Unified Representation of Building Energy Modeling Using GIS Tools

Design Project

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Contents

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Objectives

The final completed objectives of this project include:

Gathering of data from RegBL, Swisstopo, and SATOM

Creation of a PostgreSQL database following 3DCityDB

Import of RegBL, Swisstopo, and SATOM data

Assignment of a common EGID identifier using Intersection

Python script to query data from database to create .xml file

Running of .xml file in CitySim Pro for simulation results

Future objectives of this project include the creation of:

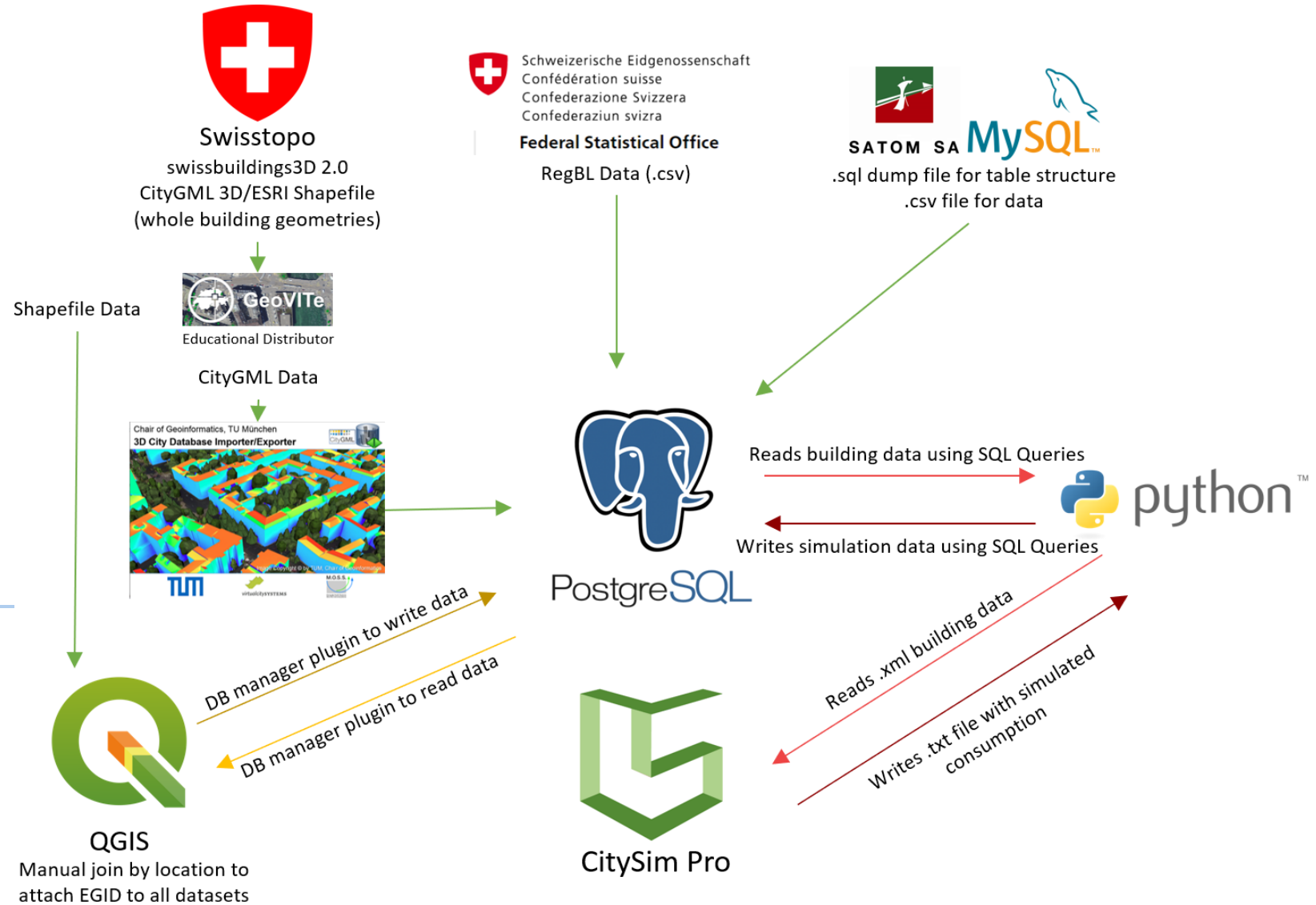Comparison of actual and simulated data using QGIS maps

