

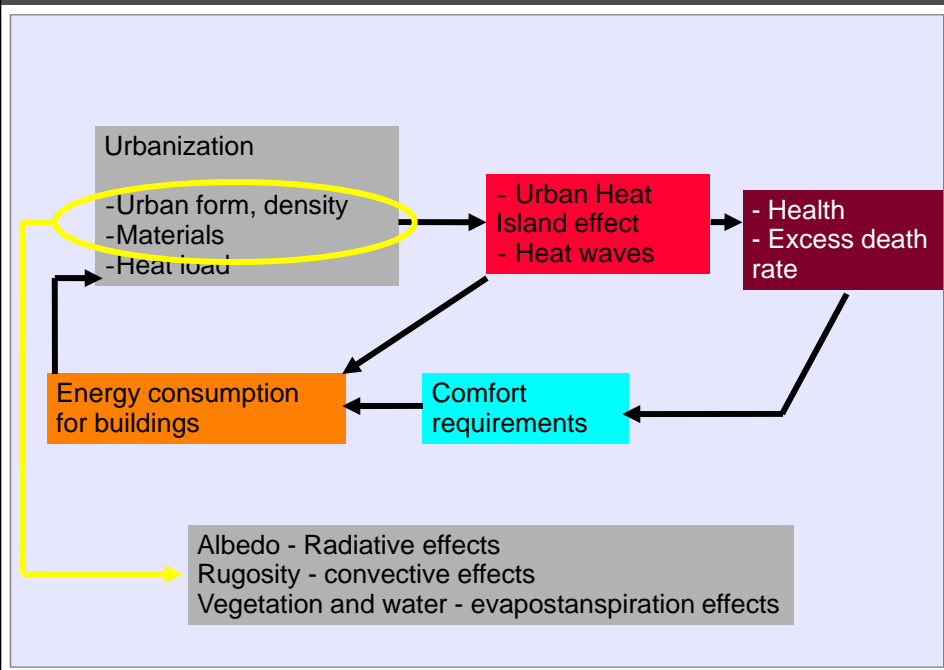
MITIGATING URBAN HEAT ISLAND EFFECT BY URBAN DESIGN FORMS AND MATERIALS

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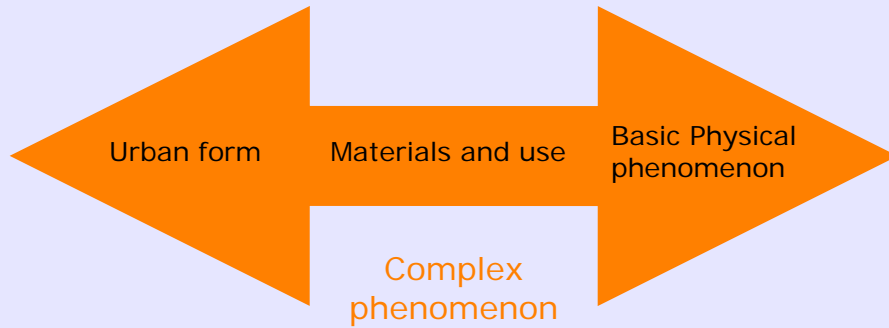
5th Urban Research Symposium
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Introduction : Urban Heat Island



Introduction : Indicators



Indicator

∅ simplified measure that combines part of the influent parameters to allow us to compare their effect on the complex

