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City Information Modelling for lifecycle assessment

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

LCA for district ecodesign : new data opportunity

District LCA, although useful for early ecodesign of urban project, is rarely used (Lotteau 2015). Among challenges to overcome : LCA 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 ?

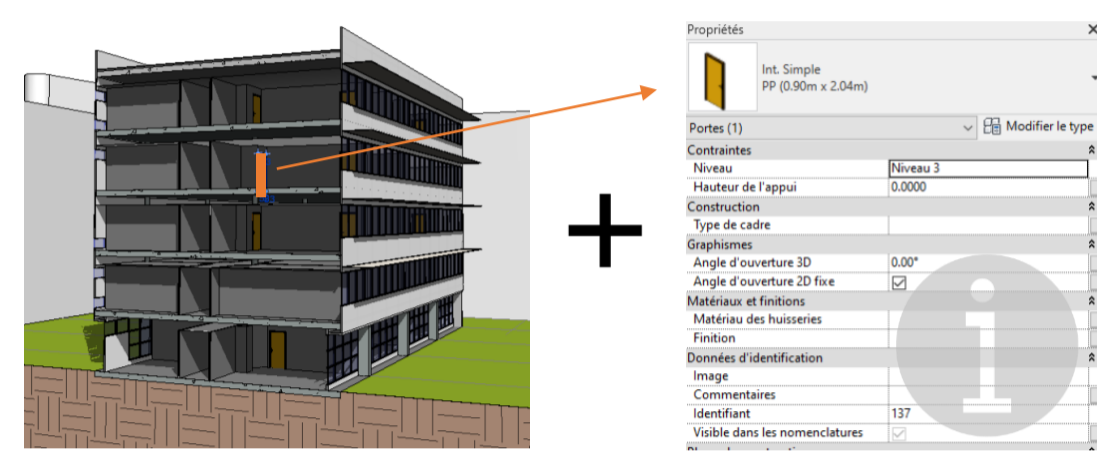


Fig. 1 : BIM Model and example of properties associated with a door

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 Data, BIM, etc.) and heterogeneity of data formats
- ⇒ Scarcity of CIM-LCA coupling studies



Fig. 2 : CIM schema

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

Information needed for district LCA

Site

- Total length of underground networks (tap water, used water, urban heat networks)

Buildings

- Land surface used
- Build surface
- Users
- Assessed period
- Previous land use

Public spaces

- Type (Road, sidewalk, green spaces, etc.)
- Area
- Public spaces management (waste, lighting, water uses)

Underground networks (guidelines respected)

- Underground networks easy to identify (naming convention for the file name)
- Each discipline has its file (used and waste waters, lighting, communication, tap water and heat network)
- Elements have a specific IFC Data Set displaying needed information

