



Neighbourhood morphology, entropy, and solar energy potentials

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Content

Urban form indicators

- Building/street geometry
- Density and compactness

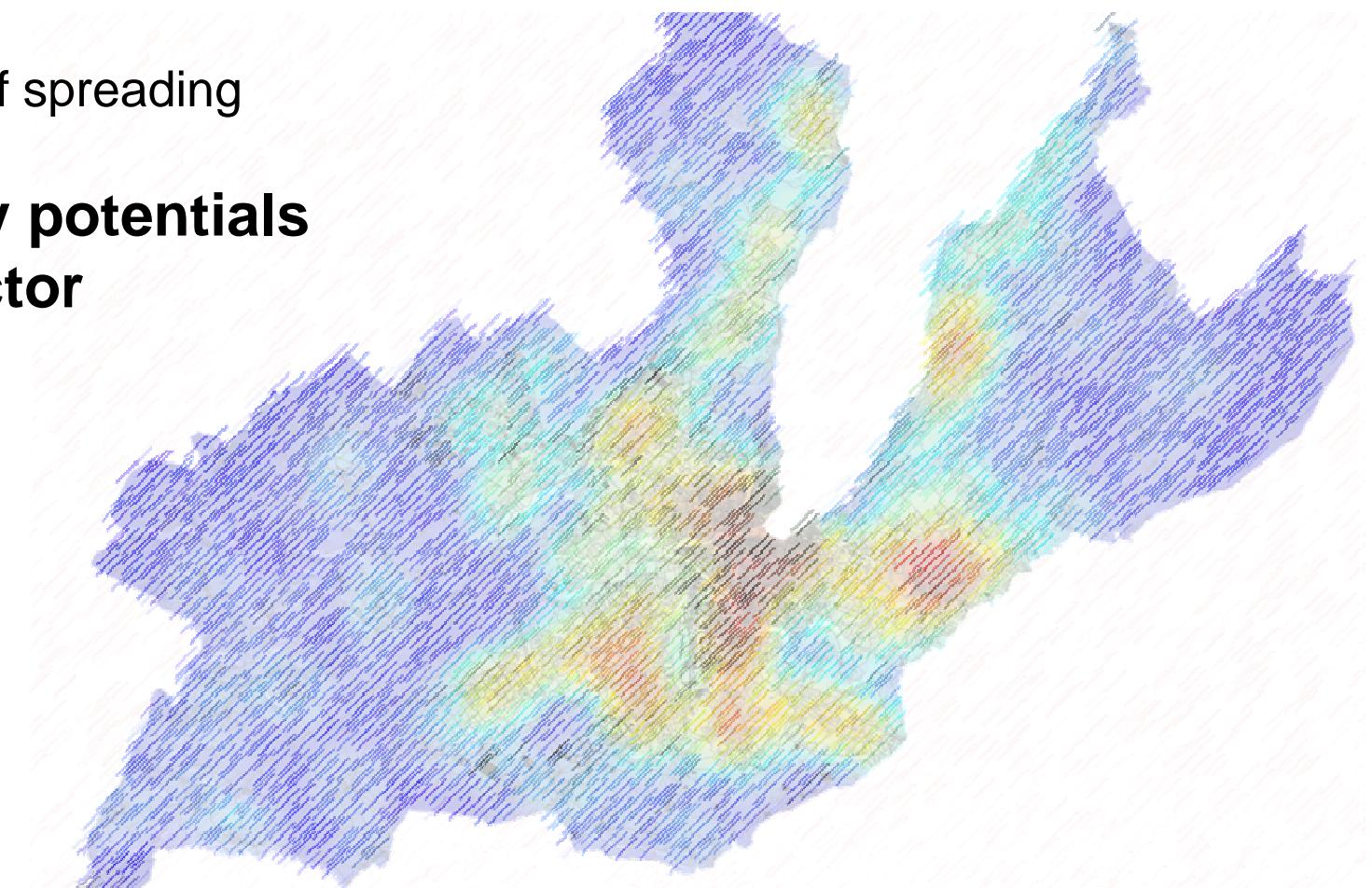
Entropy

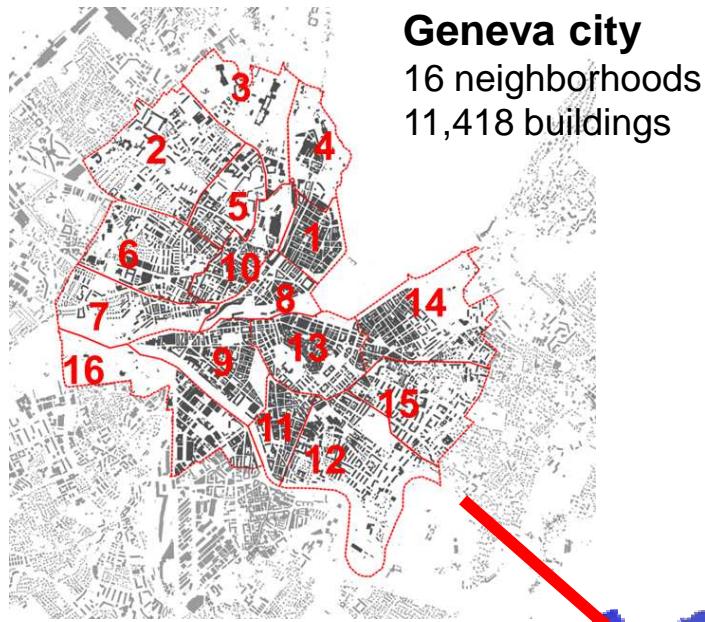
- A measure of spreading

Solar energy potentials

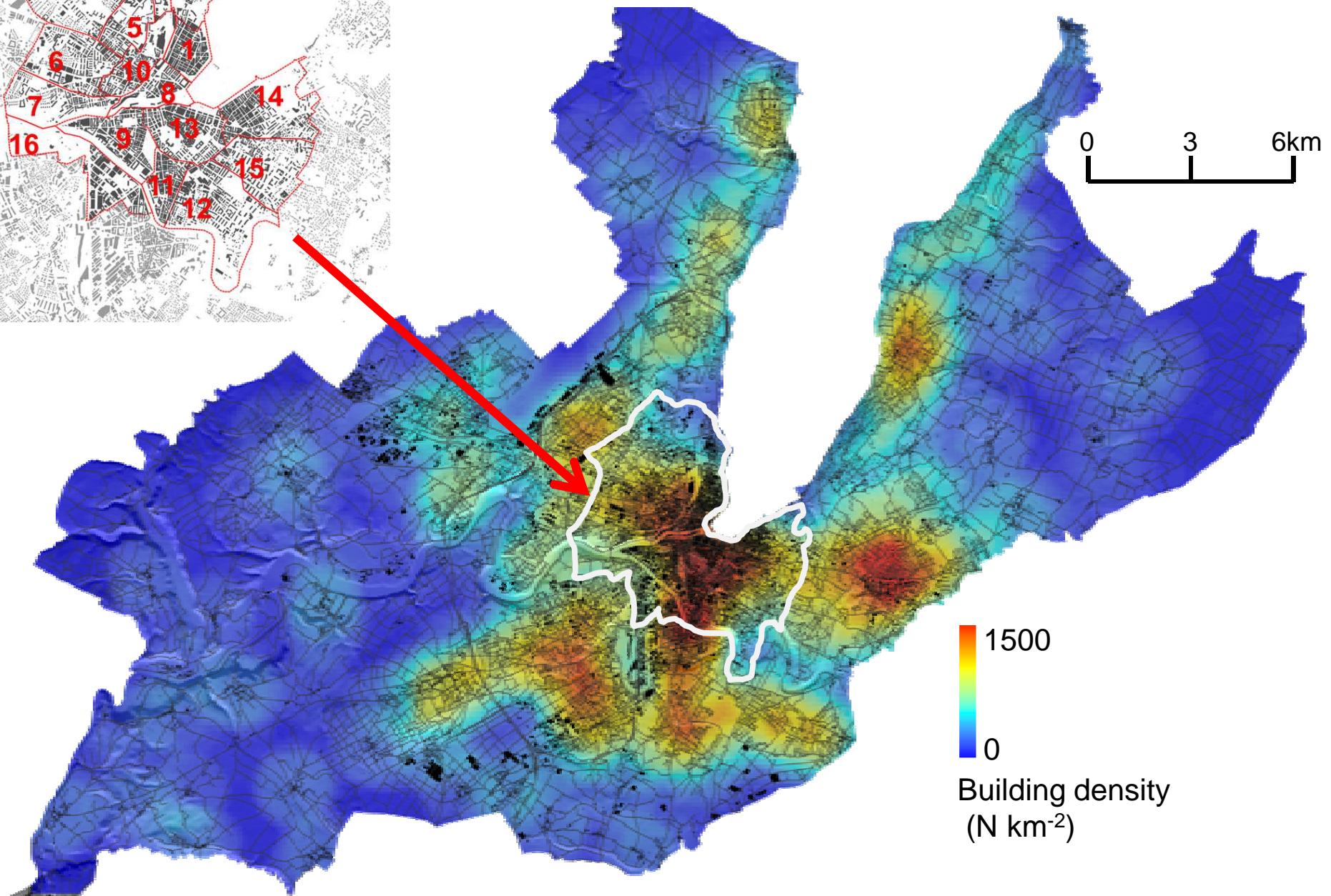
Sky view factor

Conclusion





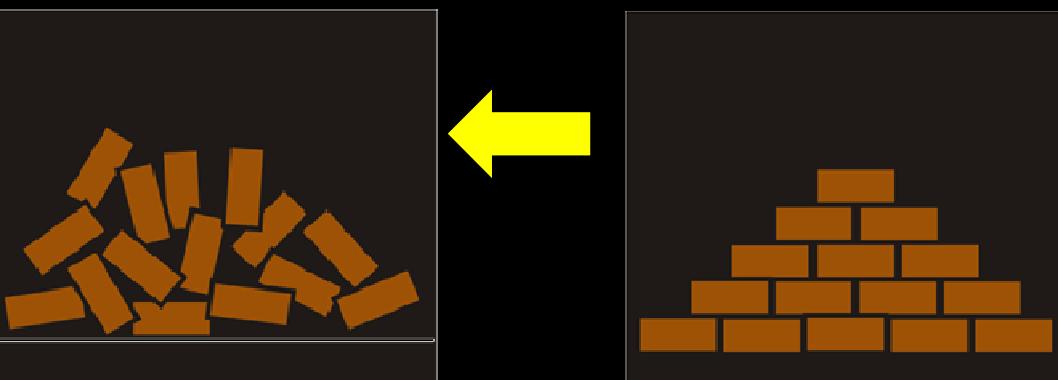
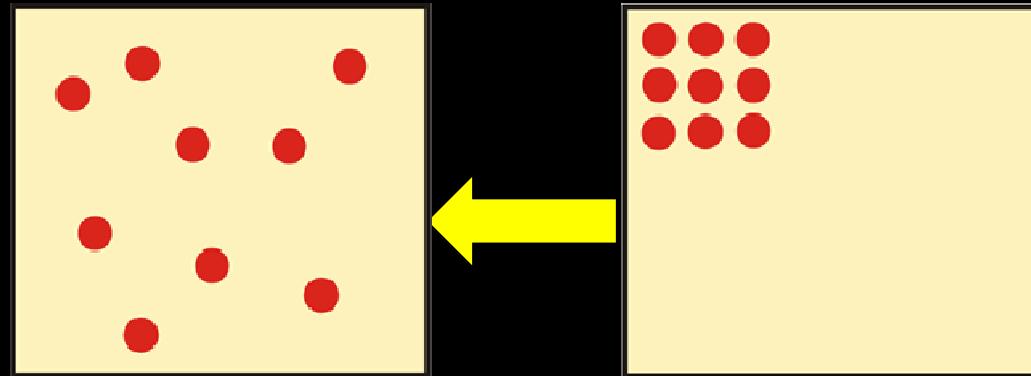
Geneva canton



Urban form indicators

Building/street	Descriptor	Unit
Geometry	Orientation	Azimuth, degree
	Average perimeter	m
	Average volume	m^3
	Average area	m^2
	Average height	m
	Average length	m
Density & compactness	Number of buildings/streets per unit area	$N m^{-2}$
	Site coverage (Footprint area/ site area)	%
	Plot ratio (Total floor area/ site area)	-
	Volume/area ratio	m
Entropy	A measure of spreading/dispersal	No unit

Disorder is more probable than order



Entropy is a measure of spreading or dispersal.

