Current Chinese Economic Report Series

Kui Wen
Erjuan Zhu *Editors*

Report on Development of Beijing, Tianjin, and Hebei Province (2013)

Measurement of Carrying Capacity and Countermeasures

Springer

Current Chinese Economic Report Series

More information about this series at http://www.springer.com/series11028

Kui Wen • Erjuan Zhu
Editors

Report on Development of Beijing, Tianjin, and Hebei Province (2013)

Measurement of Carrying Capacity and Countermeasures

Springer

Editors
Kui Wen
Capital University of Economics and Business
Beijing, Beijing, China

Erjuan Zhu
College of Urban Economics and Public Administration
Capital University of Economics and Business
Beijing, Beijing, China

ISSN 2194-7937 ISSN 2194-7945 (electronic)
Current Chinese Economic Report Series
ISBN 978-3-662-46204-1 ISBN 978-3-662-46205-8 (eBook)
DOI 10.1007/978-3-662-46205-8

Library of Congress Control Number: 2015935063

Springer Heidelberg New York Dordrecht London
© Social Sciences Academic Press and Springer-Verlag Berlin Heidelberg 2015
This work is subject to copyright. All rights are reserved by the Publishers, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publishers, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publishers nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

Springer-Verlag GmbH Berlin Heidelberg is part of Springer Science+Business Media (www.springer.com)

Members of the Editorial Board

Blue Book Series on Beijing, Tianjin, and Hebei Province

Wen Kui: Professor and Doctoral Tutor of the Capital University of Economics and Business, director of the editorial board for Blue Book Series on Beijing, Tianjin, and Hebei

Wang Jiaqiong: Principal, Professor, and Doctoral Tutor of the Capital University of Economics and Business

Ding Lihong: Deputy Principal and Professor of the Capital University of Economics and Business

Wang Minglan: Deputy Director and Researcher of Research Office of the People's Government of Beijing Municipality

Yang Kaizhong: Deputy Director of the Beijing Development and Reform Commission, Secretary-General, Professor and Ph.D. supervisor of Peking University, President of the Regional Science Association of China

Wei Houkai: Deputy Director and Researcher of the Institute for Urban and Environmental Studies Chinese Academy of Social Sciences and Doctoral Tutor

Xiao Jincheng: Director and researcher of the Institute of Spatial Planning & Regional Economy, National Development and Reform Commission P.R.C, and Doctoral Tutor

Sun Jiuwen: Director and Professor of the Institute of Regional and Urban Economy, Renmin University of China, and Doctoral Tutor

Li Guoping: Deputy Dean of the School of Government of Peking University, and Dean of the Beijing Development Institute, Professor, and Doctoral Tutor

Fang Chuanglin: Director, Researcher and Ph.D. supervisor of the Office of Urban geographic and Urban Development Research, Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences

Dong Suocheng: Director, Leading Professor and Ph.D. supervisor in Regional Ecological Economics and Resource Economics, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences

Shi Minjun: Deputy Director of the Research Centre on Fictitious Economy and Data Science, Chinese Academy of Sciences, and Professor and Doctoral Tutor of the University of Chinese Academy of Sciences

Yang Zhenjiang: Deputy Director of the Tianjin Development and Reform Commission, Director of the Binhai New Areal Development and Reform Commission, and researcher

Hao Shouyi: Dean of the Binhai Research Institute in Tianjin, and Professor and Doctoral Tutor of Nankai University

Zhou Liqun: Dean of the Binhai Development Institute Nankai University, Professor and Doctoral Tutor;

Wang Liguo: Deputy Dean and researcher of the Tianjin Academy of Social Sciences

Wang Tianwei: Researcher of the Institute of Economics, Tianjin Development and Reform Commission

Zhao Hong: Vice-principal and Researcher of the Beijing Academy of Social Sciences

Wu Yiqing: Deputy Principal and Professor of Hebei University of Economics and Business

Zhang Gui: Professor, Ph.D. supervisor and deputy director of center for Beijing-Tianjin-Hebei Development Research in Hebei University of Technology

Shen Tiyan: Professor, Ph.D. supervisor of the School of Government management in Peking University. Executive Vice Director of the China Center for Regional Economic Research

Zhang Yaojun: Associate Professor of the Population and Development Research Center, China Renmin University