NB : pipe diameter available but not considered in the ecodesign tool

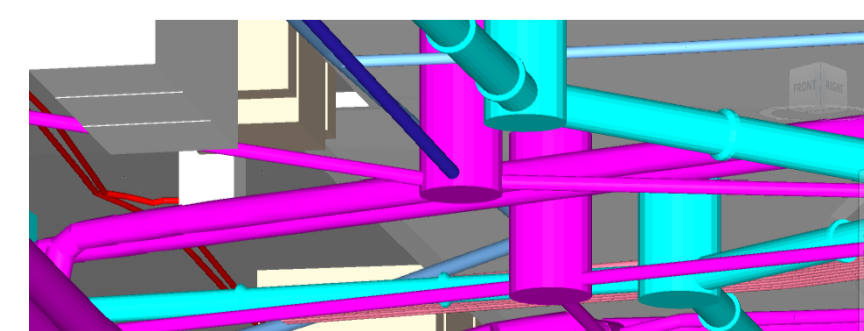


Fig. 4 : Underground networks

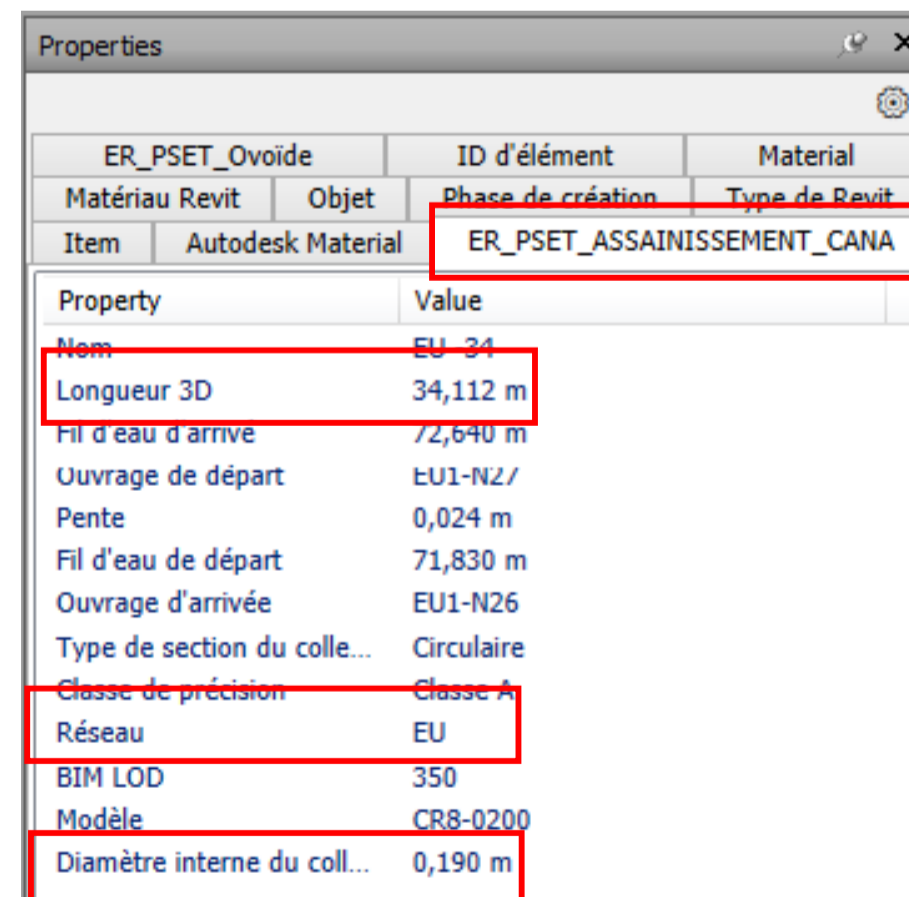


Fig. 5 : Pipe properties

Information available in our experimental CIM

Some aspects can be automatically measured :

- Underground networks length
- Public spaces areas

BIM modelling guidelines were established for easier exploitation...

...but some were not respected in earlier phase

Public spaces (guidelines not yet respected)

Heterogeneity of surface data labelling :

- Fig. 7 : area can be found in the "Cotes" property set under the "Surface" property
- Fig. 8 : area in the "BaseQuantities" property set but not in "Cotes" property set