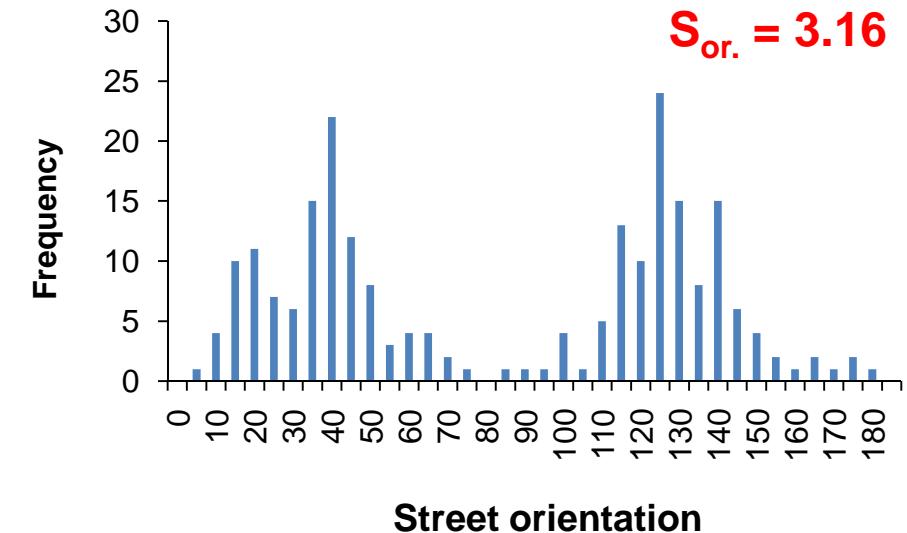
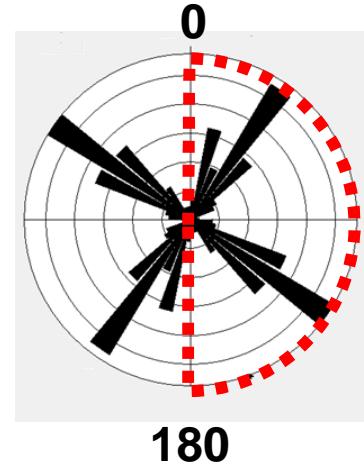
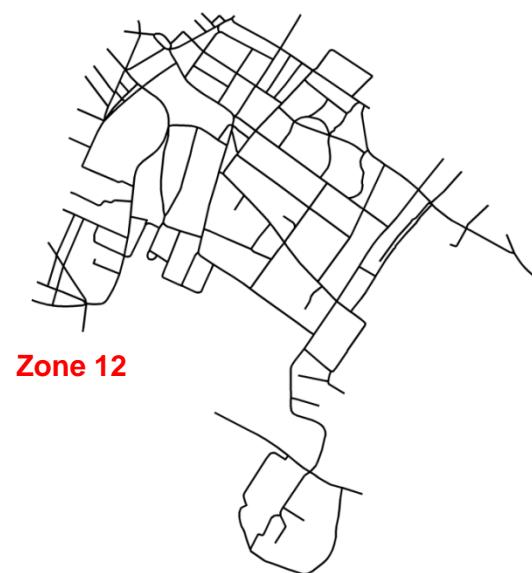
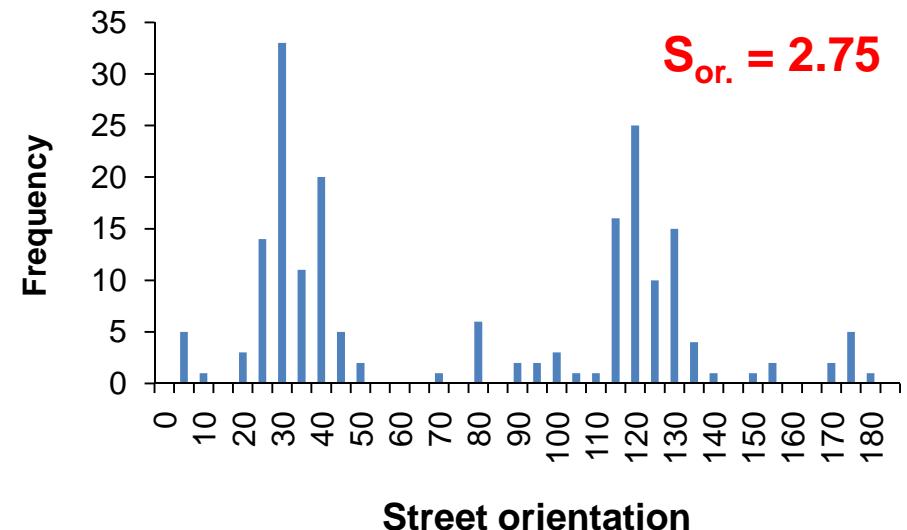
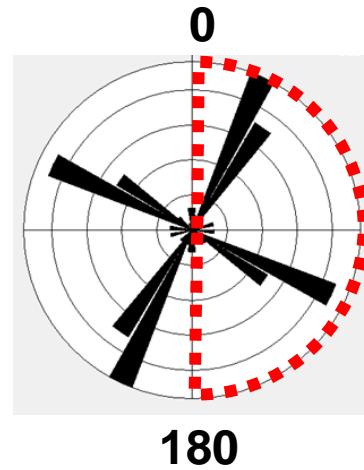
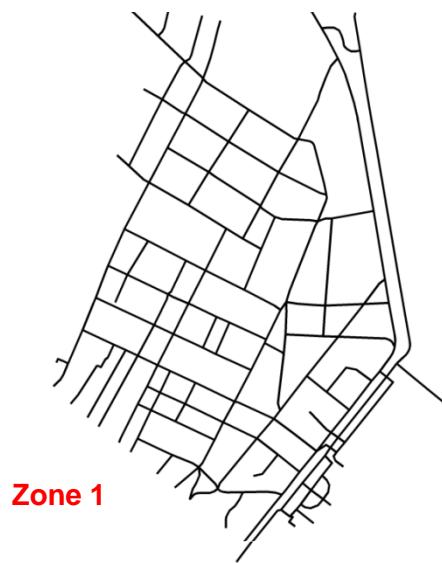
It is used in statistical mechanics and in information theory

$$p_i = \frac{n_i}{N}$$

$$S = -k \sum_{i=1}^t p_i \ln p_i$$

number of bins
constant
probability

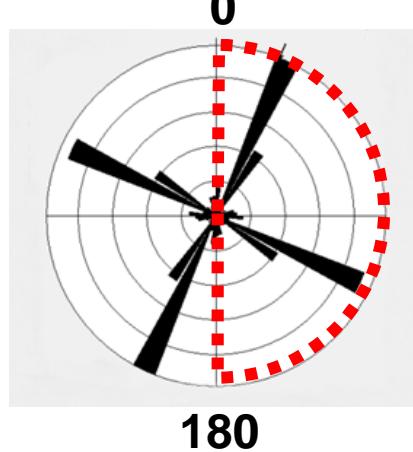
Street orientation and entropy



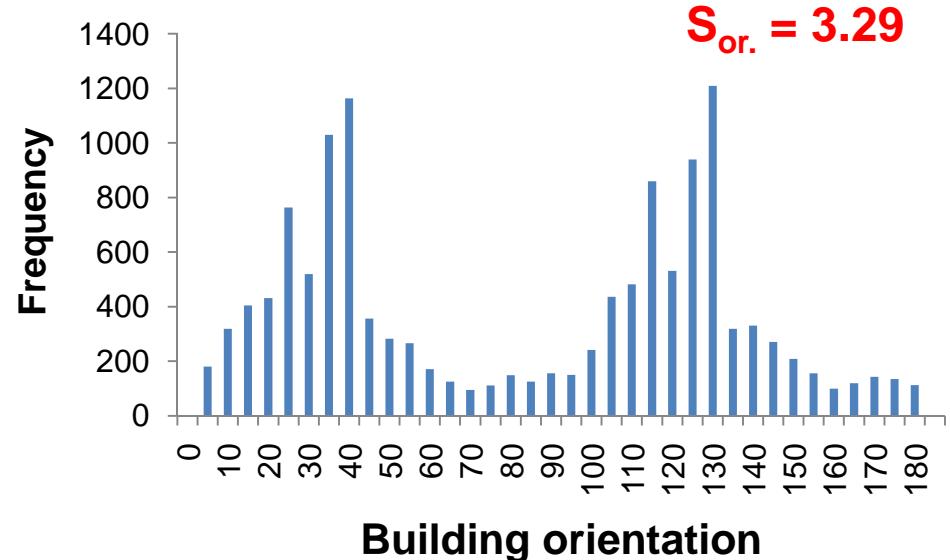
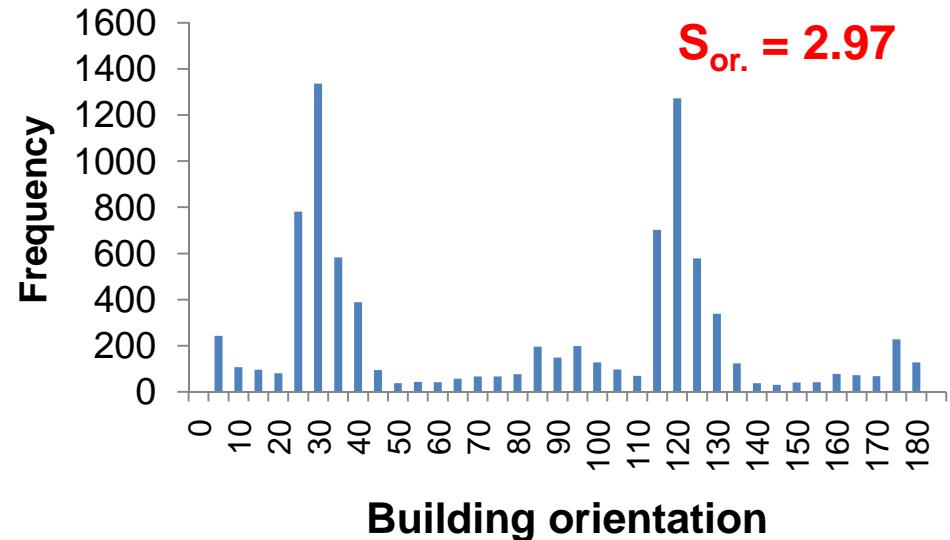
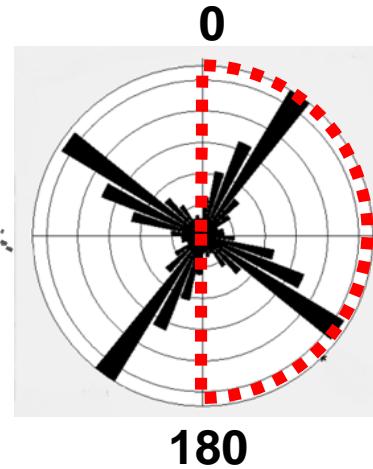
Building orientation and entropy



