

City Information Modelling for lifecycle assessment

Alexandre Mielniczek, Charlotte Roux, Florence Jacquinod

▶ To cite this version:

Alexandre Mielniczek, Charlotte Roux, Florence Jacquinod. City Information Modelling for lifecycle assessment. LCIC 2022 – collaborate, innovate, co-create | FSLCI e.V., Jun 2022, Berlin, Germany. hal-03712883

HAL Id: hal-03712883

https://hal.science/hal-03712883

Submitted on 4 Jul 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

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 - <u>alexandre.mielniczek@gmail.com</u>, 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)

Case study: analysing a district CIM

• Large district: 20.6 Ha, started in 2018 and under construction until 2027

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

is georeferenced so as to allow for the aggregation of all models into one

• Each model is dedicated to a specific building and a specific discipline and

⇒ The CIM contains 140.000 BIM objects 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)

Some aspects can be automatically measured:

Underground networks length

BIM modelling guidelines

were established for easier

Heterogeneity of surface data labelling:

• Fig. 7: area can be find in the "Cotes"

Fig. 8: area in the "BaseQuantities"

Fig. 7 : Road properties

property set under the "GrossArea"

property but not in "Cotes" property

y x

Données d'identification

property set under the "Surface"

Public spaces areas

property

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

"La Vallée" district in Châtenay Malabry, France

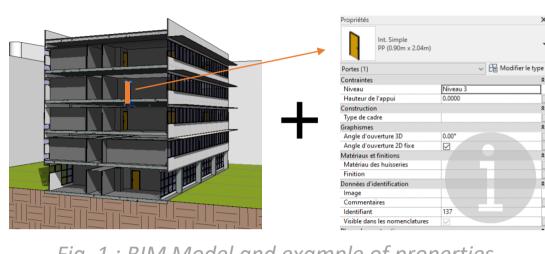
Mixt uses Dwellings/ Offices/ Shops

at the district scale

□ ZPC_AFR_ZAC_C.nwd
□ ZPC_AFR_ZAC_C.nwd
□ ZPC_AFR_ZAC_C.nwd
□ ZPC_EAR_ZAC_C.nwd
□ ZPC_ECB_LOT_AL_T_191224.nvt
□ ZPC_ECB_LOT_AL_T_191224.nvt
□ ZPC_ECB_LOT_AL_T_191224.nvt
□ ZPC_ECB_LOT_AL_T_191224.nvt
□ ZPC_ECB_LOT_GC_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_101201.nvt
□ ZPC_ECB_LOT_BC_T_T_10122.nvt
□ ZPC_ECB_LOT_BC_T_T_191121.nvt
□ ZPC_ECB_LOT_BC_T_T_1911224.nvt
□ ZPC_ECB_LOT_RC_T_1911224.nvt
□ ZPC_ECB_LOT_RC_T_1911224.nvt
□ ZPC_ECB_LOT_RC_T_1911224.nvt
□ ZPC_ECB_LOT_RC_T_1911224.nvt

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?



associated with a door

BIM (Building Information Model) = 3D objects with properties (type,

building site Standardized open exchange format with categorized objects

quantities, etc.) representing a

- ⇒ 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



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

Information needed for district LCA

 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

- Area
- management (waste, lighting, water uses)

- Type (Road, sidewalk, green spaces, etc.)
- Public spaces

respected in earlier phase exploitation...

Public spaces (guidelines not yet respected)

Information available in our experimental CIM

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, Property 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