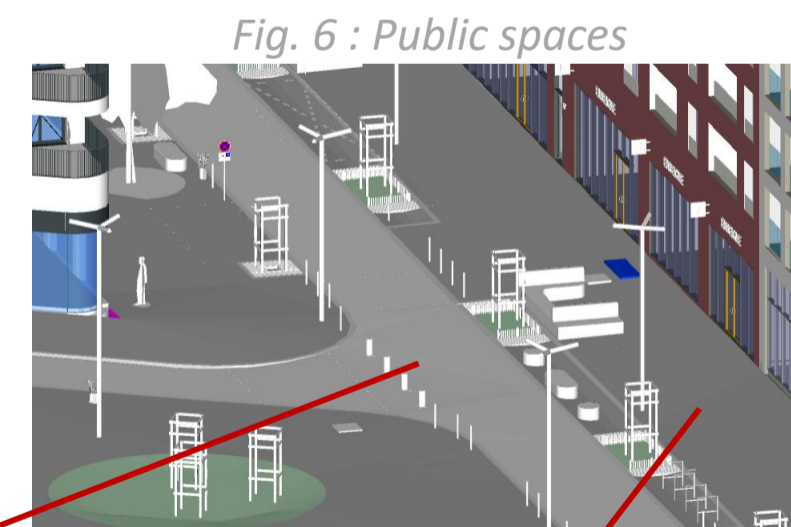


Fig. 6 : Public spaces

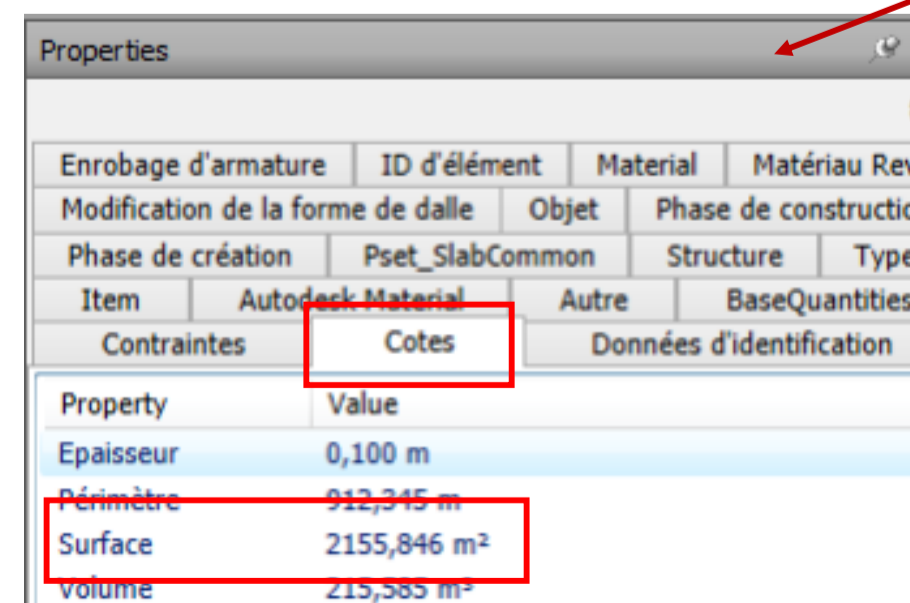


Fig. 7 : Road properties

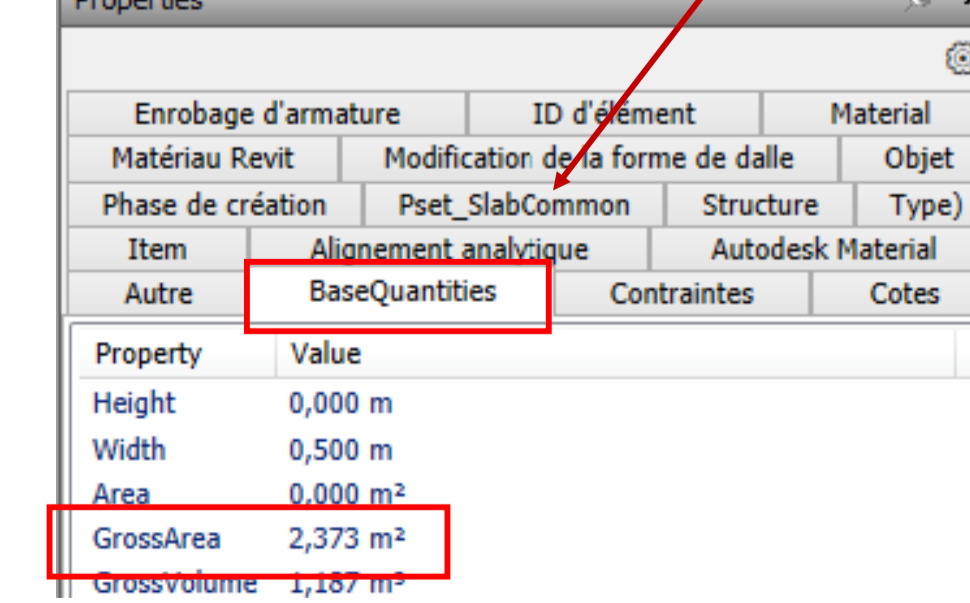


Fig. 8 : Sidewalk properties

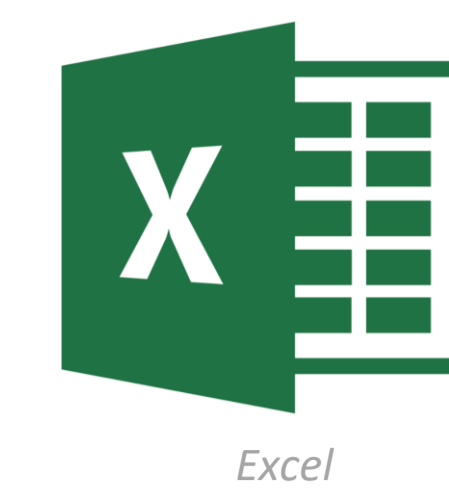
Data exportation



Exportation

- Name, for the composition
- Material Name, to double check composition
- Surface and GrossArea since the value can be found in either one or the other property

