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**The Model and Application of  
Carrying Capacity of Relative Resource**

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# 1.Introduction

Since the end of the 20th century, the concept of the carrying capacity and its calculation method have been improved, and a set of international models for calculating regional carrying capacity have created, such as ecological footprint model, being widely used in regional sustainability study in China.. (Wackernagel, 1996a, Wackernagel, 1997b).

However, **the traditional methods of calculating carrying capacity can not be used directly in empirical analysis in China due to the national conditions**, for example the largest population and limited resources. The population of China is always much more than the population carrying capacity of resources.

It is difficult for China to reduce the population and increase the natural resources in short time.

So, the key problem is how to reasonably distribute the population and economy activities across the heterogeneous geographical space, according to the regional carrying capacity of relative resource (CCRR).

The CCRR study can be used as one of the basic research for ecological economic regionalization and the major function oriented zoning policy in China.

## 2.The concept of CCRR

"taking the specific one or more regions as reference zone, calculating carrying capacity of resources in the research area, according to the possession of resources or consumption per capita in the reference zone and resources stock of the research area".

**IF the resources A can carrying population B,**

**THEN the resources  $N \times A$  can carrying population  $N \times B$**

**IF region A is sustainable and region B is more sustainable than A,**

**THEN region B is sustainable**

**IF region A is unsustainable and region B is more unsustainable than A,**

**THEN region B is unsustainable**

As an assessment method of regional sustainability, CCRR has been gradually accepted in China, but there are some difficulties in empirically research on Chinese regional sustainability, for **it is difficult to find a relatively large and sustainable development region as an ideal reference zone.**

**We identified the average relative indicators of the larger region including the study area as the reference standard criteria** and formulated the CCRR model, by which the theoretical population carrying capacity, GDP carrying capacity of the study region can be calculated reasonably.

**we can acquire cognition for coordinating the spatial distribution and the flow of regional population and economic activities, by analyzing the situation of CCRR and comparing the theoretical population CCRR with the actual GDP CCRR within the region.**

### 3. The Model of CCRR

The traditional calculation model is the Weighting Linear Sum Model.

The population CCRR:

$$C_{sp} = W_l C_{npl} + W_w C_{npw} + W_e C_{cep}$$

The economic (GDP) CCRR:

$$C_{sg} = W_l C_{gl} + W_w C_{gw}$$

It is defective in the random weight choice and the neglect of coupling among different resources.

## We preliminary constructed the Geometric Model of CCRR

The population CCRR:

$$C_{sp} = \sqrt[3]{C_{npl} \times C_{npw} \times C_{ecp}}$$

$$C_{npl} = I_{pl} \times Q_l$$

$$C_{npw} = I_{pw} \times Q_w$$

$$C_{ecp} = I_{pec} \times Q_{ec}$$

The economic (GDP) CCRR:

$$C_{sg} = \sqrt{C_{gl} \times C_{gw}}$$

$$C_{gl} = I_{gl} \times Q_l$$

$$C_{gw} = I_{gw} \times Q_w$$

The Geometric Model can avoid selection of the weight, and considering the relative match relation among the different resources.

## Classification of the development states according to the CCRR

$P$  —— the actual population,  $G$  —— the actual GDP

According to the calculation result of the CCRR of 31 provinces in China in 2005, we classified 9 development states.

| State                    | Description  | Future development orientation  |
|--------------------------|--|---|
| $P > C_{sp}, G > C_{sg}$ | overloading, relatively high population and economic density   | optimization, improve development quality   |
| $P > C_{sp}, G < C_{sg}$ | overloading population, surplus GDP capacity, relatively high population density, insufficient economic development                    | key region of development, increasing population carrying capacity through economic development |
| $P < C_{sp}, G < C_{sg}$ | surplus population and GDP capacity, relatively rich resources, relatively small population density, insufficient economic development | scientific and gradually development  |
| $P < C_{sp}, G > C_{sg}$ | surplus population carrying capacity, GDP overloading, relatively small population density, relatively sufficient economic development | optimization of development, guide population to flow in  |
| $P > C_{sp}, G = C_{sg}$ | population overloading, GDP load, relatively large population density, economic development relatively moderate                        | moderate development, appropriately guide population outflow                                    |
| $P < C_{sp}, G = C_{sg}$ | surplus population carrying capacity, GDP load, relatively small population density, relatively moderate economic development          | moderate development, guide population to flow in   |
| $P = C_{sp}, G > C_{sg}$ | loaded with the population, overloading GDP, relatively moderate population density, relatively sufficient economic development        | optimization  |
| $P = C_{sp}, G < C_{sg}$ | loaded with the population, surplus GDP capacity, relatively moderate population density, insufficient economic development            | key region of development   |
| $P = C_{sp}, G = C_{sg}$ | loaded with the population and GDP, population and level of economic development are almost the same to that in the reference area     | moderate development  |

