

## Spatial modeling applied to the cities in Japan

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### 1. Introduction

This study analyses large and middle scale cities in the northern and eastern areas, in special case of Sapporo and Sendai cities, adopting the compact city model. We present this model to improve the cities' master plan; and we will compare it with Aomori city. Using Geographic Information Systems (GIS) we study the land use system, population and urbanization areas. Sendai and Sapporo each have more than 1 million people while Aomori city has almost the 30 percent, for that reason it is important to study the land use transformation and population growth using time series. We applied Kriging models to study the population density, and statistical analysis was performed to analyze the land use transformation with the projected population. The objective of this study is to analyze the relationship between the population and land use in a 100mt mesh area through spatial analysis models such as variograms, krigging models and linear mixed models.

### 2. Method

Regarding to the spatial predictions of unknown quantities, the Krigging models are a good way to achieve the missing information (Bivand 2008), these models have been applied by several researchers in different fields, for example: to determine the spatial distribution of termites in a shortgrass steppeland (Rives-Dasi et al. 2001), to develop a potential temperature-dependent distribution map for the male gypsy moth (Sharov 1999); but to study the spatial correlation we developed some variograms models, this model quantifies the spatial extent of correlations (Marzban 2009), for that reason it is useful to analyze the population density per mesh area using variables which can affect it such as land use, and so on.

### 3. Data analysis

In a previous experiment we found the land use promotion area, land use control area and district area for the metropolitan areas involved. That data was obtained through the LUCKY system, it presents the land use planning areas. From the GIS homepage we were able to get the land use information by 100 mt mesh in 3 periods of time (1991, 1997, 2006), after we overlaid this information with the land use planning area in order to analyze the land use in the promotion, control and district areas. The population data was downloaded from the Official statistics of Japan, however just the information of 2000 and 2005 is available. This information was measured by districts and towns. We contacted the Statistics Bureau to get the information of 1990 and 1995 in order to study the land use transformation and the population in the same period of time.

### 4. Discussion

The people located in Aomori city is leaving the rice fields since 1995, the reduction has been given in more than 60% until 2005, however the building sites are being increasing in the first period in more than 13.35% and in the second period in more than 20%, while the population in the promotion area has grown in 6.09%. It means that people prefer to reach the places with high population density. In the kriging models developed we figure out that the promotion area's core is fulfilling with the compact model and some high population groups are appearing in this area. In a future experiment we will analyze those groups, and we will be able to get some information about the population behavior according with the land use; also we will analyze those groups through clustering methods taking in count the time series. For Sendai and Sapporo, in the periods 1995-2000 and 2000-2005, the building area increased more than 25% and 30% respectively, the population located in other agricultural land decrease in more than 20% and more than 50% respectively, it also means that people are leaving this area in order to achieve the metropolitan area. To analyze the behavior of the population in Sendai and Sapporo metropolitan areas, it is needed to study the population clusters in the area which depending on time series and land use.

Keywords: Krigging model, Land Use Transformation, Urbanization, Compact Cities