

CityGML 3DCityDB-Loader plugin for QGIS

A quick overview

Giorgio Agugiaro, Kostantinos Pantelios, Camilo León-Sánchez

124th OGC Member Meeting
Digital Twins - Land and Sea
5 October 2022, Singapore



Open
Geospatial
Consortium

License

This presentation is licensed under the [Creative Commons License CC BY-NC-SA 4.0](https://creativecommons.org/licenses/by-nc-sa/4.0/). According to CC BY-NC-SA 4.0 permission is granted to share this document, i.e. copy and redistribute the material in any medium or format, and to adapt it, i.e. remix, transform, and build upon the material under the following conditions:



- **Attribution:** You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
- **NonCommercial:** You may not use the material for commercial purposes.
- **ShareAlike:** If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.
- **No additional restrictions:** You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Overview

- 3DCityDB-Loader: Motivation
- Plugin overview
- (Mini) live demo
- Conclusions & outlook



Motivation

IDEA:

- **CityGML 3D City Database:** Why not letting users benefit from *directly* working with the 3DCityDB?
 - No need to work with files
 - Editing of feature attributes could become way easier
 - SQL/relational model are rather well-known in the user community
 - Last but not least.... "3D city models belong best in a database" 😊



Motivation

BUT:

- 3DCityDB structure is rather complex
 - Lots of nested tables, intricate structure
 - Data management is difficult, although some functions are provided (e.g. delete functions)
 - There can be multiple citydb schemas in the same database instance (aka "scenarios")
- CityGML does not follow the Simple Feature for SQL model (SFS)
 - Nested features
 - One feature can have multiple representations (multiple LoDs, multiple geometry types)
- The existing **Importer/Exporter** offers some functionalities, but its *raison d'être* is basically different (...as the name says!)

Example: query of all (building) roofs constructed since 2015

Motivation

Plugin overview

Demo

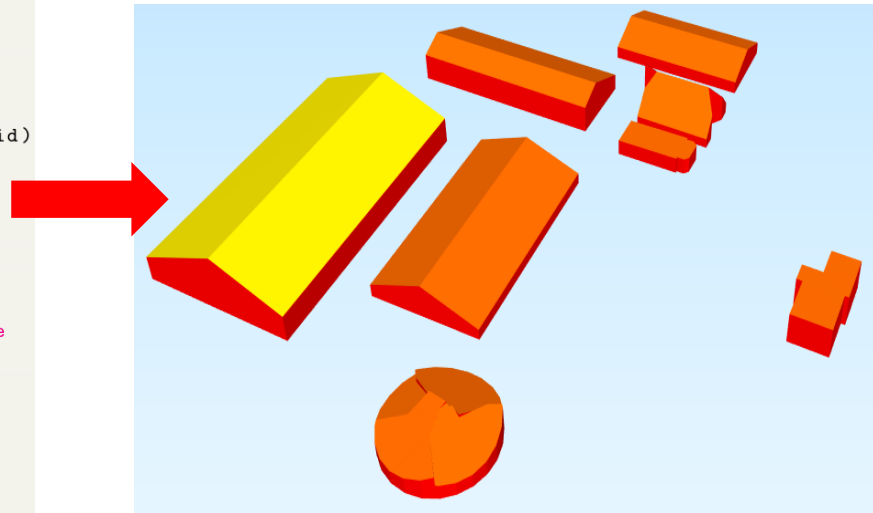
Conclusions

Resources

```

1 SELECT
2     ts.id AS roof_id,
3     co_ts.gmlid AS roof_gmlid,
4     b.id AS building_id,
5     co.gmlid AS building_gmlid,
6     b.year_of_construction,
7     ST_Collect(sg.geometry) AS roof_geom
8 FROM
9     citydb.thematic_surface AS ts
10    INNER JOIN citydb.cityobject AS co_ts
11        ON (co_ts.id = ts.id)
12    INNER JOIN citydb.surface_geometry AS sg
13        ON (ts.lod2_multi_surface_id = sg.root_id)
14    INNER JOIN citydb.building AS b
15        ON (b.id = ts.building_id)
16    INNER JOIN citydb.cityobject AS co
17        ON (co.id = b.id)
18 WHERE
19     ts.objectclass_id = 33 AND -- roofsurfaces
20     b.objectclass_id = 26 AND -- buildings
21     b.year_of_construction >= '2015-01-01'::date
22 GROUP BY
23     ts.id,
24     co_ts.gmlid,
25     b.id,
26     co.gmlid,
27     b.year_of_construction
28 ORDER BY
29     b.id,
30     ts.id;

