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Spatial Structures and Dynamics of Global Coastal Cities. Analysis and Evaluation Approaches to Support Sustainable Metropolitan Development

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Summary of the project

The existence of metropolitan regions acting as cores strengthening the structure of the urban systems on a broader scale is a spectacular aspect of the polarization of human activities in cities. In a transnational context, these regions may seem at first glance hardly comparable between one another especially when working on geographical spaces with strong cultural and societal differences. The main research hypothesis was that, regardless of the country of origin, the spatial arrangements within a metropolitan region were able to act as both a catalyst or as an inhibitor of further urban development and redevelopment. This was particularly true for the case studies selected in this research research project, namely Osaka (metropolitan area located in Japan, a developed country referred to as a post-growth economy) and Marseille Provence (France, developed country with slow economic growth). Rio de Janeiro (Brazil, recent urbanization and recent economic development) was a third proposed case study but it has to be abandoned due to data availability issues (building elevation and slum areas were not available).

The aim of this research was to identify coherent spatial structures and dynamics inductively from the different features and characteristics of the intra-urban level of the two case studies. The study of the internal organization allowed localizing and understanding the spatial inequalities in terms of urban integration, mobility patterns and socio-economic development. The main objective was to assess not only opportunities but also potential difficulties (risks) associated with metropolitan/coastal development. The results of the analyses were expected to highlight the most homogeneous spaces in terms of urbanization, sustainability and socio-economic characteristics in order to provide recommendations to accelerate urban development/renewal in suburbs and/or central areas with the greatest needs and to improve the quality of life within coastal regions in the long run.

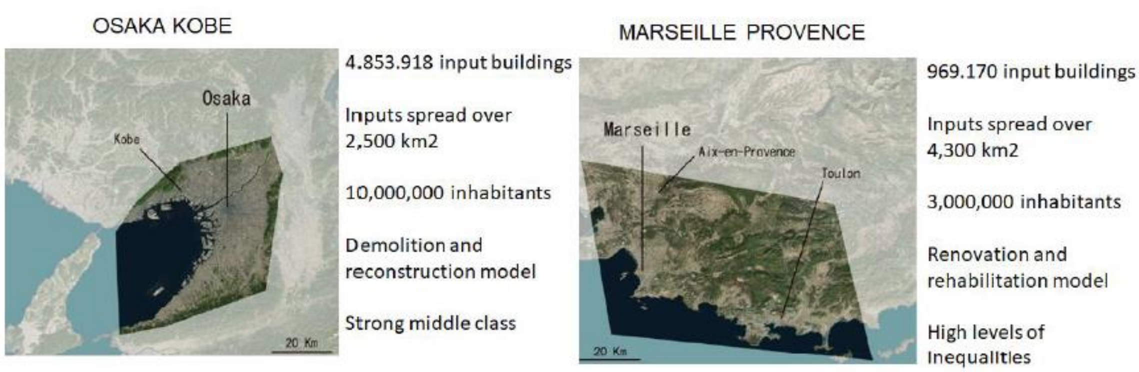

Figure 1. The Challenge of dealing with Metropolitan Areas

As highlighted in Figure 1, the main challenge of this research was to develop and apply spatial algorithms to metropolitan case studies made of several millions of inputs (buildings, grid data and network).

Research methodology

To carry out this research, AI-backed data mining approaches were adopted. We recall this this study aimed at understanding three different components of city life: urban integration, mobility patterns and socio-economic development. From this perspective, several protocols related to each of these three components have been implemented, developed and/or improved throughout this research.

Multiple Fabric Assessment method (Figure 2), originally developed by Fusco and Araldi (2017) has been used and improved within the urban component of this project (Araldi et al., 2018). MFA aims at analyzing the city from the pedestrian point of view. First step (1) is the spatial unit definition i.e. the partition of space, named in this method "proximity bands". Proximity bands are constructed through the generalized Thiessen Polygon built for and around each street network segment, limited at a given width (10, 20 and 50 meters according to calculated indicators).

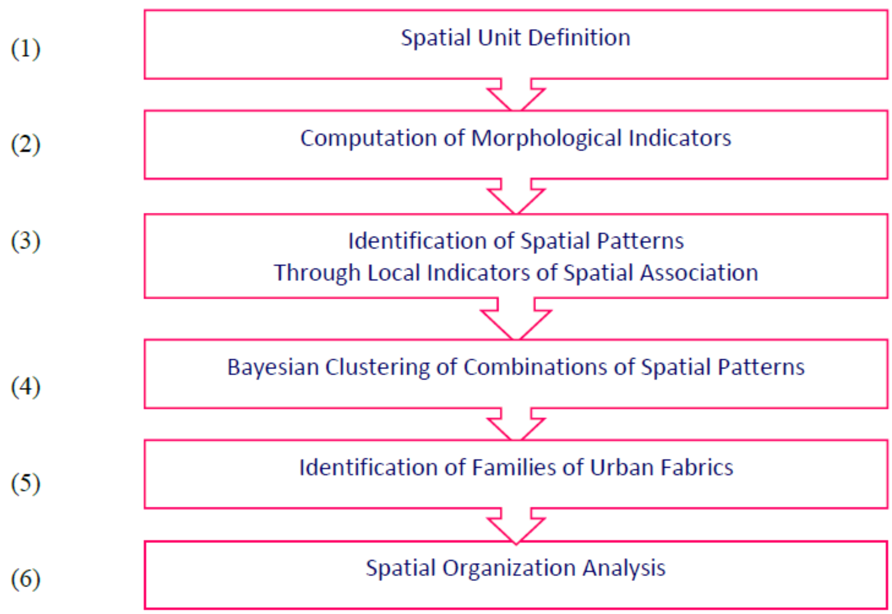

Figure 2. Urban Fabric analysis methodology (MFA Protocol)

