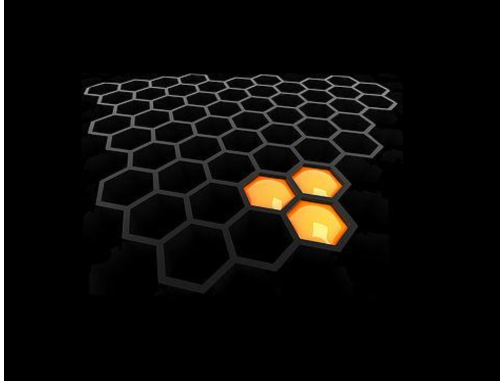

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Roughness Length Characterization for Urban Climate Maps in the City of São Paulo – SP, Brazil

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ZEPHYRUS climate change and environmental systems

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IGOT Instituto de Geografia e Ordenamento do Território UNIVERSIDADE DE LISBOA
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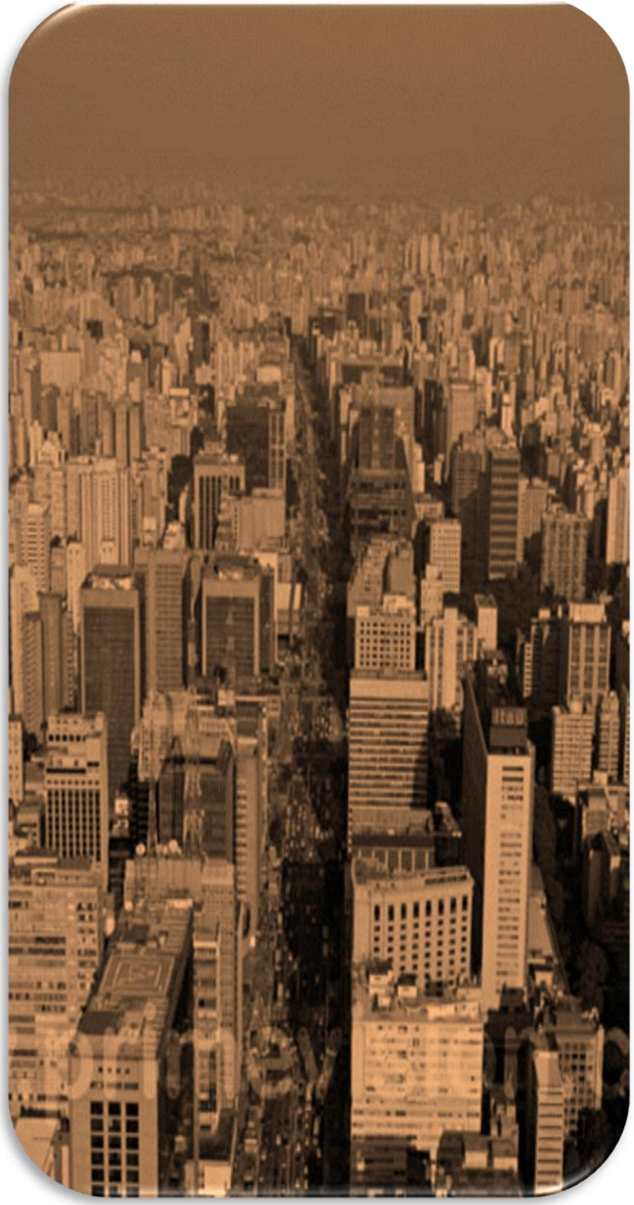
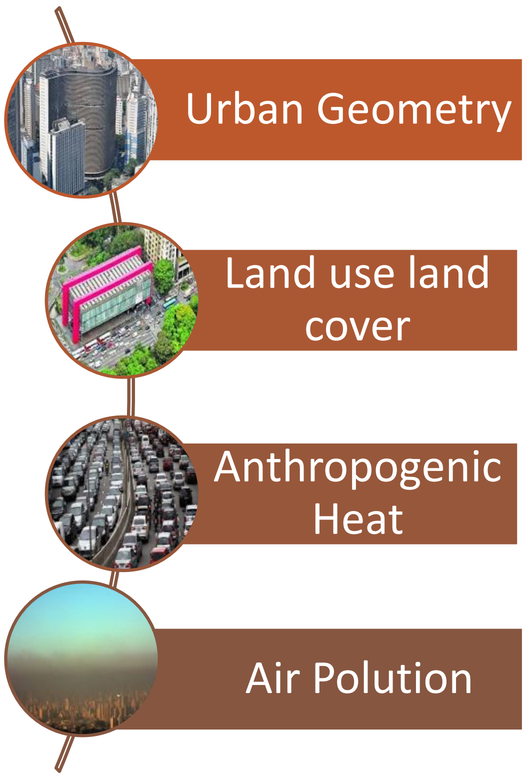
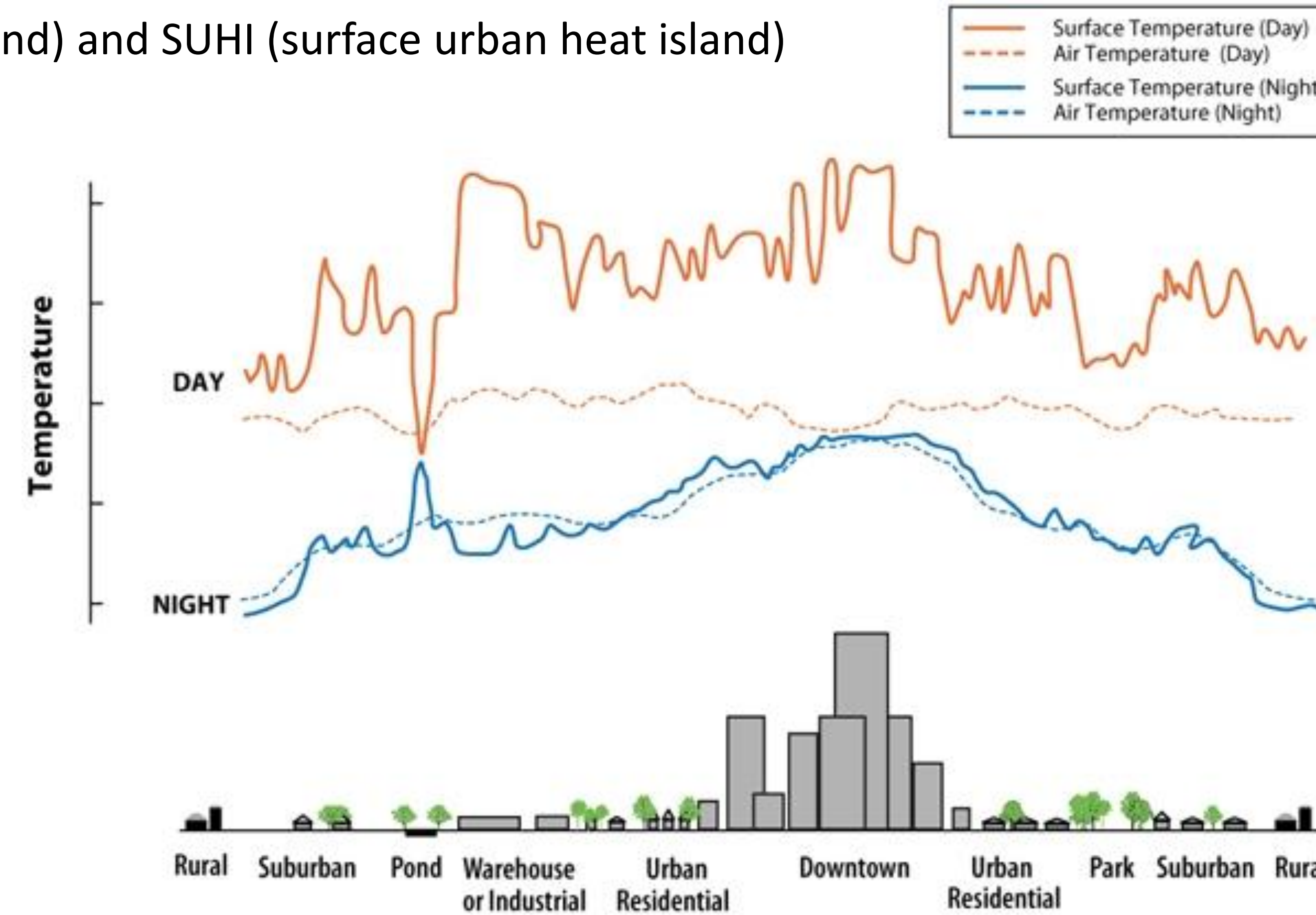


