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Integrating urban climate into urban master plans using spatially distributed information—The Seoul example

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ABSTRACT

The main aim of this paper is to examine ways to integrate urban climate information into urban planning using spatially distributed information. To achieve this, the structures of urban planning in the study area and their contents concerning climate issues were examined. Spatially distributed information on ventilation, air quality and thermal situation in the study area was generated using the CAMPUS framework, which is a set of climate analysis and evaluation tools suitable for planning purposes. Finally, urban planning strategies concerning ventilation, air quality and thermal situation were suggested, and planning measures for implementing the planning strategies were recommended. This study will contribute to a discussion on how urban climate information can be more efficiently considered in urban spatial planning. Furthermore, the information generated in this study can support the development of an evaluative framework for the integration of the climate information into the environmental assessment process, e.g. the implementation of strategic environmental assessment (SEA) in urban planning.

Introduction

For many years, changes in climate have been observed all over the world. The climate changes impact on human and natural systems, for example, human health, ecosystems, biodiversity, and water resources in urbanized areas. They can also affect urban infrastructures such as settlements and water systems. As the impacts of climate change will affect ecological environments as well as built-up environments in urban areas, spatial planning and built environment design will play an important role in the development of viable responses for climate change adaptation and mitigation (Broto, 2011). The adaptation responses are often associated with immediate responses to climate variability, and hence design implications for buildings through energy-efficient building technologies and models have often discussed (Smith, 2010; Seo et al., 2013). In addition to the adaptation responses, climate mitigation actions have a long-term effect, and hence they are playing an increasingly larger role in urban planning in the context of global climate change (Wende et al., 2010; Frerichs et al., 2011; Zanon and Verones, 2013). But there is an on-going debate about the need to priorities climate change adaptation over mitigation actions (Broto, 2011), since the goals between climate change adaptation and mitigation can be sometimes in conflict (Williams et al., 2010). However, mitigation actions should be considered as a form of adaptation when adapting a long-term view and both should be approached in an integrated way as part of an overall policy of sustainable development (Davoudi et al., 2009). In this context, spatial planning needs to consider climate information in the planning processes of defining basic land use structures, and incorporate it into long-term urban development strategies. To achieve this, a comprehensive understanding of both climate conditions in entire cities which focuses on planning purposes and climatic properties of land use structures like urban greening is needed.

For a long time, it has been tried to understand environmental conditions for integrating climatic aspects into urban planning. For instance, climate and air quality have been dealt with as planning factors (Barlag and Kuttler, 1991; Reuter et al., 1991; Schirmer et al., 1993; Mayer et al., 1994; Barlag, 1999; Schirmer, 2005; Foken, 2007; Katzschner et al., 2009). In particular, climatic conditions have been analyzed for various kinds of planning purposes, e.g. landscape planning (Mosimann et al., 1999; Horbert, 2000), environmental impact assessment (Trenkle, 1998; Welsch, 2008), and urban master plan (Drautz and Reuter, 2011). In addition, guidelines are provided to enable climate experts and regional and urban planners to consider climate issues like cold air effects and human bio-meteorology in urban and environmental

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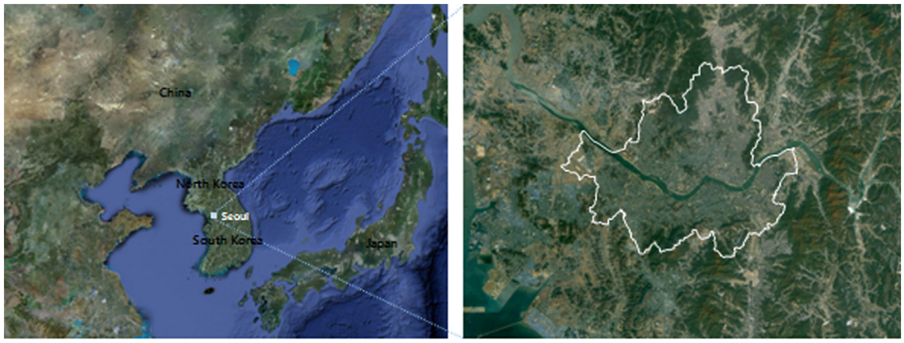

Fig. 1. Location of the study area.