MLA that uses difference maps to analyze gaps in the simulation

Use gaps to calibrate CitySim Pro for better energy-use prediction

Project Overview

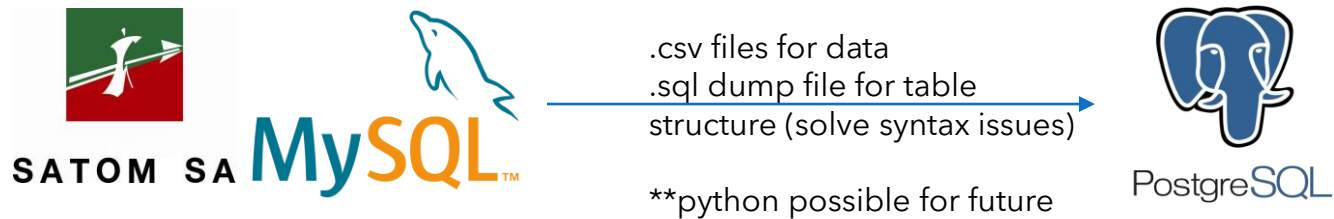Data identification, collection and import

SATOM 🔋

3D geometry 🏠

RegBL ⓘ

SATOM

- Collection
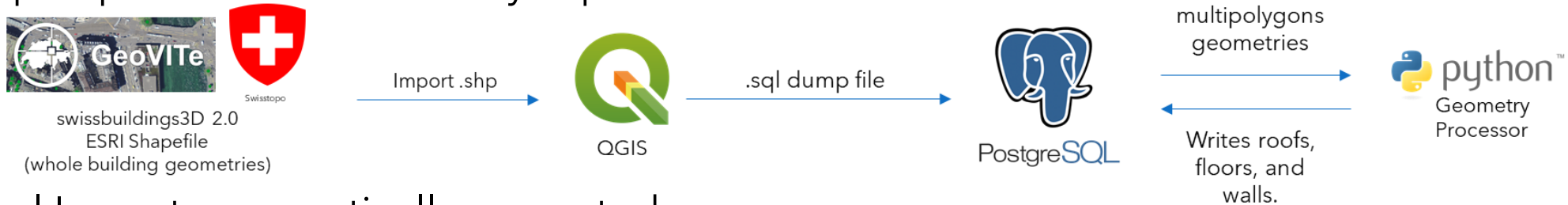 - Contains: building footprint, coverage, occupancy data, energy use
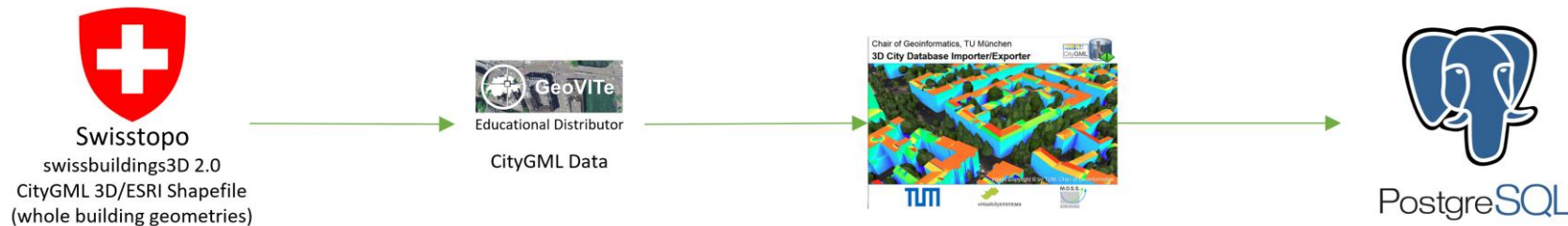 - Format: SQL Dump file

- Import

.csv files for data
.sql dump file for table
structure (solve syntax issues)

