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Alexandre Mielniczek, Charlotte Roux, Florence Jacquinod

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Toward enhanced ecodesign of urban project thanks to City Information Modelling

Alexandre Mielniczek¹, Charlotte Roux², Florence Jacquinod¹

¹LaSTIG - Laboratoire des Sciences et Technologies de l'Information Géographique & EIVP - Ecole des Ingénieurs de la Ville de Paris - alexandre.mielniczek@gmail.com,

²Navier Laboratory, Ecole des Ponts ParisTech

CLCA for district ecodesign : new data opportunity

Consequential CLCA, although useful for early ecodesign of urban project, is rarely used and there is still few literature (Roux 2020)

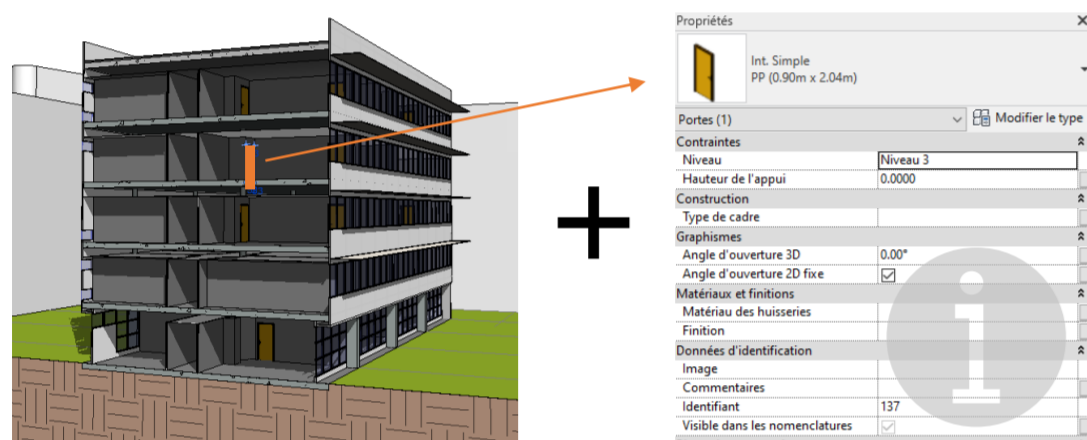
⇒ among challenges to overcome : CLCA requires many datasets and data sources

Today, more data are available in City Information Models (CIM) (Deprêtre et Jacquinod 2021)

- Building Information Models (BIM),
- Urban open geodata, either public or private.

In this poster, we explore the potential of CIM geodata for CLCA through the analysis of the relevance of an existing CIM for LCA

What are BIM and CIM ?



BIM (Building Information Model) = 3D objects with properties (type, quantities, etc.) representing a building site

- Standardized open exchange format with categorized objects (IFC)
- ⇒ Numerous BIM-LCA coupling studies

CIM (City Information Model)

- District or city scale
- Diverse 3D models (public spaces, underground networks)
- Multiple data sources (GIS, Urban Open Datas, BIM, etc.) and heterogeneity of data formats
- ⇒ Scarcity of CIM-LCA coupling studies



