science and technology of production, scientific research, education, life orderly. To study regional green space can effectively absorb the city carbon emissions, increase carbon sink influence city, construct a real low carbon space layout (Fig.5).

Summary

The pattern of three source-greenland is based on the theory of greenland spatial pattern, search it according to actual situation of the study area and related research results, select the most important carbon sink factors which influenced ecological environment and other influences, take them as the effects the constraint conditions of urban ecological space. The factors would be the mutual superposition based on the spatial analysis, form the ecological support spatial pattern with natural elements. Form the whole low-carbon network of the greenery place as a source of oxygen outside, greenbelt-greenheart inside and neighbor-greenland by the qualitative and quantitative analysis method. At the end, optimize the urban

ecological spatial pattern in the level of urban carbon source and sink distribution to help urban to become more perfect on planning and development.

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References

- [1]B-H Zheng, L-Y Liu. Strategy on Spatial Planning of Low-carbon City Based on the Carbon Emission Scenario Model: A Case Study of Xishan Low-carbon Demonstration Area, Urumqi. Urban Development Studies, 2013,09:106-111 (in Chinese)
- [2]K-J Yu, S-S Wang, D-H Li, *et al.* The function of ecological security patterns as an urban growth framework in Beijing. Acta Ecologica Sinica,2009,03:1189-1204. (in Chinese)
- [3]Song Yu-qin,Cao and Ming-lan: Landscape ecological security assessment of Beijing City based on RS and GIS. Yingyong Shengtai Xuebao,2011,21(11)
- [4]L-Y Liu. Low-carbon urban spatial planning based on carbon emissions scenario simulation analysis.Central South University.2012
- [5] X-M Zhang, S-F Li, X-J Huang *et al.* Effects of Carbon Emissions and Their Spatio-Temporal Patterns in Jiangsu Province from 1996 to 2007. Resources Science,2010,04:768-775. (in Chinese)
- [6]Li B. Research on the Technology System and the Calculation Method of Carbon Emission of Low-Carbon Building. Degree of Doctor of Philosophy in Engineering. Huazhong University of Science & Technology,2012.
- [7]Christen A, Coops N, Kellett R, *et al.* A LiDAR-Based Urban Metabolism Approach to Neighbourhood Scale Energy and Carbon Emissions Modelling[R]. University of British Columbia, 2010.
- [8]Edward L Glaeser,Matthew E Kahn.The Greenness of Cities.Carbon Dioxide Emissions and Urban Development[J]. Journal of Urban Economics,2010(67) :404-418?
- [9] Z-T Wang, Z-J Wang, Y Bao,Landscape pattern analysis on the urban green space system of Tongren City based on GIS .Journal of Gansu Agricultural University, ,2011,02(01):110~114 (in Chinese)
- [10]C Zhang, H Q Tian, G S Chen, *et al.* Impacts of urbanization on carbon balance in terrestrial ecosystems of the Southern United States[J].Environmental Pollution.2012, 164:89-101
- [11]Ge M. Study on Assessment of Low carbon Eco-city. Dissertation for the Doctoral Degree in Management. Harbin Institute of Technology,2012.
- [12] H-B Zhang. Organization of Spatial Structure and Collaborative Planning of Low-carbon City,Dissertation for the Doctoral Degree in Engineering, Harbin Institute of Technology, 2012
- [13] L Lai. Carbon Emission Effect of Land Use in China, Dissertation for the Doctoral Degree in Engineering ,Nanjing University,2010
- [14]M. Margaret Bryant. Urban landscape conservation and the role of ecological Greenways at local and metropolitan scales. Landscape and Urban Planning,2006,76(1-4):238