Jiang Sangeng: Deputy Dean of the Institute for Economic and Social Development of Megalopolis, Capital University of Economics and Business, Professor and Doctoral Tutor

Zhu Erjuan: Professor and Doctoral Tutor of the College of Urban Economics and Public Administration, Capital University of Economics and Business

Contents

Part I
General Report

Chapter 1
Basic Situation of Carrying Capacity of Beijing, Tianjin, and Hebei Province and Development Countermeasures

Kui Wen, Erjuan Zhu, Guixiang Zhang, Tanglin Ye, Qingling Wu, and Hui Zhu

1.1 Research Background and Multiple Perspectives

1.1.1 Background

Globally – The contradiction between the human pursuit for a higher standard of living and the limited resources and environmental carrying capacity of the Earth is growing progressively. With the rapid development of industrialization and urbanization around the world, the development of mega-cities and metropolitan regions has become an irresistible trend. With rapid growth of urban population and rapid expansion of quantity and size of cities, resource environment of cities and regions is facing increasing pressures and serious challenges. In particular, in the context of the global climate crisis, whether development of cities and regions can adapt to the carrying capacity of resources and environment is at stake.

China – In the face of a severe situation of tight resource constraints, serious environmental pollution and ecosystem degradation, achieving sustainable development is a vital objective for its ecological civilization. After the 18th National People's Congress, promoting the construction of an ecological civilization is regarded as a priority for economic and social development to actively promote the transformation of the development mode.

Beijing-Tianjin-Hebei region – There are increasing pressures on the regional resource and environment so that we urgently need to set the foundation, and then explore the valid method to ease the pressure and to enhance carrying capacity. The "Twelfth Five-Year Plan" period is an important phase for Beijing-Tianjin-Hebei

K. Wen (✉) • G. Zhang • T. Ye • Q. Wu • H. Zhu
Capital University of Economics and Business, Beijing, Beijing, China

E. Zhu
College of Urban Economics and Public Administration, Capital University of Economics and Business, Beijing, Beijing, China

© Social Sciences Academic Press and Springer-Verlag Berlin Heidelberg 2015

K. Wen, E. Zhu (eds.), *Report on Development of Beijing, Tianjin, and Hebei Province (2013)*, Current Chinese Economic Report Series, DOI 10.1007/978-3-662-46205-8_1

region to accelerate economic restructuring, industrial upgrading, and to build world-class technology innovation base, advanced manufacturing research and development transformation base, and heavy chemical industry base, and a crucial period of regional industrial integration, spatial optimization, urban and rural integration, eco-building and constructing a city agglomeration with more international competitiveness. With the mass gathering of the modern industry, especially the chemical industry, in coastal areas, the pressure of regional resource and environment is increasing; with the accelerated process of urbanization, more and more population flow into mega-cities such as Beijing and Tianjin, which has brought enormous pressure on urban transportation, resource ecology, and public services. We urgently need to make a basic judgment about the carrying capacity of Beijing-Tianjin_Hebei region, and need to explore effective methods to ease the pressure and to enhance the carrying capacity at the foundation.

1.1.2 Multiple Perspectives

In today's norm of global low-carbon development, the ecological civilization in China is regarded as an objective of sustainable development for the Chinese nation, as well as Beijing, Tianjin, and Hebei, to build eco-livable homes under the guidance of the concept of scientific development, we believe that, when researching and estimating the carrying capacity of a city or a region, and exploring the method of "decompression and increasing capacity," it is necessary to expand the field of research. We not only need to integrate a single element with carrying capacity, urban carrying capacity combined with regional, but also integrate practical carrying capacity with the potential capacity, and absolute capacity and relative capacity. These new perspectives and new understandings help us to grasp the nature, to understand the rule, to broaden our horizons, and to tap into the potential, which provide theoretical guidance for the realization of regional harmonious development between man and environment.

