Theoretical Research of the Urban Comprehensive Carrying Capacity in the Epoch of Urbanization

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Abstract

Conventional wisdom suggests that ecological factors are prominent constraints of cities in the urbanization process. By contrast, this article provides a fresh conception of the urban comprehensive carrying capacity in the context of ecosystem, economy and social dimensions. Based on in-depth analysis, the author makes out a list of informative area-based indicators in three differentiated layers and the findings are that the urban comprehensive carrying capacity is an entanglement of three subsystems of resource carrying capacity, economic carrying capacity and social carrying capacity, with all concepts fundamental to sustainable urbanization process.

Keywords: Urbanization, the Urban Comprehensive Carrying Capacity, Resource Carrying Capacity, Economic Carrying Capacity, Social Carrying Capacity

1. Introduction

Urbanization is a typical epoch evolved along with industrial and technological revolutions. It is the concentration of the motive powers of society in big cities and makes the agriculture subordinate as merely one branch of industry, thus reproduced as part of the accumulation process of the social and economic development. The description discloses the concerns about the carrying capacity of the cities, that is, how many people a given city can accept efficiently and effectively. The word efficiently means that the unfettered inflow population may reach the maximal load of the recipient city so as to attain the ecologically productive optimum, whilst the word effectively points out two constraints of the urbanization. On one hand, the number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural, social, cultural and economic environment for present and future generations. On the other hand, the living standards of all the inhabitants shall not be eroded by any possible means, which can be well evidenced by their consumption level, daily habits, and of course, their explicit and inexplicit earnings. Indeed, the closer one look at the relationship between inhabitant numbers and environmental degradation, the clearer it becomes that, at root, the key issue for cities, as recipient place in the process of urbanization, is not simply how many immigrants dwelling in specific cities, but also how much contributions this subordinate group have made for the sustainable development of this city, and definitely within its resource stretch.

The concept carrying capacity does exist when the target cities pinpoint their geographic location, and was intensified when such subordinate group began the exploitation of resources, and has been further reinforced along with urbanization. For those who would not launch an in-depth thinking, it offers a welcome life-belt. As far as the ecological stress does not reach the marginal area, the inhabitants, including the old and the newcomers, can nurture or cultivate urban behavior, modes of thought, and types of activity involved instinctively in their city lives. The 1992 UN

Conference on Environment and Development (UNCED) on sustainable agriculture, the UN Food and Agriculture Organization (FAO) argues that government should evaluate the carrying and population supporting capacity of major agriculture areas, and, where such areas are deemed to be overpopulated, take steps to change the man/ land ratio by facilitating the accommodation of migrating populations into better-endowed areas. Though this clearly alleged statement is quite full of worries about the rural areas and the peasants forced into resettlement, if we take on a new perspective from the recipient urban regions, it's rather clear that the terms of carrying capacity does not simply mean land area. It has too much to do with resources and ecosystem. What's more, it involves some factors such as the above-mentioned carrying and population supporting capacity, and more other economic and social parameters, and these may combine together to make sense of a new conception the urban comprehensive carrying capacity in the context of ecosystem, economy and society dimensions rather than the externally imposed accumulation process, thus attain the optimum mechanism of resources, environment, economy and society on a harmony scale.

The main contribution of this paper is the redefinition of the urban comprehensive carrying capacity as an entanglement of resources carrying capacity, economic carrying capacity and social carrying capacity, and lists the key assessment indices in three differentiated layers and discusses in depth, thus pioneers in the research perceptions. The first section of the study encompasses the co-relations between urbanization and the urban comprehensive carrying capacity. Section two outlines the conceptual framework of the comprehensive carrying capacity, and lists its enriched definition with ecological, economic and social ties. Section three offers conclusions as to the entanglement of the ecological, economic and social carrying capacity in the regional development of the chosen cities on the sustainable basis.