⇒ Need to define requirements for the production of CIM easily usable for CLCA

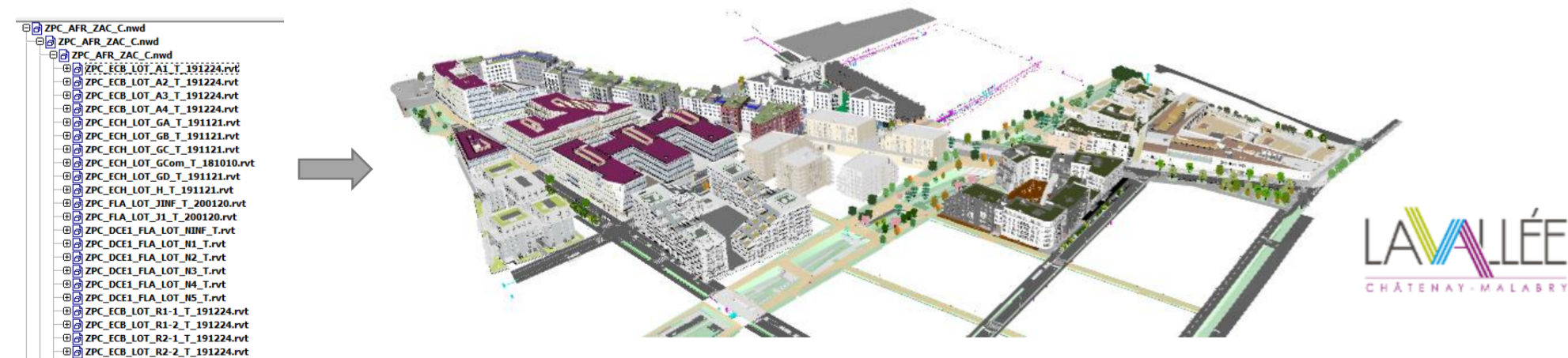
Case study : analysing a district CIM

“La Vallée” district in Châtenay Malabry, France

- Large district : 20.6 Ha, started in 2018 and under construction until 2027
- Mixte uses Dwellings/ Offices/ Shops

- **CIM of the entire district** made by various stakeholders (real estate developers, general contractor, architects, urban planner, design offices, public actors, etc.) working together to develop **more than 40 digital models**
- Each model is dedicated to a specific building and a specific discipline and is georeferenced so as to allow for the aggregation of all models into one at the district scale

⇒ The CIM contains **138.000** BIM objets providing more than **1.2 million** properties values offering huge analysis potential, although not always easily usable at the district scale (Deprêtre et Jacquinod, 2021)



References

Deprêtre, A., et F. Jacquinod. 2021. « EVALUATING URBAN INTENSITY THROUGH A CITY INFORMATION MODEL – INTERMEDIATE RESULTS FROM AN ACTION RESEARCH PROJECT ». ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences VIII-4/W2-2021 (octobre): 153-60. <https://doi.org/10.5194/isprs-annals-VIII-4-W2-2021-153-2021>.
Chapter 1. Consequential LCA applied to building and district, in Peuportier B, Leurent F, Roger-Estrade J (2020) Eco-Design of Buildings and Infrastructure: Developments in the Period 2016–2020. CRC Press

Data quality discrepancy between CIM objects

Some objects have many linked data, walls for instance...

Walls are being modelled in BIM for many years. In this example of a wall of the district CIM, at least 9 properties could be used for LCA.

As an example, « Analytical Properties » tab or « Structure » give precise informations about wall materials and dimensions that can be used in thermal studies which is a very important aspect of building LCA.