Introduction : Our approach

Develop models to represent and understand complex phenomenon

Physics based models

Validation of indicators



Indicator

Propose simple indicators that allow us to predict urban planning performance

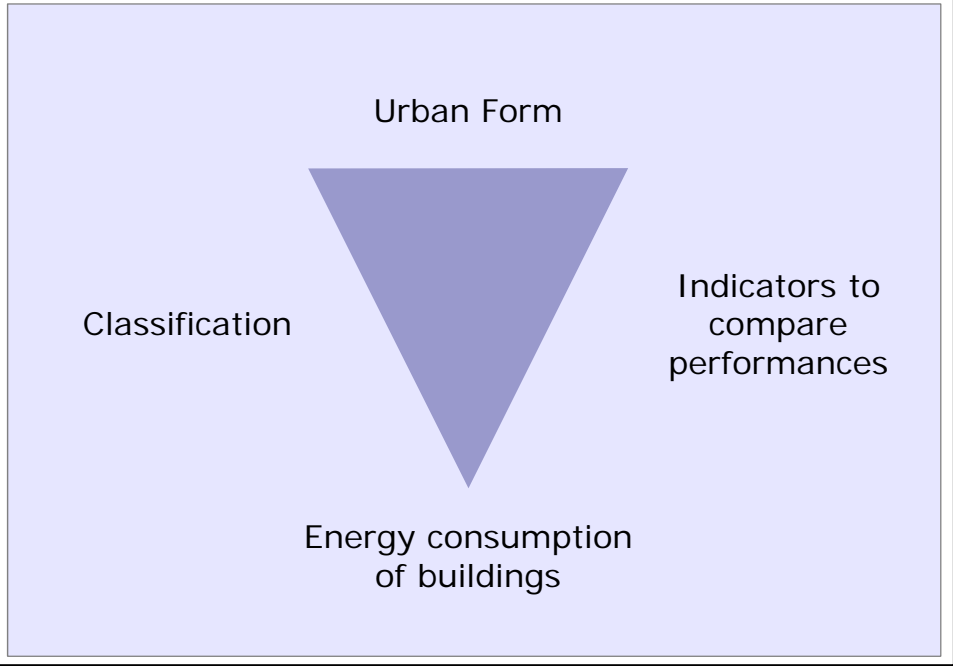
Characterisation of urban forms



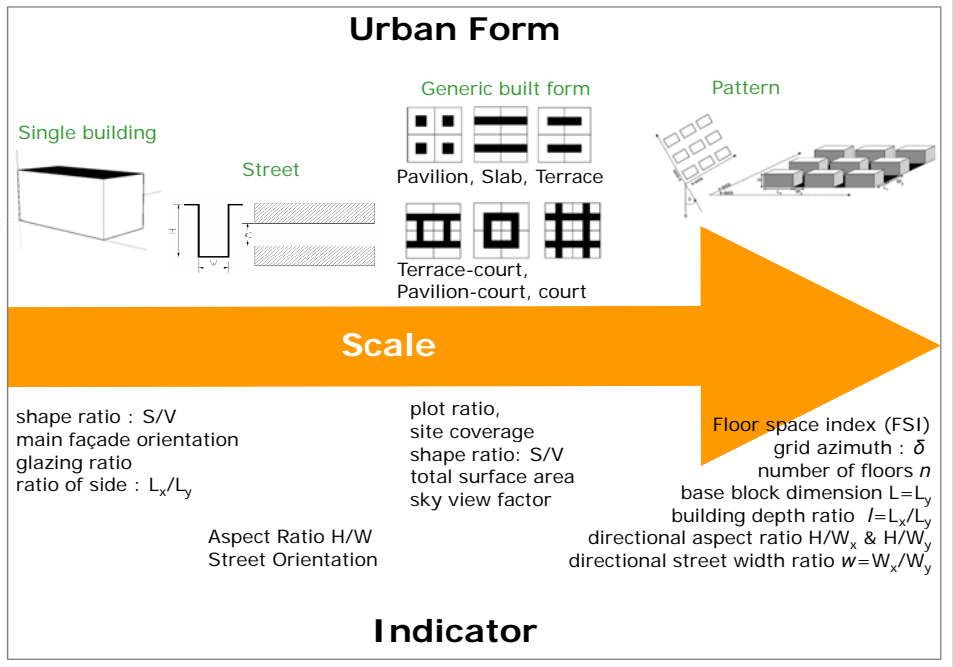
Typology

Classify urban form

1 - Urban form and energy



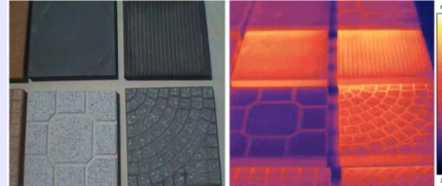
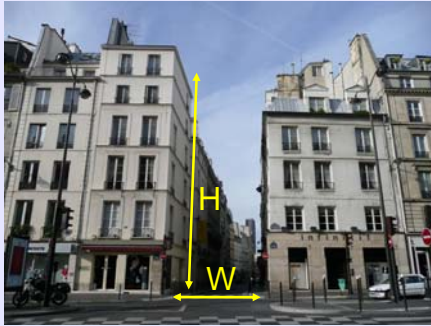
1 - Urban form and energy



2 - Albedo of urban surfaces

Albedo

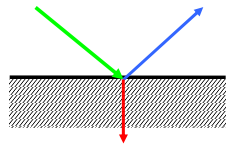
Urban form (solar access, inter-reflections)
Sun position
Materials and arrangement



Doulos, L.; Santamouris, M. & Livada, I. Passive cooling of outdoor urban spaces. The role of materials *Solar Energy*, 2004, 77, 231-249

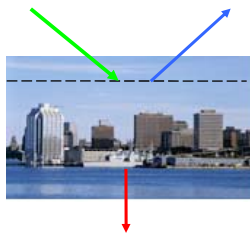
2 - Albedo of urban surfaces

Plane and isolated surface



$$\text{albedo} = \frac{\text{energy reflected}}{\text{incident energy}} = \frac{1 - \text{energy absorbed}}{\text{incident energy}}$$

Rough surface



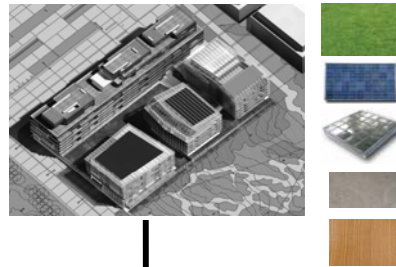
$$\text{albedo} = \frac{\text{energy reflected to the sky after inter-reflections}}{\text{incident energy}} = \frac{1 - \text{energy absorbed}}{\text{incident energy}}$$

2 - Albedo of urban surfaces

