ANALYSIS OF THE FACTORS THAT DETERMINE THE EVOLUTION OF LAND USE IN SMALL URBAN SETTLEMENTS IN THE NORTH COAST OF GALICIA

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The growth of cities in the twentieth century brought about a variety of problems that many authors have tried to tackle through the study of urban growth processes. Most authors have focused on the analysis of the dynamics of large cities (Cheng and Masser, 2004; Xiao et al. 2006), but little has been done to understand the evolution of small villages (Sui and Zeng, 2001; Pinto and Antunes, 2007). In this paper, we analyze urban growth processes in Ribadeo, a small town on the north coast of the region of Galicia, NW Spain, in order to extrapolate the knowledge gained from the analysis of this area to similar urban areas in the region and to determine how to deal with the shortcomings caused by urban growth processes.

Urban growth in Galicia took place in the last three decades, when rural population migrated to the cities on the Atlantic coast. Galicia is characterized by population dispersion; in fact, Galicia comprises 30% of the urban settlements in Spain while its area accounts for only 5.6% of the total area of Spain (Enríquez and Rodríguez, 2007). Large urban areas grew by taking advantage of the scattered rural settlements around them, which helped create a disperse rururban structure (Precedo and Míguez, 2008). Many Galician authors have studied urban growth from demographical or social and economic perspectives (Souto, 1997), but only a few authors have tried to establish a relationship between urban growth and the spatial drivers of growth.

The study area comprises the Ribadeo urban core area and four surrounding districts. Ribadeo is a municipality with a population of 9704, located on the northeast coast of the region of Galicia, Spain. Up to 63% of the population of Ribadeo lives in the main urban core. Ribadeo is located at the junction of two main roads that communicate the region of Galicia and the neighboring region of Asturias. For this reason, Ribadeo acts as the urban center that provides services to the surrounding rural areas and small urban cores. A coastal range divides the municipality into two main areas: a coastal plain that is crossed by one of the main roads and concentrates most of the urban growth, which is fostered by the expansion of the Ribadeo urban core, and the inland valleys, which are more rural.

Raster maps of roads and land uses for 1995 and 2003 were generated at 35-meter cell resolution using orthophotographs of the same years and additional geographical information. These maps, a cadastral parcel map and a digital terrain model were used to derive 35 m resolution maps of the analyzed variables and factors. The following land uses were considered in the study: commercial, industrial, residential and urban (which comprises commercial, industrial and residential, plus parks and institutional buildings).

The evolution of land use patterns between 1995 and 2003 was analyzed using spatial metrics such as total area, largest patch index (percent total area occupied by the largest patch of a given land use), mean area (mean area of the patches of a land use), area weighted shape index (perimeter-area ratio of the patches of a land use), area weighted fractal index (which accounts for the complexity of land use patches), and contagion index (which measures the degree of diversity of a landscape). These metrics have been chosen because they have been used in other studies to analyze the dispersion and complexity of urban patterns (Herold et al., 2002; Long et al., 2009; Sweetnam, 2007).

Logistic regressions were used to analyze the influence of a number of variables on the changes from non-urban land uses to the land uses studied. Logistic regression is a statistical method that determines the relationship between a number of dependent variables and the probability of change of a binary variable. In this case, logistic regressions are performed to determine the probability of change from a non-urban land use (value 0) to an urban land use (value 1). The dependent variables were chosen according to the variables used in similar studies (Sui and Zeng, 2001; Li and Yeh, 2004; Lau and Kam, 2005). To find the variables that were correlated, the Spearman index was used, such that the variables that provided redundant information were removed from the analysis. The values of the remaining variables were normalized so that the coefficients obtained from logistic regressions for each variable could be compared.

Finally, two logistic regressions were performed; the first regression determined which variables had a significant influence on the observed changes by using the Pr>|z| index, which indicated the probability that variation was due to chance. The second regression estimated the degree to which the significant variables affected the observed changes.

The analysis of the evolution of the land uses in each district of the area during the study period revealed that residential land uses developed mainly in districts near Ribadeo with small villages, which attracts the development of single-family housing. The growth of industrial land uses is located mainly in the districts crossed by the main road, and the growth of commercial land uses is located exclusively in a well-communicated district near the Ribadeo urban core.

The results of the analysis of spatial metrics suggest that the growth of residential land uses was caused by the expansion of the existing patches, which have grown irregularly, thus creating complex patterns. Commercial land uses grew by producing larger and less complex patches, whereas industrial land uses grew in disperse, small patches. The analysis of urban land use patterns as a whole revealed larger and more compact patches. Yet, such patches were more irregular and complex.

The logistic regression analysis reveals that the distance to the Ribadeo urban core has a positive influence on the probability of development of residential land uses. This finding suggests that the Ribadeo urban core is expanding towards its outskirts. Main

roads attract residential growth near them. Nevertheless, locations too close to main roads repel the residential use. Yet, secondary roads attract the residential land use as well as other commercial and residential land uses, whereas industrial land uses repel residential development. Closeness to the coastline does not exert a positive influence because of the laws that ban construction in this area. Commercial land uses, located mainly in regular parcels near the main road and close to the Ribadeo urban core, are attracted by other commercial uses but repelled by other land uses. The drivers of the expansion of industrial land are closeness to main roads and closeness to commercial land uses. On the contrary, closeness to residential land uses exerts a negative influence on growth.

These results have demonstrated that logistic regressions and spatial metrics are useful tools for the analysis of growth processes in small urban areas. In the case study, the spatial analysis of urban land uses showed that small urban areas in Ribadeo have grown mainly by the expansion of existing urban patches. Most of the urban growth occurred in Ribadeo corresponds to residential land uses. Residential development took place mainly in rural areas near the Ribadeo urban core, taking advantage of the existing urban structure.

By using logistic regression analysis, the drivers of urban expansion were identified. Residential land uses grew near roads, but not near roads that held too much traffic, such as main roads. As observed for larger cities, industrial land uses had a negative influence on the growth of residential land uses. In the study area, commercial land uses were influenced by accessibility and by the construction of a large commercial area. Accordingly, the commercial land use grew at the junction of two main roads near the Ribadeo urban core. The drivers of growth for industrial land uses were closeness to main roads and closeness to other industrial land uses. The disperse growth pattern observed was caused by the development of commercial land uses in an area planned for industrial land uses. As a result, industrial activities had to look for other locations that were not considered in urban plans.

In short, urban land use dynamics in Ribadeo are not too different from the dynamics of large cities, where closeness to roads and other urban land uses determine urban core structure. Our results show that urban patterns, though apparently disperse, take advantage of the distribution of existing urban settlements for growth.

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