1. Introduction

- The densely compacted (tropical) megacities - thermal component and air circulation are constantly changed;

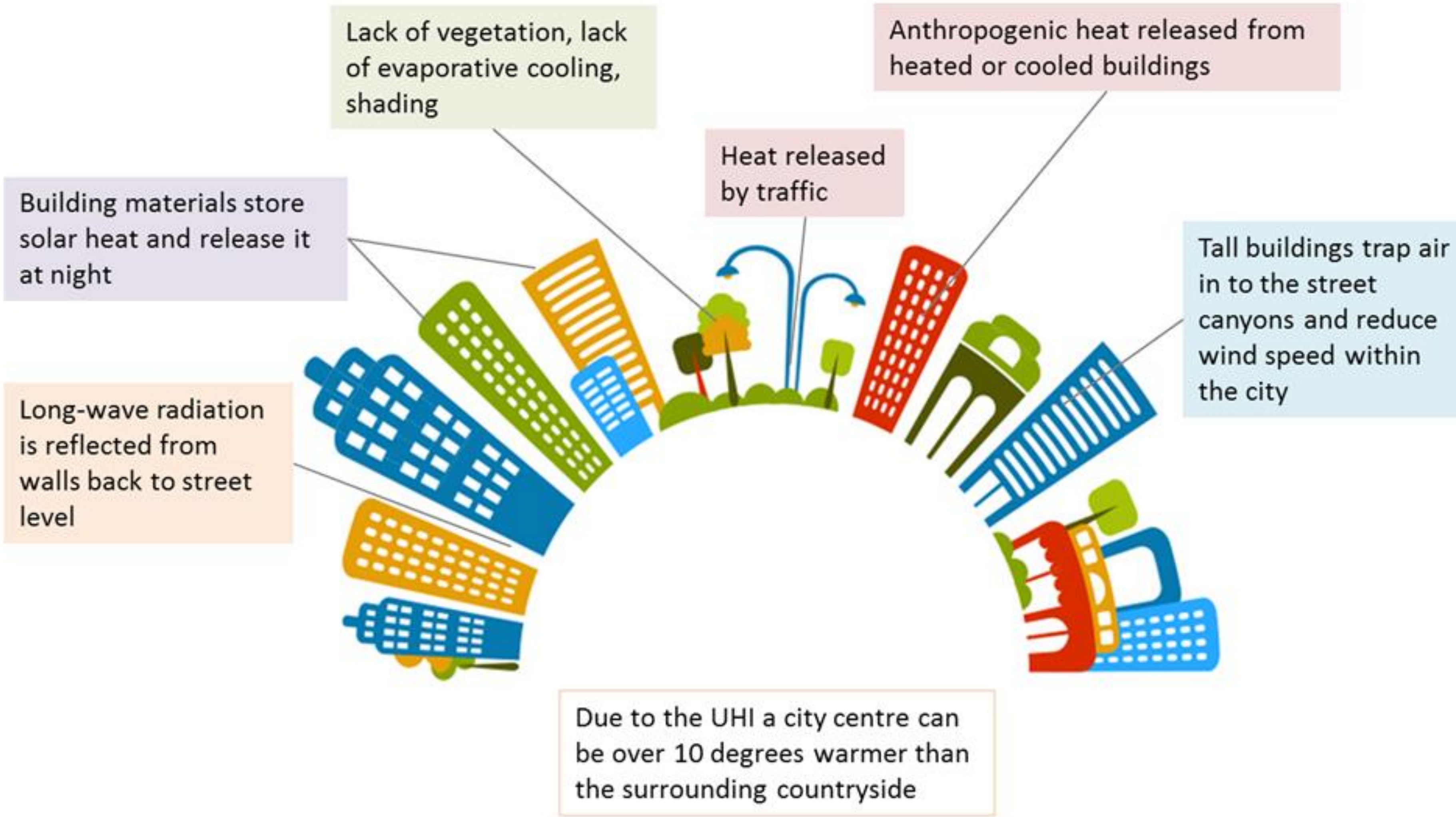
- UHI (urban heat island) and SUHI (surface urban heat island)





