Path selection for low-carbon economic land use pattern in China

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Abstract

Ministry of Land has been highly concerned about energy-saving emission reduction and the land use impact on global change. In 2008 they had set up a special project on commonweal industry research named “the effect and control of carbon emission reduction in land use planning”, which sought to build low-carbon land use structure and layout through creating land use planning technique on the basis of revealing the mechanism of land use carbon emission effect. This study evaluates preliminary research results which are the study on carbon emissions effects of land use in China. On this basis we proposed some suggestion: (a). We can reduce direct carbon emissions from the four aspects: the reduction of ground hardening, promoting green building, low-carbon infrastructure, thrift and intensive utilization of land; (b). The indirect carbon emissions are mainly from anthropogenic source, so we can use policy instruments to control; (c). Conservation of land carbon sinks is an essential part of low-carbon land use.

Keywords: Low-carbon economy; Land use pattern; Carbon emission

1. Introduction

The low-carbon economy with low power consumption, low emission, low pollution as the basic features, which response to impact of climate warming by carbon-based energy as basic requirements, and in order to achieve sustainable development of economic and society, is an economic development model that adapt to post-industrial society and implement resource conservation and environment friendly. In China land is a scarce resource and factor, so land use planning undoubtedly is the main content that

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land use policy participate low-carbon economy. In the context of that the low-carbon economy has become the common values of contemporary country, as major emitters of carbon the land use planning in China should focus on low-carbon development as one of the basic problem.

At present, the low-carbon economy and low-carbon land use planning research literature has begun to emerge. Fang think carbon emissions and land use structure have some relationship, he promote compact development pattern\textsuperscript{[1]}. Glaeser and Kahn study on the relationship between Carbon emissions and land use pattern. The results show that the more stringent constraints on land-use, the lower level of carbon emissions by residents. For example, per capita emission in High-density central area is less than the low-density suburban\textsuperscript{[2]}. Crawford and French discussed the relationship between spatial planning and the low-carbon objectives, and then they thought the key to achieving low-carbon objective was concept changes in planners who should pay more attention to low-carbon city concept and enhance the use of low-carbon technology\textsuperscript{[3]}

This study evaluates preliminary research results which is the study on carbon emissions effects of land use in China. According to this we try to propose some suggestion for land use pattern from three aspects.

2. Evaluation on carbon emission by land use in China since 1980s

Land use not only involved directly in the process of carbon emissions/carbon absorbing in terrestrial ecosystem, but also indirectly affected regional carbon emissions standards. Thus, the study on effect of carbon emissions in land use process is not just related to the issue of rational organizing land use, moreover it is the key starting point to land use planning cope with carbon emissions.

2.1. Basic concept of Land-use carbon emissions

The global increase in atmospheric carbon dioxide effects by land use change is second only to the burning of fossil fuels. According to Richard Houghton who is a well-known expert in carbon cycle estimate that carbon emissions caused by land use change had reached 1/3 of emissions caused by human activities from 1850 to 1998, and in China the cumulative carbon emissions is 10.6 billion tons from 1950 to 2005 which had reached 30% of all carbon emissions from anthropogenic source as well as 12% of Global carbon emissions by land-use change over the same period\textsuperscript{[4]}. Land-use carbon emissions can be further divided into direct and indirect carbon emissions. Direct carbon emissions can be broken down into carbon emissions by land use changes or land-use type keeping. Indirect carbon emissions is all anthropogenic carbon emissions by various land use types such as heating, transportation land emissions, Process emissions.

2.2. Direct carbon emissions in land use process

Terrestrial ecosystems in China showed significant carbon sink in 20 years from 1985 to 2005, the level of average annual carbon sink is about 0.154-0.167 billion tons. From the classification point of view, vegetation carbon and soil carbon pool all presented the function of carbon sink in which annual vegetation carbon sink is about 0.108-0.121 billion tons and the annual soil carbon sink is weaker because the number is only 1/3 of vegetation carbon sink. From the perspective of ecosystem type the function of forest carbon sink plays an important role in the whole terrestrial ecosystems for the value is 2/3 of all carbon sink\textsuperscript{[5]}. From a regional perspective in the Eastern, Southern and Northern China land-use carbon sink effects is more significant, yet in the Northeast and Southwest the land-use carbon emission effects is more significant.
2.3. Accounting the carbon emissions from anthropogenic source