2. Literature Review

Urbanization supports a counsel of wonders as the concentration of the motive powers of society in big cities, thus sprouts the intensified research on the concept of carrying capacity. In effect, far from being a neutral and objective measure of ecological stress, the urban comprehensive carrying capacity is already being mentioned by some scholars and consolidated their alternative option of research beyond ecology and resources. The core part of the research is the maximal load of the recipient cities in the process of urbanization. The "modern" emergence of carrying capacity dated back to an essay published in 1798 by Thomas Malthus. The essay hypothesizes that human population tends to grow in an exponential fashion, but that food production is limited to arithmetic growth (Malthus, 1798). The study on carrying capacity of resources and environment originated from the demographics, species biology and applied ecology (Dhondt, 1988; Cohen, 1995; Price, 1999; Seidl and Tisdell, 1999; Graymore, 2005). It is now applied to a wide range of disciplines, including biology, ecology, anthropology, geography, tourism and business management. Since the end of 18th century, some west scholars have established the theoretical and methodological bases on the study of carrying capacity (Malthus, 1798; Verhulst, 1838; Odum, 1953; Hardin, 1986; Slesser, 1990; Daily and Ehrlich, 1992; Meyer and Ausubel, 1999). A long list of Chinese scholars have addressed the carrying capacity issue in the domestic regional arena and their analyses mainly focus on different aspects such as carrying capacity of regional talents (Wei and Feng, 2010), ecological carrying capacity rationale (Zhang and Wang, 2010; Liu and Cao, 2010; Li, 2009; Chen and Nie, 2010; Qiao, 2009), the carrying capacity in the lens of resources such as land& water and environment (Feng and Liu, 2006; Chen and Hui, 2007; Tan et al., 2007; Yang and Liu, 2010; Gu and Li, 2010; Song, 2010; Duan and Liu, 2010; Tang and Guan, 2010), and a combination with direct or indirect reference to carrying capacity (Shi, 2010). With the deepening of the research on carrying capacity of resources and environment, more and more scholars have recognized the limitations and one-sidedness of the study on carrying capacity of the single-element perspective (Fang and Lin, 2009), and discussed actively the theories and methods of comprehensive carrying capacity of resources and environment.

The general literature review discloses that the scholars and practitioners have shown their worries and anxieties in their confined perspectives of research, and felt the necessitated spur in the definition of comprehensive carrying capacity. Yet no convincing breakthrough has been made in the published surveys which limit their theoretical acceptability. Just as overuse of not-easily replaceable resources is a transgression of long-term ecological carrying capacity, the concept of urban comprehensive carrying capacity requires the advocacy groups to acquire a diversified momentum in the fields of ecosphere, economic sustainability and social initiatives.

3. The Co-relations between Urbanization and the Urban Comprehensive Carrying Capacity

3.1 What is the Urbanization?

A conventional starting point is the definition of Hope Eldridge Tisdale, offered in 1942, that urbanization is a process of population concentration. It is the regrouping of a population over time from a dispersed to a concentrated settlement pattern, consequently reduces the population density of certain rural zones while increases the density of others, thus the process may be simply defined as a process of population concentration in more and/ or bigger cities. Later, other academics proposed a new conception of behavior urbanization that urbanization is a process that involves people in

urban behavior, modes of thought, and types of activity whether they live in cities or not. Then the phase-in of structural urbanization provides a more in-depth explanation of the relative doctrine that urbanization is the process of the change in the organization of society that fosters population concentration. The urbanization in such structural dimension places emphasis on the connection that a large number of people performing various urban functions thus require the appearance of coordinators such as bishops, merchants, bankers, provincial governors, communication lines and more cross-cutting relationships. The above-mentioned three phases of urbanization can not be disentangled from each other and makes it rather difficult to define which one predominates in a typical time period. Thus this interrelation can only be cited by a resultant fact, say, the uneven urbanization pace is quite obvious with the mid-China and eastern China fostering at a higher speed while western China experiencing a rather slower rate, in particular the ethnic regions.