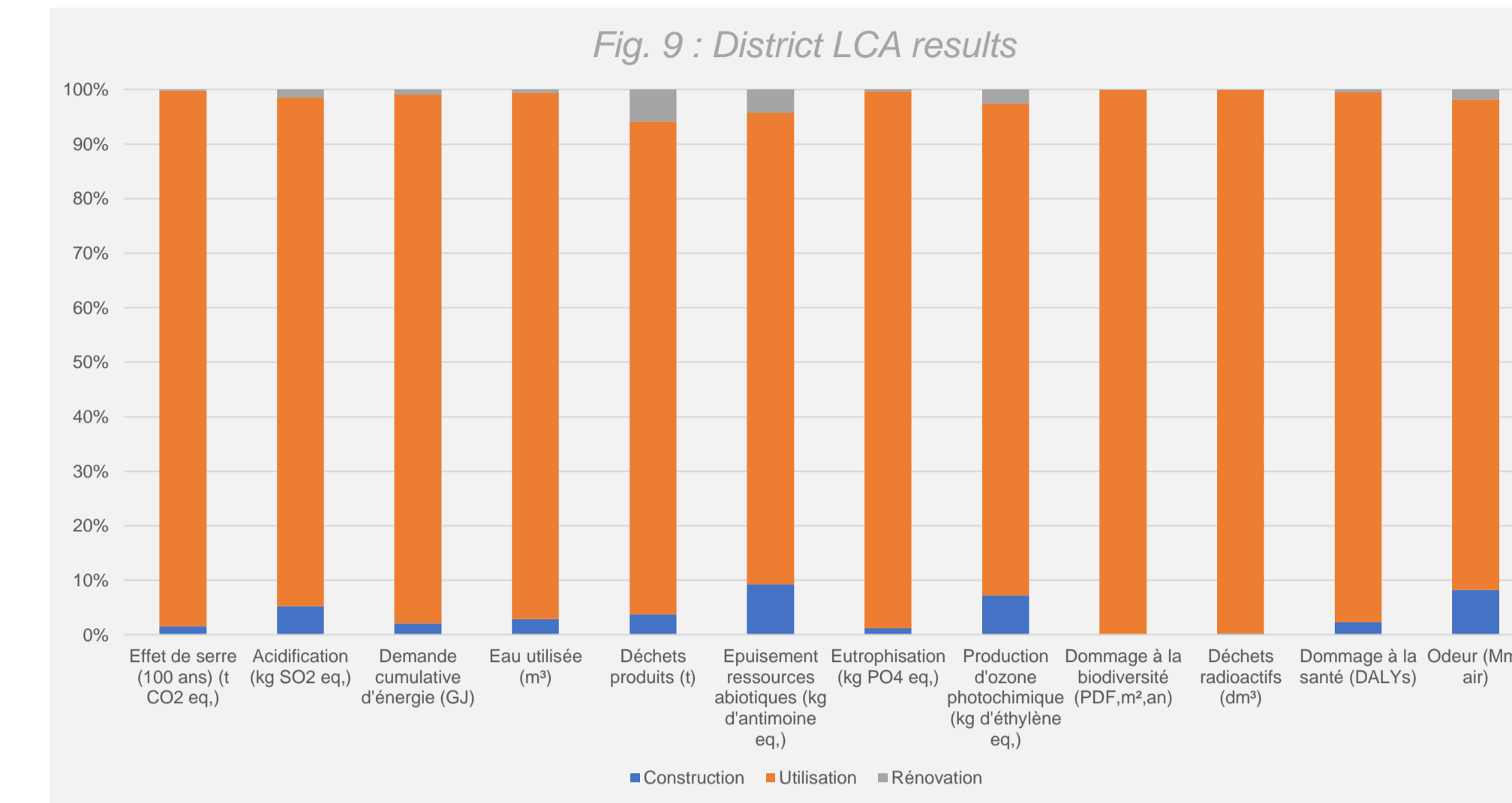
Post process



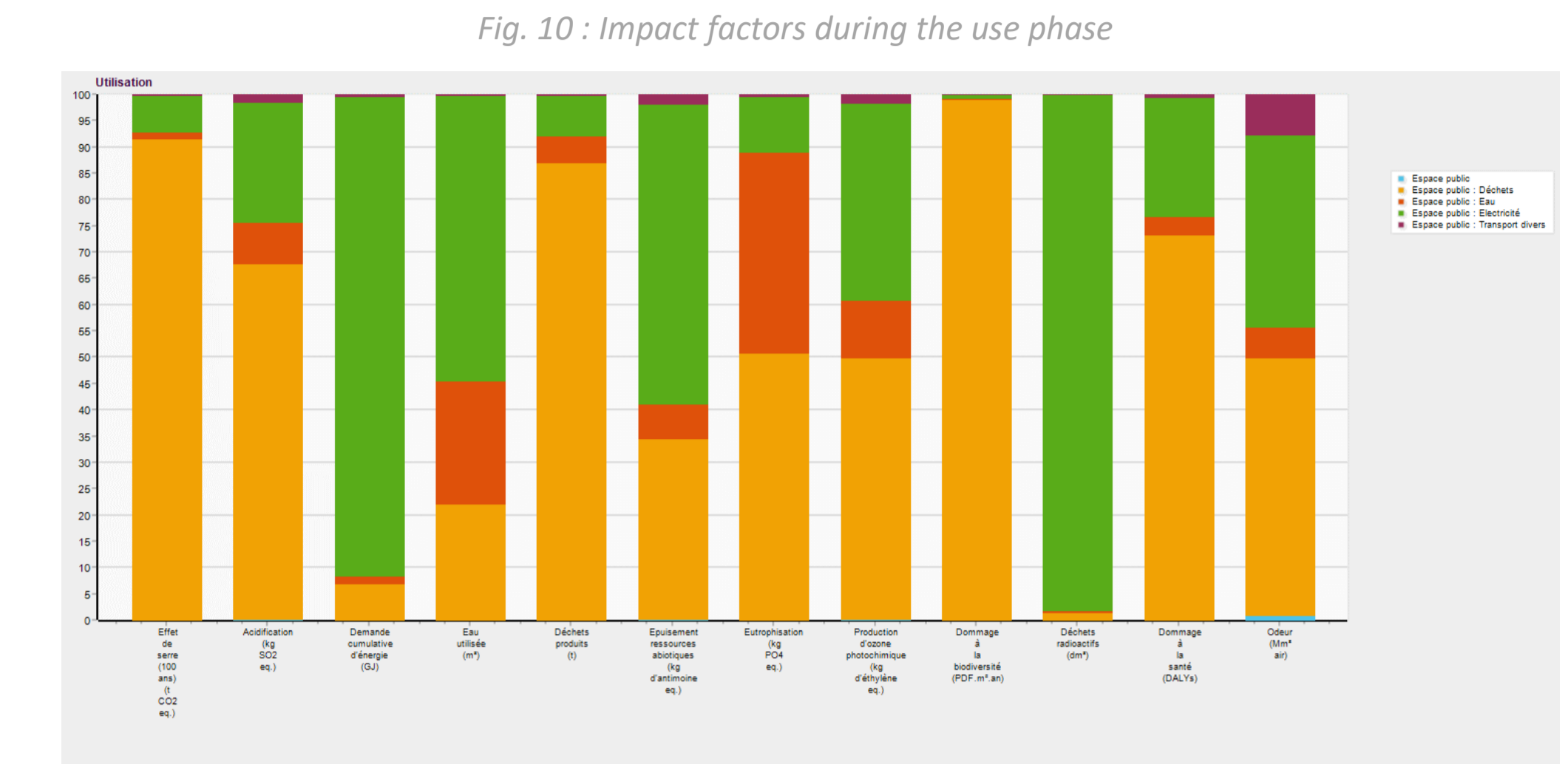
Mapping our quantities to standard types available in the ecodesign tool