Calculation procedure with **Solene**

Direct incident energy,
reflections
-> albedo

2° Radiative
simulation



1° Model



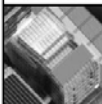

Meshed surfaces
+ Materials
radiative
characteristics



2 - Albedo of urban surfaces

Application to Lyon Confluence Project

1° Materials review

	Single glazing + Metal diaphragm	0.08	0.72	0.16	Solar Collectors	0.05
		0.35				
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	Single glazing + Metal diaphragm	0.08	0.72	0.16	Solar Collectors	0.05
		0.35				
	Single glazing + Rough Concrete	0.08	0.42	0.16	Green roof	0.33
		0.35				

Example of block A North

2 - Albedo of urban surfaces

Application to Lyon Confluence Project

The different blocks	Simulation date	Global Energy incident (KWh)	Energy Solar Absorbed (KWh)	Albedo
North Block A	21-6	1834	1570	0.14
	21-3	1192	1024	0.14
	21-12	446	380	0.15
South Block A	21-6	1947	1341	0.22
	21-3	1259	922	0.19
North Block B	21-12	475	374	0.19
	21-6	3563	2574	0.27
	21-3	2083	1501	0.28
South Block B	21-12	562	389	0.30
	21-6	2694	1675	0.37
	21-3	1785	1011	0.43
C block	21-12	668	355	0.50
	21-6	4589	3561	0.22
	21-3	2822	2181	0.23
Lyon confluence	21-12	871	671	0.23
	21-6	11101	8656	0.22
	21-3	6202	4713	0.24
Garden city	21-12	2001	1524	0.24
	21-6	6356	4943	0.22
	21-3	3770	2914	0.24
	21-12	1146	871	0.26