3.2 The Urban Comprehensive Carrying Capacity and the Process of Urbanization

The origins of the term carrying capacity are uncertain with researchers variously stating that it was used in the context of international shipping or that it was first used during 19th century laboratory experiments with micro-organisms. While the biologists adhere to the opinion that the concept of carrying capacity is well rooted in biological science, and describes the rise and decline of plant and animal populations, thus define carrying capacity as the maximum population of a given species that can survive indefinitely in a given enviroment. Nowadays it evolved from the ecosphere such as the number of sheep or cattle that could be maintained on grazing land without degrading the land so that it could no longer support the animals, to the urban field of debates that cities may be defined as the transmission body of production factors of any kinds, and the spacial-system of inhabitants, economy and culture etc. This versatile functions of cities sprout a concept of comprehensive carrying capacity and it was more than often applied to relatively simple population-enviroment corelations.

A common fallacy is to equate existing and seemingly open or unused spaces with the kind of resources and ecologically productive land needed to support human life under modern conditions. The process of urbanization challenges this misappropriation and well alleges that the criterion of how many people a recipient city can accommodate, or as the case may be, whether a region is overpopulated or not, is not the land area, but the urban comprehensive carrying capacity. The urban comprehensive carrying capacity is a notion with rich implications and being affected by bundles of factors relative to the urban advancement with common attributions in one group. The general level of the comprehensive carrying capacity of a given region may reflect the aggregate supporting ability, and the potentiality in short time span either in ecological, economic, or social parameters. This may be considered as the natural capital stocks and may decay along with the population increase decided by the natural increase deducted from the birth rate and death rate of both the old inhabitants and the urbanized newcomers. The population migration and the necessitated consumption behavior are twins. Therefore, both should be carefully reexamined and ascertain that both can contribute to sustainability in light of carrying capacity considerations. It was noted that the consumption habits of humans are much more variable than those of other animal species, making it considerably more difficult to predict the carrying capacity of the earth, or that of a specific region. Consequently, the question, how many people can the Earth, or a specific region support, does not have a single numerical answer, now and ever. Anyway, one thing is rather clear that as the environment is degraded, carrying capacity actually shrinks, leaving the environment no longer able to support even the number of people who could formerly have lived in the area on a sustainable basis.

4. The Conceptual Framework of Urban Comprehensive Carrying Capacity

In view of biological science, urban carrying capacity is used to denote the optimum number of given species that a specific ecosystem could sustain without interfering with its basic structure and stability. This notion describes the rise and possibly following decline of plant and animal population including human being. It clarifies that there is a limit to the growth of any biological population, and declares that within a closed system some parameters may determine the pattern of population rise and collapse. Nowadays the concept of urban carrying capacity evolved from the ecosphere to the urban field of debates that urban area is the exact carrying body of all the inhabitants, and the further social and economic advancement conducted by such group, thus the soar-up of the social welfare in general sense. This versatile description sprout a concept of the urban comprehensive carrying capacity focsing on how many people a given urban area may absorb in in relation to a sustainable scale. The comprehensive carrying capacity refers to the maximum population that can survive indefinitely in a given enviroment if we take into full considerations of the biological, economic, and social factors of the cities, and furthermore, the combination of these factors may sustain economic activities for this maximal load on a long run basis.

4.1 The Resources Carrying Capacity

4.1.1 The Groups of Natural Capital Stock

Conventional economists and planners suggest that the factors of production are definitely substitutable for one another, and in which using any resources more intensively guarantee an increase in output. Their vision assumes the world in which because of technology and trade, human carrying capacity is infinitely expandable. Along with the industrialization of most so-called advanced countries, the ecological researchers couldn't keep blind to the fact that the material standards of the wealthy can not be extended to the others, since no all countries can be net importers of carrying capacity. More scholars began to worry that this group if big powers are running massive unaccounted ecological deficits with the rest of the planets, thus arise the concept of resources carrying capacity. The extensive research on the resources and ecosystem make quite clear the core doctrine that despite the technological sophistication, humankind are in a state of obligate dependence on the productivity and life support services of the ecosphere. Thus, on Earth, or even in a certain region as a limited close system, adequate land and associated productive natural capital are fundamental to the prospects for continued civilized existence.