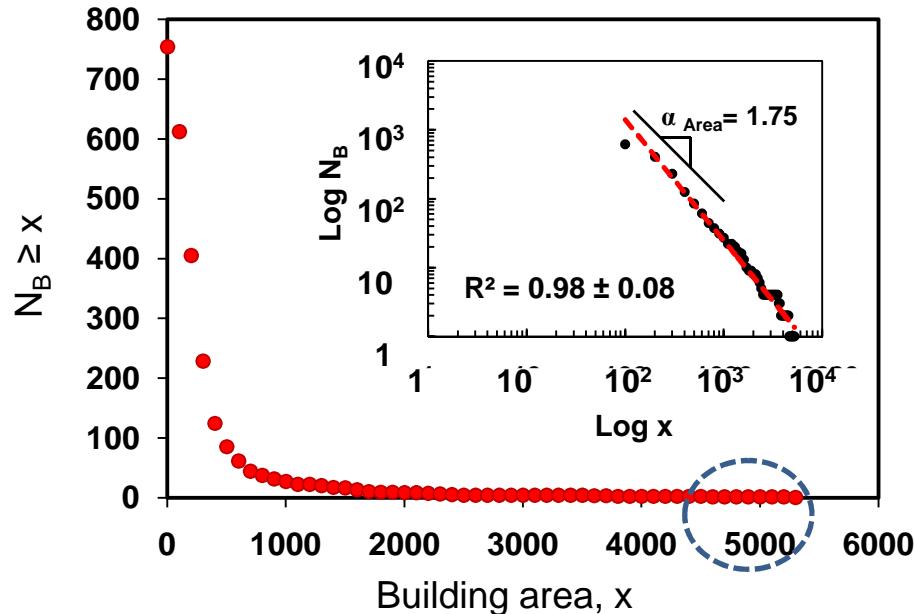
Zone 1



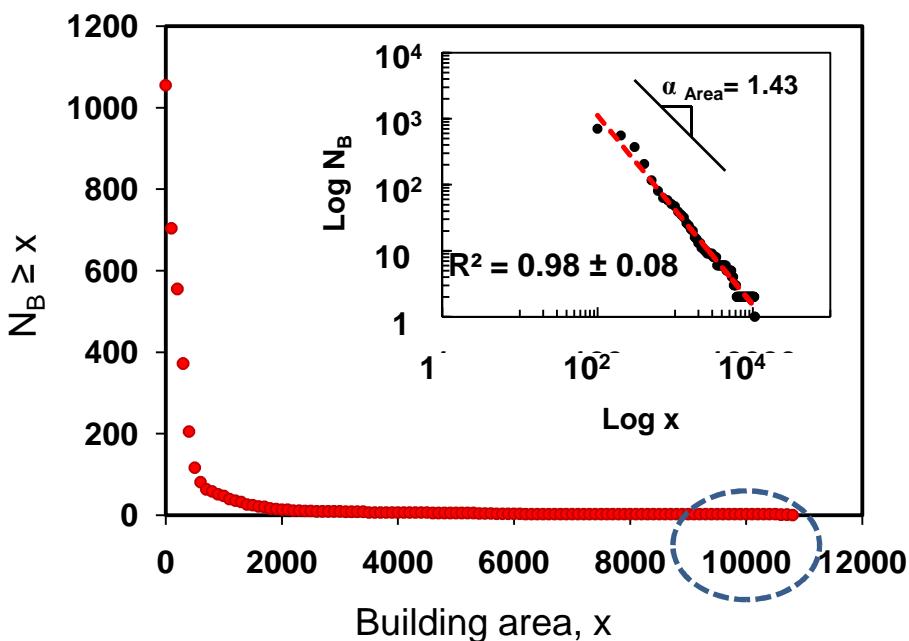
Zone 12



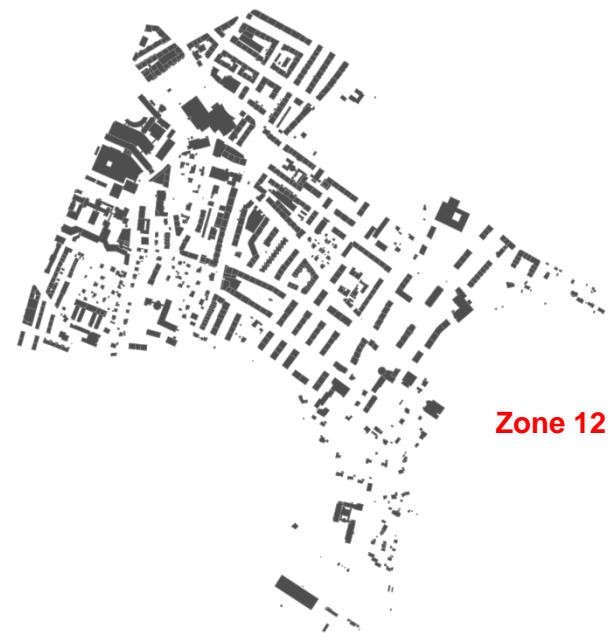
Area distribution and entropy



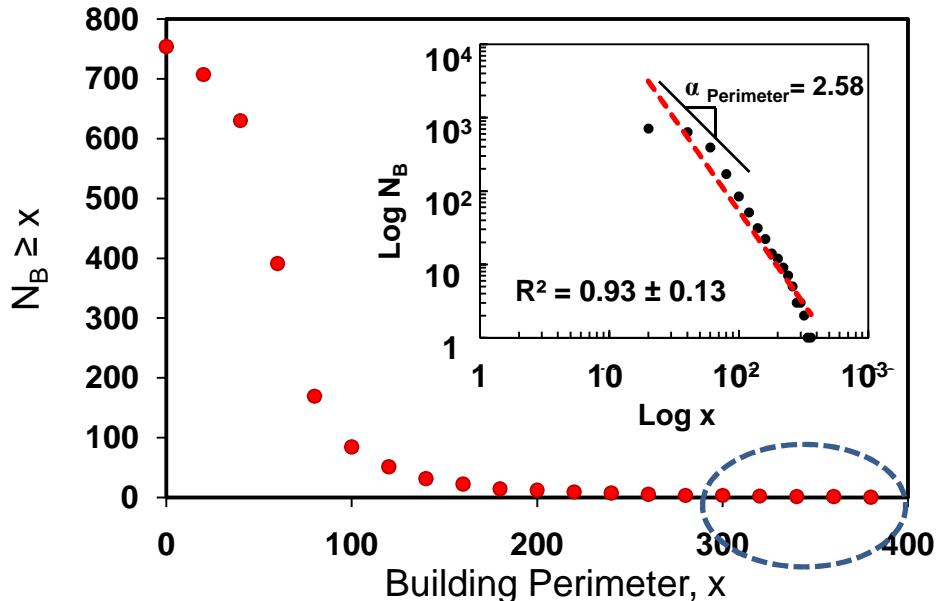
Av. Area, m ²	299
Entropy of Area	2.289



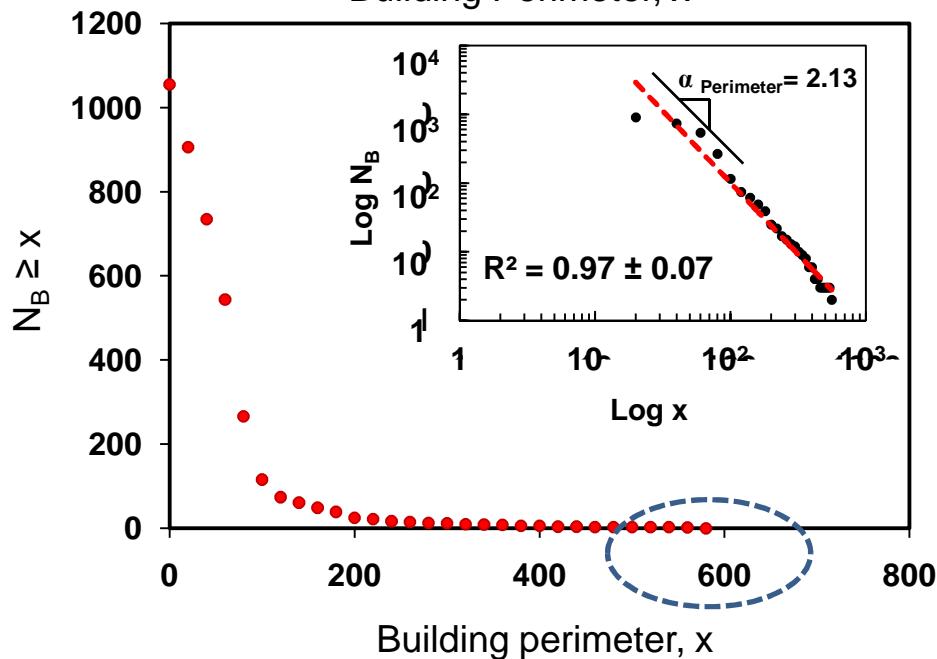
Av. Area, m ²	311
Entropy of Area	2.658



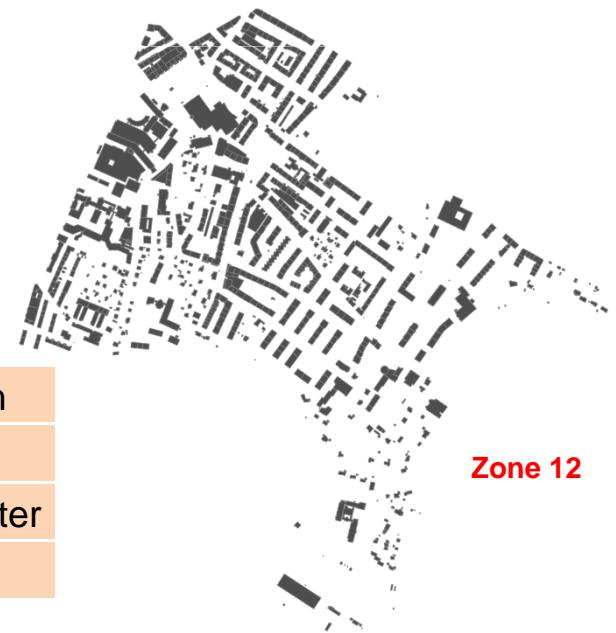
Perimeter distribution and entropy



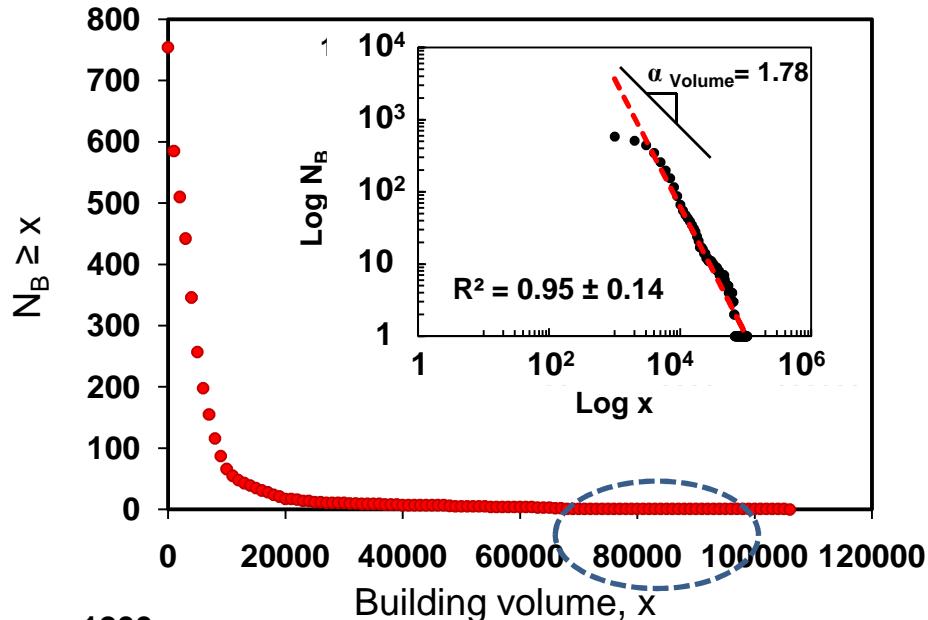
Av. Perimeter, m
67
Entropy of Perimeter
1.839



Av. Perimeter, m
66
Entropy of Perimeter
2.032



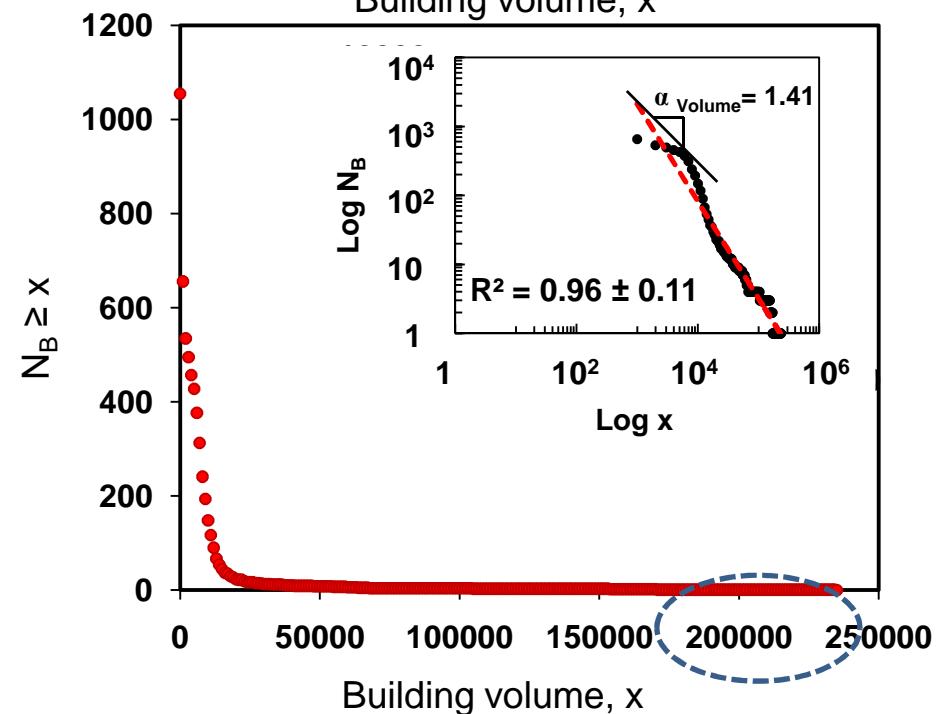
Volume distribution and entropy



Av. Volume, m ³
5081
Entropy of Volume
2.919



Zone 1

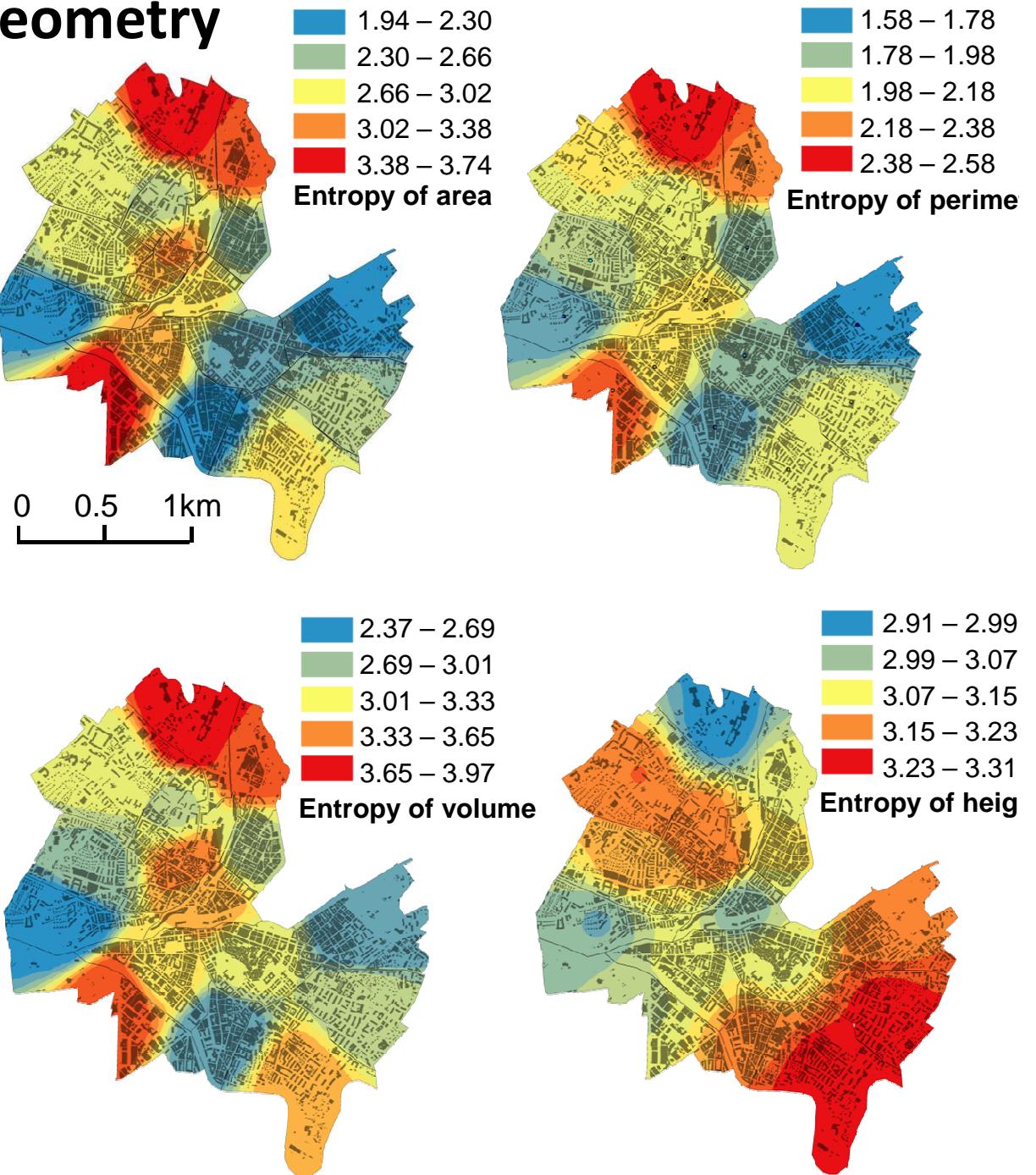
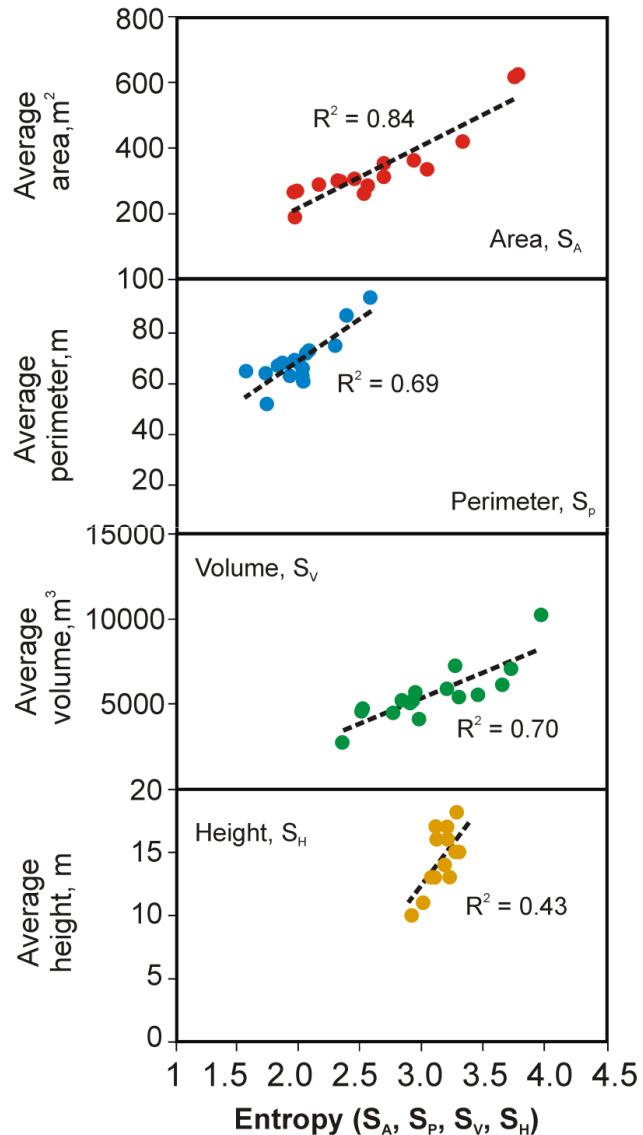