About the studies from carrying capacity of a single element to integrated carrying capacity. Evolution of the concept of carrying capacity experienced the development course from the community carrying capacity, the resource carrying capacity and the ecological carrying capacity to the integrated carrying capacity (See Table 1.1), because the human depends not only on the natural ecological environment, but also complex environments supported by the artificial environment system and socio-economic system. Therefore, it is necessary to expand the studies from a single-element carrying capacity to integrated carrying capacity. Integrated carrying capacity refers to the carrying capacity of a city or a region's natural resources, ecological environment, infrastructure, and social facilities for economic and social activities and urban population. It consists of the carrying capacity of the natural environment and the carrying capacity of the artificial environment, both in regards to the population and it's socio-economic activities, and are influenced and constrained by the socio-economic support system. As for today's large cities, particularly metropolitans, research on single-element natural

Table 1.1 Evolution of the concept of carrying capacity

Name	Background	Meaning
Community carrying capacity	Ecology development	Bearable quantity of ecosystem for communities living in it
Land carrying capacity	Population expansion, shortage of land resources	Productive capacity of land resources in a region, as well as bearable population under certain conditions
Carrying capacity of water, minerals and other resources	Shortage of water, minerals and other resources, population growth, surge in industrial water	Bearable population of water and other natural resources in a region, bearable strength of industrial and agricultural production activities of water and other natural resources in a region
Carrying capacity of environment	Environmental pollution	Holding capacity of regional environmental for pollutants, bearable strength of a regional environmental for human development activities
Carrying capacity of ecology	The integrity of ecosystem damages, functions reduces	Bearable maximum socio-economic activity strength or interference limit of ecosystem
Complex carrying capacity	"Urban disease" of mega-cities	Natural resources and environment, economic and social resources and environment form a complex, multi-level ecosystem; and "human-land system" are opposites

Source: The table is compiled on the basis of precursors' research findings

carrying capacity is clearly not enough. For example, a storm in Beijing on July 21, 2012 exposed the vulnerability and weakness of the urban infrastructure in Beijing – the limit of the carrying capacity of the underground pipe network, which warns us about the city security. Only when perspectives of research expand from the natural carrying capacity to a comprehensive one can our vision, means, and methods to find and solve problems be wider and more in line with the actual development.

About the studies of the carrying capacities from cities to regions. We paid more attention to studies on carrying capacity of a single city in the past, which was necessary at the early stage of single city development. But at the present day of economic globalization and regional economic integration, global resource allocation has changed, and any city is a component part of the urban system in the world, and a highly open system. A city owns limited resources, but through opening to the outside world and exchange, it can obtain and share resources from other regions to achieve sustainable development. Particularly like the capital Beijing, the ultra-mega-city with a population over ten million where it is difficult to bear the burden of its resources and ecological environment, it really needs to have wide regional visual field, and needs to put urban development in a larger region. It is possible for the pressure of a city to be mitigated in a larger region; it is expected that its own

"short board" of resources and environment can be extended in a region; it is possible for surrounding areas, with its own resource advantages, to become its resources through functions complementation.

About studies from absolute carrying capacity to relative capacity. The relative carrying capacity can be studied through setting targets of carrying capacity and looking at the relationship between supply and demand of carrying capacity. In the same conditions of resource ecological environment and socio-economic and technology, relative to the different standards of per capita consumption and given life goals, different resources and environments bear different population sizes. "The maximum number of people the earth can support" is very different from "the maximum quality for the people on earth." The former only meets the basic standard of existence, and the latter meets the ideal or optimal goal, such as wealth and environmental livability, and so on. Similarly, from the point of view of supply and demand of resources and environment, the smaller the population size and economic and social activities as carrying objects are, the smaller the fixed carrying pressure of resources and environment is, the stronger the relative carrying capacity is.

About the studies from practical carrying capacity to potential capacity. Practical carrying capacity can be measured according to the "Barrel Theory." If the amount of water in the barrel depends on the shortest slab of the barrel, practical carrying capacity of cities or regions is measured by a minimum practical carrying capacity in individual resources and development conditions, and potential capacity can be obtained through change of impact factors, remedy of the "short board" and then upgrade urban integrated carrying capacity. In fact, there is potential carrying capacity in real life. For instance, through technological progress and efficient use of land, the original land carrying capacity for the population can be greatly improved. If analysis and measure of practical carrying capacity of cities or regions are the important prerequisite to grasp the current status and trends and to find the "short board" of carrying capacity, it is more important for us to attach importance to the studies of potential carrying capacity. We can discover, explore and release potential carrying capacity through analysis of various influencing factors of carrying capacity of resources and environment, and can find an effective way to solve the difficult problems, to break through bottlenecks, to mitigate the pressure, and to improve the carrying capacity.