As a stock of natural assets, natural capital has three broad classes of renewable, replenishable and non-renewable. Renewable natural capital, such as living species and ecosystems as forest, is self-producing and self-maintaining using solar energy and photosynthesis, and yield marketable goods as wood fiber and unaccounted essential service as climate regulation. Or a fish stock, which can provide a harvest after months or even years of careful feeding, and may increase or decrease in the numerical figure as the owner wishes. Replenishable natural capital, such as groundwater and ozone layer, is non-living but is also often dependent on the solar engine for renewal. As we all know, the ozone layer is so indispensable to human being for such services as waste assimilation, erosion and flood control, and protection from ultra-violet radiation. Finally, non-renewable natural capital such as fossil fuel and minerals, are analogous to inventories. Any use implies liquidating part of the stock. As the renewable and replenishable natural capital are essential for life support and are generally non-substitutable, these two categories are more important for sustainability research and impose far more constraints on the present inhabitants and future generations.

4.1.2 The Characteristics of the Resource Carrying Capacity

In brief, the resource carrying capacity refers to the maximal number of individuals who can be supported in a given urban area within natural resource limits, or in a deeper sense, the maximal accommodation ability of the given region to the social and economic activities for such the maximal load, and definitely, without degrading the natural ecological environment for present and future generations. The conception owes static characteristics, since from biological perspective, one can only define the carrying capacity level of a given region in a fixed state of resources, and within the chosen time span, as any kinds of resources may not experience a radical change within a short time span. On the other hand, the resource carrying capacity has the typical dynamics, as any estimates of resource carrying capacity are only conditional on future human choices and natural events. It may fluctuate along with the technological advancement, the mass migration etc. The technology innovation, once put in production use, can reduce the resource inputs in general for the same amount of output, thus enhance the resources carrying capacity of the chosen region. Yet the effects of population growth drastically reduce the bio-capacity for consumption levels per capita will simultaneously climb up.

4.1.3 The Sub-indices of the Resources Carrying Capacity

Resources carrying capacity is usually determined by two groups of indices. The first is pressure-support factors, which are fairly indispensable to the economy development of a certain region such as water, air, land, ecosystem, and resources of various kinds. Each of the factors may owe its own subsystem and has an enriched coverage for a respective index.

The other group may be called as pressure factors, which are some human-induced impacts both directly and indirectly on the environment, and consequently modify the local resources carrying capacity. The thorny problems are correlated with environmental externalities that are as broad as to include climate change, species loss, ozone depletion, deforestation, environmental acidification, illegal dumping of industrial wastes, chemical incidents—either sporadic release or chronic nuisance emissions, plausible exertion of raw materials, and non-point source biological pollution of rivers etc. Rather than expediting the mass population shift from the countryside to the urban city, preserving ecosystems is simultaneously necessary, especially in the domestic places that are particularly rich in biodiversity, and ensuring adequate food health and safety etc, because such concerns may ascend to the highlight of degraded environment, which might afflict the carrying capacity of a region, and also impact that of the regions thousands of miles away.

The biological carrying capacity tells us that the biophysical limits of our environment are key in determining how many human can survive at what levels of consumption. It clarifies that there is a limit to the growth of any biological

population within the given urban region, which inevitably places explicit limits for the embedded social and economic activities, and identifies some of the parameters that determine the pattern of population rise. Additional layers of complexity occur for the human population in terms of the dynamics involved. It is easy to understand the two cities living in exact proximity may have definitely different carrying capacity due to the range of criterion for determining whether a region is overpopulated or not.

4.2 Economic Carrying Capacity

4.2.1 The Implications of the Economic Carrying Capacity

The definition of the resources carrying capacity states that regardless of the technology, humankind depends on a variety of ecological goods and services provided by nature and that for sustainability, these must be available in increasing quantities from somewhere on the Earth as population and mean per capita resource consumption increase. The fundamental question for biological economics is whether the aggregate resource stock of the Earth, or of a certain city is adequate to sustain the present population, and the anticipated load of population increase. The market economy, and the continuous growth of domestic trade and international trade come to break this heightened threat of ecologically induced instability. Many ecological goods and the accompanied services are subject to market signals or the related behavioral change of the host environment, thus this group of necessities can be possibly internalized by physical flows and transformations through distances, say, from distant regions all over the world via the channel of commercial trade. So as a result of high population density in urban cities, the unavoidable increase in per capita energy and material consumption is made possible by technology and trade, thus the ecological locations of human settlements no longer coincide with their geographic locations. One may dare say that in twentieth century, cities and industrial regions are dependent for survival and growth on the hinterland of ecologically productive landscapes, so in twenty-first century the purely ecological terms is of little importance for the carrying capacity of a city, then what is comparatively significant to address the issue?