Av. Volume, m ³
5415
Entropy of Volume
3.31



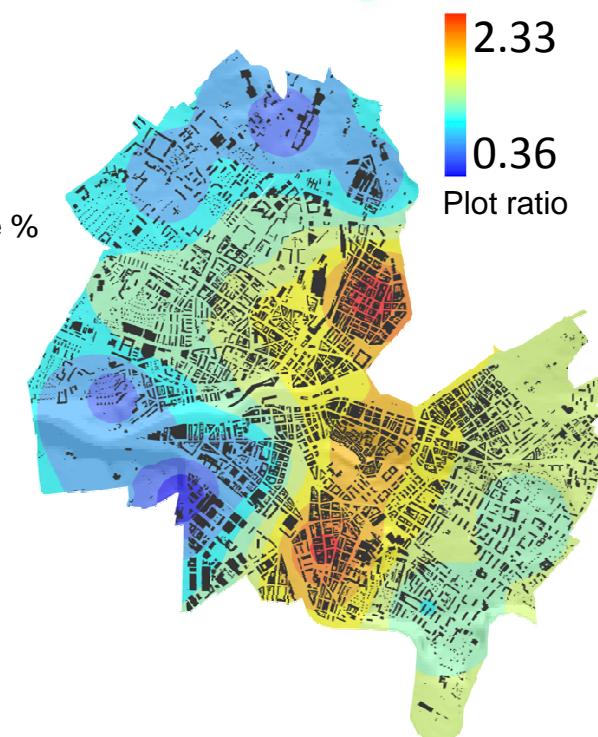
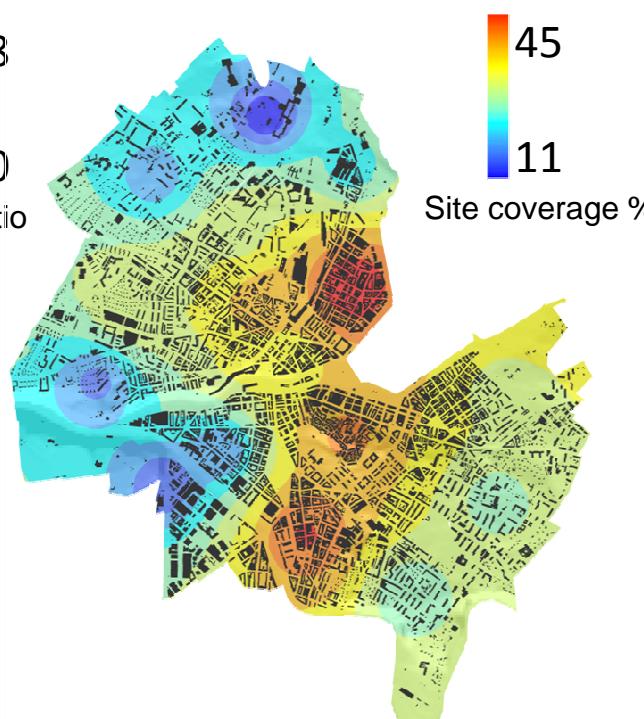
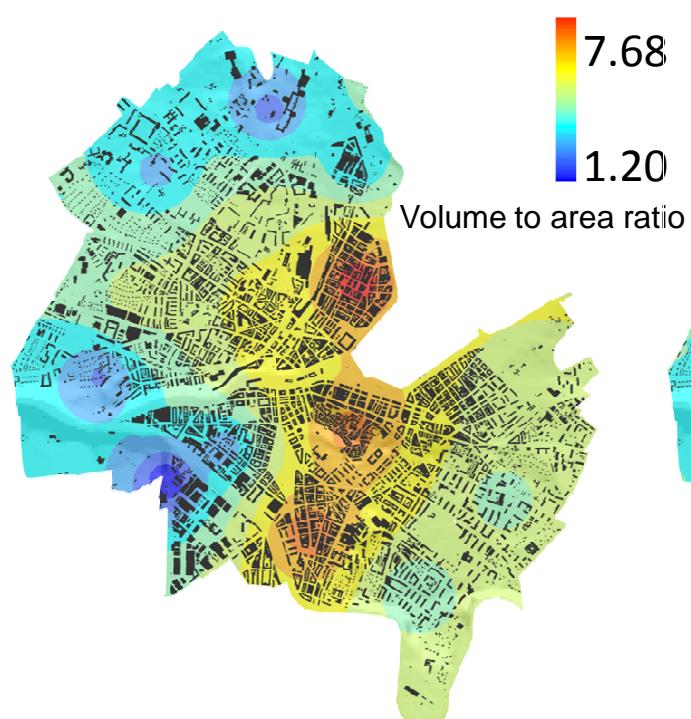
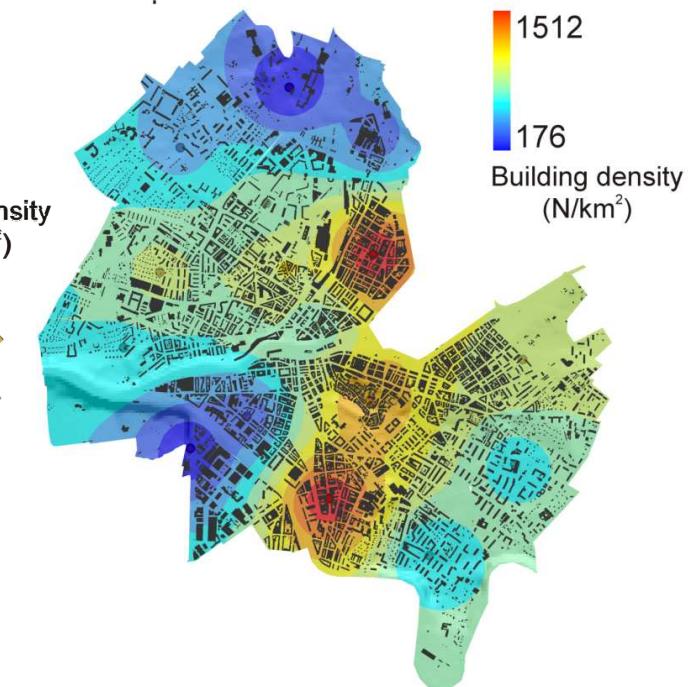
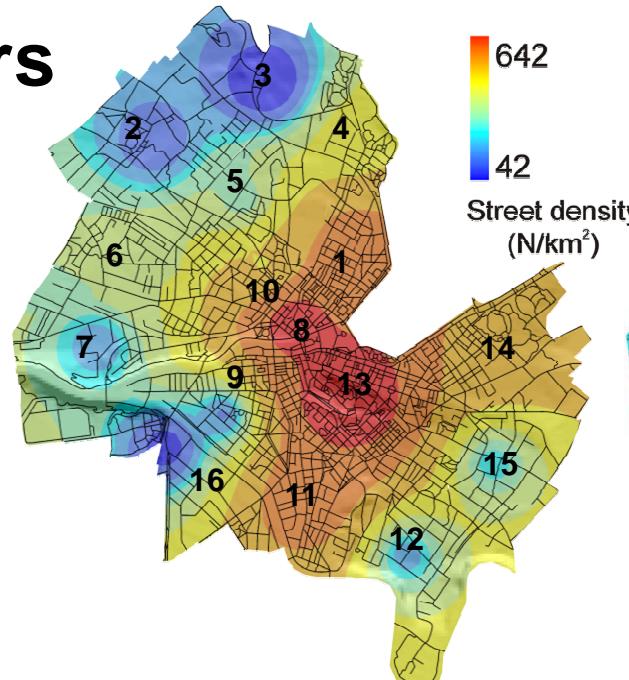
Zone 12

Entropy and building geometry



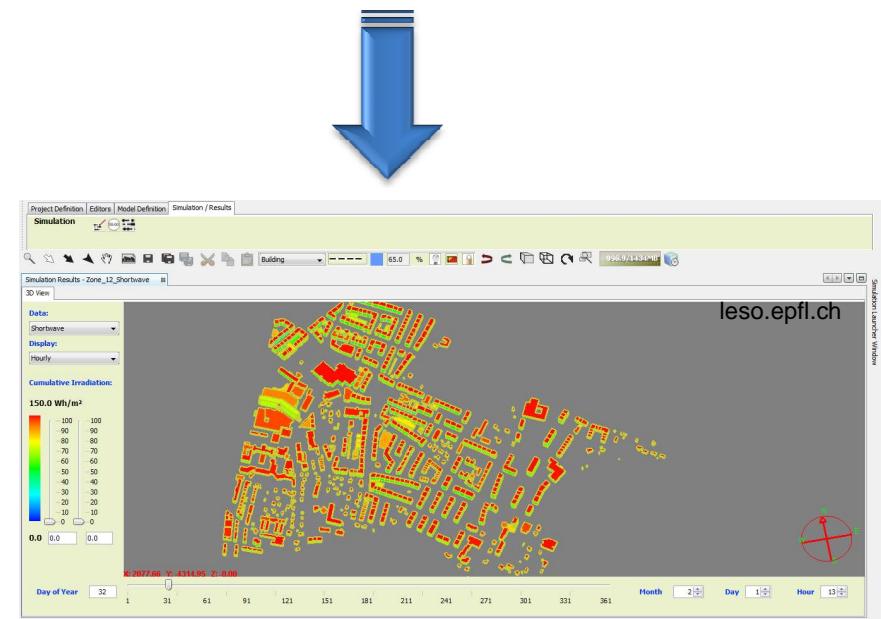
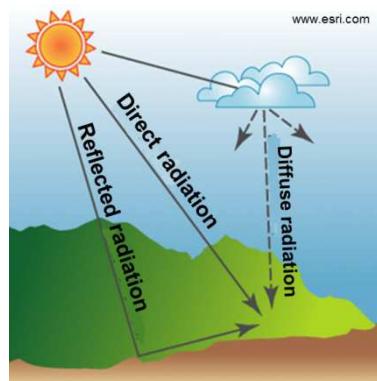
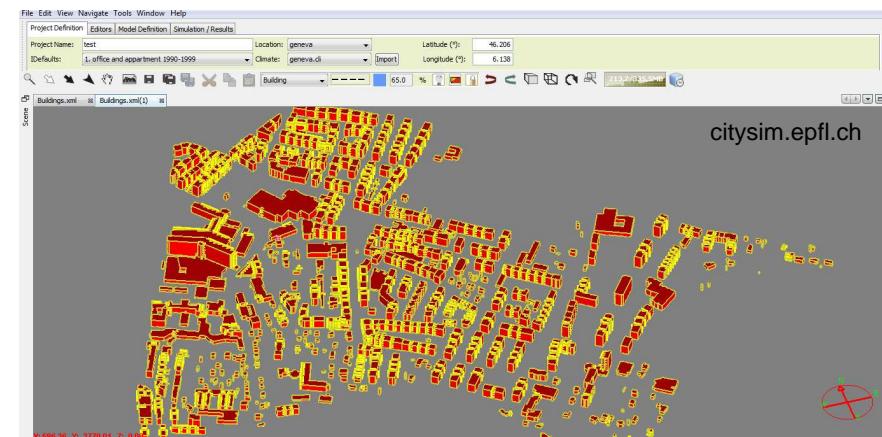
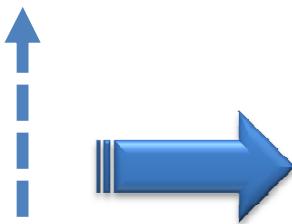
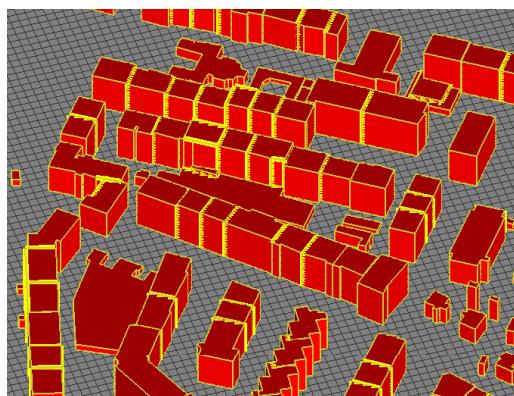
Density indicators