Source: www.epa.gov

Urban Heat Island and balance energy



Source: www.climateandus.com

Air circulation - wind patterns

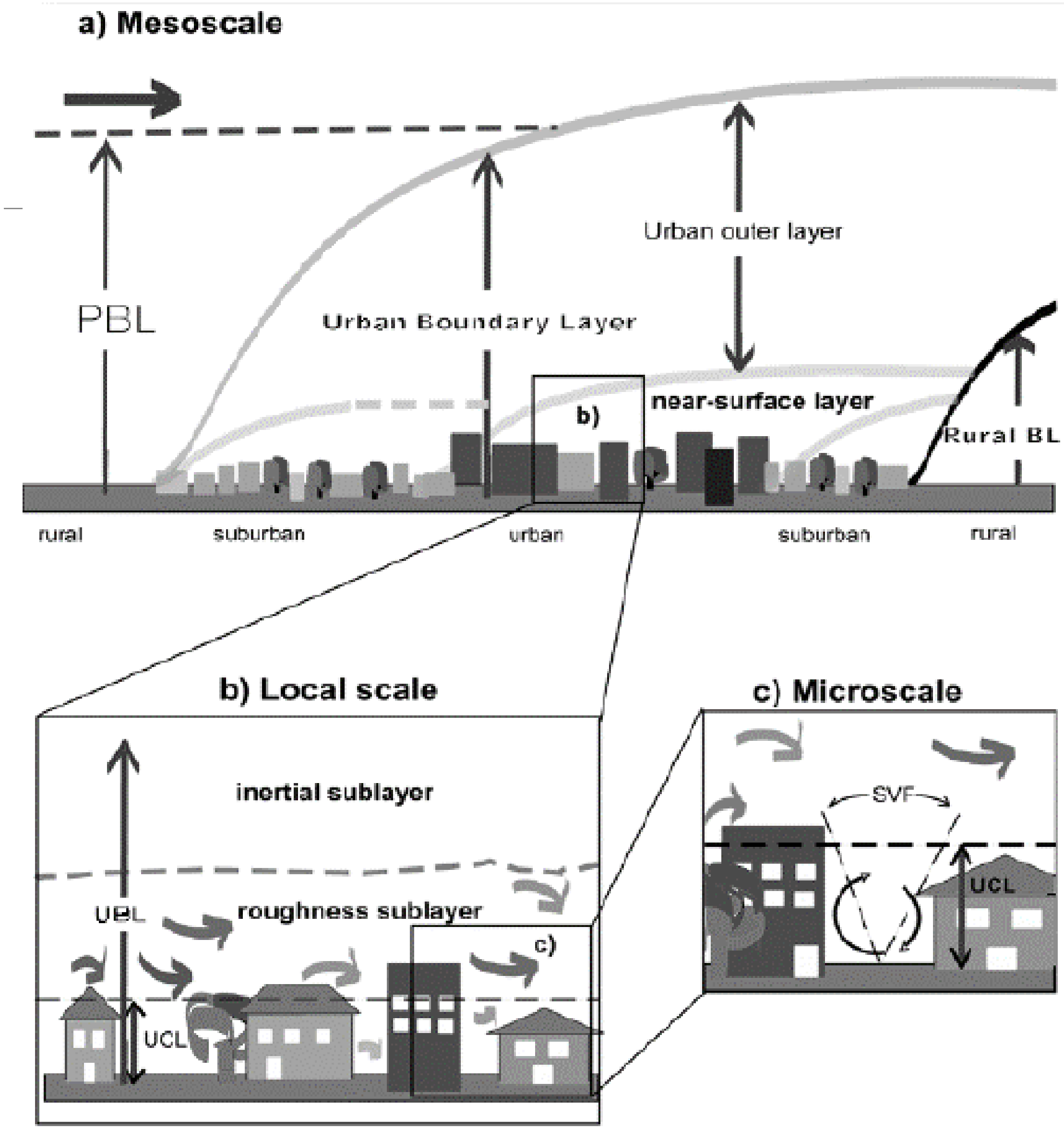
- The growth and density urban:

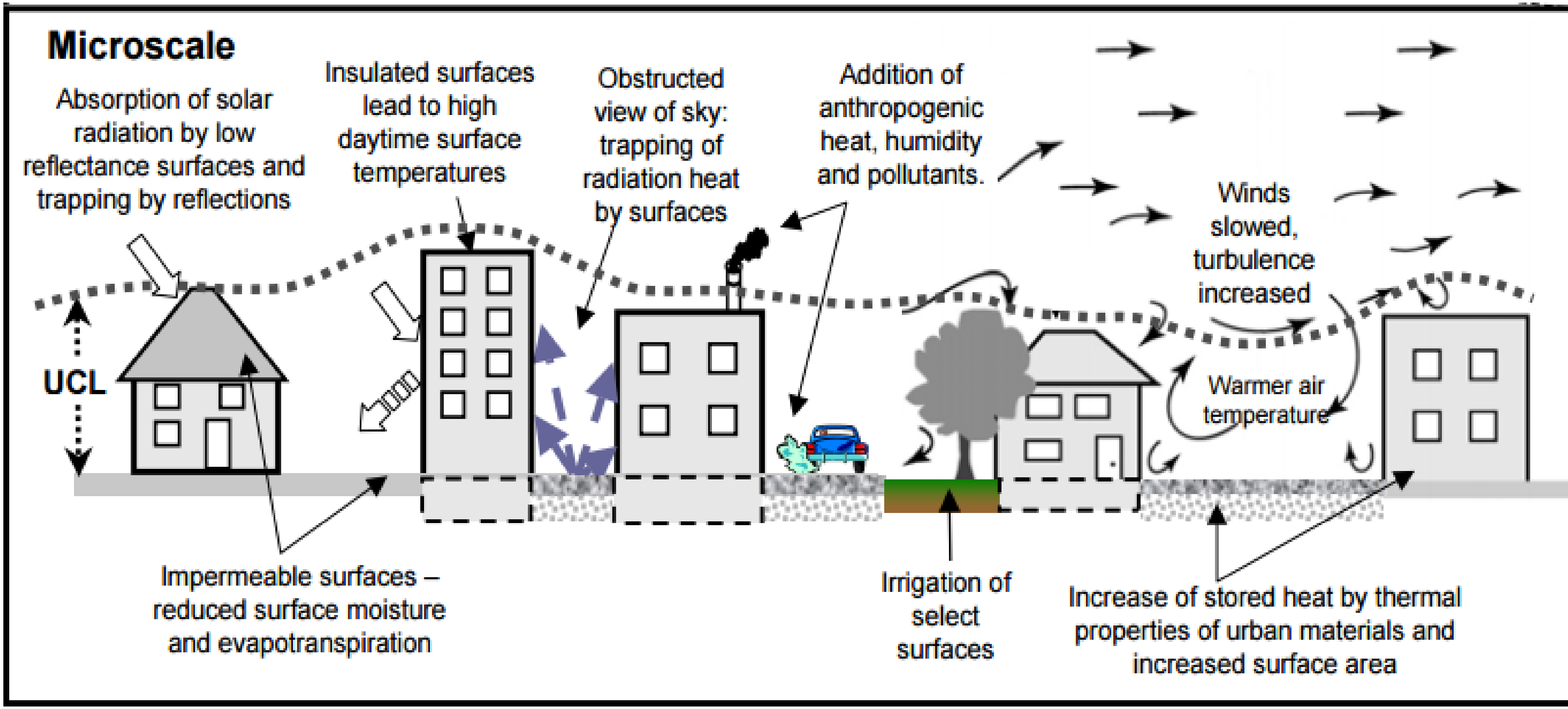
Aerodynamic Roughness

Wind Speed and Ventilation of cities

Change in heat transfer advection

(Alcoforado et al., 2005).