Lyon Confluence Phase 1



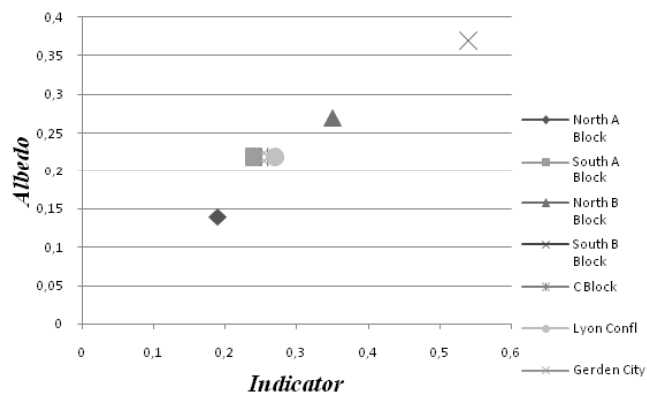
Garden city

2 - Albedo of urban surfaces

- The more a surface see the sky, the more it participates to the albedo
- The bigger the material's albedo is, the more the surface participates to the albedo

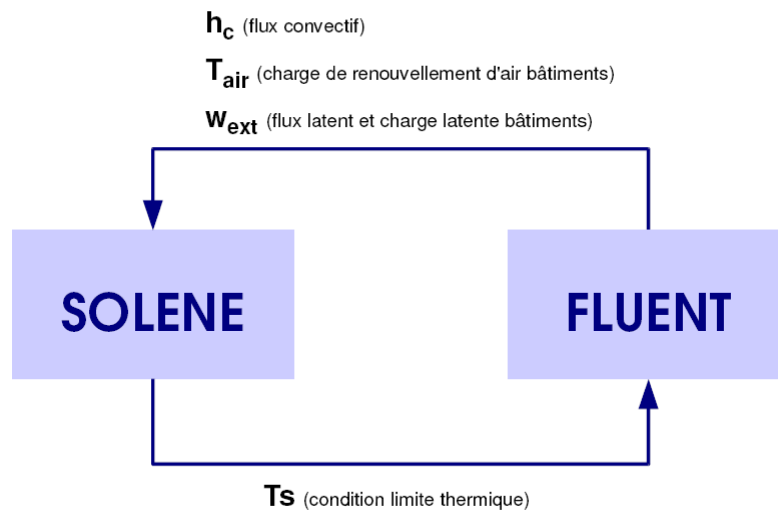
Albedo indicator including materials' albedo and SVF

$$A_i = \frac{\sum \alpha_i \psi_i S_i}{\sum \psi_i S_i}$$



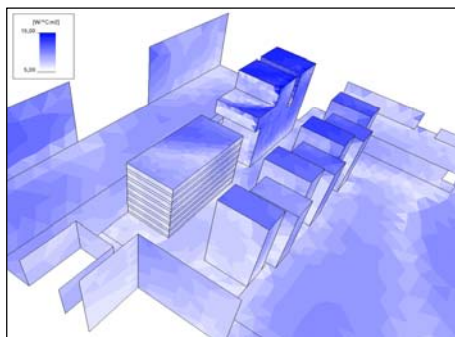
3 - Microclimatic simulation

Modelling – Simulation tool

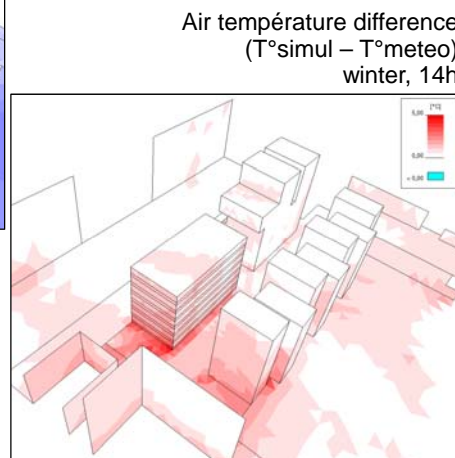


3 - Microclimatic simulation

Results (Microclimatic variables)