- Street density
- Building density
- Volume/area ratio
- Site coverage %
- Plot ratio

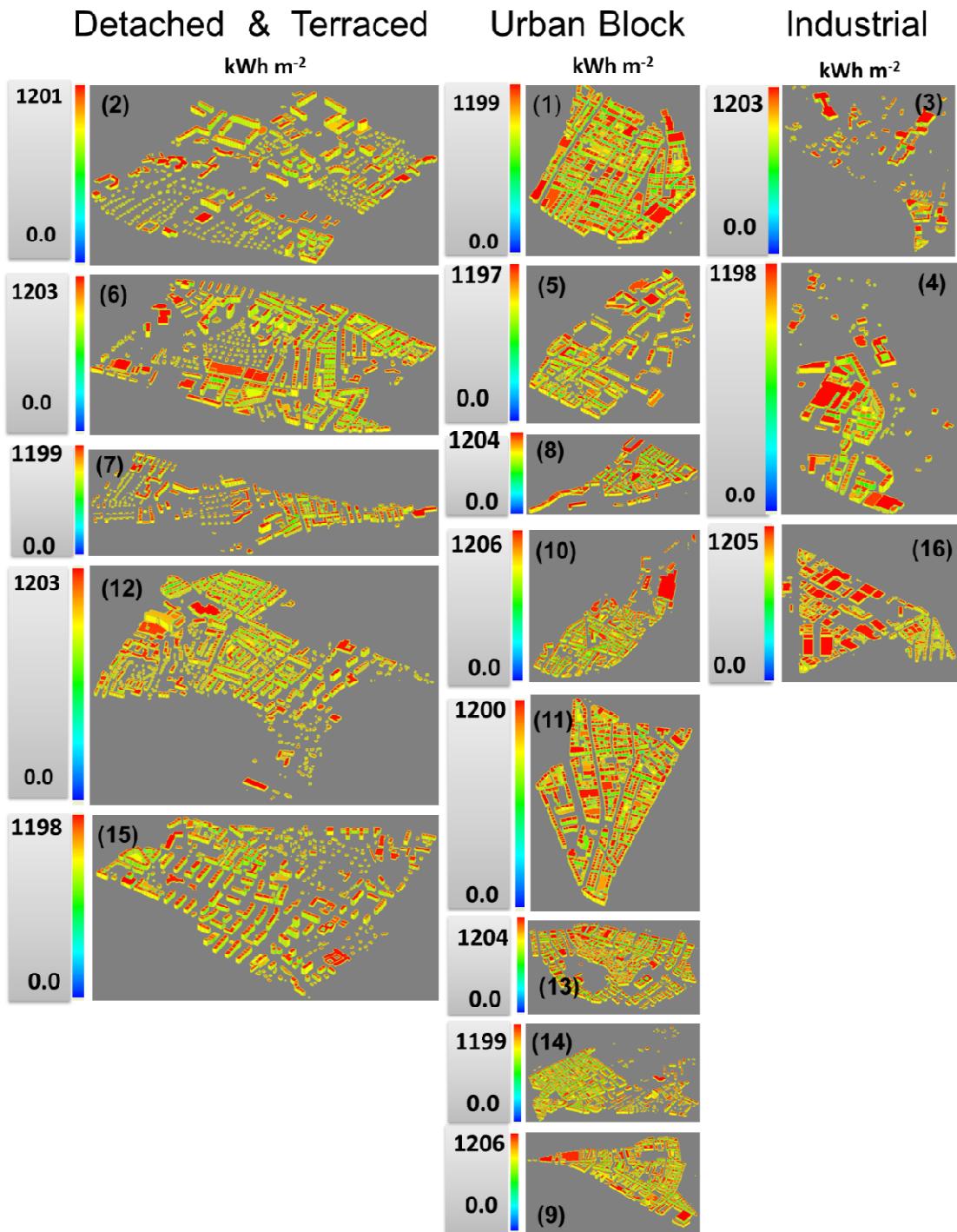


Hourly solar radiation simulation using CitySim

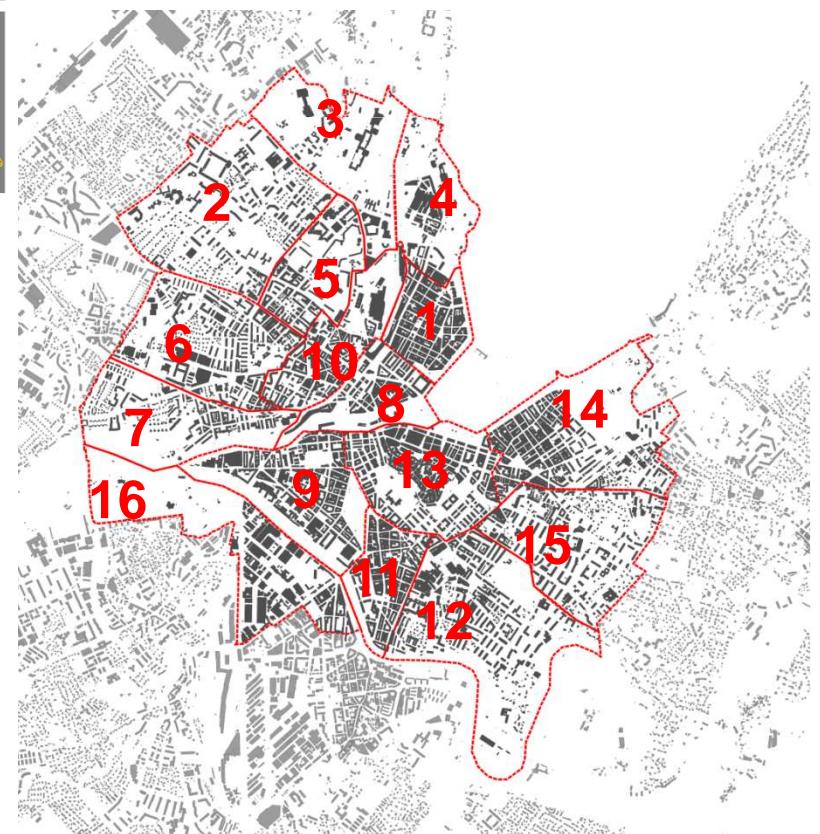
3D model of building typologies
export in DXF or XML format as
input data for CitySim



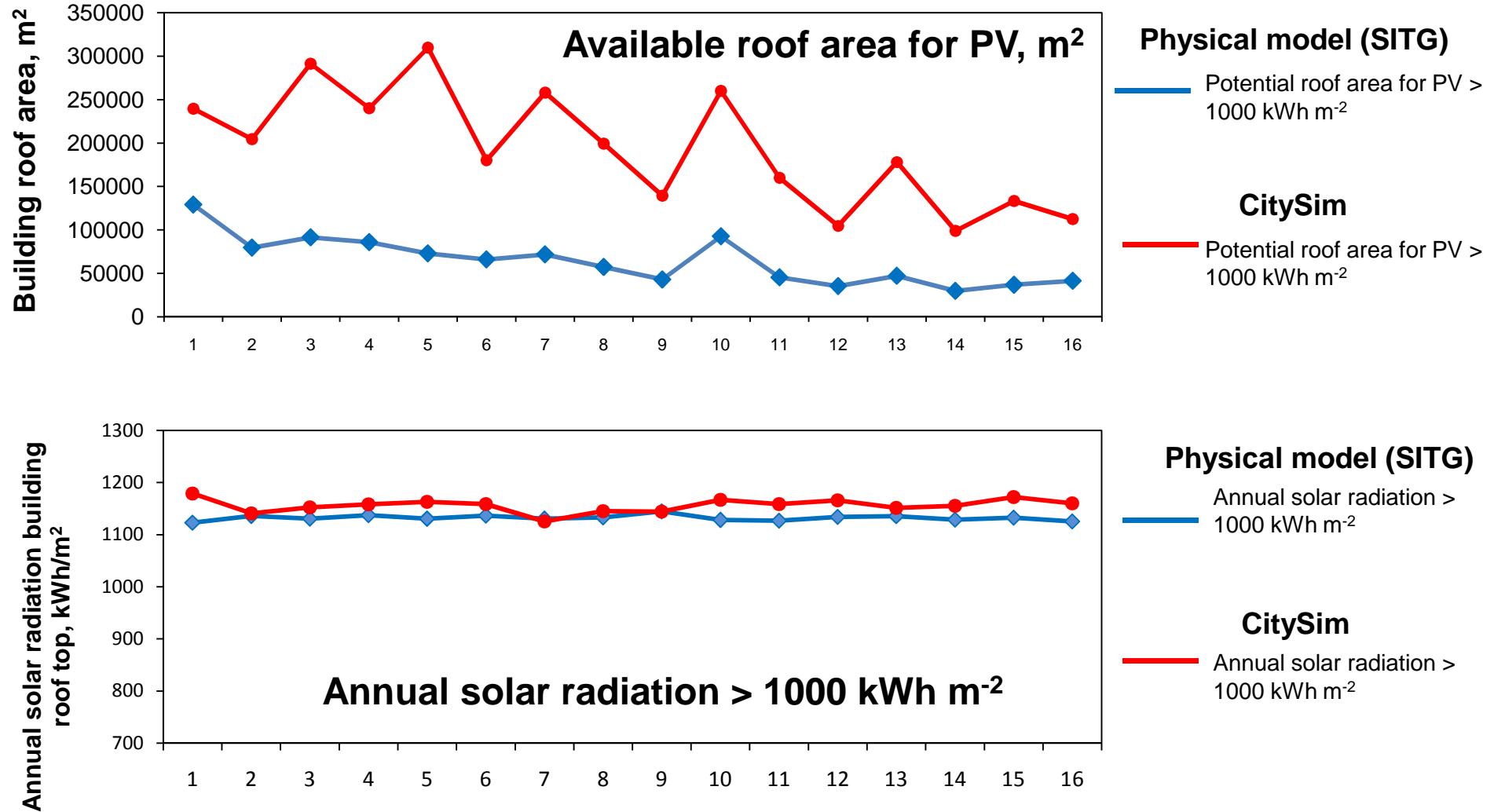
Weather data (cloud
cover, precipitation, relative humidity, wind
speed and direction, air temperature,...)