Source: Google Maps.

planning (Verein Deutscher Ingenieure, 1998, 2003, 2004). Urban land use/cover classification scheme has been also developed to find land use/cover classes suitable for representing the climatic properties (Eum et al., 2011). Especially, urban green spaces have examined in view of its potential to regulate urban climates. Bowler et al. (2010) reviewed studies to evaluate available evidence on whether greening interventions affect the air temperature of an urban area, and Mathey et al. (2011) focused on the potentials and constraints of various types and structures of urban green spaces and vegetation in influencing climatic conditions in urban areas.

The possibility of improving urban climatic conditions by policies and strategies of urban land use and design has been also discussed. Rosenfeld et al. (1996) and Emmanuel (1997) proposed policies for the reduction of heat islands and strategies on land use control to mitigate the disadvantageous effects of urban heat islands during the summer. Other strategies are to cool cities, e.g. by planting trees or switching the dark surfaces of roofs and pavements to light reflective surfaces (Konopacki et al., 1997; Akbari et al., 2001; U.S. EPA, 2008). Although these proposals suggest efficient planning policies and strategies for improving urban climate conditions, they focus mainly on detailed planning measures and urban design elements without a comprehensive understanding of climate conditions in entire cities. Hence, they do not incorporate urban climate information into basic urban development strategies. This is partly because they do not have comprehensive climate information for planning purposes. In this context, spatially distributed information on urban climates, such as an urban climatic map, can be an important tool to integrate urban climatic factors with urban planning considerations, by presenting climatic phenomena and problems in the form of spatial maps (Baumüller, 2008; Ren et al., 2011).

The main aim of this paper is to examine ways to integrate urban climate information into urban planning using spatially distributed information. To achieve this, the paper has three main aims. First, it examines the structures of urban planning in the study area, and their contents concerning climate issues. Second, it seeks to generate spatially distributed information on urban climatic characteristics using analysis and evaluation tools suitable for planning purposes. Third, the paper aims to suggest planning strategies concerning the urban climate for a strategic urban plan, and to recommend planning measures for implementing planning strategies.

Structures of urban planning system

Study area

The climate of a region is modified by climatic factors such as topographic conditions and land use. Seoul, the capital city of the Republic of Korea, is located at a longitude of 126°59′E and latitude of 37°34′N, about 30 km east of the Yellow Sea (Fig. 1). It encircled by inner and outer mountains ranging from 111 m to 836 m above sea level. It is divided by the Han River, which flows from east to west toward the Yellow Sea. In addition, an overall population of more than ten million has made Seoul a densely built-up area, which covers approximately 605 km^2. The mountainous topography and the intensive land use in Seoul deeply affect the unfavorable ventilation situation, and induce disadvantageous climate conditions such as urban heat islands and air pollution problems. Table 1 shows basic climatological information of Seoul.

Urban planning in study area

Since 2003, the national territory of the Republic of Korea has mainly been managed by two laws, namely the "Framework Act on the National Land (FANL)" and the "National Land Planning and Utilization Act (NLPU)". Of these, NLPU sets spatial plans for urban areas, which are the main plans for managing urban land use. According to NLPU, the spatial plans for urban land use are divided into three levels: the comprehensive urban plan, the urban master plan and the urban management plan. The comprehensive urban plan sets the long-term (20-year) framework for future development of more than two adjacent cities (Article 2(1) of NLPU). The urban master plan, a binding plan, defines basic land use structures for subordinated spatial plans as well as long-term (20-year) strategies for urban development on a city level (Article 2(3)). The urban management plan, as a mid-term (10-year) plan for urban physical development, comprises designation of zoning districts, district unit plans, and other plans concerning land use, transport, environment, industry, culture, and so on (Article 2(4)).

Among these plans, the urban master plan includes the overall goals of a city, designation of zones in accordance with population distribution, plans for conserving the environment, urban infrastructure, urban parks and open space, and other details (Article 19). Since subordinate plans like the urban management plan are

Table 1
Basic climatological information of Seoul (average values from 1981 to 2010).

Temperature (°C)			Precipitation (mm)	Wind speed (m/s)	Relative humidity (%)	Frost day[a] (day)
Mean	Maximum	Minimum				
12.5	17.0	8.6	1450.5	2.3	64.4	83.5

[a] Average values from 1998 to 2009.