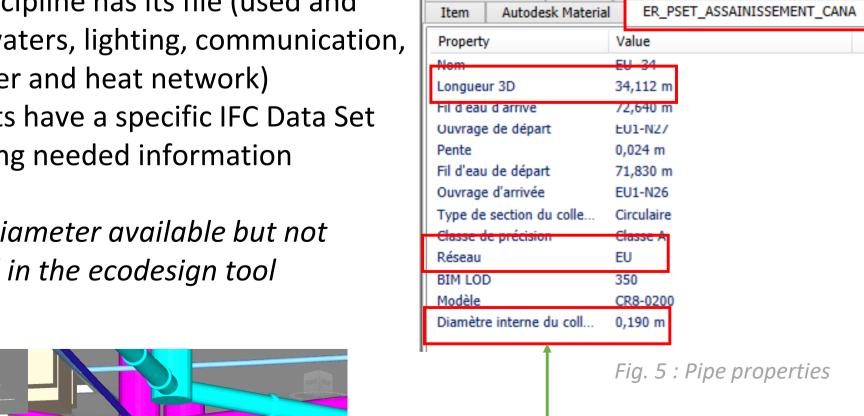


Fig. 4: Underground networks







Fig. 8 : Sidewalk properties

Contraintes

BaseQuantities

Value

GrossArea 2,373 m²

Property

...but some were not

Data exportation

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



Mapping our quantities to standard types available in the ecodesign tool

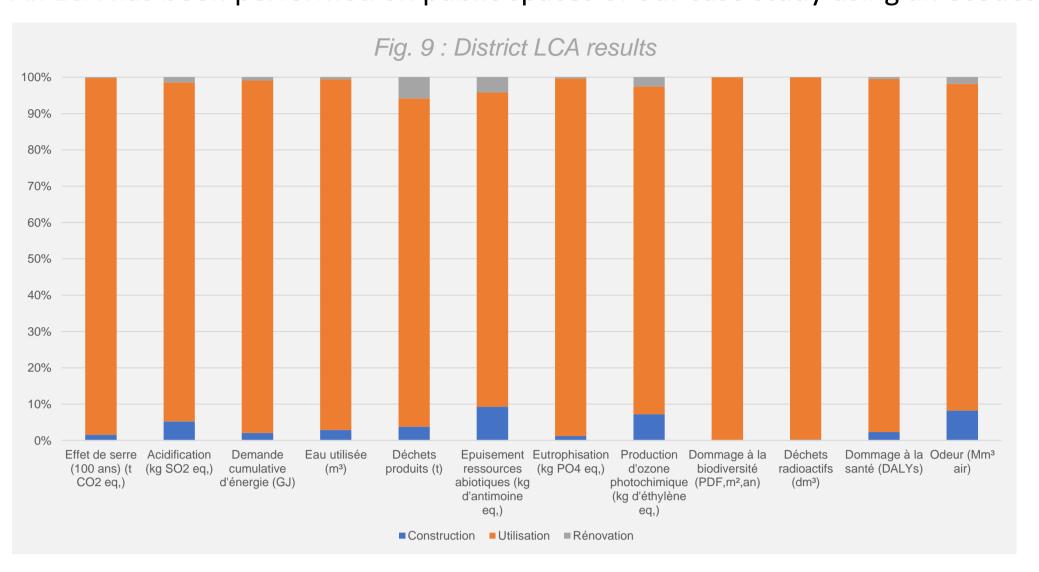
Sidewalk, upperlayer only

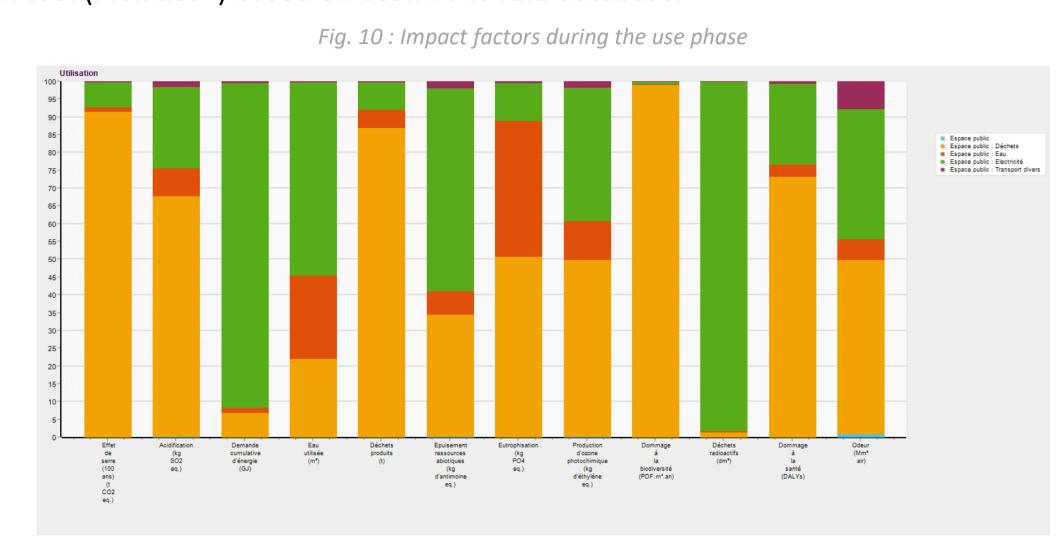
Sidewalk, border

(pavers)

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.

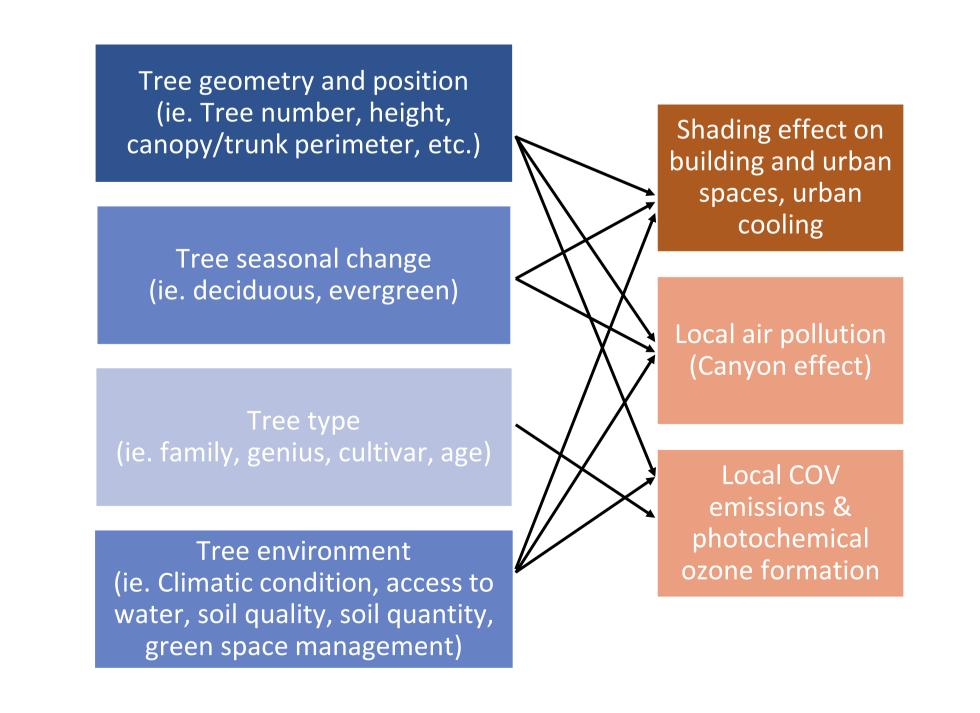
2 modelling methodologies:

CIM

- 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)

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

CIM data potential for LCA



Road, upperlayer only (coating) Fig. 11: Single-layer public space modelling Road, including all artificialized layers Greenspace, including all artificialized layers

Fig. 12: Multi-layer public space modelling

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 geovisusalition 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 Dufrasnes, 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.