Public spaces LCA

An LCA has been performed on public spaces of our case study using an ecodesign tool (Pléiades®) based on Ecoinvent v2.2 database.



⇒ The use phase is the main contributor to most impacts due to Electricity and Waste.



Improvement of public surfaces modelling

For this public space surfaces LCA, we consider artificialized layers excluding only untouched natural ground.

2 modelling methodologies :

- Single-layer (fig. 11), granting access to surface layer only
- Multi-layer (fig. 12), granting access to complete layers composition of roads / green spaces / sidewalks / etc. with associated data for each layer (Thickness, Material)

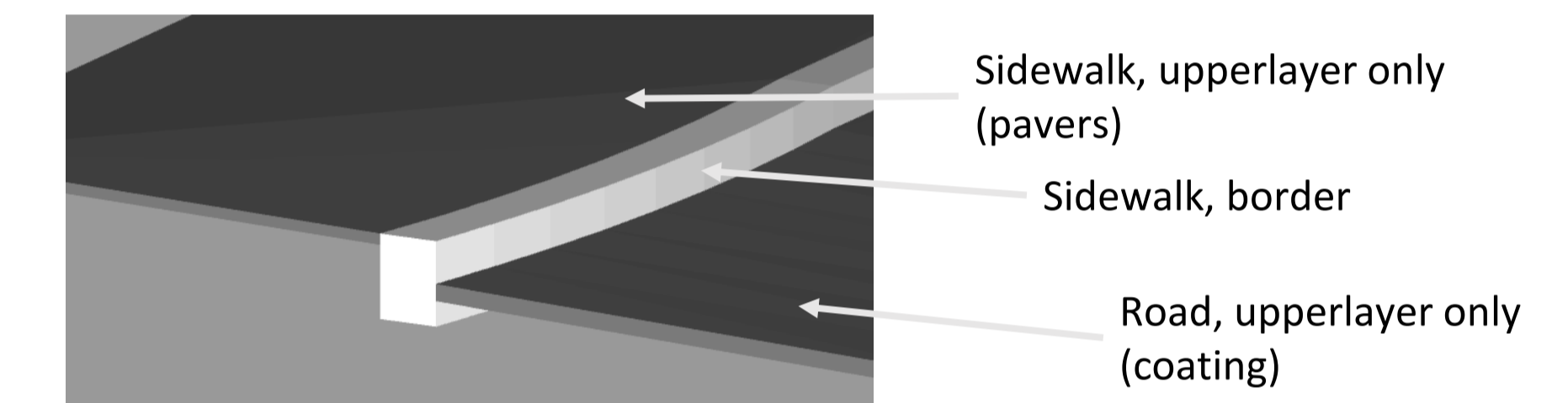


Fig. 11 : Single-layer public space modelling

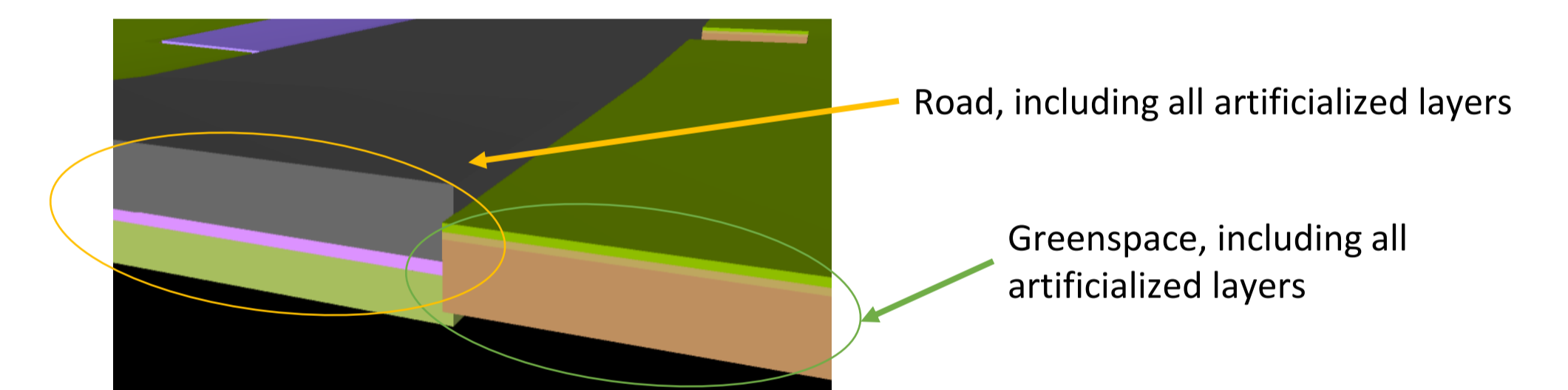
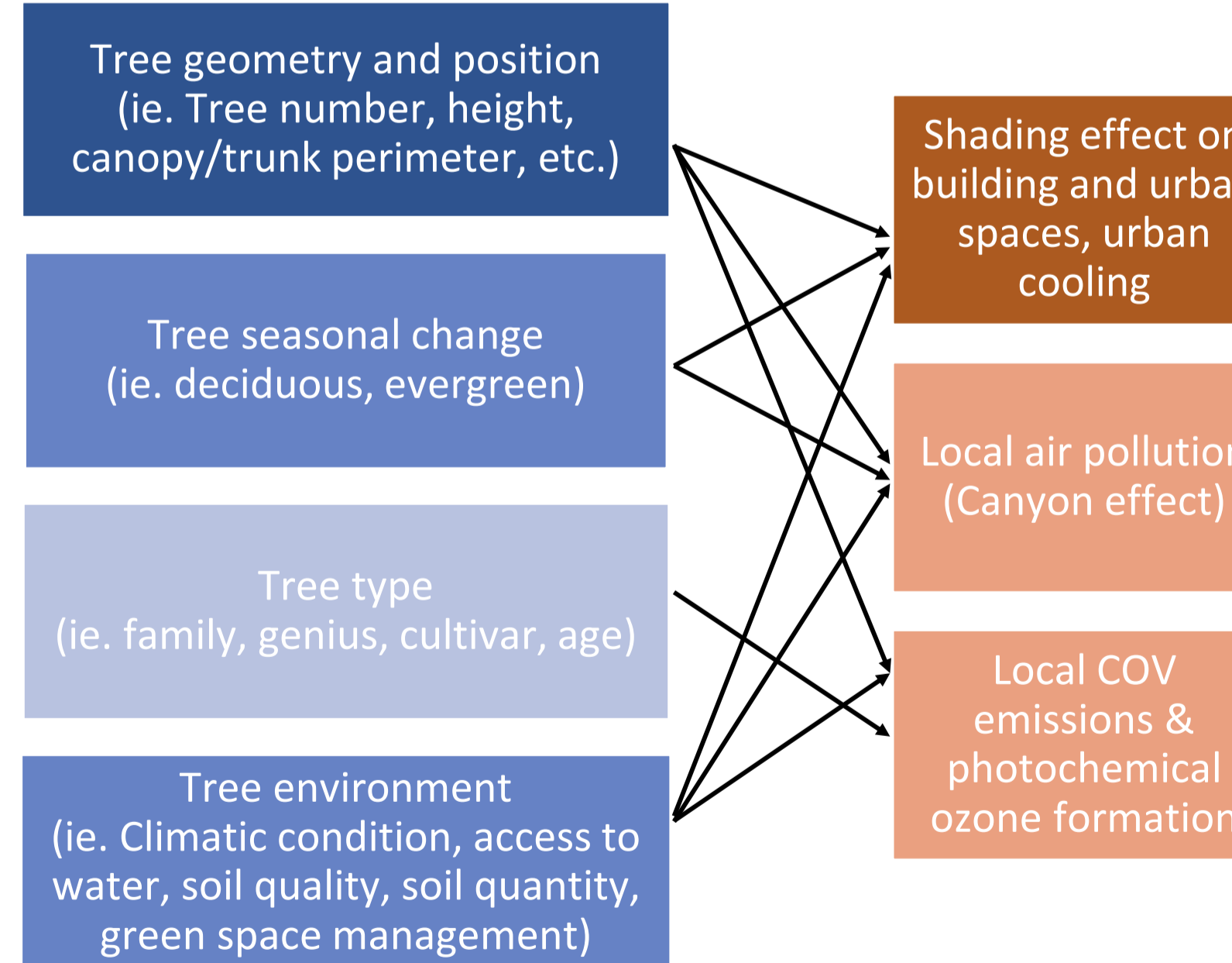


Fig. 12 : Multi-layer public space modelling

⇒ Multi-layer modelling significantly improves the LCA data collection and further the ecodesign study precision

CIM data potential for LCA



How to improve CIM usability for LCA ?

- Precisely define LCA information needs
- Optimize data structuration (for LCA and other applications)
- Expand LCA to include phenomena such as urban heat island effect

Future work

- Refine, develop and extend district CLCA thanks to geodata from CIM
- Provide guidelines and associated control protocol to improve CIM quality
- Explore the potential of exploratory geovisualisation for LCA scientists ⇒ Explore, understand and better anticipate the use of complex geodatasets

TAKE HOME MESSAGE

- Improving ecodesign of urban project is possible thanks to CIM
 - Models should be segregated by discipline
- Model producers have to respect project specific guidelines in order to enable data exploitation in ecodesign tools

References

Lotteau, Marc, Philippe Loubet, Maxime Pousse, Emmanuel Dufresnes, et Guido Sonnemann. 2015. « Critical Review of Life Cycle Assessment (LCA) for the Built Environment at the Neighborhood Scale ». Building and Environment 93 (novembre): DOI : 165-78. 10.1016/j.buildenv.2015.06.029

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.