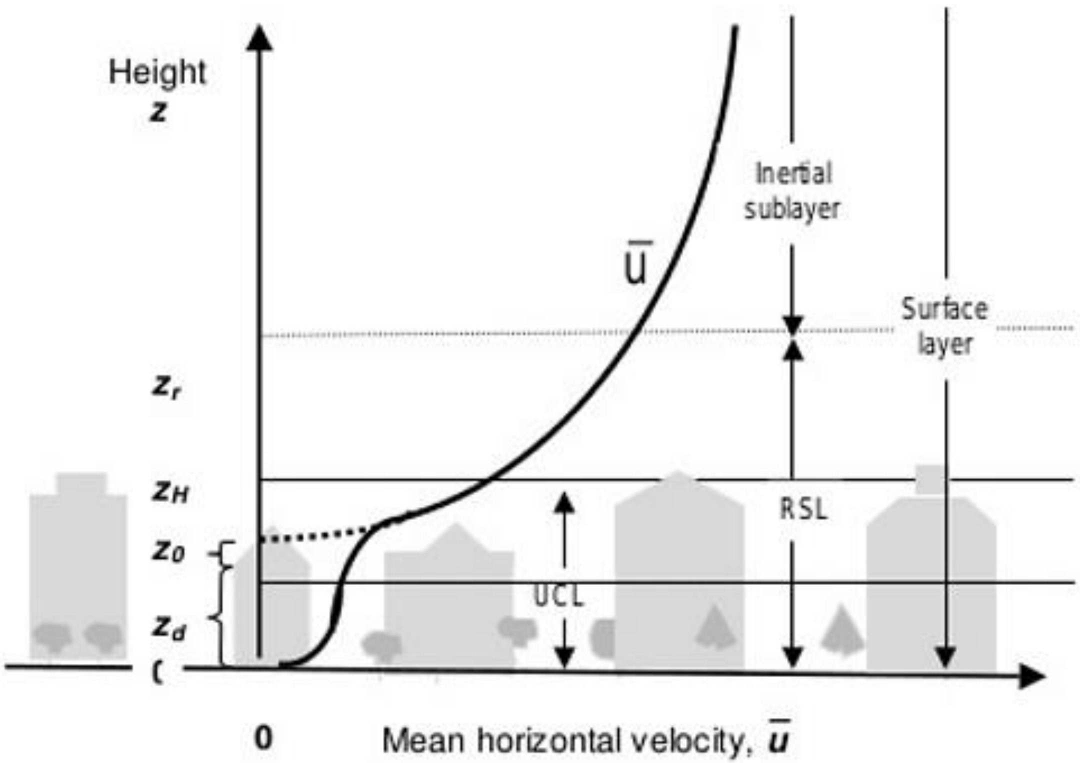




turbulences increase (50 to 100%); wind speed reduction (20 to 30%)

Aerodynamic Roughness length (z0)

- z0 is the height where neutral wind profile reaches zero
- Height, shape, topography, density, and spacing of roughness elements in the upwind area (Lopes, 2003; Prata, 2005; Oke, 2006; Fariña, 2009).
- Allows to infer about the changes in the velocity and flow of the winds;



Source: Oke, 2006.

Why we study the roughness length in urban spaces?

Hamper the formation of UHI;

↓

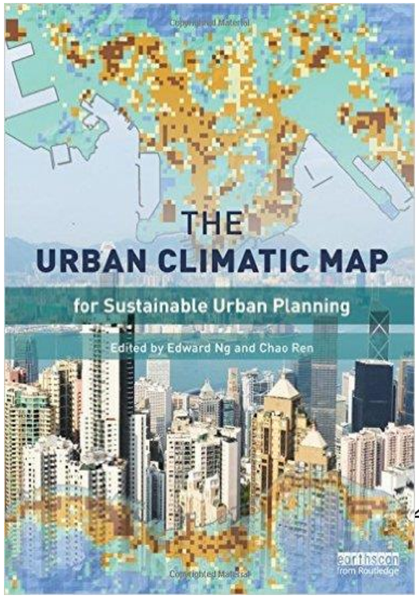
Potential ventilation paths (pollutants dispersion);

↓

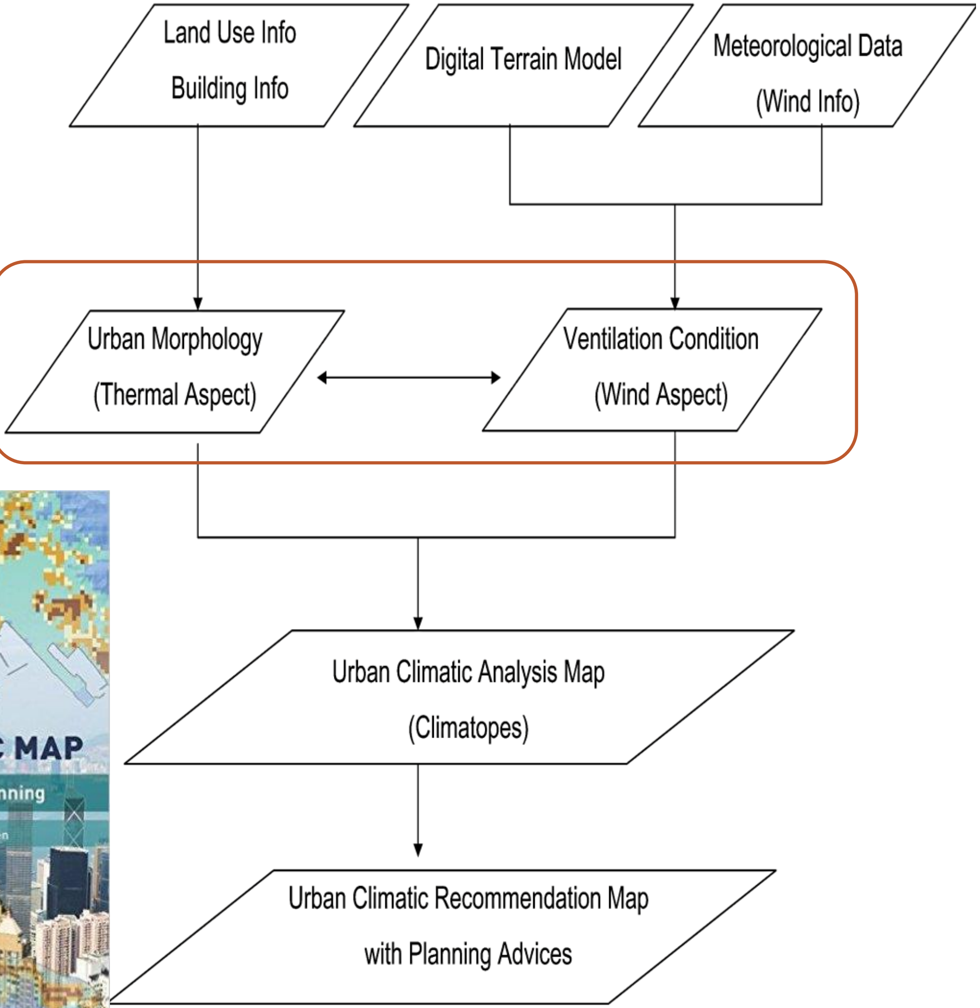
Conditions of thermal comfort to the population;

↓

Urban Climatic Maps (UCMaps)



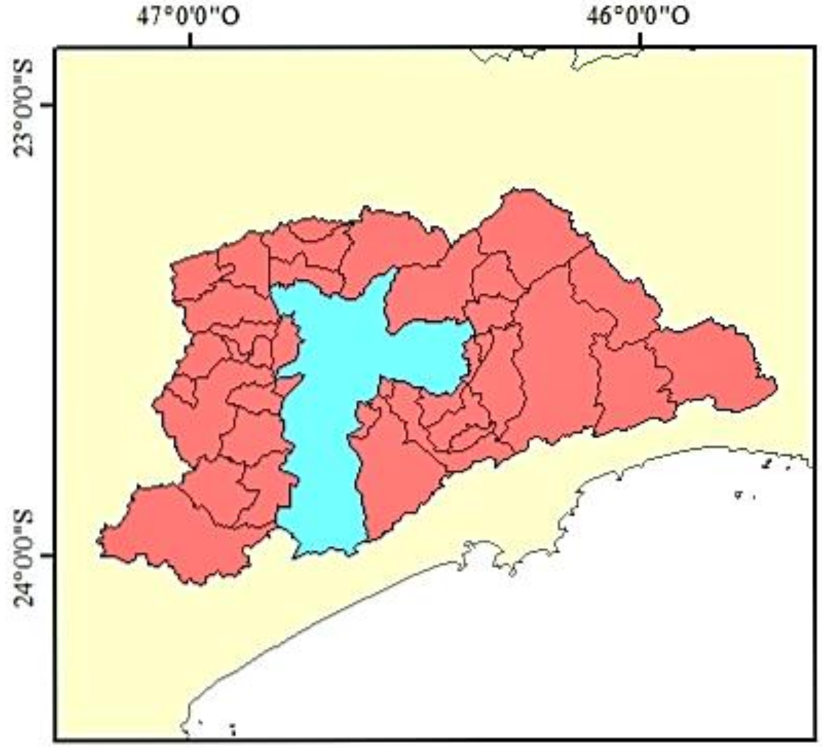
Edward Ng, 2015



Source: Burghardt et al., 2010.