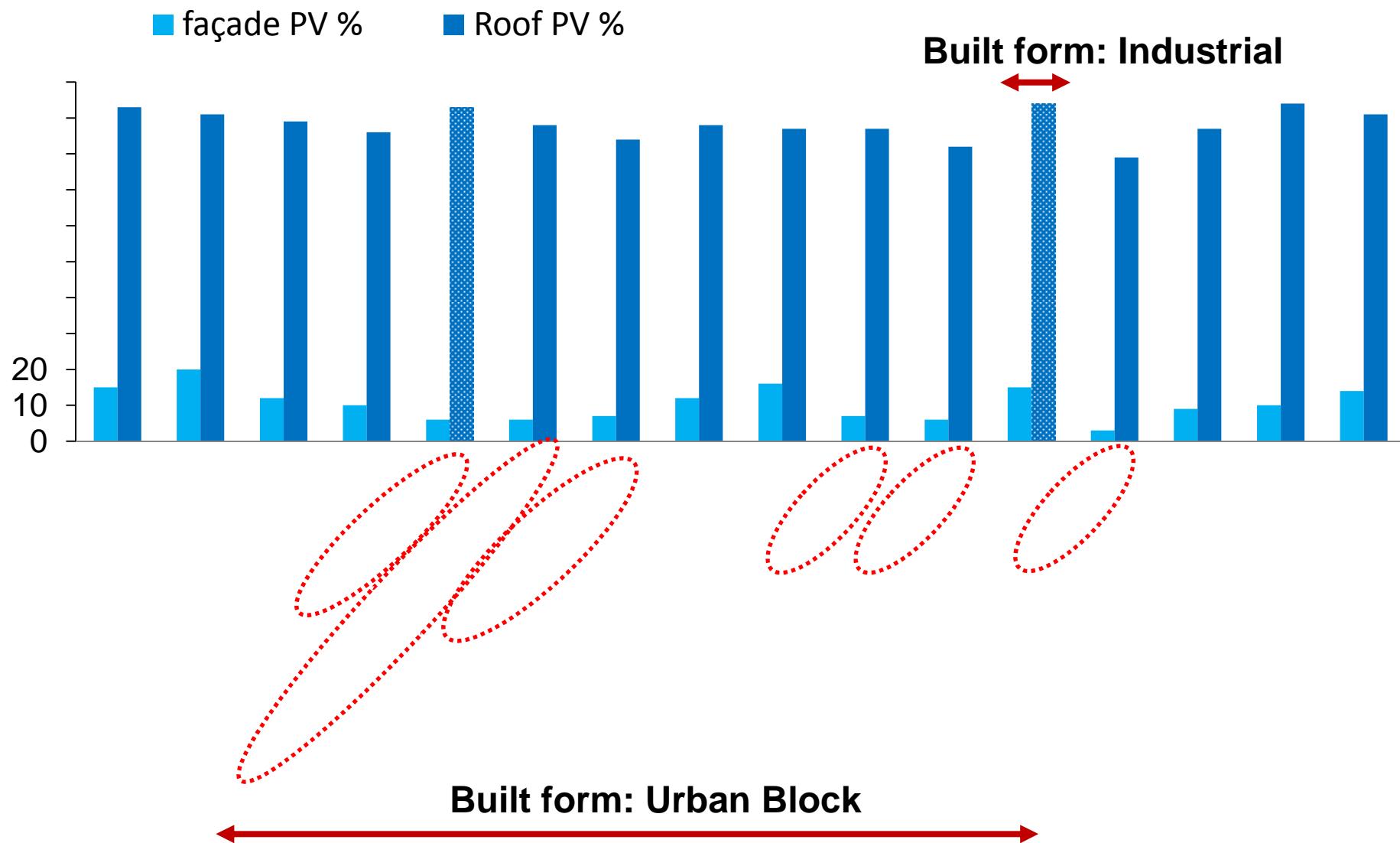


Built form and solar energy



Comparisons of solar radiations with flat roofs and slope roofs

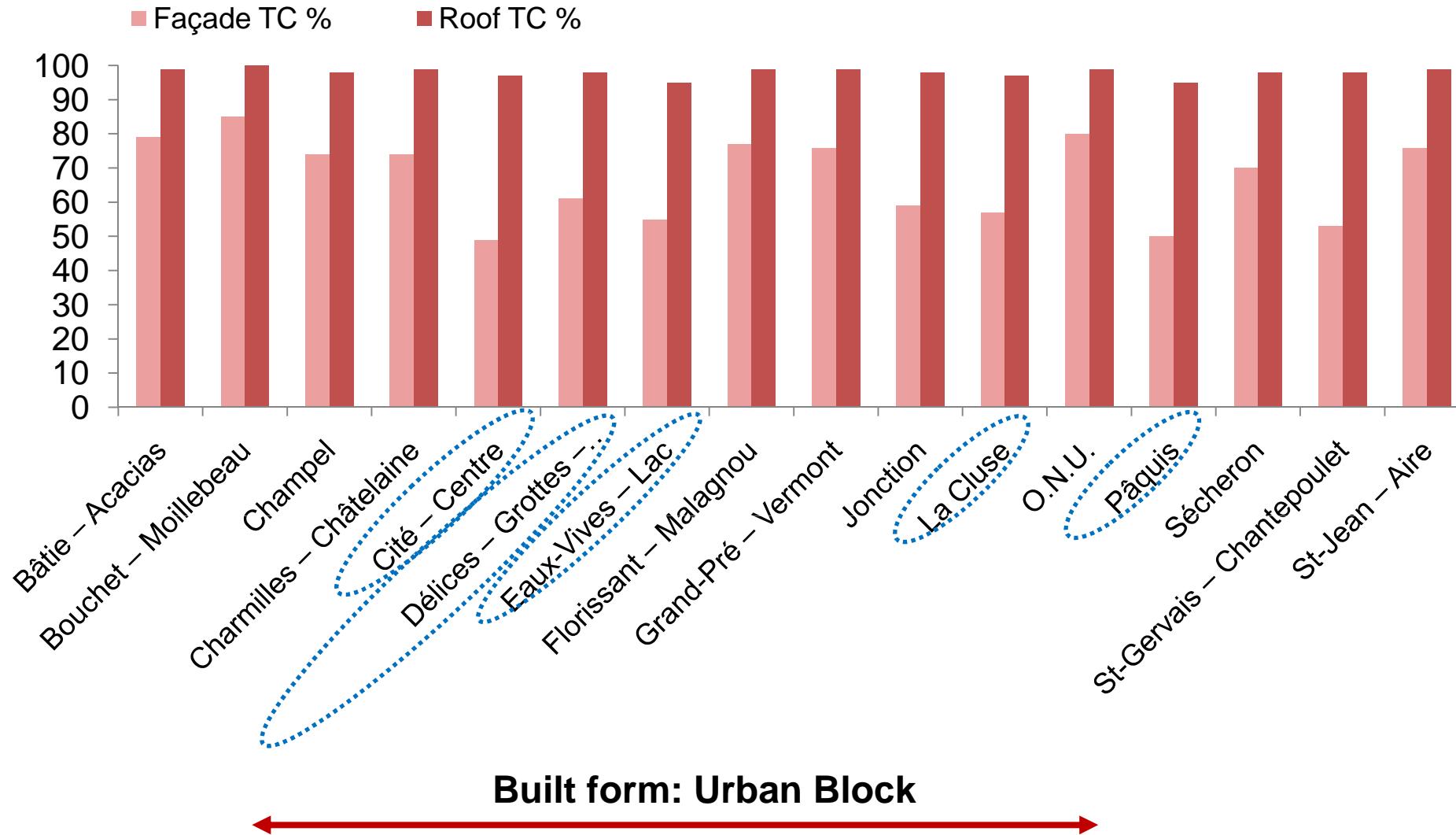




Thresholds [Compagnon, 2004]

PV potential : % of roof area with annual irradiation $\geq 1000[\text{kWhm}^{-2}]$

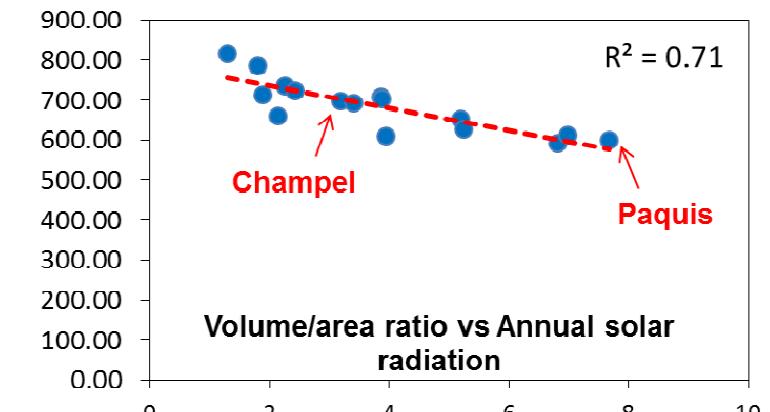
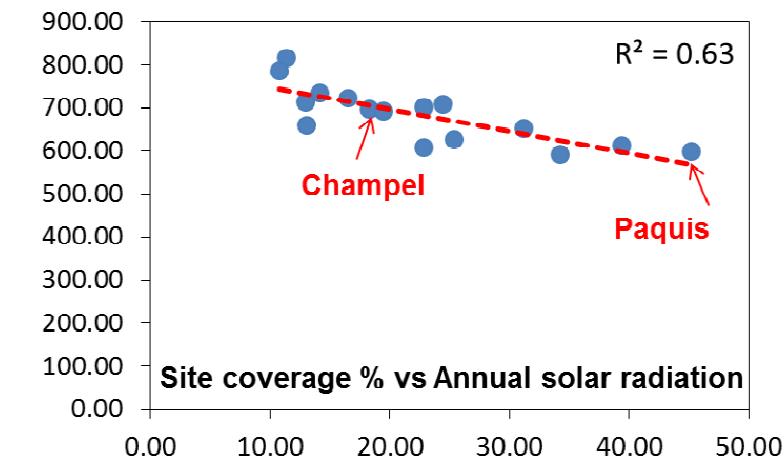
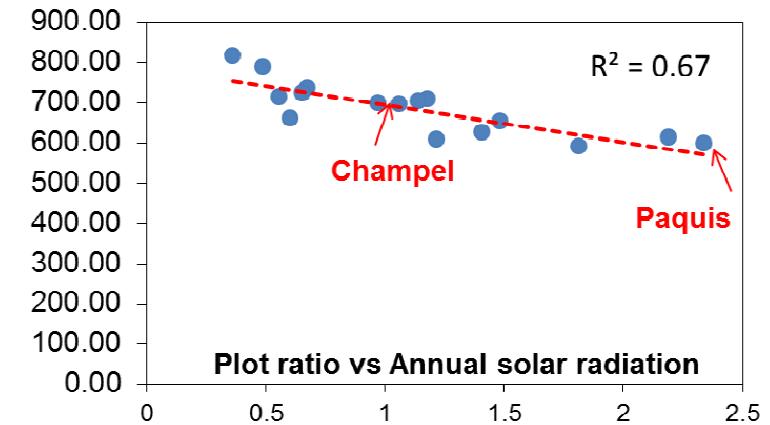
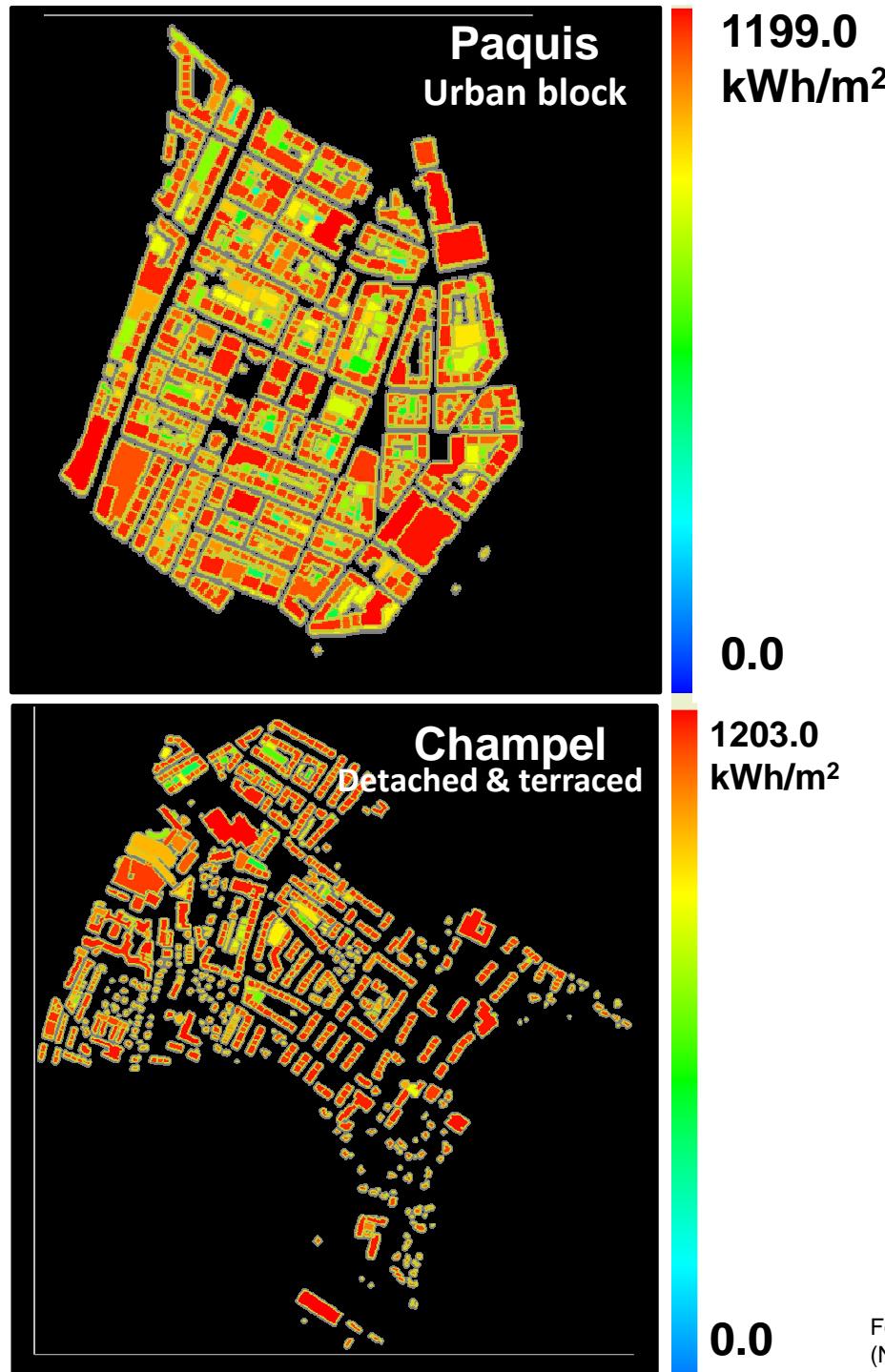
PV potential: % of façade area with annual irradiation $\geq 800[\text{kWhm}^{-2}]$