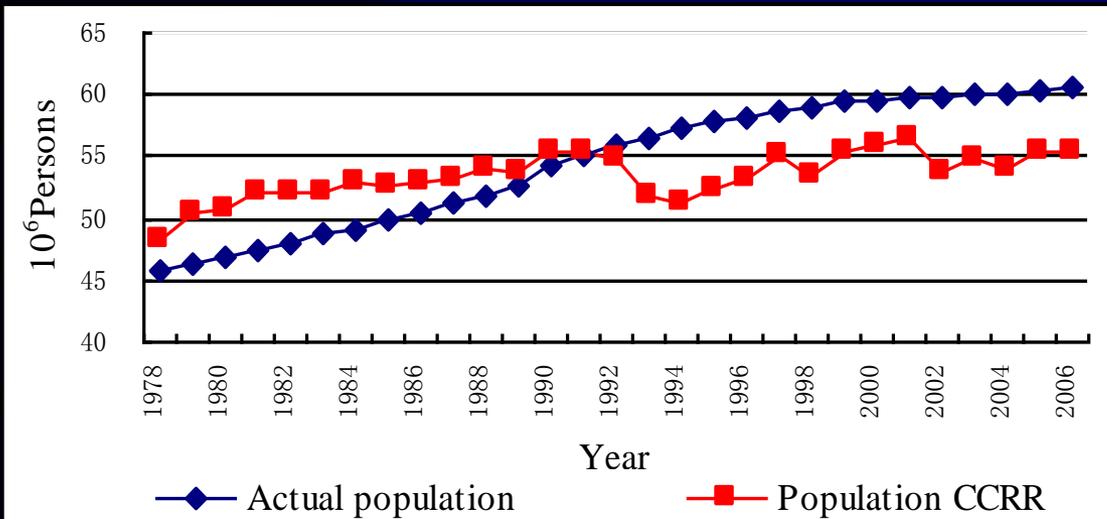
## 4. A case Study of Hubei Province in Central China

Hubei, as an important province with rich water resource and arable land and the two resources highly coupled, is one of the national grain & cotton production bases in China.