Selection and Delineation of Study Area

- São Paulo - 462 years
- Population: 11.9 million (IBGE, 2014)
- Metropolitan population: 22 million (39 cities)

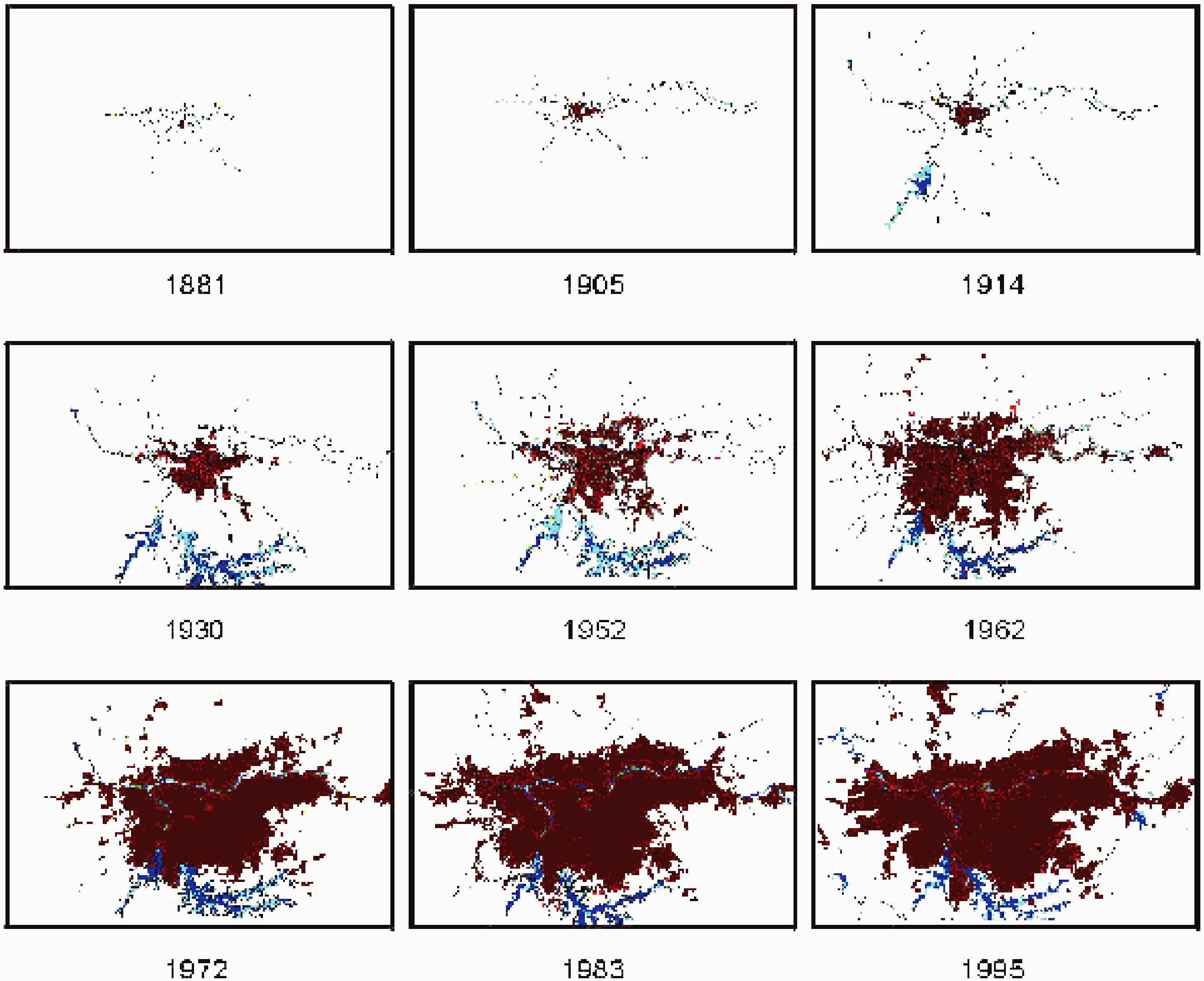


- Elevation - 750 m
- Relative Humidity: 78% (annual average)
- Climate: humid subtropical

(22ºC to 27ºC in summer - 15ºC to 21ºC in winter)

Source: www.prefeitura.sp.gov.br

Growth and density urban in São Paulo



Population growth

Year	Population
1872	31 385
1900	239 620
1920	579 033
1940	1 326 261
1950	2 198 096
1960	2 781 446
1970	5 924 615
1980	8 493 226
1991	9 646 185
2000	10 434 252
2010	11 244 369
2014	11 967 825

Source: IBGE

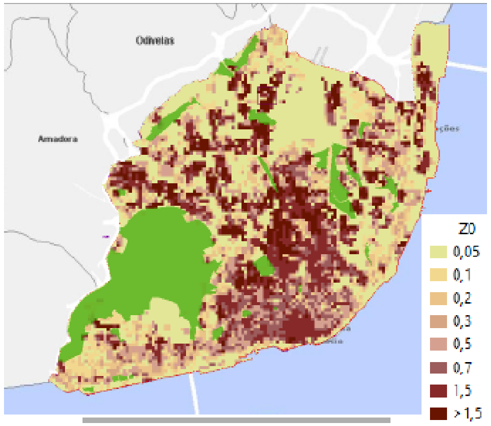
Source: FAU – USP, 2016.