We take comprehensive level of carbon emissions by four departments in 1995 as an example, there are 2.642 billion tons of CO₂, 0.032 billion tons of CH₄, 3.3 billion tons of carbon dioxide equivalent. By 2005 the total emission involved 5.55 billion tons of CO₂, 0.038 billion tons of CH₄, 6.34 billion tons of carbon dioxide equivalent. From the perspective of regional carbon cycle the emissions from anthropogenic source in China is three times of storage of terrestrial ecosystems, however by 2005 the emissions from anthropogenic source is more than ten times of terrestrial ecosystems. This means that since 1980s the emissions from anthropogenic source are growing much faster than promotion on absorptive capacity of terrestrial ecosystems.

2.4. Indirect carbon emissions in land use process

Through consolidating the sector carbon emissions we can give the overall evaluation about carbon source/sink in China. In 1985 net carbon emissions is low level which is about 323TgC(10⁶t); By 1995 net carbon emissions rapid increased to 740TgC which is more than doubled; From 1995 to 2000 net carbon emissions increased slightly to 805TgC, but from 2000 to 2005 net carbon emissions shoot up to 1.54PgC(10⁹t). That is to say net carbon emissions in China are doubled per 9 or 10 years and the average annual growth rate is about 7.8%.

2.5. List of land-use carbon emissions in China

On the basis of estimation on carbon storage changes in terrestrial ecosystems and calculation of national carbon emission inventories, we can omni-directional inspect various types of carbon emissions which involve in the process of land use change or socio-economic emissions for land as a carrier. So we can assist decision-makers to promote carbon reduction from the perspective of land regulation. There has been net carbon emissions accounting standards(“+” indicated the effect of carbon storage and “—” indicated the effect of carbon emissions)(Table 4.)

Table 4. Carbon emissions accounting standards for changed land use pattern

<table>
<thead>
<tr>
<th>Land groups</th>
<th>Arable land (tC/ha)</th>
<th>Garden land (tC/ha)</th>
<th>Woodland (tC/ha)</th>
<th>Pasture (tC/ha)</th>
<th>Construction land (tC/ha)</th>
<th>Wetlands and water (tC/ha)</th>
<th>Unused land (tC/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable land</td>
<td>-0.502</td>
<td>0.362</td>
<td>3.197</td>
<td>-0.781</td>
<td>-56.727</td>
<td>0.500</td>
<td>-3.985</td>
</tr>
<tr>
<td>Garden Land</td>
<td>-0.897</td>
<td>-0.033</td>
<td>2.802</td>
<td>-1.176</td>
<td>-57.122</td>
<td>0.500</td>
<td>-4.380</td>
</tr>
<tr>
<td>Woodland</td>
<td>-3.732</td>
<td>-2.868</td>
<td>-0.033</td>
<td>-4.011</td>
<td>-59.957</td>
<td>0.500</td>
<td>-7.215</td>
</tr>
<tr>
<td>Pasture</td>
<td>0.038</td>
<td>0.902</td>
<td>3.737</td>
<td>-0.241</td>
<td>-56.187</td>
<td>0.500</td>
<td>-3.445</td>
</tr>
<tr>
<td>Construction land</td>
<td>0.418</td>
<td>1.282</td>
<td>4.117</td>
<td>0.139</td>
<td>-55.807</td>
<td>0.500</td>
<td>-3.065</td>
</tr>
<tr>
<td>Unused land</td>
<td>3.483</td>
<td>4.347</td>
<td>7.182</td>
<td>3.204</td>
<td>-52.742</td>
<td>0.500</td>
<td>0.000</td>
</tr>
</tbody>
</table>

3. Some suggestion for land use pattern in new period

The core of land use planning is the land use pattern, while the low-carbon economy pattern of land use involve both “low carbon” and “economic”. We should give full play to biological effects of land-carbon sink, and use advanced energy saving technology to reduce carbon emission in the process of the
specific land use activities. Specifically, we can proceed in two ways of “emission reduction” and “carbon sinks” that reduce direct or indirect carbon emissions of land use and increase the ability to absorb carbon.

