Architectural Archetypes Database
– Propositions for WUDAPT

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Outline

- Required data for WUDAPT
- Methodology of Architectural types (from MAPUCE to WUDAPT)
- Example for Toulouse
- Propositions for WUDAPT
WUDAPT levels 0, 1 and 2

Level 0

Toulouse, France

LCZ Compact Mid-rise

**Definition**
Form: Attached or closely spaced buildings 3–9 stories tall. Buildings separated by narrow streets and inner courtyards. Buildings uniform in height. Sky view from street level significantly reduced. Heavy construction materials (stone, concrete, brick, tile); thick roofs and walls. Land cover mostly paved or hard-packed. Few or no trees. Moderate space heating/cooling demand. Moderate to heavy traffic flow.

Function: Residential (multi-unit housing; multistory tenements); commercial (office buildings, hotels, retail shops); industrial (warehouses, factories). Location: Core (old city, old town; inner city, central business district; periphery (high-density sprawl)). Correspondence: UCZ (Oke 2004): A1, A2, A4, Dc2 (Eidelsen 1990/91).

**Illustration**
High angle

Low level

<table>
<thead>
<tr>
<th>Properties</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sky view factor</td>
<td>0.3</td>
<td>0.4</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Canopy aspect ratio</td>
<td>0.75</td>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Mean building height</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>Terrain roughness class</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Building surface fraction</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Impervious surface fraction</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>Permeable surface fraction</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Surface albedo</td>
<td>0.15</td>
<td>0.2</td>
<td>0.25</td>
<td>0.3</td>
<td>0.35</td>
<td>0.4</td>
</tr>
<tr>
<td>Anthropogenic heat flux</td>
<td>&lt; 75 W/m²</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
</tbody>
</table>

**Level 0 LCZ map**
This is the same map !!!
WUDAPT levels 0, 1 and 2

Toulouse, France

Level 2
+ fine scale data

This is the same map !!!

e.g. building height map
(source : MAPUCE project)

One can mix levels 1 & 2
How can we obtain the lvl 1 & 2 parameters?

- Building height (& other morphological parameters) maps
  - From GIS building data
  - From satellite data

- Land use (vegetation, impervious surfaces)
  - From satellite images

- Anthropogenic heat fluxes
  - From vehicle counting
  - From buildings energy models

- Architecture (albedo, emissivity, thermal characteristics)
  - ???

Status:
- Building height (& other morphological parameters) maps: OK
- Land use (vegetation, impervious surfaces): OK
- Anthropogenic heat fluxes: OK, NO
- Architecture (albedo, emissivity, thermal characteristics): NO
Architectural types: MapUCE project

Transdisciplinary project

Goal n°1: develop modelling strategy to provide data on urban climate and building energy demand
Urban data (morphology, architecture, socio-economical)
Adaptation of TEB
Simulations and evaluation

Example: building type in Nantes

Goal n°2: develop methods to take into account the produced data for urban planning

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The MapUCE database - Overview

**Administrative datasets**
- Digital basic map
- Census data
- ...

**Urban tissue**
- Building type, use, LCZ
- Construction period
- Geographical location

**Surveys on human behaviour**

**Urban morphology**
- Building height
- Building fraction
- ....

**Building architecture**
- Roof and wall materials
- Insulation
- ....

**Behavioural indicators**
- Heating design temperature
- Internal heat release
- ....

The MaPUCE data will be available for the 80 largest cities in France

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Architectural typologies

Administrative datasets
- Digital basic map
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TEB-BEM & other models

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Architectural typologies

From **10 LCZ** → **4 archetypes of buildings (architecturally speaking)**

→ this reduces the number of needed architectural information
Conclusions of WUDAPT December workshop

For each of the 4 Architectural typologies:

- Required architectural description:
  - Wall materials (material, presence of insulation) & covering / colour
  - Roof materials
  - Window/wall ratio
  - Use of Heating or Air Conditioning systems
  - Number of floors

- That may depend on:
  - Building's use
  - Building's age
  - Location: country, ...

→ Need of a architectural information
→ Need to link with the physical variables of models
Example for Toulouse: Building's types

Level 2 building's type:
Where are the 4 buildings architectural types?

Map of building's typologies

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Example for Toulouse:
Architectural characteristics

Level 2 building's type
+
Level 2 building's use (not shown)
+
Level 2 building's age (not shown)
+
Location: Toulouse region

We use architectural characteristics
Typical from Toulouse agglomeration
(red bricks for old buildings, ...)

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Example for Toulouse: Modelling of Energy Consumption

- Level 2 building's type
- Level 2 building's use
- Level 1 arch. territory
- building's database

Model inputs → Level 2 Model outputs

Simulated (TEB) building's anthropogenic flux

Inventory (top-down method)

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Architecture varies from one location to another

At country scale (here France)

Architectural territories
Before 1948 (a lot of variety)
Architecture varies from one location to another at world scale. Here are examples of architecture for mid-rise buildings:

- Seattle
- Copenhagen
- Andalousia
- Shanghai
- Quito, Equador
- Tombouctou, Mali
Architecture varies from one location to another

At world scale (→)

Architecture for houses

Seattle

Copenhagen

Andalousia

Shanghai

Quito, Equador

Tombouctou, Mali
Propositions for WUDAPT

- To think in terms of 4 buildings archetypes
  - Houses, Buildings, High-rise buildings, Industrial buildings

- To define building's architectural properties
  - For each territory (Country ? Continent ? Region ? City ? LCZ ?)
  - Potentially as a function of: building's use & age, local population income

- The information could be gathered through
  - Architects' expertise
  - Crowdsourcing
  - Other sources ?