1.2 Analysis Framework and Indicators to Measure

1.2.1 Theoretical Basis

Mechanics theory – the mechanics theories involved in the studies on carrying capacity include theories of statics in classical mechanics, structural mechanics, fluid mechanics, mechanics of materials, soil mechanics, and rock mechanics, and

other sub-disciplines. Among them, the statics mainly concerns how to set up equilibrium conditions of various systems of forces in the system under static conditions. Structural mechanics mainly solves the law of stress and transmission of carrying structural system, as well as how to optimize the existing carrying structure. Fluid dynamics mainly focuses on the law of motion of comprehensive carrying factor in variable conditions.

Ecological theory – ecology is the science of the relationships between organisms and their environments. Its development has manifested three main characteristics: from qualitative studies to quantitative studies, from individual ecological systems to complex ecological systems, and from basic science to applied science. The basic theories about ecology include biological environment, ecological factors, the succession of biotic communities and the ecological system theory.

Economic theory – the application of economic theories in the carrying capacity is mainly manifested in the application of the bifurcation theory in economics including development economics, regional economics, population economics, and environmental economics. Many environmental problems can be described by economic terms, such as allocation of scarce resources, allocation of risks and benefits, competitive benefits, and so on, as well as a lot of environmental damage is also due to economic factors. The economic theory is applied to study the carrying capacity mainly to solve how scarce resource environments and artificial environments achieve the optimum allocation and effective utilization in the development process of cities or regions, and how economy, society and ecology achieve their harmonious development.

Sociological theory – sociology is strongly integrated humanities, is concerned with systems, groups, psychology, security, and structure of human society. The sociological theory is applied in studies on carrying capacity to mainly discover characteristics of social activities of regional social groups, such as behaviors, norms, practices, psychology, and structure and the intrinsic mechanism of influencing the carrying capacity, and effective ways to settle how to mitigate the pressure through changes of influencing factors, such as advances in science and technology, lifestyle, values, social systems, to enhance the carrying capacity.

1.2.2 Analytical Framework

This paper argues that, theoretical analytical framework of integrated carrying capacity of a city or region can consist of carrying objects, the carrier, and external environment. Carrying objects mainly include population size, consumer pressure, human socio-economic activities, and pollutants. The carrier consists of two parts, the carrying capacity of the natural environment and of the artificial environment. Carrying capacity of the natural environment consists of the natural resources system and eco-environmental system; the system of natural resources includes land resources, water resources, mineral resources, and forest resources; eco-environmental system includes air, water, soil, and biological species. Carrying