The answer is the economic carrying capacity. Though it is beyond the research of the mainstream analyses, and far from a perfect mechanism of definition, layers of sub-indices, and updated approaches and models, it poses overwhelming importance in the referent research. The urban economic carrying capacity refers to the notion that at what level of capabilities the resources within the chosen urban area can be effectively contributable to the economic development. It mainly supports the argument that to be sustainable, the supporting capability of a city should be adequate to the economy factors as population, enterprises and technology. Obviously it is predictable in the short run based on the current pace of economic development and the explicit or inexplicit economic policies. Since the economic development requires continuous flows of technology advancement, the phase-in of newly born enterprises and the move-up of the labor structures etc, the urban economic carrying capacity is, in no case, a constant speculation.

4.2.2 The Sub-indices of the Economic Carrying Capacity

The economic carrying capacity is made up of various indexes in hierarchical order with four core elements as economic aggregate, economic structure, economic level and economic benefit. Economic aggregate is usually the first determinant of the urban economic carrying capacity. It can well portray the general development scale and pace of a chosen region, and usually the core index in the macro economic regulation. Economic aggregate mainly consists of the elements as GDP, number of total population and labor forces, land area etc, and these indices combine together to signal how many population and how many newly born enterprises may phase in such a region in future time.

Economic structure contains various indices such as industrial structure, commodity structure, technology structure, structure of enterprise scales, employment structure etc. These factors interweave with each other to act as the indispensable foundation of the economic activities of a region and the important determinant of its future development trend.

Economic level can well reflect at which phase of development the chosen region is undergoing its economic advancement, and furthermore, to identify the concrete difference with other regions, then to choose its directive strategies for future soar-up. The sub-indices include real income per capita, three industrial structure, gross agricultural output value per head, total industrial output per capita, output value of tertiary industry per head, financial revenue per person, investment in fixed assets per capita, retail sales of social consumer goods per head, urbanization level, coefficient of structure similarity, index of special structure concentration etc.

Economic benefit refers to the efficiency of the production factors inputs in the material production process of a region. It consists of the different indicators as integrated investment benefit, investment effect coefficient, rate of investment in fixed assets etc.

The above-mentioned four factors work together as the resultant force of economic carrying capacity of a certain city,

which is the pillar establishment for present pace of economic development, and the future potentiality and trend as well.

4.3 Social Carrying Capacity

4.3.1 The Implications of the Social Carrying Capacity

A related rationale for carrying capacity is the social carrying capacity. The social carrying capacity states the supporting ability of a given region to its inhabitants in the context of economy development condition. This very supporting capacity refers to both the supporting capacity for population quantity and the supporting capacity for population quality. The former means how many people either the present citizens or the possibly future inflows the city may accommodate, or we may define it as population load the urban social resources may sustain for the present and future inhabitants of the given region. The latter announces that despite the mere population increase, the possibly adequate capability to enhance the living quality for this group of people.

4.3.2 The Characteristics of the Social Carrying Capacity

The social carrying capacity owes the characteristics of constancy, changeability and exclusiveness. It is comparatively constant for the reason that though how many humans the city can realistically support can't be answered exactly, the finite amount of population that can be raised in a chosen place is evident, because the social resources of any kinds couldn't be altered or improved within a short time span. The changeability explains the social supporting capacity of the city has a nature of fluidity, and it may be expanded, slowly and gradually, along with the urban development. Exclusiveness is that accompanied with the urbanization process, the inflows of the social resources can't sink in easily, thus can't integrate with the original system as a unified entity in short time.