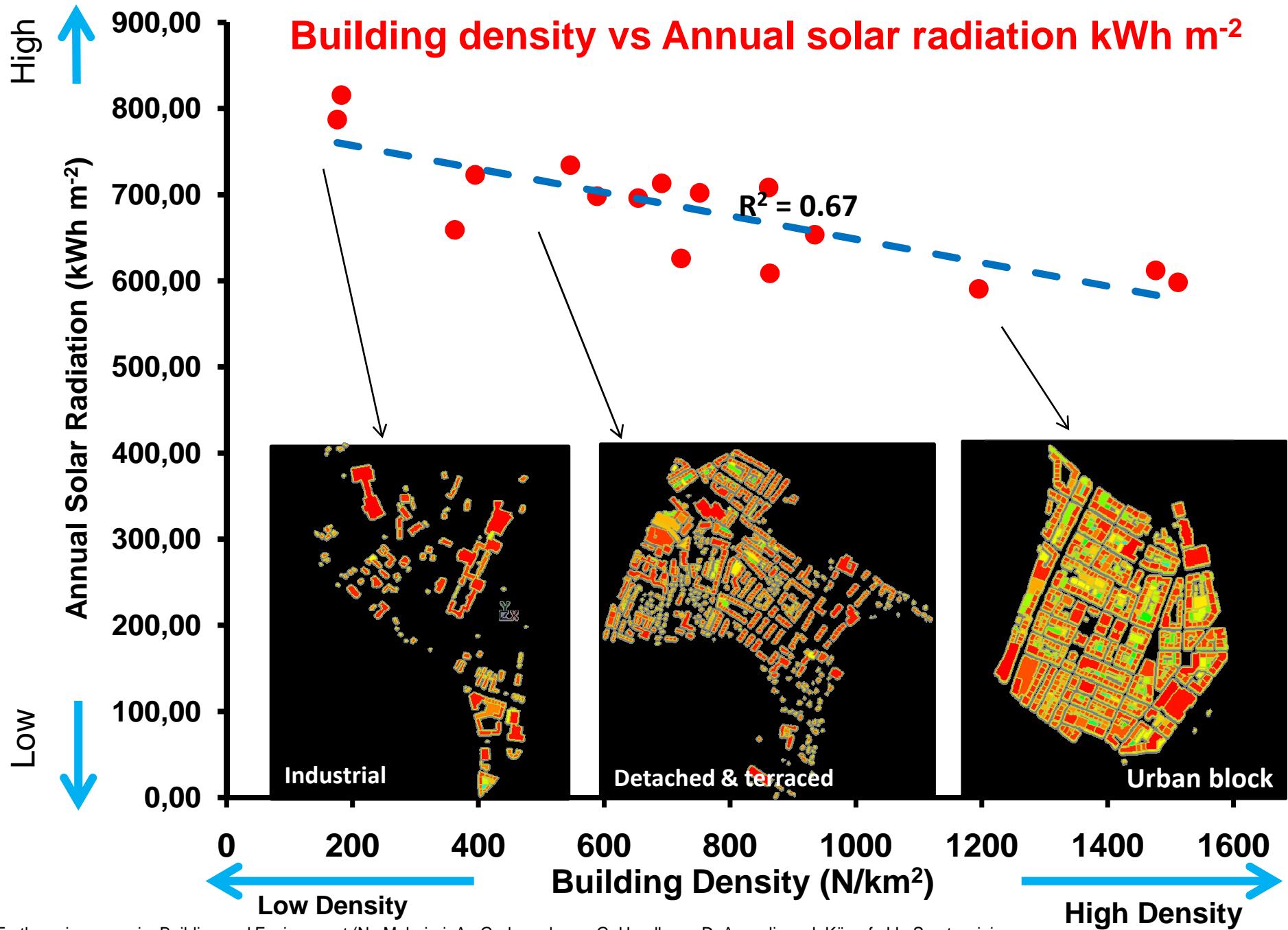


Thresholds: (Compagnon, 2004)

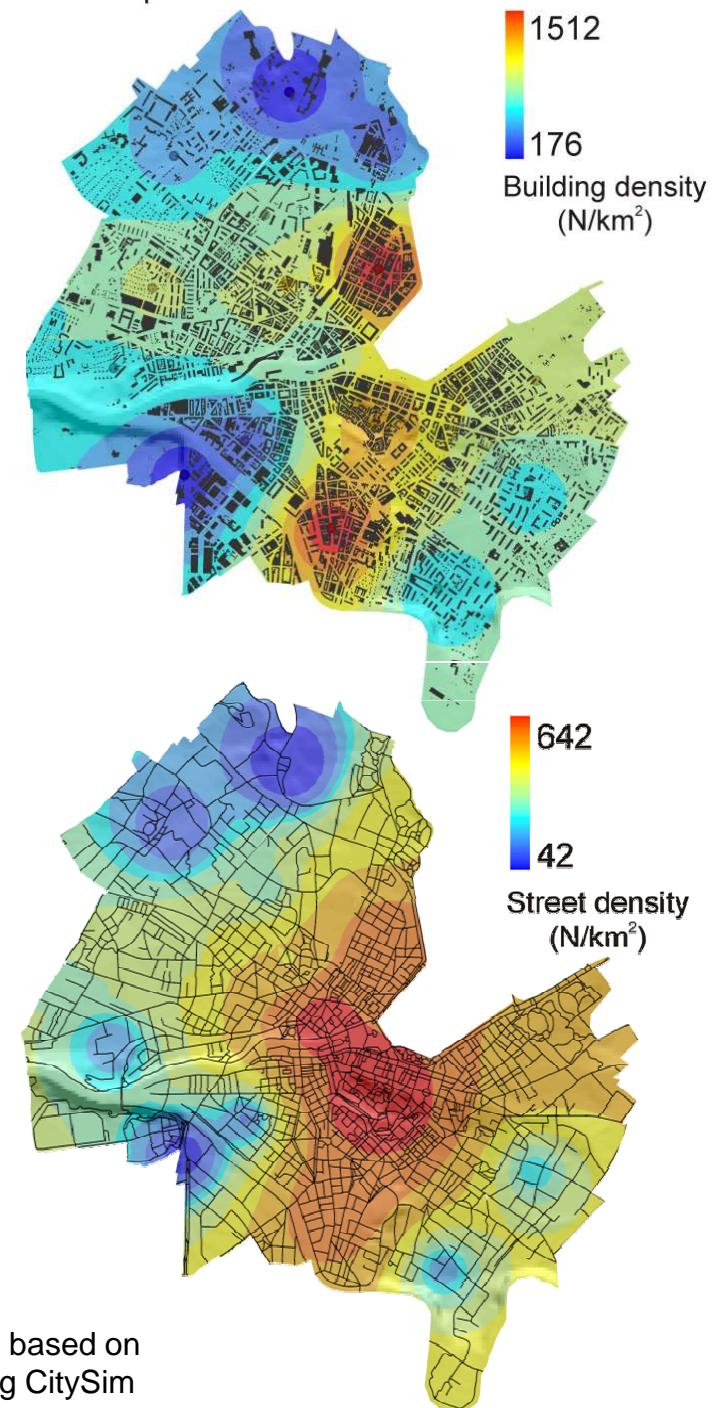
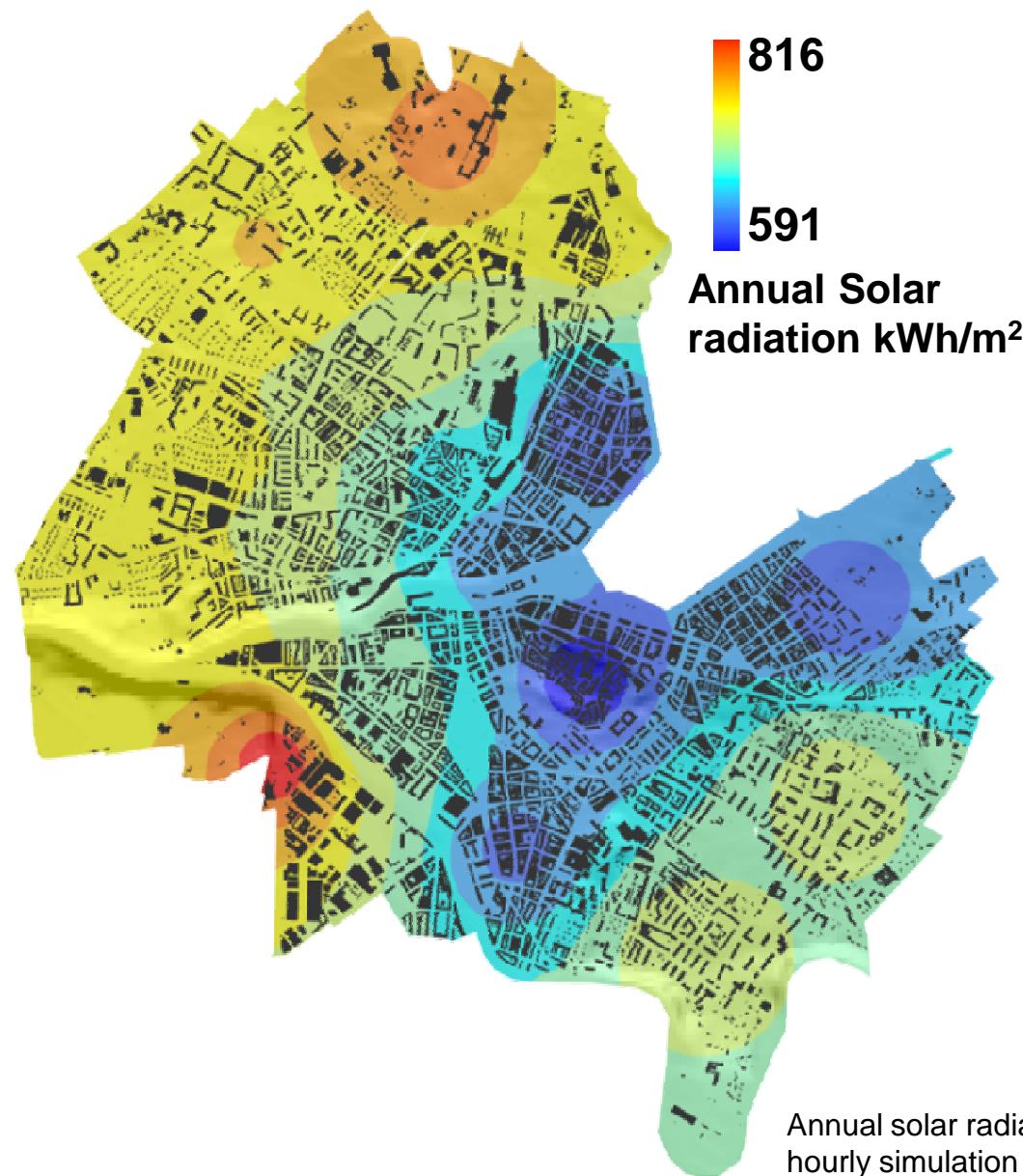
Solar thermal collector : % of roof area with annual irradiation $\geq 600[\text{kWhm}^{-2}]$

Solar thermal collector : % of façade area with annual irradiation $\geq 400[\text{kWhm}^{-2}]$

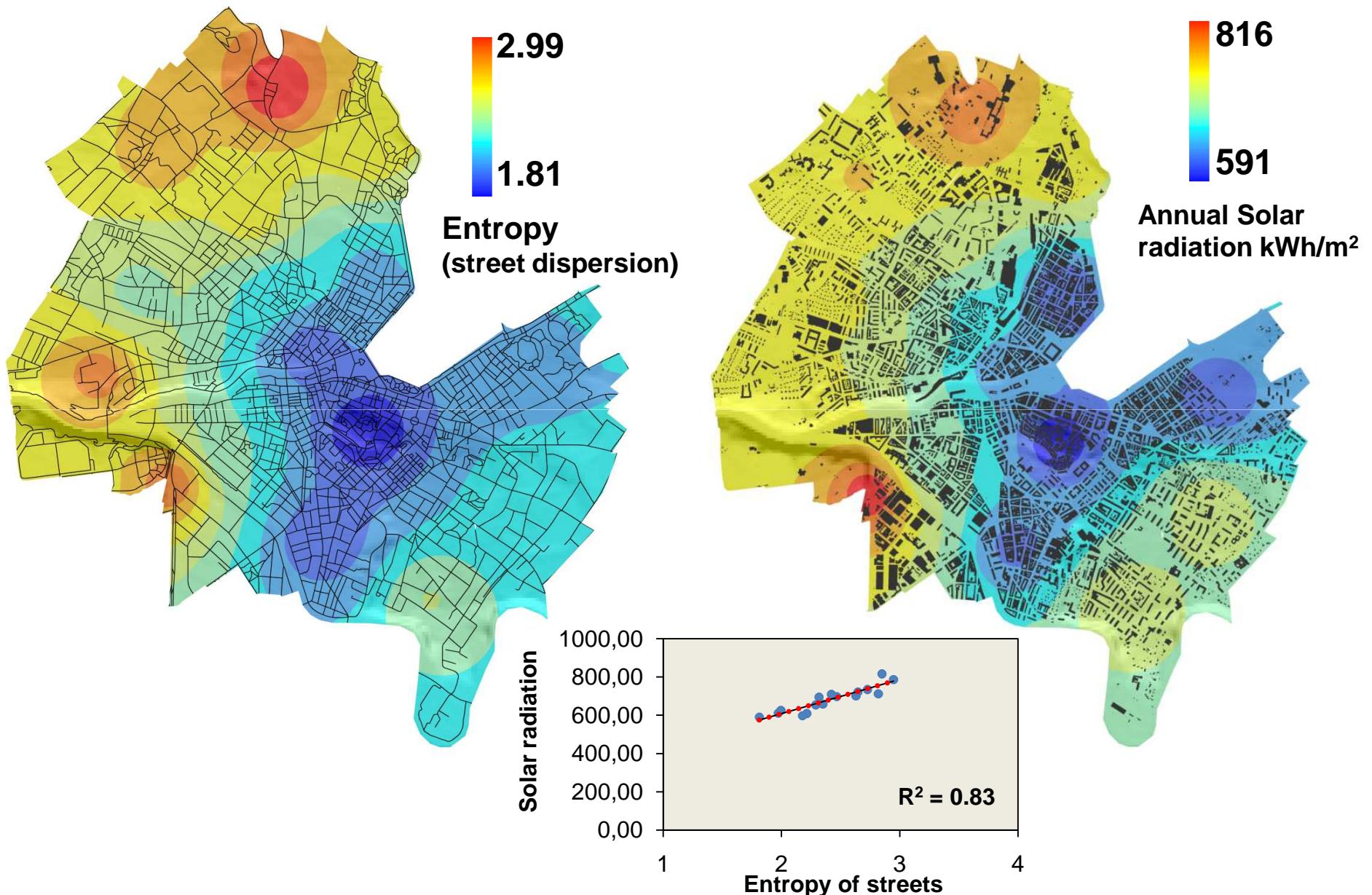




Building/street density gradient and annual solar radiation (kWh m^{-2})

