Joint characterization and visualization of urban climate and morphology

Keywords

Spatial analysis, visual analytics, urban morphology, urban climate, Local Climate Zones, measures and metrics.

Context

Past decades urban planning process evolved from urban sprawl to densification, with notable effects on the urban environment and climate, especially in terms of temperature rising in some areas. These specific urban areas, called Urban Heat Islands has many negative outcomes on inhabitants health and comfort: heat waves, poor dissipation of pollutants, high thermal inertia, increased energy consumption (e.g. air conditioning).

Some of the factors affecting the energetic performance and the micro-climate of an urban area are directly related to its buildings morphology and its land use properties. In order to study the influence of these factors, some simulation models have been developed, taking into account the 3D-geometry of the environment (e.g. those of the ERA4CS UrCLIM project). Furthermore, the Local Climate Zone (LCZ) classification has been developed to classify units of landscape as regions of uniform surface cover, structure, material, and human activity, using properties such as height and layout of buildings, soil permeability, « green » cover ratio, etc. The goal is to assess the zone propensity to be an urban heat island, or to contain one. The relevance and the computability of this classification on the available data have to be assessed, as well as its match with the outputs of the UrCLIM simulation models.

The main issue to be addressed during this internship is methodological. Given a portion of the urban fabric, how can we accommodate the « morphological » point of view and the « climatic » point of view? How can we operate the comparison, similarity highlighting or conversely differences reconciliation of these two distinct information layers?

Figure 1: Data from MApUCE project: LCZ, inter-building spaces, vegetation density

Topics

Several questions are to be discussed regarding the co-visualization of these two points of view:

- How can the similarities or differences between points of view be presented in an efficient way to a user?
- How can we combine statistical analysis of indicators with visual analytics so that these two approaches complete each other?
- How to operate the navigation between the adequate scales of observation during the co-visualization?
- What kind of data could enrich the analysis of the urban fabric areas (land use, digital elevation model, vegetation cover, shadowing)?

Objectives

From the produced data coming from MApUCE and UrCLIM projects, the internship aims to achieve the following objectives:

- Review of existing works dealings with morphological metrics that can be computed on public and/or open data available for French cities (e.g. Toulouse).
- Implementation and evaluation of these metrics and their discriminating power on the selected urban zone of interest.
- Study the link between climate and environment morphology, by comparing climatic properties derived from urban climate models outputs with morphological metrics.
- Design a workflow to automate this comparison
- Propose adequate renderings and visualizations of the information before and after this comparison

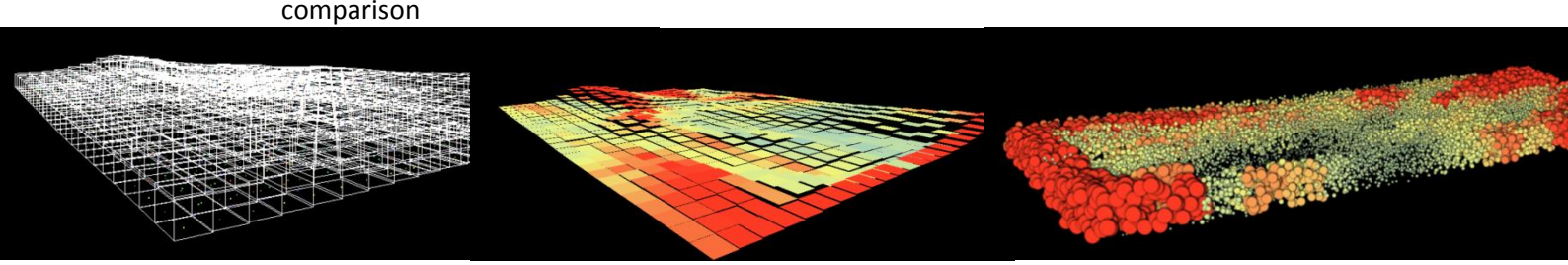

Figure 2: From Meso-NH data to the visualization of various temperature differentials (J. Gautier, UrCLIM, 2019)

Skill requirements

Master student in Computer Sciences or Geographic Information Sciences, with a taste for pluridisciplinarity and urban sciences.
Prior knowledge in one of these domains confers an advantage:

- GIS 3D or 2,5D.
- Visual Analytics, cartography, and dataviz.
- Statistical analysis, especially spatial analysis.

Time period & workplace

5 to 6 months, starting from February 2020
Internship takes place in the STRUDEL/GEOVIS teams of the LaSTIG laboratory of the French National Mapping Agency (IGN) in Saint Mandé (94), close to Paris.

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