Then (2), descriptors of urban form, economic activity and social characteristics of the population were either gathered or calculated through specific spatial analysis algorithms. In step (3), the prevalence of indicators is calculated for each proximity band, allowing the identification of statistical significant local over/under representation of each considering the surrounding values. Inductive search of spatial patterns of these indicators and of their mutual relations is then carried out through Bayesian Network (BN) algorithms (4). This step, accounting for clustering analysis, amounts to group "*set of objects in such a way that objects in the same group are more similar to each other than to those in other groups*. These groups are, in our study, families of urban fabrics (5), the latter being defined as the physical aspect of urbanism. In a final step (6) indicators at the intra-urban level and thematic maps can be produced in order to visualize and quantify the results.

The second component of this project, mobility patterns, has been addressed by running three different network centrality algorithms: reach, straightness and closeness. Through the use of Multi Centrality Assessment tool (Porta, 2010), networks are assessed and evaluated from a configurational perspective. The centroid of each building is projected to the network through its shortest Euclidian path before running the centrality algorithms.

The third component of this project, socio-economic development, has been dealt with by acquiring and matching the Census data at the 200 meters (Marseille, France) and 250 meters (Osaka, Japan) grid scale.

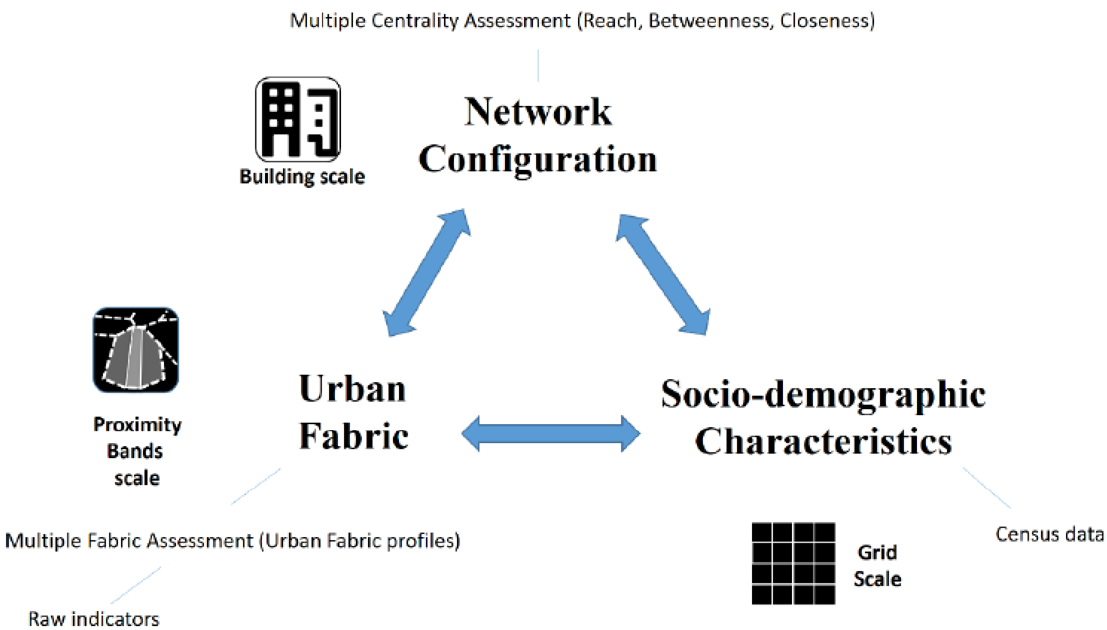

Figure 3. Cross-Analysis; urban integration, mobility patterns and socio-economic development

This project, in his final step (Figure 3) is now linking and analyzing the three different components together. Due to different scales of analysis (Building, grid and proximity bands), several methodological issues emerged and were dealt with (or are still in the process of being dealt with). Socio-demography indicators, network centrality and urban fabrics results are currently still analyzed, compared and homogenized.

Preliminary results/impacts

The identification of relevant spatial structures allowed questioning the role of the main drivers giving rise to the spatial differences. Coherent spatial structures and dynamics have been identified inductively using as inputs the different features and characteristics of the intra-urban level. The main objective was to assess not only opportunities but also potential difficulties (risks) associated with metropolitan development/redevelopment. The geographical space being not homogeneous, studying the roles of the spatial arrangement (and the diversity) within the intra-urban level as drivers of urban dynamism became an important challenge to provide recommendations for a more sustainable development.

Figure 5. Visualization of the different urban families for Marseille (left) and Osaka (right)

Figure 5 shows for example the different families obtained for both case studies; thus allowing to study the different "lifestyle" within each family by (1) studying the indicator distribution, (2) analyzing the different thematic maps produced and (3) doing fieldwork in each case study. The identification of these relevant spatial structures allowed questioning the role of the main drivers giving rise to the spatial differences, such as the link between the three components of this project. Our hypothesis has been partially confirmed since most of the time, a specific spatial arrangement (morphological regions made of apparently similar "ingredients") brought comparable outputs as regards to urban functionalities. However, sometimes, similar urban functionalities were made of different inputs, a phenomenon related for example to the temporary nature of urbanization in Japan as compared to the renovation model of old buildings in France (Perez et al., 2018).

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