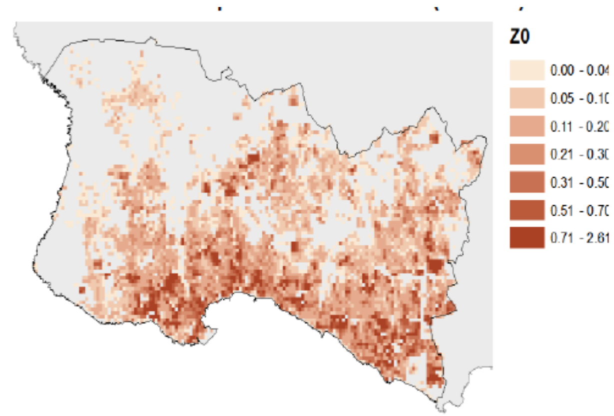
Tab. Population growth in São Paulo

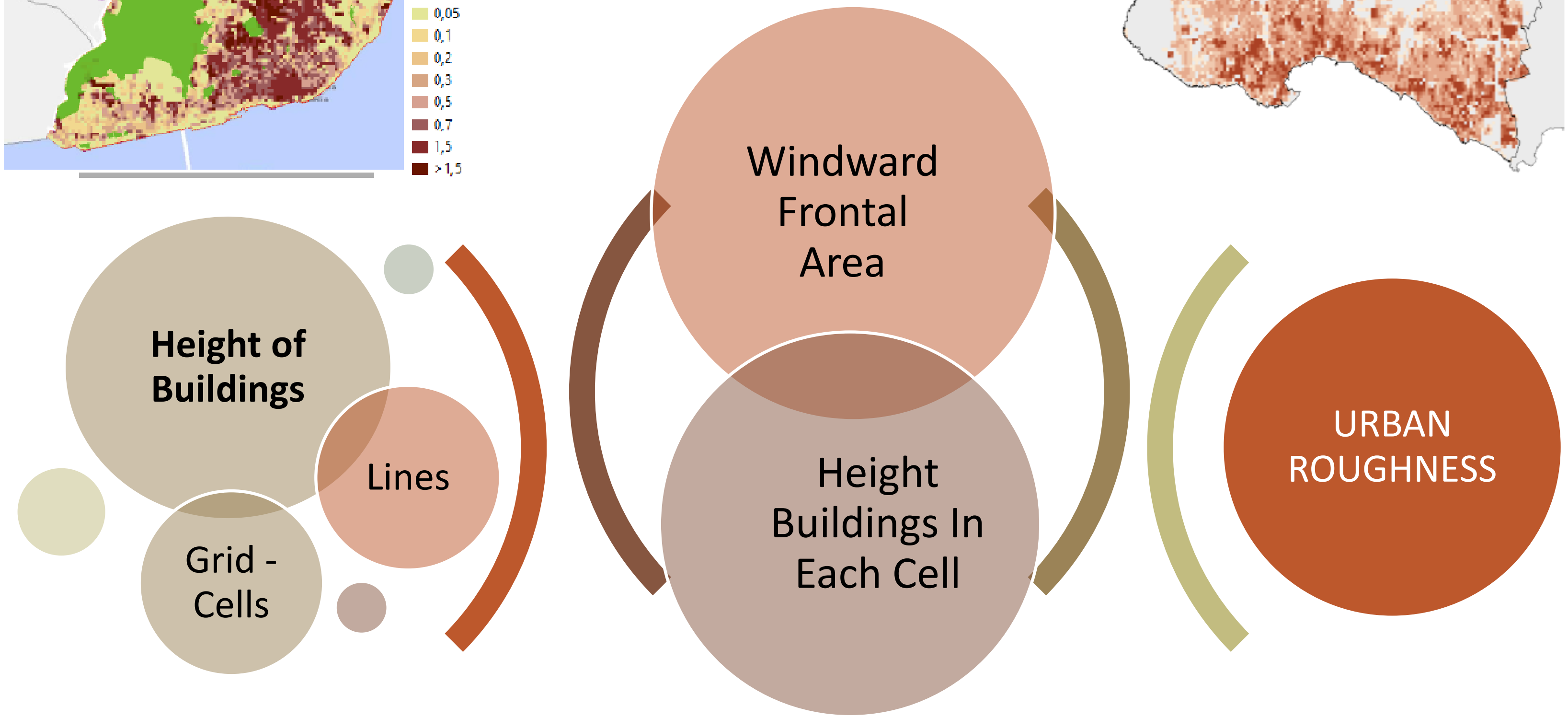
How to calculate morphological indexes to a megacity like São Paulo with huge heterogeneity of geometry and land/land cover?

Methodology

- The methodology developed with a GIS environment is presented, applied to Lisbon (Correia et al., 2015) and Cascais (Lopes & Correia, 2012)





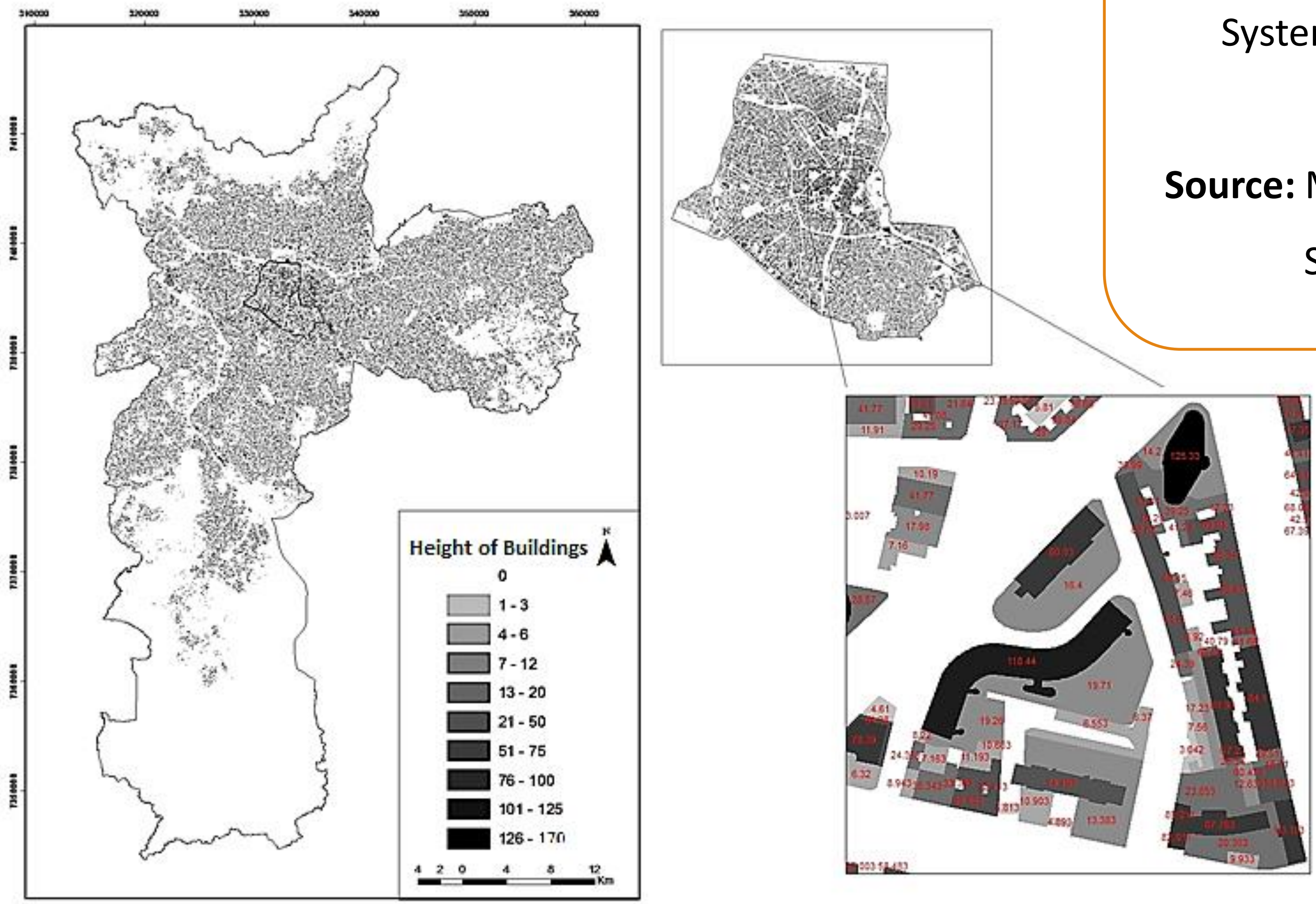


Vector-based buildings database

Data/Shapefiles:

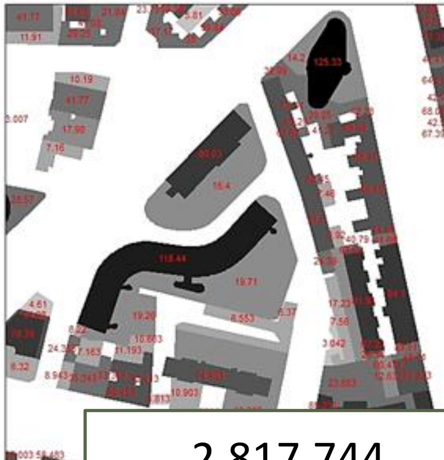
System of Buildings

Source: Municipality of São Paulo



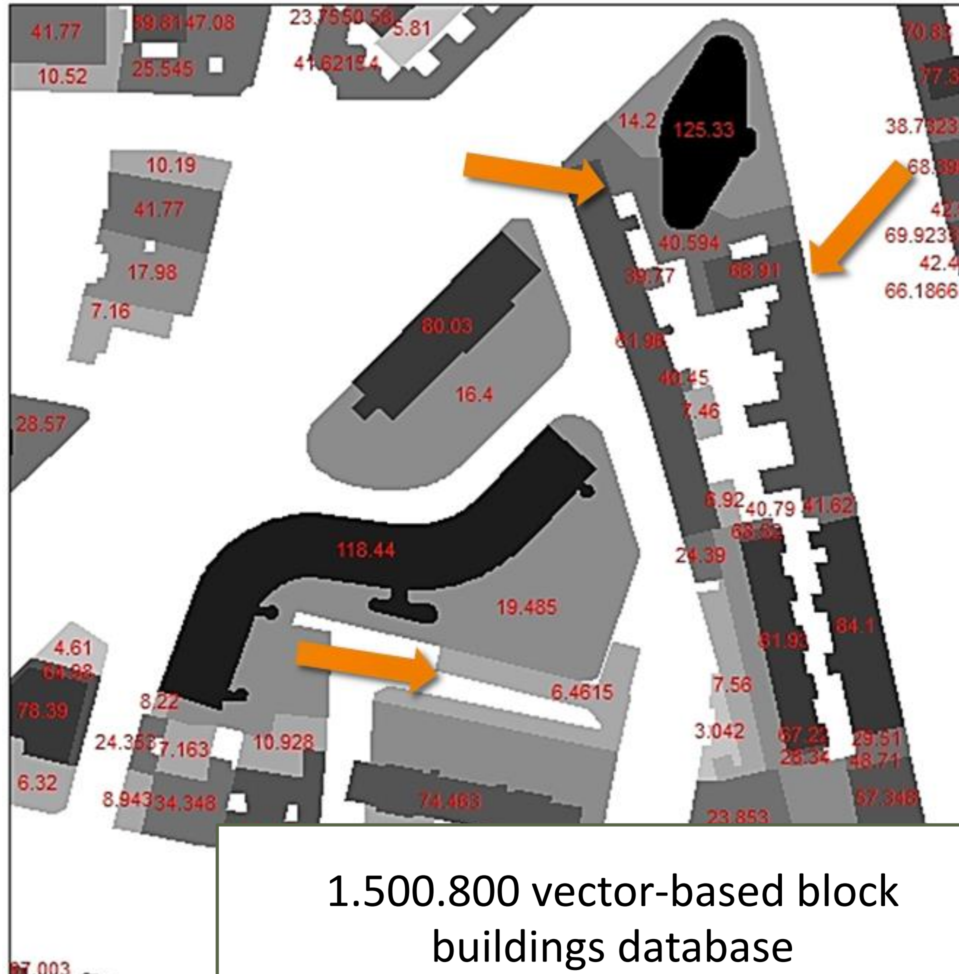
2.817.744 polygons

Generalization

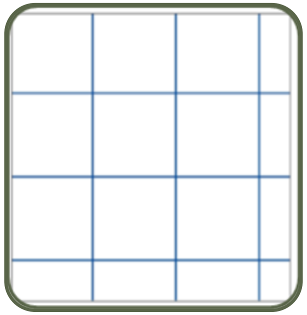


2.817.744

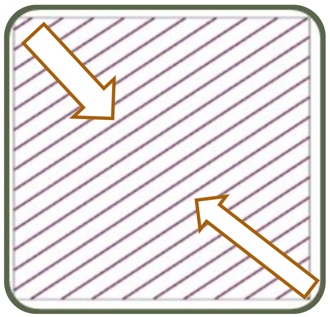
Tool- Dissolve / Spatial Join



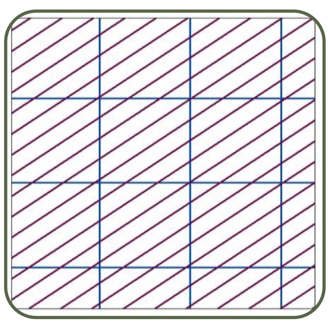
1.500.800 vector-based block buildings database



Create units of analysis
CELLS 100x100 m **(dimensions of a city block) -** Create **Fishnet**

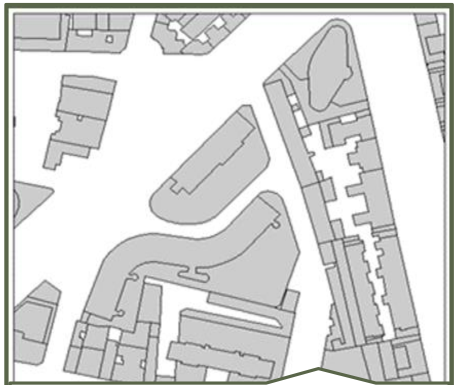


Create lines to calculate
Windward Frontal Area - 20 m 20 m parallel lines perpendicular to the prevailing wind SE – NW



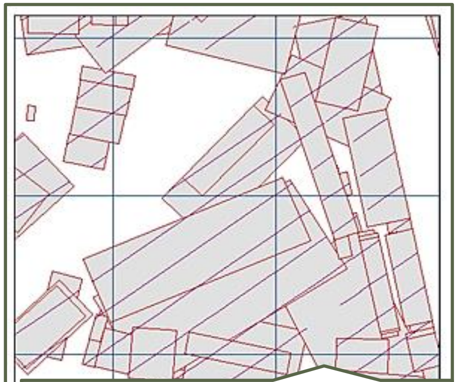
Cels - These data were divided into cells, together with the height of the buildings, footprint area and volume.