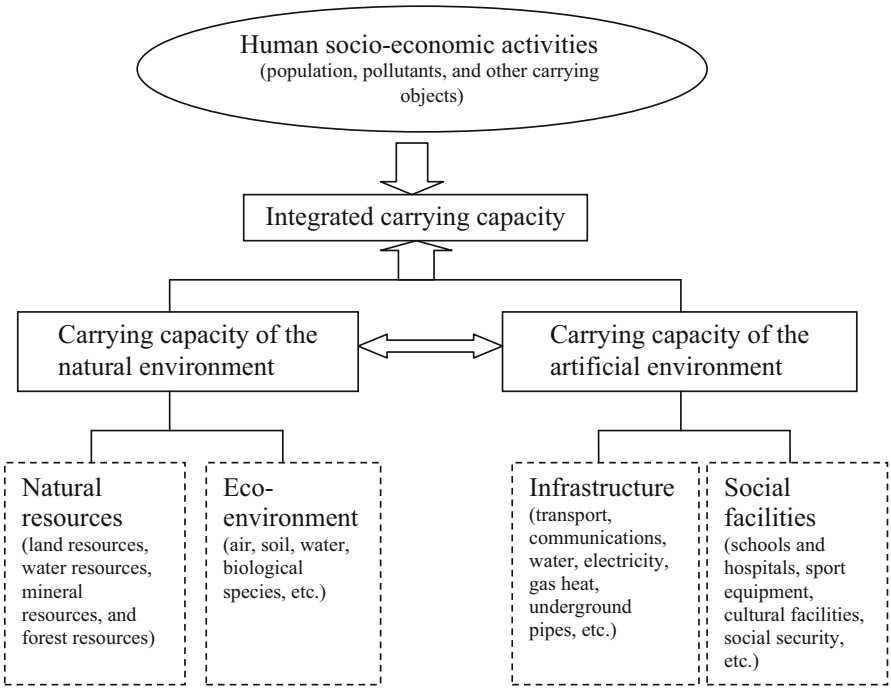

Fig. 1.1 Structure of integrated carrying capacity

capacity of artificial environment consists of infrastructure (such as transport, communications, water, electricity, gas heat, underground pipes, etc.) and social facilities (such as the facilities of science, education and culture and health, including schools and hospitals, public services, social security, etc.). The external environment is the economic and social support system. Whether the carrying capacity of natural environment is the first environmental carrying capacity and the carrying capacity of artificial environment is the second one, all are in economic and social development conditions and environments, and are influenced and constrained by economic hard factors (such as GDP, per capita GDP, financial revenues, etc.) and social soft environment (such as system, culture, management, etc.). See Figs. 1.1 and 1.2.

1.2.3 Interrelation

First one is the relationship of carry and carried and of action and reaction between the carrying capacity of natural environment and the carrying capacity of artificial environment within the carrier. The carrying capacity of the natural environment is also called the first environmental carrier, is the basis of sustainable development of

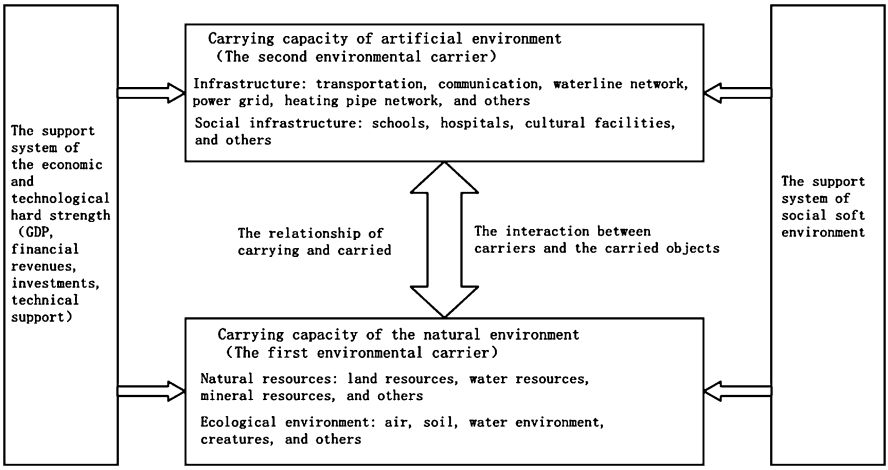

Fig. 1.2 The relationship between carrying capacity and social and economic support system

cities and regions, and it decides the direction, scale, and speed of human activities. The carrying capacity of artificial environment is also called the second environmental carrier, is the indispensable carrier for the normal operation of the human economic and social activities. Carrying capacity of artificial environment has carrying capacity for carrying objects (such as population size, consumer pressure, pollutants, and human socio-economic activities), and has some pressure on the carrying capacity of the natural environment; it is restricted and influenced by the carrying capacity of the natural environment, and its development reacts to the carrying capacity of the natural environment and human economic and social activities.

Second one is the interaction between carriers and the carried objects. Natural and artificial environmental carrying capacities together compose the integrated carrying capacity of a city or region, and jointly support cities, regions, countries, their population, and their socio-economic activities. The carrier and carried objects actually have a supply and demand relationship. The basic path of harmonious development between carrier and the carried object can be found through enhancing the carrying capacity and alleviating the pressure.

Third one is the interaction between the carrier and the external environment. Both the carrying capacity of the natural environment and the carrying capacity of artificial environment is influenced and constrained by it. They are both dependent on the economic and social support system, and are influenced and constrained by the economic and technological hard strength (such as GDP, financial revenues, investments, technical support, etc.) and the social soft environment (such as systems, culture, management, etc.). In general, the stronger the economic strength of a city or region is, the stronger the carrying capacity of the artificial environment. The higher the level of social development is, the stronger the people's consciousness of protecting the environment and energy conservation, and the lower the resource consumption and the environmental pollution.