```



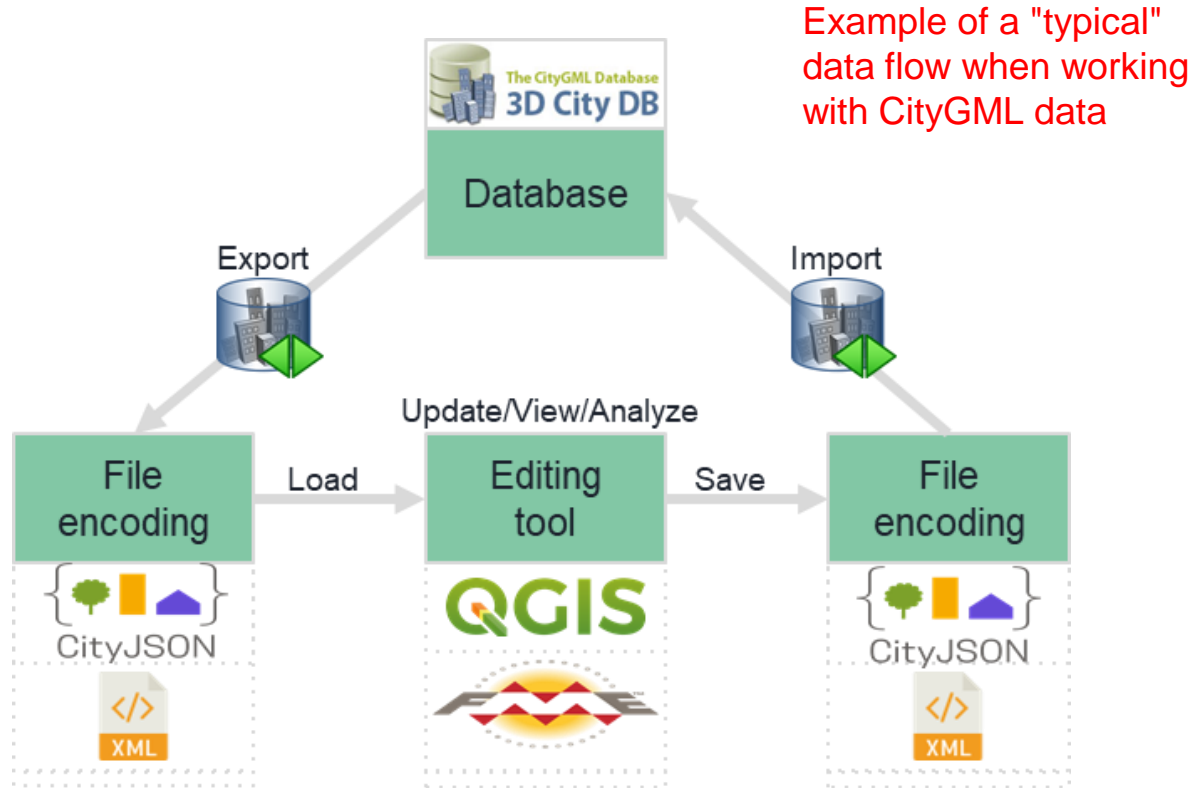
Motivation

SO:

- Why not using **QGIS**?
 - Well-known and established open-source software
 - Rather mature, version 3.22 LTR released in autumn 2021, well documented
 - Native support for PostgreSQL/PostGIS, support also for Oracle Spatial
 - Has strong 2D and some (definitely less mature) 3D visualisation functionalities
 - Can be extended with Python-based plugins