Convective exchange coefficient (h_c)
winter, 14h

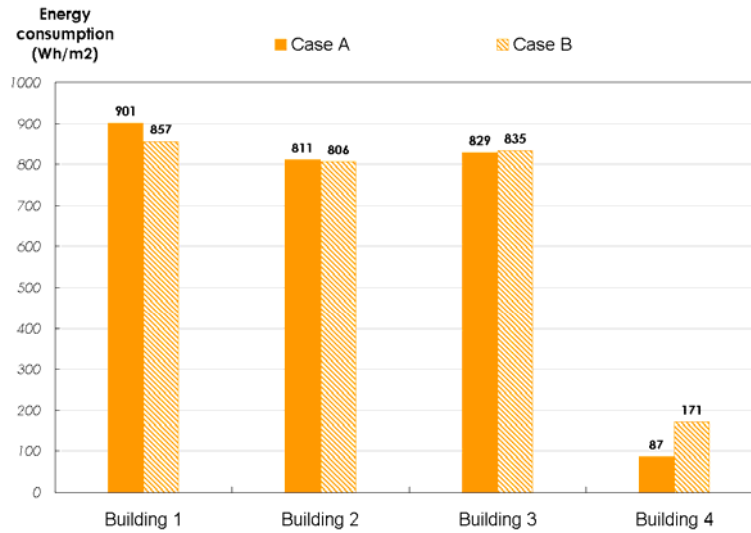


Air température difference
($T^{\circ}simul - T^{\circ}meteo$)
winter, 14h

3 - Microclimatic simulation

Results (Energy consumption of buildings)

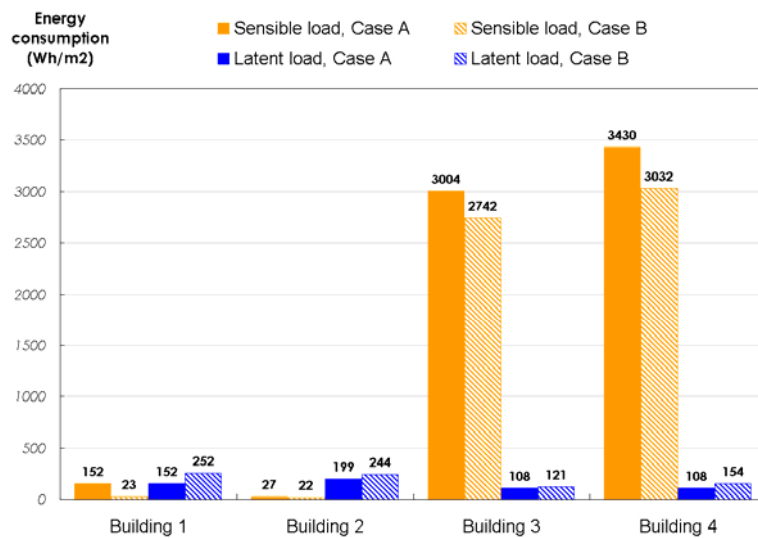
In winter



3 - Microclimatic simulation

Results (Energy consumption of buildings)

In summer



Conclusion

- Study 1 : Possibility to classify urban fabrics by the mean of morphological indicators
- Study 2 : Development of a morpho-physical indicator able to evaluate quickly solar implication in the UHI
- Study 3 : Development of a fine tool able to treat microclimatic scale

Future work :

- Methodologies to go from one scale to another
- Validation
- Design strategies