**python possible for future

3D geometry

- Collection
  - Request from Swisstopo under Educational License

- .shp Import – not semantically separated

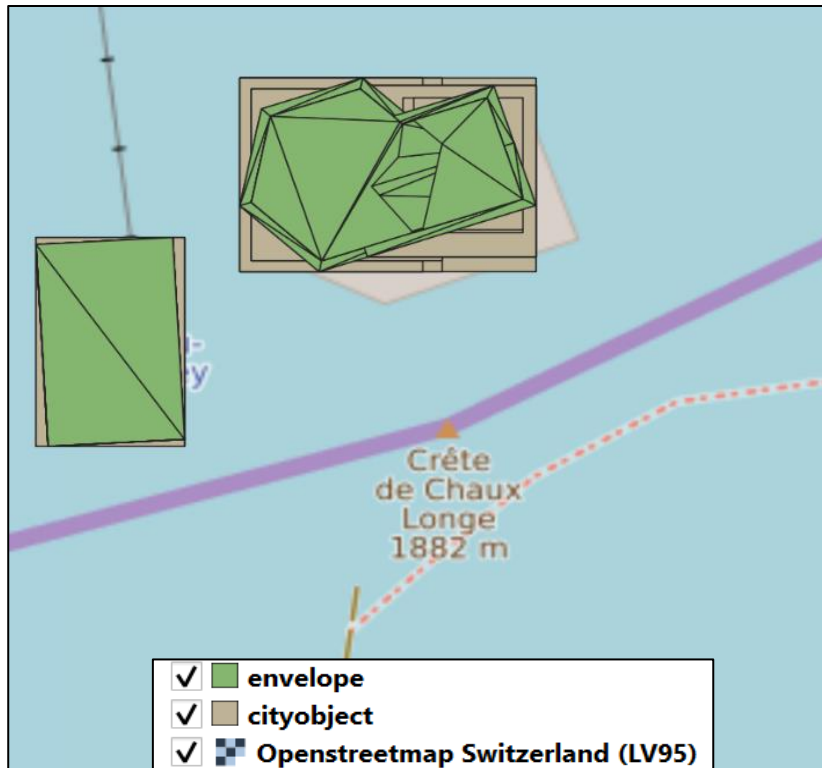swissbuildings3D 2.0
ESRI Shapefile
(whole building geometries)

Import .shp

QGIS

.sql dump file

PostgreSQL

Reads multipolygons geometries

python™
Geometry Processor

Writes roofs, floors, and walls.

- .gml Import – semantically separated

Swisstopo
swissbuildings3D 2.0
CityGML 3D/ESRI Shapefile
(whole building geometries)

GeoVITe
Educational Distributor
CityGML Data

Chair of Geoinformatics, TU München
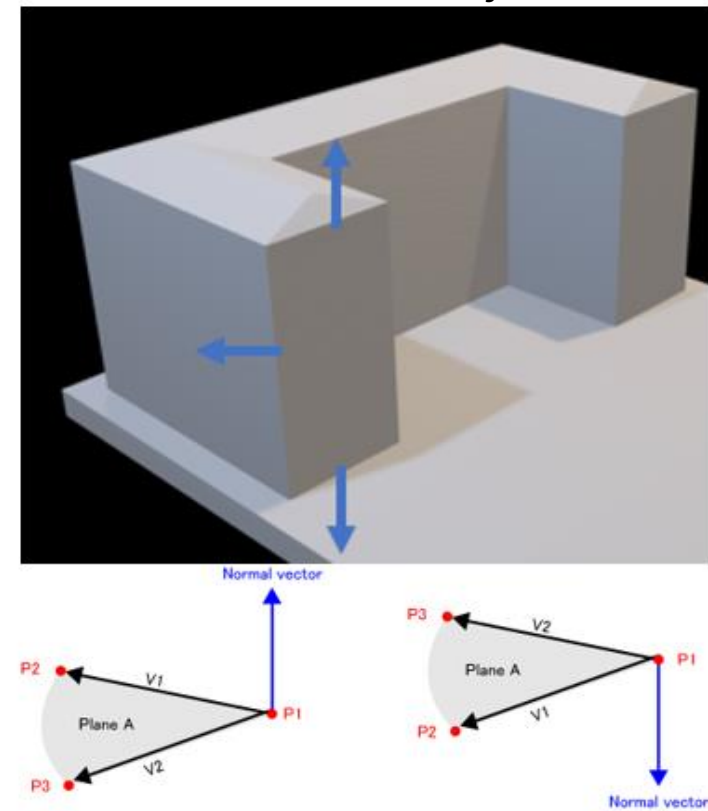3D City Database Importer/Exporter

PostgreSQL

Shape file Uses

CityGML Coordinate Verification

Alternative to CityGML

RegBL (i)

- Collection
  - Request from Swiss Federal Office of Statistics under Educational License
  - Contains: construction year, number of rooms, number of floors, EGID