3.1. Land use pattern of reducing direct carbon emissions

The first improvement is to minimize surface hardening. As an important carbon sink the raw land has become victims of urbanization which has been occupied a large area, the carbon cycle is destroyed which lead to land carbon emissions rise violently. Therefore, the reduction of the ground hardening is forced choice to keep the land carbon sink function and to reduce the land carbon emissions. As for that some hardened ground is necessary, we should explore the use of new technologies, new materials to make improvements. These practices will help maintain the rapid urbanization process and the balance of environmental protection.

The second point is to use low-carbon technology in infrastructures. The railway is the most low-carbon green transportation in all conveyance. In China the external cost of railage is 1/11 of road transportation’s, while the freight cost is 1/25 of road transportation’s. Thus, in the process of urban and rural infrastructure construction we should strive to develop mass transit and non-motorized traffic system to change the car-oriented traffic mode.

The third way of improving land use pattern is intensive and economical. According to "Economic Information Daily" reported, urban construction land per capita in China had reached more than 130 m² which is much higher than 82.4 m² per capita in developed countries. The extensive utilization mode of urban construction land is the important reason leads a large number of land-use carbon emissions. Economical and intensive land use can not only reduce the consumption of land resources, but also generate more advanced architecture model, more efficient ways of operation and more scientific shunt configuration.

3.2. Land use pattern of reducing indirect carbon emissions

First of all, we can start from land supply policy. Land supply mainly involved in building low-carbon economy is the total supply of construction land which is the most important factor to influence speed and efficiency of the overall development in low-carbon industry. It is an important measure to promote low-carbon economy by Inhibition of the total amount of construction land for high-carbon industrial projects and supporting low-carbon. The decision maker can arrange the total amount of low-carbon land use and layout in the overall plan of land utilization by planning maps and regulatory indicators.

Secondly tax adjustment and land price are also very effective means of regulation. Extensive use of the land should be imposed heavy tax, on the contrary intensive use of land should be imposed light tax. Through a variety of tax system it will alleviate burdens on low-carbon industry. Land price is also an efficient way to promote rational land use. If the land for low-carbon economic projects is grant of primary land market, government could give the most favorable price; if it is grant of secondary land market government could privilege in term of the transfer tax.

The carbon market is a very important indirect carbon emissions source. The carbon trade makes the scientific issue of climate change and the technical issue of reducing carbon emission closely integrate with economic issue of sustainable development. It relies on market mechanism to solve the synthesis problem with science, technology and economy. In 1978 China’s carbon emissions is 1.38 billion tons but it increased to 2.8 billion tons in 2007. With the rapid economic growth the carbon emissions will further increase, thus it is beneficial to accelerate low-carbon technologies and low-carbon industries by establishing and improving carbon trading market system.
3.3. Conservation of land carbon sinks

To implement low-carbon economic land use not only need effectively reduce the carbon emissions, but also give full play to the “carbon sink” effect of forests, grasslands, wetlands and other ecological land. The studies indicated that forest vegetation can absorb carbon dioxide and fix in biological organisms through photosynthesis which is about 1-1.5 billion tons of annual net carbon uptake. Most of the unused land agricultural land has significant natural carbon sink function and ever-increasing space. The measure include the scale increase of forest area, Controlling the area reduce speed of arable land, grassland, marsh and beach. Meanwhile, on the ecologically fragile areas and the ecological advantage area we should pay attention to recuperate, improve and enhance the land carbon sink effects.

4. Conclusion

This study evaluated the preliminary results on effects of land-use carbon emissions, and on this basis we proposed some suggestion for low-carbon economic land use pattern in China including the following aspects:

I. We can reduce direct carbon emissions from the four aspects: the reduction of ground hardening, promoting green building, low-carbon infrastructure, thrift and intensive utilization of land.

II. The indirect carbon emissions are mainly from anthropogenic source. So we can improve it through land supply policy, tax adjustment and land price, furthermore we should establish the system for carbon emissions market as quickly as possible which performs the same standards with Europe and USA.

III. There is some researches show that afforestation, reforestation, and management for grassland management and restoration would reduce 440 million tons of carbon emissions. Thus conservation of land carbon sinks is an essential part of low-carbon land use.

At present, many cities put forward the idea of building a low-carbon land use pattern, but most of them stay in the target macro-level because of the lack of operational measures for implementation. In future only through in-depth study we can build the theoretical basis and ensure the connotation of low-carbon land use, promote the innovative development of land use planning.

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References