Calculate Windward Frontal Area

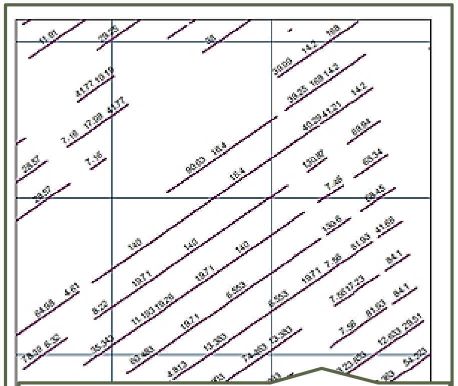


Block buildings

Regular block buildings



∩ with lines and grid

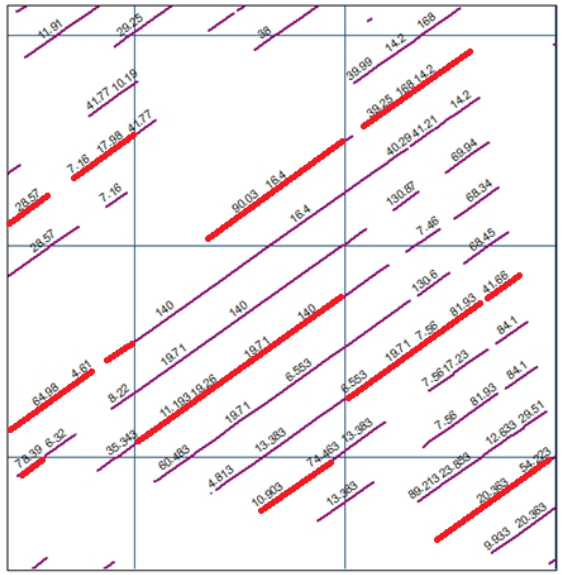


Windward Frontal Area

Aerodynamic Roughness length (z0)

Roughness length (z0) = 0.5h x s/S (Lettau, 1969)

(z0) = 0.5h x



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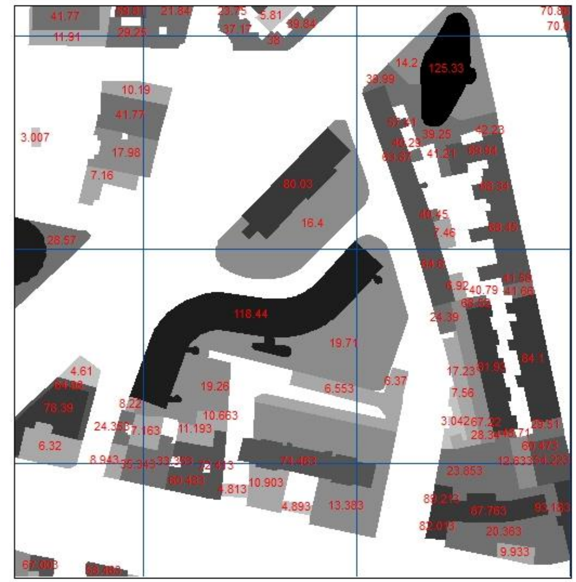


s - frontal area

Windward Frontal Area

S – cell area

Height Buildings in each cell

Results

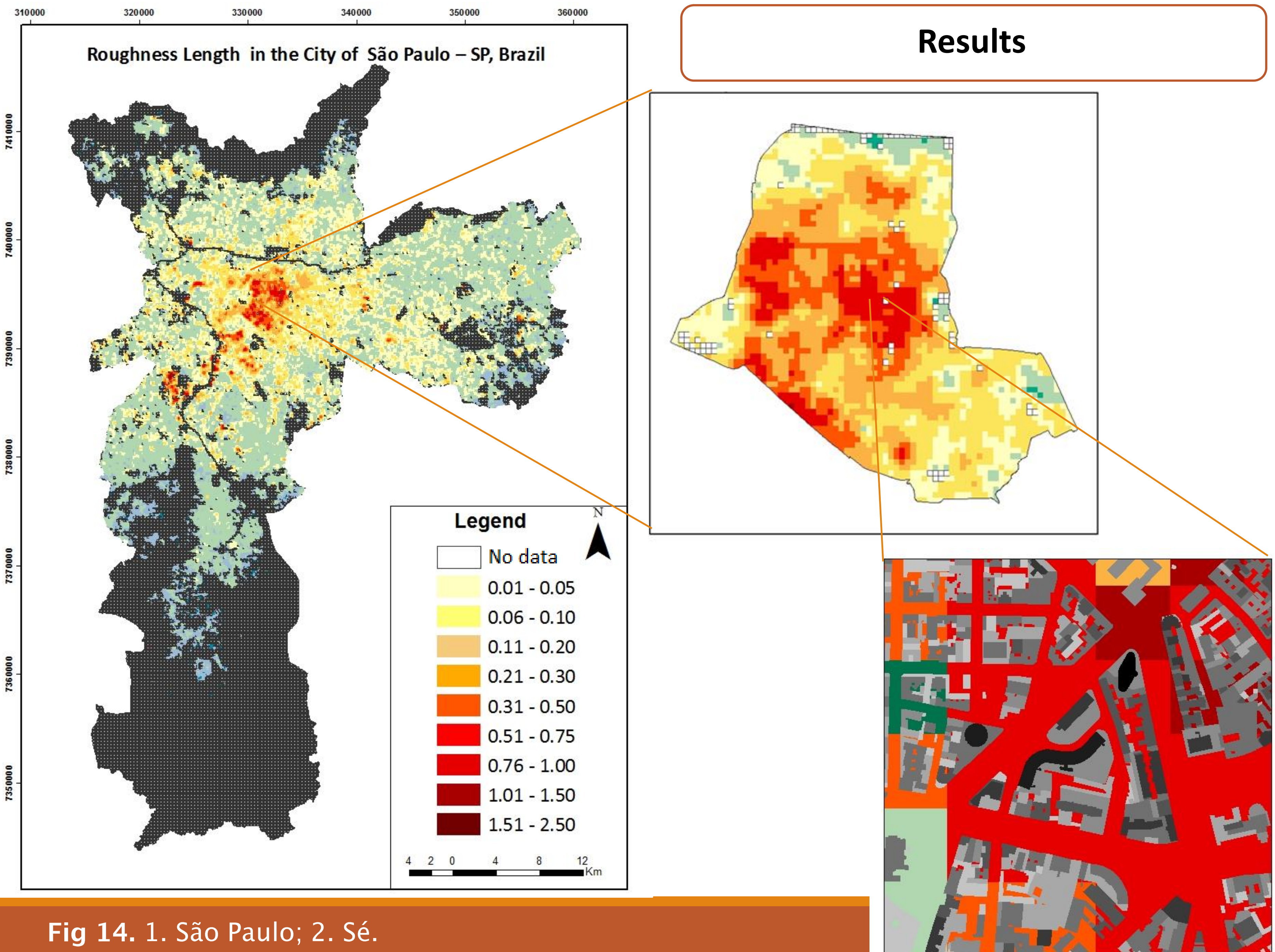
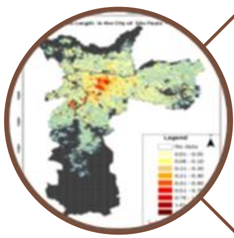


Fig 14. 1. São Paulo; 2. Sé.

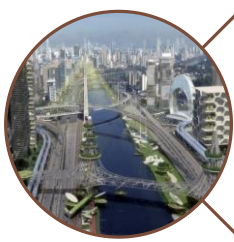
Conclusions

The model can be envisaged as a good tool for calculate indexes urban to megacities – simple and quick way.

Further variables can to be incorporated in the model to account for urban density and morphology, UCMaps and Thermal Comfort.



The results promoting the maintenance and management of potential ventilation paths in the megacity of São Paulo and other cities in Brazil.



Contribute to urban planning for estimate futures scenarios for tropical cities .

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http:// www.prefeitura.sp.gov.br/

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Thank you!