- Import
  - Format change: CSV to Database
  - Syntax modification

Data Storage Structures

Customized structure with Python Script
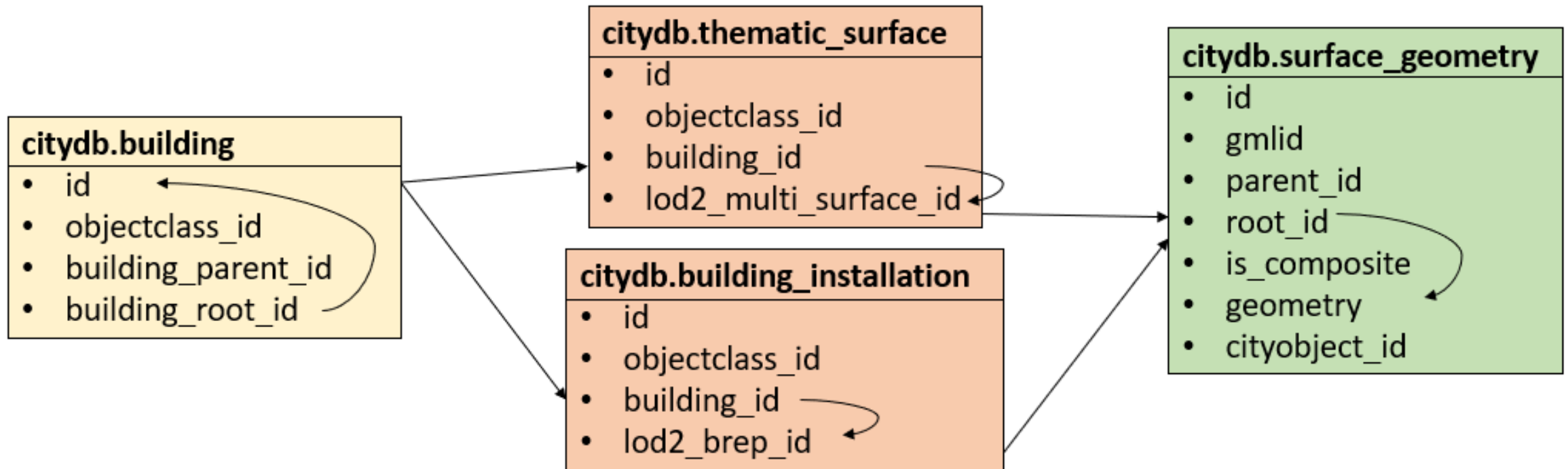
3DCityDB

SATOM

Occupancy Relation Table

RegBL

Customized structure with Python Script

city.buildings
- geometry
- coverage
- ssid
- height
- egid
- altitude
- infiltration_rate
- construction_year
- gross_volume
- occupancytype
- n_floors
- n_people
- heating_year
- max_heating_hour
- citysim_kwh

city.envelope
- class_id
- egid
- geometry
- glazing_ratio
- composite_id

occupancy_data.occupancy_type
- occupancy_type_id
- surface_personne
- equipment_power
- lighting_power
- ventilation_rate_day
- ventilation_rate_night
- ventilation_rate
- ventilation_coeff
- nat_ventilation_coeff

climate.horizon
- phi
- theta

surfaces_data.composites
- composite_id
- composite_name

surfaces_data.glazing_ratio
- index
- class_id
- period_start
- period_end
- value

surfaces_data.layers
- layer_id
- composite_id_fk
- material_id_fk
- layer_number
- thickness

surfaces_data.materials
- material_id
- material_name
- conductivity
- cp
- density

3DCityDB

SATOM

satom.batiments	satom.mega	satom.tblcliendatathistory
• ogr_fid	• megabatiment	• sdbus
• shape	• megaegid	• datetime_time
• client	• fake_megacategorie	• cnt1_energy
• shape_area	• sdbus	

- 3-hour data
- Sdbus is a number labeling an energy consumption region
- Megabatiment and client are the same and make up one sdbus area
- Default occupancy types assigned in megacategorie
- Skewed footprints
- Partial EGIDs

Occupancy Relation Table

satomtype	occupancytype
Ecoles	8
Commerce	4
Piscines couvertes	3
Commerce; Habitat Collectif; Restauration	6
Dépôts; Industrie	9
Administration; Dépôts	2
Administration; Commerce; Dépôts	4
Administration	2
Commerce; Dépôts; Habitat collectif	6
Lieux de rassemblement	10
Restauration	5
Administration; Habitat collectif	2
Commerce; Habitat collectif	4
Habitat collectif; Restauration	6
Habitat collectif	1
Habitat individuel	1
Installations sportives	3
Hôpitaux	7
Administration; Commerce; Habitat collectif; Restauration	6
Industrie	9

