A Comparative Spatial analysis on Land-use Clusters for Accessibility

Wasim Shoman
Istanbul Technical University
Maslak
Istanbul, Turkey
Wss7@hotmail.com
Shoman16@itu.edu.tr

Hande Demirel
Istanbul Technical University
Maslak
Istanbul, Turkey
demirelha@itu.edu.tr

Abstract

To perform land use based accessibility analysis, classes in land use thematic map are converted to representative points in their corresponding centroids. However, city scale analysis imposes huge amount of data reflecting negatively on computing time. This study proposes a new methodology to find proper gridding system that helps in accurate clustering of origins-destinations in accessibility analysis. The study finds the best gridding system that can provide the most accurate extracted information at higher resolutions. The methodology followed within the study is to convert raster land use thematic map to grids using three polygon types (squares, regular hexagons and triangles). Each of these geometric polygons different results and patterns when it is used to grid the land use layer. Later, the study investigates the best resolution of each gridding system that illustrates the original land use map within acceptable error limits. Each of these grids in each resolution is assessed in a) its ability to represent the original areas of the land use map, b) its ability to represent the same number of features in the original land use map after clustering the neighbour polygons of the same class, and c). its ability to provide more accurate accessibility analysis.
Keywords: Grid; Land use; Accessibility; GIS; Hexagon; Thematic map.

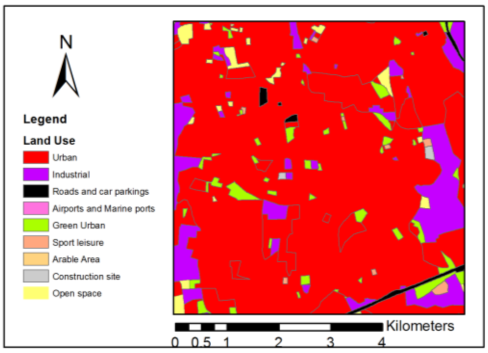
1 Extended Abstract

Land use change has become an important aspect of global change, since land use/land cover change is a major factor for global change because of its interactions with climate, ecosystem processes, biodiversity, and, even more important, human activities (Lopez et. al., 2001 and Aguilar et al., 2003). It is also a way to analyze future scenarios by modelling different future pathways (Fuglsang et al. 2012). Calculating accessibility for an area provides significant information about the quality of the existing state of the transportation system at many spatial levels. A new project funded by the TUBITAK (The Scientific and Technological Research Council of Turkey) researches the changes in accessibility due to changes in land use and transportation network growth, along with other subjects, as its goals using the concepts of Geographic Information System (GIS) for part of Istanbul, Turkey. The project investigates the roles of attraction and destinations points in changing the land-use patterns. The project, also, aims to improve the ability of individuals to access any type of economic and social activities by upgrading the transport network after simulating the future statues of the study area.

To analyze land use based accessibility in GIS environments, land use classes presenting their corresponding areas are converted into points in their centroids. However, land uses are not identical in their areas, plus their areas are geometrically irregular Figure 1.

A system to convert the land use thematic map into representative points, where each point holds the attribute of its corresponding land use, is required. This is implemented by gridding the land use thematic map into geometrically regular smaller units. While trying to precisely implement this process, several problems arise such as; which gridding system should be used and what is the best cell area (resolution) that provides enough accuracy to implement such analysis.

Figure 1. Sample showing land use for part of Istanbul.



Square, hexogen and triangle are considered to be among the basic regular gridding systems. They are used because of their simplicity to generate in a GIS environments and their ability to cover area of interests leaving no spaces. The purpose of this paper is to compare the captured accurate of these grids to be used in land use based accessibility calculations. The study identifies number of constrains that point out which is the best gridding system and the errors resulting in each used resolution. These constrains are: 1. Providing the least error in capturing area of important land use classes such as urban fabric and industrial classes, compared to the original land use map. 2. Providing the least error in capturing the number of clustered features of these classes. 3. Their ability to provide more accurate accessibility analysis with acceptable errors.