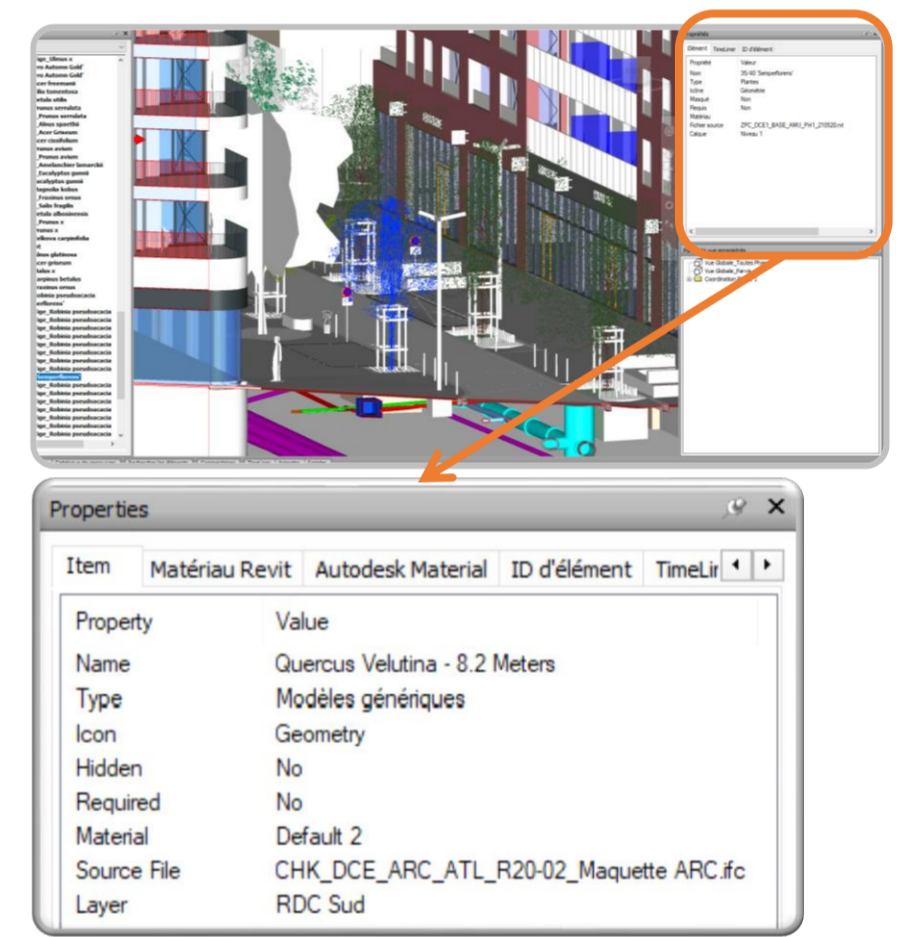
Parameter	Value
Construction	Structure
Structure	Edit...
Wrapping at Inserts	Do not wrap
Wrapping at Ends	None
Width	0.1000
Function	Interior
Graphics	
Coarse Scale Fill Pattern	
Coarse Scale Fill Color	Black
Materials and Finishes	
Structural Material	Structure métallique placostil
Analytical Properties	
Heat Transfer Coefficient (U)	12.8149 W/(m²·K)
Thermal Resistance (R)	0.0780 (m²·K)/W
Thermal Mass	234.600000 kJ/(m²·K)
Absorptance	0.700000
Roughness	3
Identity Data	
Type Image	

... when others have very few data, trees for instance

In a CIM trees as well as utilities and public spaces objects (bench, technical equipment, vegetation, etc.) are also modelled, but usually with limited sets of properties

⇒ There is no standard describing LCA requirements

⇒ If LCA requirements were defined, more properties could be added to these objects in the modelling phase



CIM data potentiel for LCA – some examples

- Urban heat island studies or Building thermal simulations
 - Shading
 - Need leaf type (deciduous or not)
 - Need tree height
- Local air pollution (Canyon effect, photochemical ozone creation)
 - Need tree specie (VOC emissions)
 - Need tree height and canopy form
 - Need to evaluate tree stress (access to water, local climate, urban soil management, etc.)

Other calculation could also be performed :

Computational Fluid Dynamic (CFD) study for air quality or wind analysis, noise calculation, solar exposition, comfort, urban intensity, ...

How to improve CIM usability for CLCA ?

Define CLCA requirements as far as CIM geodata are concerned, so as to allow urban planners to order necessary data for CLCA at early design stages (i.e. Planning and Programming)

⇒ in order to fully exploit those CIM geodata, CLCA methodologies also need to be adapted

Future work

As a wider framework for future research, we're aiming at **developping CLCA at district scale thanks to CIM**, which involves :

- Refine, develop and extend district CLCA thanks to geodata from CIM
- Provide guidelines so as to improve CIM data quality
- Explore the potential of exploratory geovisualisation for LCA scientists so as to allow them to explore, understand and better anticipate the use of complex geodatasets