Boghetti's Occupancy Number

1. Residential
2. Office
3. Sport Center
4. Commercial
5. Restaurant
6. Hotel
7. Hospital
8. Education
9. Industrial
10. Other

RegBL

city.regbl_data
- egid
- construction_year
- n_pieces
- n_floors

- Simple structure
- Limited data with many holes
- N_pieces to N_people (default of 3)
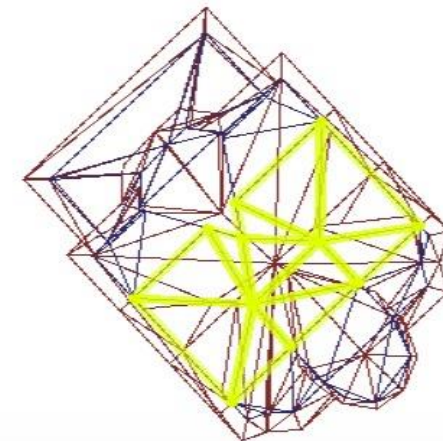- Construction_year default to 1979.9
- N_floors default to 1

Dataset Connections

- Spatial intersection with QGIS

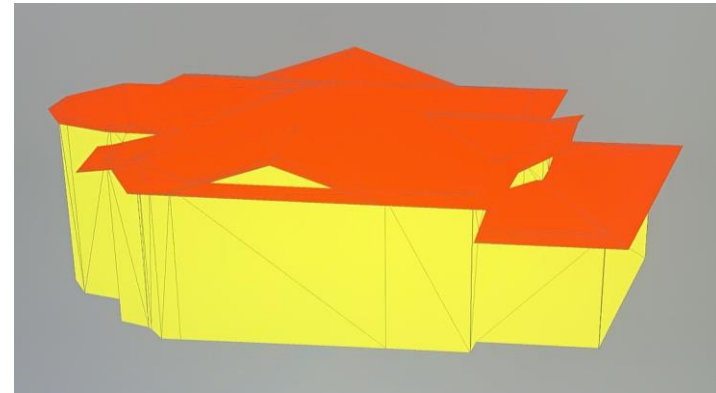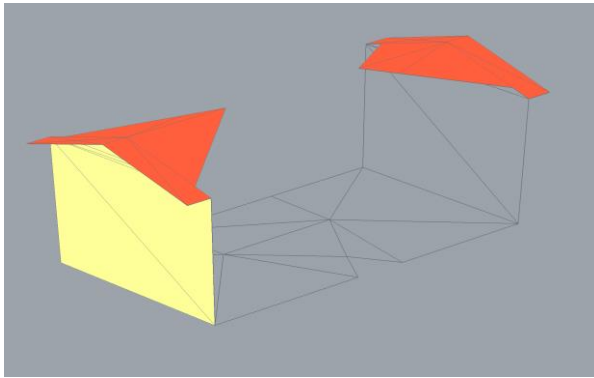- Cross-reference table