1.1 The methodolgy

Within this paper, the general used methodology is introduced provided that more details with more results are given in a later article.

1.1.1 Identifying the study area.

The study identifies Istanbul as a study area, exactly the southern west side of it. This region contains several districts with various urbanization patterns e.g. fully continuous urban fabric with dense population, sub urban area with lower density…etc.

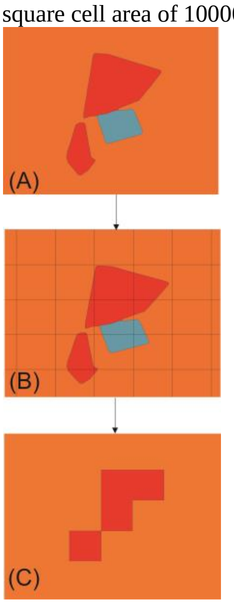
1.1.2 Extracting the original land use map.

The original land use thematic map is extracted using supervised classification of Spot 6 satellite images of the study area with a spatial resolution of 1.5 meters obtained in 2014. Among the related classes to our study are Continuous urban fabric, Discontinuous urban fabric and Industrial or commercial units.

1.1.3 Gridding the study area using the three systems

The extracted raster land use thematic map is converted to regular grids using the three systems (Square, Hexogen and Triangle). The attribute of the major area inside each polygon is assigned to it in the geodatabase (Figure 2).

Figure 2. Shows the process of assigning each cell land use value using square cell area of 10000 meter^2.



1.1.4 Finding the errors

The resulted area and clustered feature numbers from the original extracted thematic map are compared to the resulted statistics from each method at each scale. Each land use class is modelled separately using each gridding method.

1.1.5 Extract error manual for each scale

In this step, for each method and for each land use class, a relation representing both relative errors (area and clustered feature numbers errors) is provided. That is, in each scale for each method, the combined relative errors in area and feature numbers is identified. Generally according to each study purposes, the best method with its best resolution could be identified using this proposed manual. An example of the proposed manual showing the errors in area or clustered feature numbers is shown in (Table 1), <u>the given values do not represent the true extracted values.</u>

Table 1. An example of the proposed manual for each land use class. Green delineates results for square grids, blue delineates results for hexagon grid and red delineates results for triangle grids.

Error in Area	Error in clustered feature numbers %					Scale
	0.5%	1.0%	1.5%	2.0%	2.5%	
0.5%						1
1.0%						2
1.5%						3
2.0%						4

1.1.6 Recommendations

To suit an accurate accessibility analysis, acceptable errors in both area and clustered feature numbers are identified for certain important land use classes. The gridding system that can provide these conditions in its biggest resolution is selected. This means that both the biggest resolution and the best gridding system which can provide acceptable errors are identified. Choosing the lowest possible errors helps in providing the most accurate analysis as possible. Choosing the lowest resolution helps lowering the number of resulted points by which lowering the computing time for this process.

2 Acknowledgement

This work was supported by the Scientific and Technological Research Council of Turkey (TÜBİTAK), Grant No: CAYDAG-115Y692.

3 References

- Aguilara Adrián G, Peter M Wardb, C.B Smith Srb. Globalization, regional development, and mega-city expansion in Latin America: analyzing Mexico City’s periurban hinterland. Cities 20: 3–21. 2003.

- Fuglsang, Morten, Bernd Münier, and Henning Sten Hansen "Modelling land use changes according to transportation scenarios using raster based GIS indicators"., Seppelt, R. and Voinov, A. A. Lange.
- Lopeza Erna, Gerardo Boccoa, Manuel Mendozaa, Emilio Duhaub. Predicting land-cover and land-use change in the urban fringe: a case in Morelia city, Mexico. Landscape and Urban Planning. 55: 271–285. 2001.