1.2.4 Indicators to Measure

Integrated carrying capacity of a city or region is composed of a series of self-checks and corresponding development variables and constraint variables: (1) Natural resource environment variables: type, quantity and development capacity of land resources, water resources, mineral resources, and biological resources, as well as self-purification capacity of water, gas, and soil; (2) Artificial environment variables: transportation, communications, and underground pipe network, and other infrastructure variables; school, hospital, social welfare, public service facilities, and social facility variables; (3) Variables of economic and social conditions: population, per capita GDP, per capita disposable income and other economic variables, as well as education of science and technology, system management, cultural awareness and other social variables. If the objects we study are the first two variables, the carrying capacity, the variable of economic and social conditions is an indispensable factor to influence the carrying capacity. This study focuses on six elements of carrying capacity, namely land, water resource, ecological environment, population (object carried), transportation, and other infrastructure, social facilities such as science, education, culture and health, as well as economic and social influencing factors. This study regards the above three variables, namely natural resource environment variable, artificial environment variable, and variable of economic and social conditions as the Level-I indicators, regards the six factors focused on as Level-II indicators, and respectively selects some indicators that can reflect the development variables (namely supply support) and constraint variables (demand pressure) as Level-III indicators, so as to compose the measuring indicator system of integrated carrying capacity. See Table 1.2.

1.3 Analysis of the "Short Blab" of Carrying Capacity in Beijing, Tianjin and Hebei

This study has respectively made empirical analysis to land, population, water resources, ecological environment, infrastructure and social facilities of Beijing, Tianjin and Hebei, and integrated carrying capacity analysis of Beijing, Tianjin and Hebei using integrated carrying capacity evaluating indicators, and has found that the carrying capacity of Beijing, Tianjin and Hebei follows the "short board," which urgently needs to be resolved.

Table 1.2 Evaluating indicator system of integrated carrying capacity of cities and regions

Level-I indicators	Level-II indicators	Indicators of reflecting supply and demand	Level-III indicators	Measurement unit
Carrying capacity of natural resource environment	Carrying capacity of land	Pressure	Population density	Person/sq.km.
			Per capita residential land area	sq.m./person
			Per capita industrial land area	sq.m./person
			Per capita dwelling space	sq.m.
			Land area required GDP per hundred million RMB	sq.km./a hundred million RMB
			Per capita area of land used for building	sq.m./person
		Supporting capacity	Regional land area	sq.km.
			Per capita built-up area	sq.m./person
			Per capita arable area	sq.m./person
			Proportion of unused land	%
			Per capita land area	sq.km./person
			Building floor area ratio	
	Carrying capacity of water resources	Pressure	Per capita water consumption	cu. m./person
			Water consumption of farmland per Mu	cu. m./Mu
			Unit GDP water consumption	cu. m./Mu
		Supporting capacity	Per capita fresh water resources	cu. m./person
			Annual rainfall-water resources	A hundred million cu. m.
	Carrying capacity of eco-environment and energy sources	Pressure	Annual per capita domestic refuse discharge	kg./person year
			Water consumption of ten thousand RMB GDP	cu. m./ten thousand RMB
			Unit GDP energy consumption	ton/ten thousand RMB GDP
			Non-fossil energy proportion	%
		Carrying capacity	Per capita green area	sq.m.
			Built-up area green area percentage of coverage	%
			Percentage of treatment of domestic sewage	%
			Percentage of waste innocent treatment	%

(continued)

Table 1.2 (continued)

Level-I indicators	Level-II indicators	Indicators of reflecting supply and demand	Level-III indicators	Measurement unit
			Percentage of number of good days of city zone at level-II air quality above	%
			Proportion of self-generated energy in current drain (%)	cu. m./person
			Proportion of environment treatment investment in GDP	%
Carrying capacity of artificial environment	Carrying capacity of infrastructure	Pressure	Gross volume of passenger traffic	Ten thousand person-times/year
			Gross freight amount	Ten thousand ton/year
			Unit GDP annual gross freight amount	ton/ten thousand RMB
			Unit area traffic flow	Vehicle/ha.
			Quantity of cars per hundred households	Vehicle/hundred household
			Illegal road use rate of vehicles	%
		Supporting capacity	Urban per capita valid traffic land use area	sq.m./person
			City zone underground mileage density	km/sq.km.
			Car park area density	km^2/sq.km.
			Per capita overall railway mileage	km./ten thousand persons
			Per capita overall highway mileage	km./ten thousand persons
			Urban ponding space density	M^3/sq.km.
			Percentage of urban ponding domain coverage	%
			Urban drainpipe density	km./sq.km.
	Carrying capacity of social facilities	Pressure	Number of students in general colleges and universities	Ten thousand persons
			Proportion of aged population in total population	%
			Percentage of social security coverage	%

(continued)