- Dissolve for missing building parts
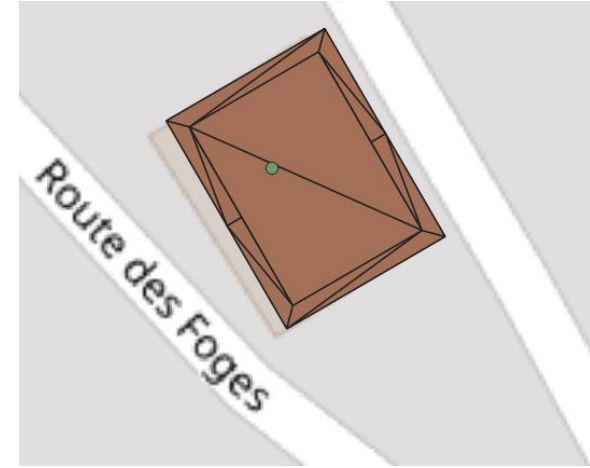
citydb.cross_reference
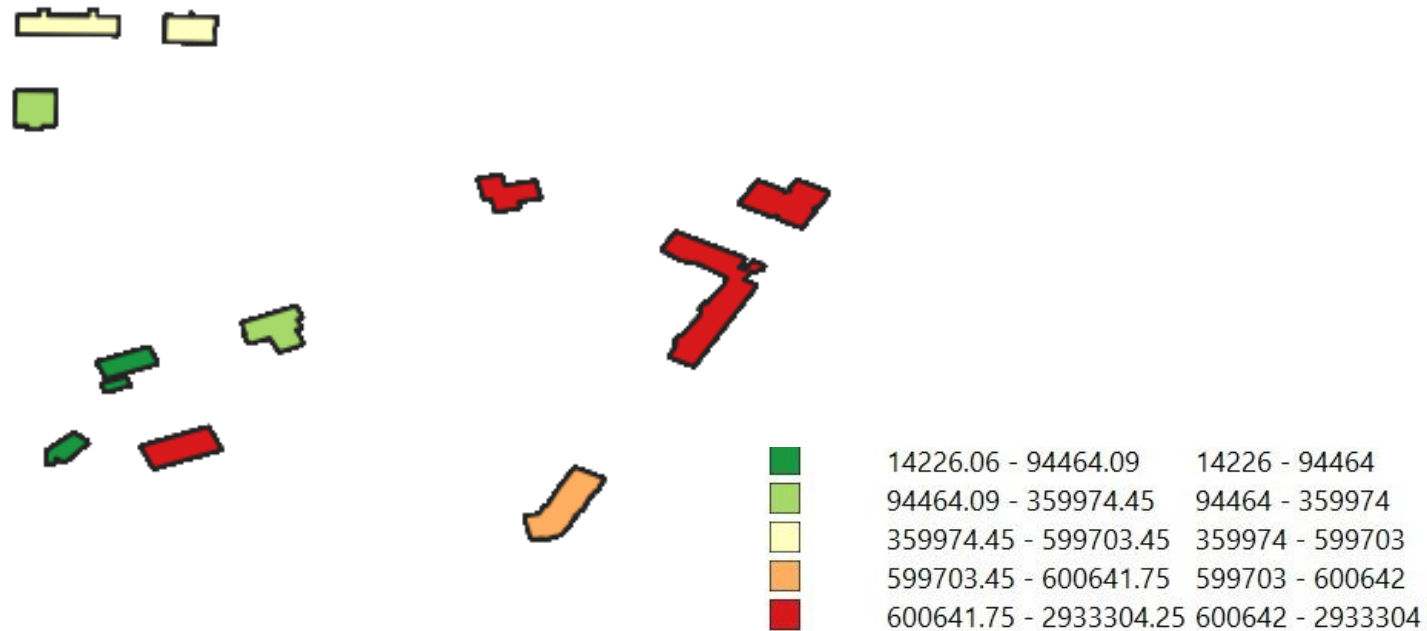- building_root_id
- egid
- satom_building_id

Python Script


```sql
SELECT ST_Transform(ST_SetSRID(ST_Translate(bat.shape,-0.00084328,-0.0012505) ,4326), 21781) AS geometry,
COALESCE(rbl.construction_year,1980.1) AS construction_year, bat.shape_area AS coverage,
COALESCE(rbl.fake_n_floors,1) AS n_floors, bat.ogr_fid AS ssid, zone.egid AS egid,
COALESCE(NULLIF(rbl.n_pieces,0),1) AS n_people, COALESCE(rbl.fake_n_floors*bat.shape_area*4,1*bat.shape_area*4) AS calc_vol,
COALESCE(ocr.occupancytype,1) AS occupancytype
FROM satom.batiments bat
LEFT JOIN satom.mega mega ON bat.client = mega.megabatiment "
LEFT JOIN city.occupancy_relation ocr ON ocr.satomtype = mega.fake_megacategorie
LEFT JOIN city.regbl_data rbl ON mega.megaegid = rbl.egid
JOIN citydb.cross_reference cros on bat.ogr_fid = cros.satom_building_id
RIGHT JOIN citydb.zone zone ON cros.egid = zone.egid LIMIT 25
```

Comparison of monitored and simulated results

Legend:

Color	Monitored	Simulated
Dark green	14226.06 - 94464.09	14226 - 94464
Light green	94464.09 - 359974.45	94464 - 359974
Cream	359974.45 - 599703.45	359974 - 599703
Orange	599703.45 - 600641.75	599703 - 600642
Red	600641.75 - 2933304.25	600642 - 2933304

Discussion

DATA QUALITY AND GAPS

PYTHON CODE PROCESSING TIME

3DCITYDB REQUIRES BETTER SCHEMA MANAGEMENT

MANUAL ACTIONS REQUIRED IF NO PLUGIN CREATED