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Determining development density using the Urban Carrying Capacity Assessment System

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Abstract

As the urban population increases, so do diverse urban problems and concerns including issues of servicing large numbers of people within existing infrastructures, as a result of over-development and over-concentration. Environmental problems, particularly air and water pollution, have become more evident and are now considered central issues for urban planners and decision-makers. To address these environmental problems, practical approaches which incorporate the concept of carrying capacity into managing urban development are needed.

This research aims at developing an integrated framework for assessing urban carrying capacity which can determine development density based on current infrastructures and land use. First, seven determining factors were identified for urban carrying capacity including energy, green areas, roads, subway systems, water supply, sewage treatment, and waste treatment, and the assessment framework was developed by integrating such factors. Secondly, the Urban Carrying Capacity Assessment System, a GIS-based carrying capacity assessment system, was developed based upon the framework. Finally, through a case study for determining the carrying capacity for an area in Seoul, South Korea, it was revealed that decision support with UCCAS demonstrated in this research can play a pivotal role in planning and managing urban development more effectively.

Keywords: Development density; Sustainable development; Urban management; Urban Carrying Capacity Assessment System; GIS

1. Introduction

Seoul is a high density, high development area with a disproportionately large concentration of residents. Approximately one quarter of the total population of South Korea live in the capital due to the fact that it is the nation's administrative, business, and commercial center. Consequently, massive and high-rise development has been an ongoing problem resulting in environmental problems such as air and water pollution.

The primary concern for administrators in the city, particularly during the major economic growth period

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in the 1960s and 1970s, has been the establishment of appropriate infrastructures for the number of people targeted. Their efforts initially focused on satisfying the public demands for adequate transportation, water supply, waste and wastewater treatment, parks and open spaces. In the process of meeting these demands however, the city has experienced harmful environmental side effects, namely pollution, which has been of great public concern because of the potentially harmful effects and deterioration of both the urban and the natural environment.

Under these circumstances, establishing a new approach for urban development and management to achieve a sustainable environment, one that meets the needs of the present without compromising the ability of future generations to satisfy their own demands (World Commission on Environment and Development, 1987), is a challenge for urban planners and policy-makers. Traditional approaches which mainly focus on supplying physical facilities need to be shifted towards more practical methods of incorporating the concept of carrying capacity into managing urban development. In addition, recent advancements in innovative theories and technologies on urban management along with the development of digital tools such as geographic information systems (GIS) are now more readily available and thus should be utilized to provide better ways for planners and decision-makers to understand complicated urban systems and thus formulate more effective urban policies and strategies.

This paper first identifies the determining factors of urban carrying capacity in Seoul, and develops ways to assess carrying capacity by integrating such factors. A GIS-based assessment system is then developed based upon the theoretical and methodological framework. Finally, the carrying capacity of a case study area in Seoul is determined using the system and its utility is examined.

2. Sustainable development and carrying capacity

2.1. Sustainable development and its indicators

Environmentally sound and sustainable development (ESSD) is a concept which aims at harmonizing the economy and the environment, and maintaining environmental quality while economic growth is pursued. This concept basically assumes that the natural environment has a limit for human activities such as various land uses. Moreover, ESSD recognizes that the exhaustive consumption of natural resources may result serious negative impacts on economic productivity and also addresses the issue of environmental pollution as it increases costs of economic activities and consequently results in limiting economic growth. Thus to maintain sustainable development, consideration should be given not only to the consumption of natural resources but also to the possible destruction of ecosystems. If the aforementioned limit is exceeded, both the natural and human environments will most likely be seriously endangered. Thus urban development, for example, should be controlled properly within the capacity that the environment can be sustained.

Various studies have been conducted on this point and a number of efforts have been made to establish sustainable development indicators which are a crucial means for understanding the progress made in achieving sustainable development. In 1996, for instance, the United Nations Commission on Sustainable Development (UNCSD) announced the formulation of a draft for sustainable development indicators in order to evaluate and to compare the degree of sustainable development of each country (United Nations Commission on Sustainable Development, 1996). Since then, sustainable development indicators have been developed and applied in many countries in the European Union (EU). International organizations such as the Organization for Economic Cooperation and Development (OECD) and the World Trade Organization (WTO) have also developed diverse indicator sets for assessing the results of their research.

The indicators developed in these countries and organizations generally include social, economic, environmental, and institutional categories. Among these, the ‘environmental’ dimension is currently a primary concern in pursuing environmentally sound and sustainable development in Korea. Environmental indicators suggested by the UNCSD, the OECD, the EU, the U.S.A., and the U.K. have mainly focused on air, forest, ocean, fresh water, and biodiversity. In this research, air and water quality among these environmental indicators are employed as strategic objectives which are of importance in urban planning and management in