4.3.3 The Sub-indices of the Social Carrying Capacity

Social carrying capacity is a well-founded premise that despite our increasing technological sophistication, humankind remains in a state of obligate dependence on the productivity and life support services of the ecosphere. Thus, from an ecological perspective, adequate land and associated productive factors are fundamental for continued civilized existence on the Earth. However, the revival of many other elements should be cited in sustainable development planning, such as population development, living quality, science, technology& education, medical care, social security system etc.

Population development is a rather abstract notion. It mainly signifies besides population increase, the intended improvement of quality of the new-comers and the change of living habits as what is previously outlined as behavior urbanization is much more important. That is, urbanization triggers an elevation process in urban behavior, modes of thought, and types of activity of the fresh dwellers from countryside, therefore they can really merge into the urban life.

Living quality is typical of the differentiated historic ages, since people have diversified demands for the living necessities while the living standards increases as the economy advances. Furthermore, it tends to be stimulated as the time goes and economic activity strengthens. Living quality is the overall evaluation of humans to its living environment, and in the micro sense, including the subjective attitude towards the community surroundings. It can be shown by bundles of factors as income level, employment, income distribution, health care, recreational activities, infrastructures etc.

Science, technology& education are usually considered as the driving forces for the general development of a given region. It refers to the process during which the government of the region help their citizens to acquire the practical knowledge and skills, thus help them to gain proficiency in problems solving. Obviously, it is conductive to economic advancement, and to the thinking models, culture dissemination, and ethics integration as well. The involving assessment indices are number of professional workers and technicians, the ability of technology innovation and assimilation, contribution rate of science& technology to economy growth, achievements in scientific research, number of patents, differentiated levels of education especially university, college and beyond, number of on-the-job training institutions and their teaching abilities, school-age children enrollment rate etc.

For the human population, more complex variables such as sanitation and medical care are sometimes considered as part of the necessary establishment. The medical care can be measured through indices as number of polyclinics, number of specialized hospitals or that of traditional Chinese medicine, hospital beds, survival possibilities of emergency rescue, and the average hospitalization days of inpatients etc.

Social security system is a series of safeguard arrangements of a nation or a local government for its citizens, especially for those with living difficulties, to ensure their basic living standards. It is closely correlated with the welfare levels of every citizen, and thus the basic foundation for society stability and sustainable development. The key indicators include social insurance, social benefit, social relief, social special care and so on.

4.4 Redefinition of the Urban Comprehensive Carrying Capacity

Based on the biological, economic and social considerations for the comprehensive carrying capacity of a chosen urban area, we can provide a useful diagram for the entangled correlations of the four individual systems. This is somewhat compatible with the famous Newton's Second Law of Motion-force and Acceleration abbreviated as F=ma, yet may offer further argument to shift the emphasis in analysis from the conventional mainstream methods.

<Figure 1 about here>

As shown in figure 1, the vector equation requires the three involving forces be integrated in the same direction, which definitely has positive pushes or accelerations for the possible climb-up of the comprehensive carrying capacity. A fundamental question is to classify the concerned factors into final research goals and subgroups serving to illustrate the analysis purpose, and furthermore, can offer fresh perspectives in policy-making in the epoch of urbanization as illustrated in figure 2.

<Figure 2 about here>

5. Conclusion

In brief, the urban comprehensive carrying capacity is a complex chaos interconnected with the ecological, economic and social throughputs of the development-oriented region. This relationship manifests the material difference between the coupling induction and the respective results of any of the aforesaid individual carrying capacity. The latter, no matter whatever the perspectives we may choose, may only allege something which is attributable to this high-ordered, dynamic, far-from equilibrium system and its co-related subsystems, and all the relative elements get much in common and share a comparatively simple relationship. In this light, the comprehensive carrying capacity owes a sense of complication. It is a combination of three self-organizing non-equilibrium systems with all concepts fundamental to sustainability, yet seeming alien to each other. So, the comprehensive carrying capacity is rather an abstracted rationale than what it is supposed to represent by a simplified linear calculation.

