

Is sustainable transportation limited by urban form? An international GIS-based approach

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Context & Objectives

Climate change and energy shortage are the new impose for geographical research about techniques, methods and policies reducing energy consumption and its effects on urban environment (Demirtas, 2013). Several researches focused on more sustainable technologies (gas BRT, electric vehicles, hydrogen, etc.) that could be used in cities to reduce atmospheric pollution (Hidalgo, and Gutiérrez, 2013). Even if the link between urban form and transportation is now obvious for stakeholders, few works stressed on the importance of buildings and networks configurations to concretely plan these renewed transportation modes (Wang et al., 2017). Moreover in numerous historical city districts, patrimony preservation is sometimes more important than operating changes for more ecological transportation modes. Unlike technologies that can be adapted in the future, urban form is a heritage that cannot sometimes be changed in a short term (i.e., few decades). In this context, our work assumptions are:

- (H1) The diagram of the Land Use Transport loop from Wegener and Fürst (1999) shows a well-known system of interactions between urban form and transportation. However, this loop does not quantify these interactions. Our assumption is that these correlations can be measured using spatial analysis and GIS techniques.
- (H2) According to their historical heritage, all cities in the world are not equal in terms of sustainable transportation system development. To clarify, every city is constraint by the heritage of its urban form. Our assumption is that quantifying the correlations between urban transport and urban patterns allows to determine the parts of the city where the transportation system is clearly determined by the urban form.

Study areas and data

In order to investigate these assumptions six different cities, showing different urban models, are compared. They can be categorized into three groups:

1. Cities in a recent developed country (USA): New York City, Los Angeles.
2. Cities in a historically rich developed country (France): Paris, Dijon, Strasbourg.
3. City in a historically rich underdevelopment country (Lebanon): Beirut.

Data collection for investigating H1 and H2 involves different sources. Depending on the field of study, data are provided by governmental agencies (IGN-Institut national de l'information géographique et forestière) or available on official governmental websites (like Data.gouv.fr or data.gov). When data is unavailable from those sources, open source data are used (for example open street maps-OSM).

Methodology

Collected data are standardized using a Cellular Geographical approach (Tobler 1979). Then, different types of graph theory indicators are applied (Kansky, 1963), where residential densities and land uses categorizations are investigated. Graph theory implements methods that focus on the properties of the road graphs (Lagesse, 2015). Whereas, cellular geography allows comparison and quantification of urban patterns within regular cells. The application of this methodology permits



to create a database with a geographical dimension to compare the different forms of cities at an international level.

Results

First, data are mapped in the form of grids containing both the elements of urban form and transportation. Second, it allows statistical analysis as Principal Component Analysis (PCA) and Hierarchical Ascending Classification (HCA). Those analyses show groups of cells that are characterized with same urban morphology and transportation services. Those groups with common characteristics are shown in all of the six case studies. Thus, the cells integrate specific buildings and network configurations along with specific - green or not - transportation modes. As we can conclude and dissipate, the heritage of every city strongly determines the development of future green transportation, and demands to be further integrated into urban planning and transportation policies.

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KEYWORDS

Urban Form / Transport Modeling / Cellular geography / Graph Theory