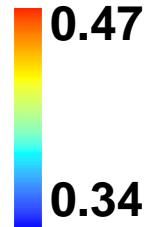
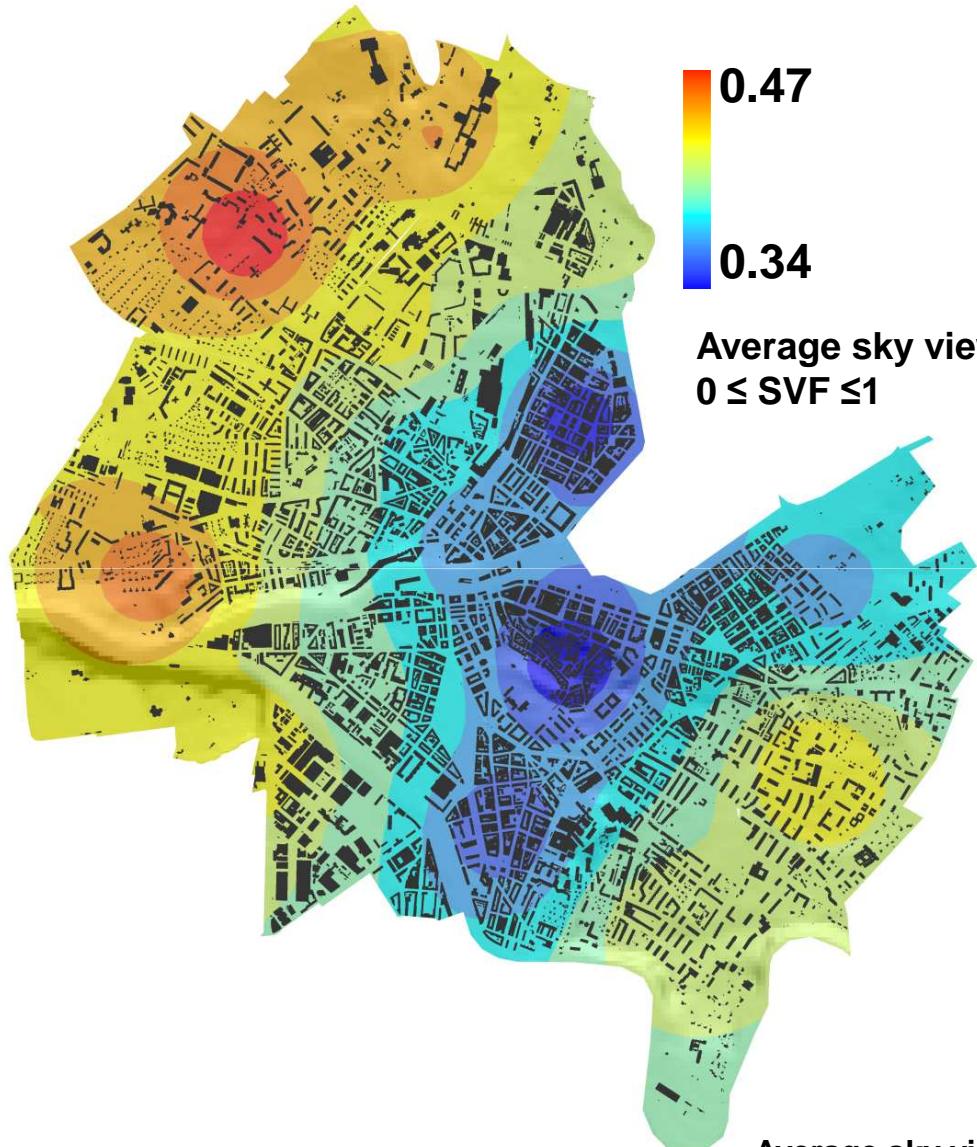


Entropy (street dispersion) and solar potentials

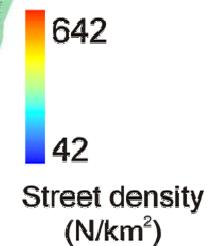
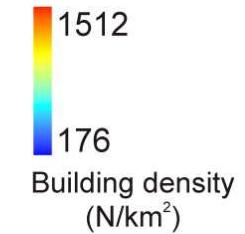
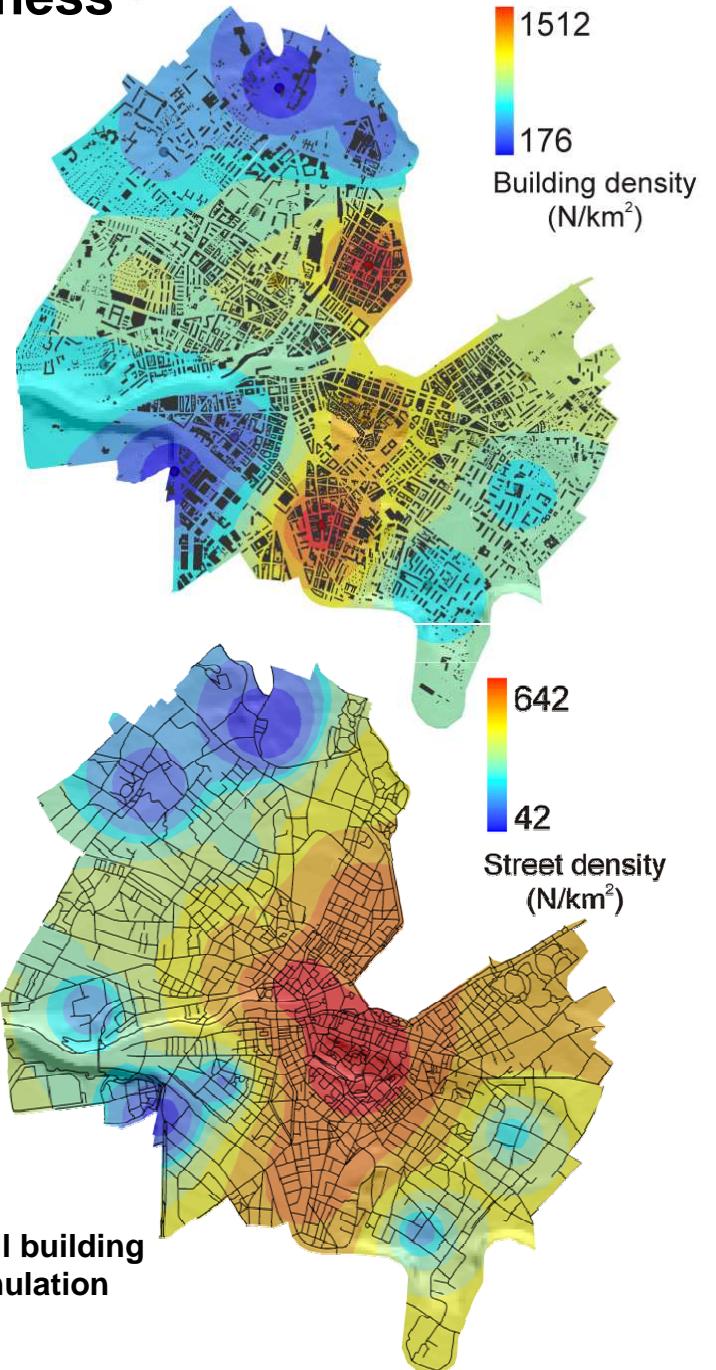


Sky View Factor: A measure of spatial openness

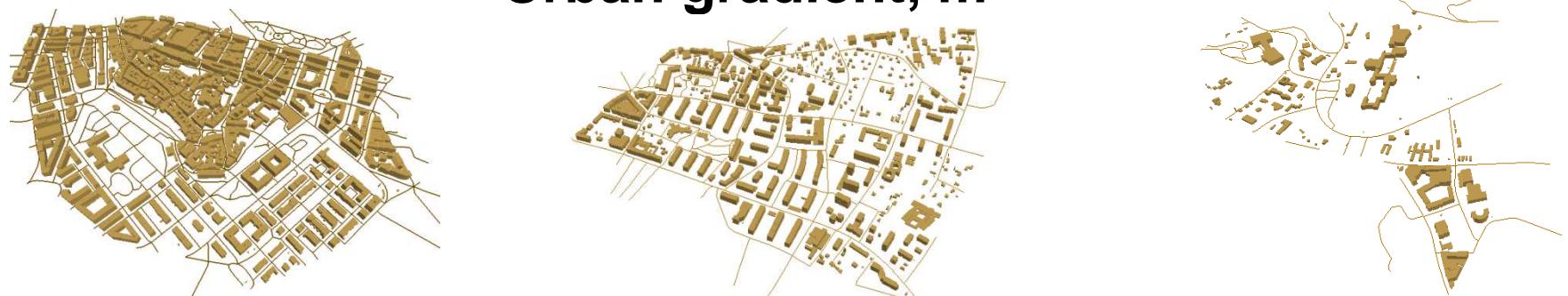
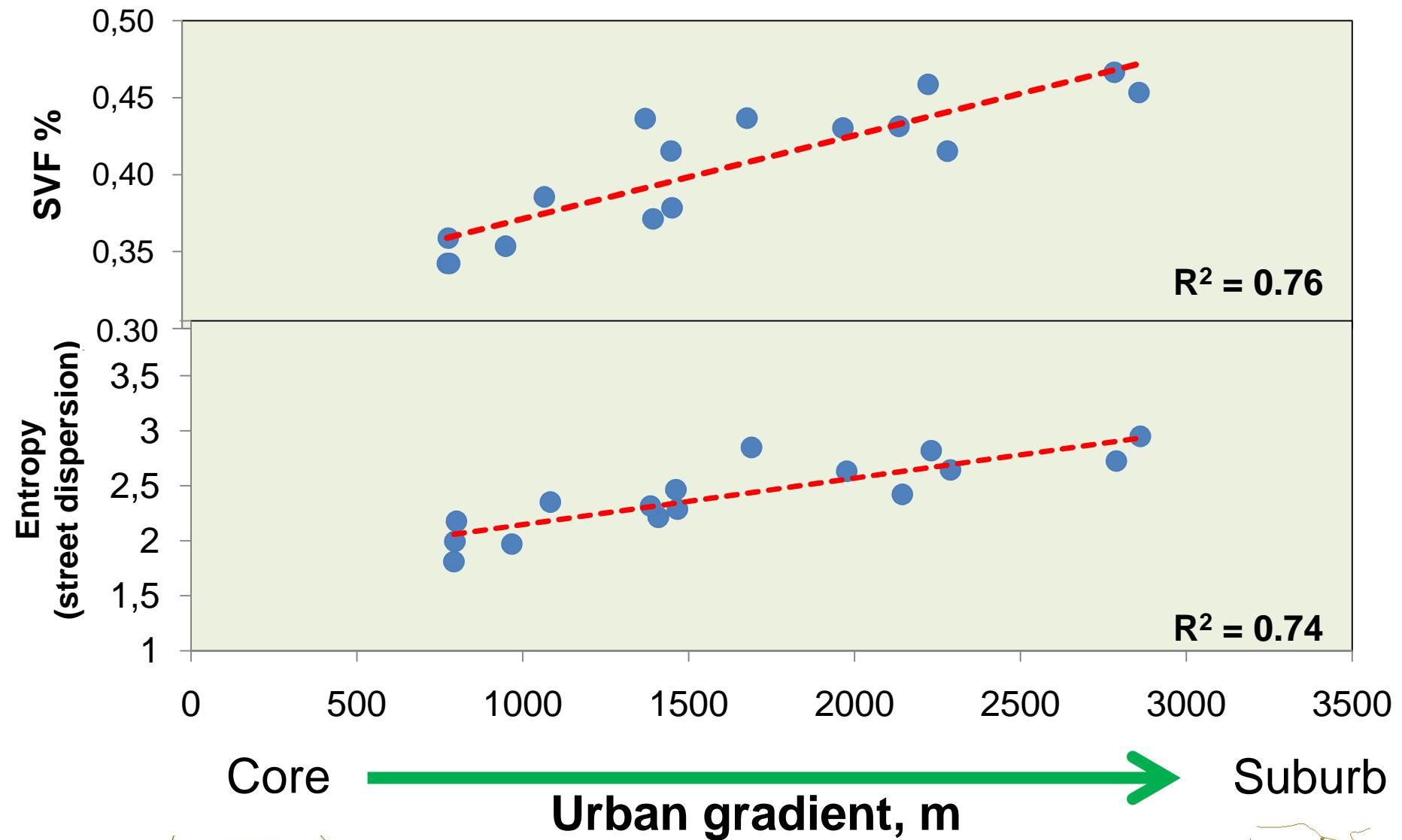
Proportion of sky visible from a given location



Average sky view factor
 $0 \leq \text{SVF} \leq 1$



Average sky view factor for all building
surfaces based on hourly simulation
with CitySim



Summary

1. Entropy is introduced as an new indicator for measuring dispersion of urban configuration that is related to PV and solar thermal collector, and SVF
2. Entropy (spreading of buildings and streets) is positively correlated with solar potential and sky view factor, and negatively correlated with site coverage and plot ratio
3. Entropy can be used for the prediction of urban configurations in order to improve the solar potential

Thank you!



Comparisons of solar radiations with flat roofs and slope roofs