Based on the thorough analysis, we may conclude that the urban comprehensive carrying capacity bears something typical. Firstly, the constancy that is decided by many factors which seem uneasy to be altered or bettered conspicuously within a short time span as the aforesaid climate and resource endowments etc. Secondly, the dynamics lies in the comprehensive carrying capacity. As the comprehensive carrying capacity depends on the conditions and resources available in the specific area, and the consumption habits of the species considered. Since both what is available in the area, and the consumption habits of the species in general change over time, the comprehensive carrying capacity for any given area is always changing. It is a function not only of population size, but also of differing levels of consumption, and can be altered by improved technology. Last is the complexity of the factors involved and interacted for a general carrying capacity level of a specific region. In broad sense, the various factors may include population stabilization, national revitalization, economic sustainability and resource conservation etc. In micro range of views, the comprehensive carrying capacity is the environment's maximal load affected by many factors as population size, the species concerned in general, habitat, food availability, water supply, living space, sunlight, environmental conditions and other necessities available in the environment. For the human population, more complex variables such as sanitation and medical care are sometimes considered as part of the necessary establishment. All the possibly existing elements intertwine for a result as to what exact number of individuals a given environment can support without significant negative impacts to the given organism and its environment.

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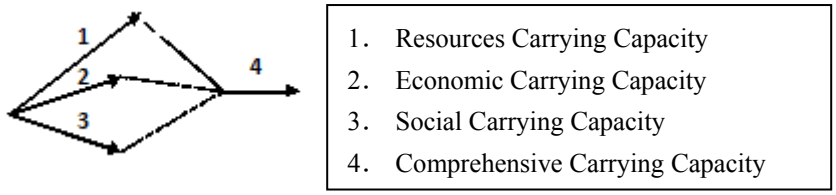

Figure 1. The Vectogram of the Urban Comprehensive Carrying Capacity

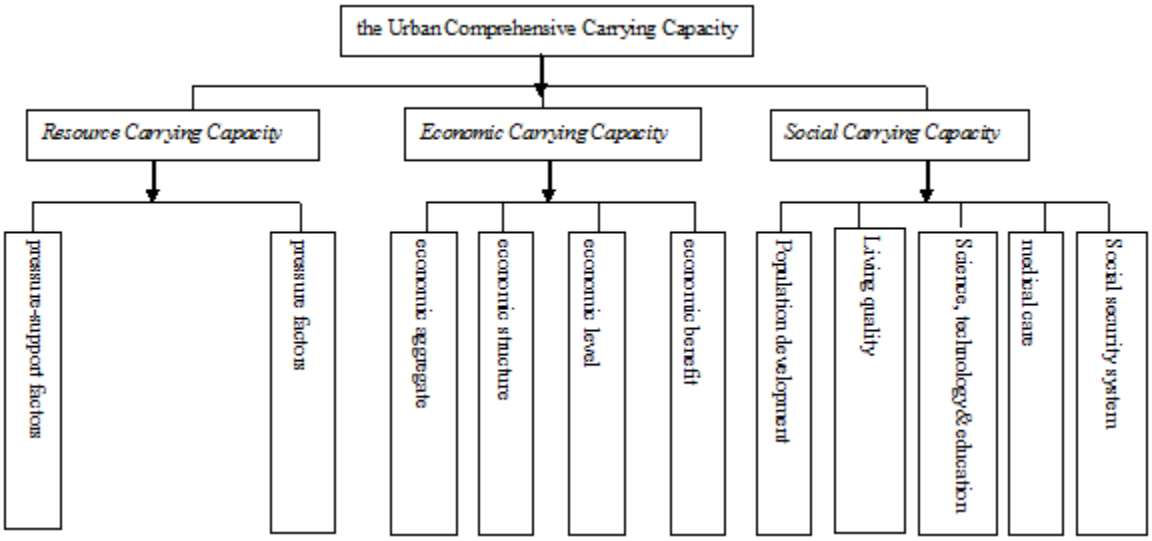

Figure 2. The conceptual framework of urban comprehensive carrying capacity