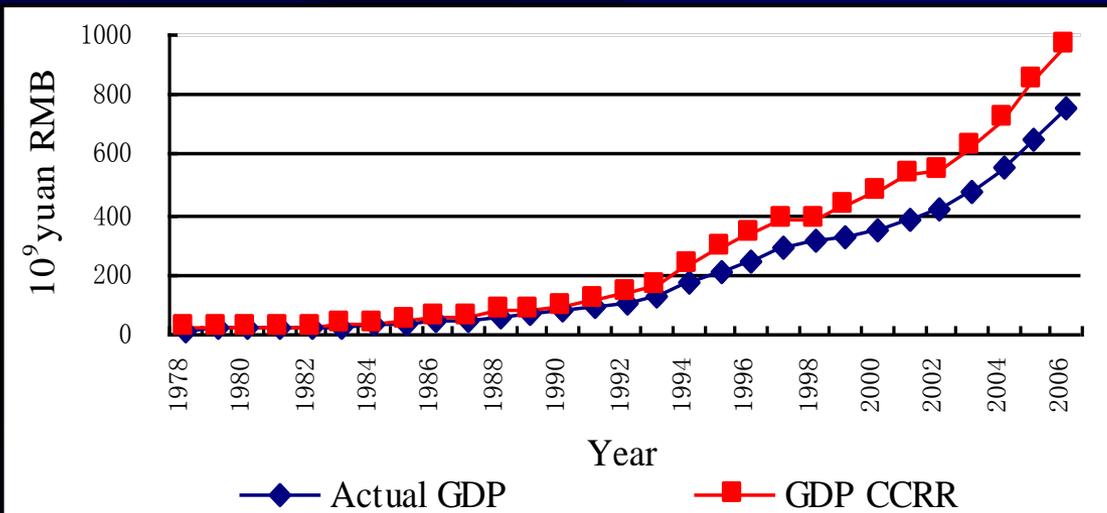


## Basic data of population, resources and economy in China and Hubei Province in 1978–2006

| Year | China                            |                                      |  |  | Hubei Province                   |                                      |  |  |
|------|----------------------------------|--------------------------------------|--|--|----------------------------------|--------------------------------------|--|--|
|      | population<br>(10 <sup>6</sup> ) | GDP<br>(10 <sup>9</sup> yuan<br>RMB) | total sown<br>area of<br>crops<br>(10 <sup>6</sup> hm <sup>2</sup> ) | total water<br>supply<br>quantity<br>(10 <sup>9</sup> m <sup>3</sup> ) | population<br>(10 <sup>6</sup> ) | GDP<br>(10 <sup>9</sup> yuan<br>RMB) | total sown<br>area of<br>crops<br>(10 <sup>6</sup> hm <sup>2</sup> ) | total water<br>supply<br>quantity<br>(10 <sup>9</sup> m <sup>3</sup> ) |
| 1978 | 962.59                           | 364.53                               | 150.104  | 440.83   | 45.75                            | 15.100                               | 7.9313   | 25.500   |
| 1980 | 987.05                           | 454.56                               | 146.381  | 443.20   | 46.84                            | 19.938                               | 7.4773   | 26.952   |
| 1985 | 1058.51                          | 904.07                               | 143.626  | 482.62   | 49.80                            | 39.626                               | 7.3313   | 26.703   |
| 1990 | 1143.33                          | 1871.83                              | 148.362  | 510.58   | 54.39                            | 82.438                               | 7.3613   | 26.635   |
| 1995 | 1211.21                          | 5981.05                              | 149.879  | 539.62   | 57.72                            | 210.940                              | 7.4140   | 24.928   |
| 2000 | 1267.43                          | 9800.05                              | 156.300  | 553.07   | 59.60                            | 354.540                              | 7.5840   | 27.060   |
| 2005 | 1307.56                          | 18395.63                             | 155.488  | 563.30   | 60.31                            | 652.010                              | 7.3913   | 25.338   |
| 2006 | 1314.48                          | 21180.80                             | 157.021  | 579.50   | 60.50                            | 758.132                              | 7.3503   | 25.879   |



The development state is  $P > C_{sp}$  and  $G < C_{sg}$  after 1991



The future development orientation for Hubei Province is to increase population carrying capacity through promoting economic development.

In fact, the centre government have drew some policies to support it

## 5. Conclusion and Discussion

### Conclusion:

- CCRR is not an appropriate method to appraise regional sustainability, but **a relatively reasonable method to study the development state and provide the objective bases to optimize the spatial structure and coordinate the relationship among resources, population and economy across regions.**
- CCRR is the basic research for ecological economic regionalization and the major function oriented zoning policy in China.
- The Weighting Linear Sum Model of CCRR is defective in the random of weight choice and ignores coupling among different resources. The Geometric Model of CCRR is suitable for study the resources well-matching regions.

## Discussion:

Some researches concern too much about single resources (land or water) while pay little attention to the **coupling researches** of multi-resources.

The **leading Restrictive resources** must be focused (land and energy in eastern china, water in west-northern china)

The **Mobility of resources** must be taken into account (the projects of South to North Water Diversion, West to East Electricity Diversion ,etc)

A wide-angle photograph of a lush green field, likely a rice paddy, stretching to the horizon. The sky is a vibrant blue, filled with numerous white, fluffy clouds. In the distance, a small cluster of buildings and trees is visible on the horizon line. The overall scene is bright and clear, suggesting a sunny day.

**Thank you for your attention**