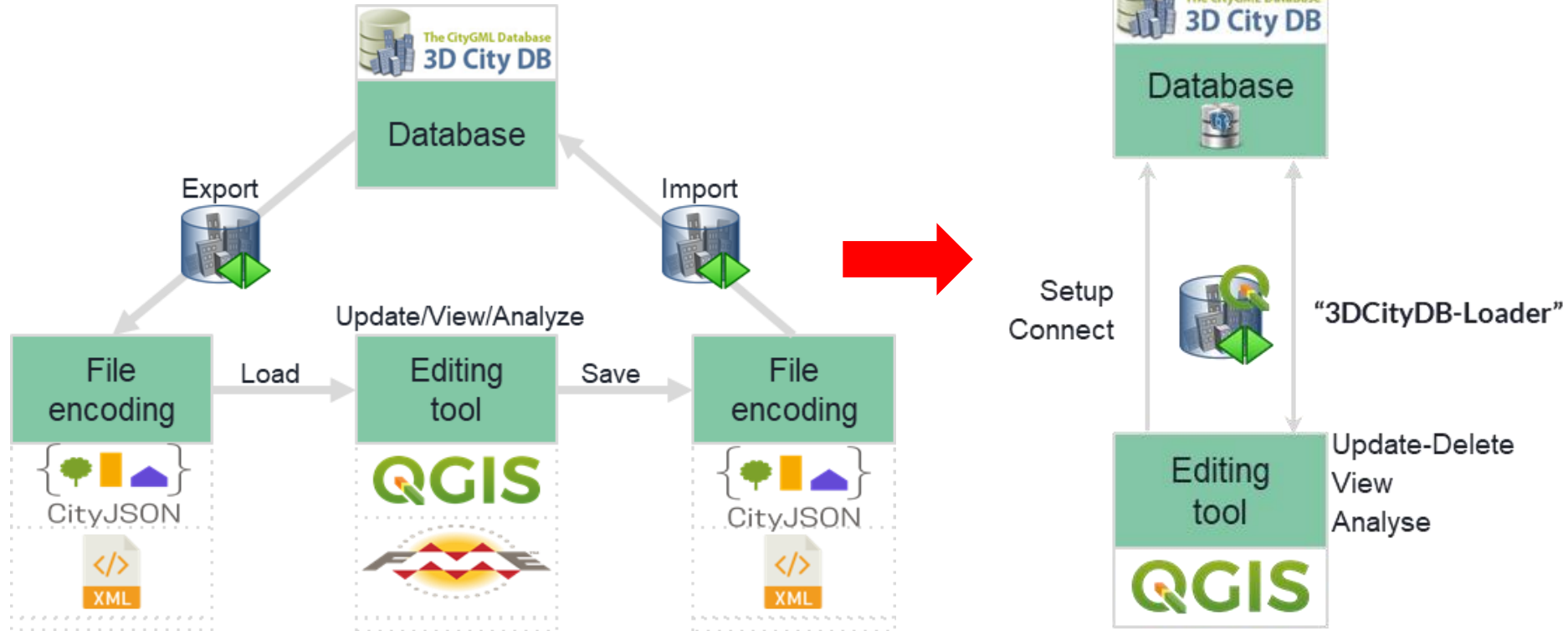


Motivation



Motivation

Vision / goal of the plugin



3DCityDB-Loader plugin overview

Main functionalities

- Create "SFS-like" layers to hide 3DCityDB complexity when interacting with data
 - Deal efficiently with multi-LoD / different geometries / implicit representations
 - Up to 530+ possible combinations in CityGML
 - Merge all standard attributes of a CityObject into a single "table"
- Deal with the possibly *huge* size of city models stored in a database
- Support for multiple citydb schemas in the same 3DCityDB instance
- Support for multiple users with different privileges (read-only, read-write)
- Editing of attributes: possible (depending on user privileges)
- Deletion of features: possible (depending on user privileges)
- Editing of geometries: NOT possible

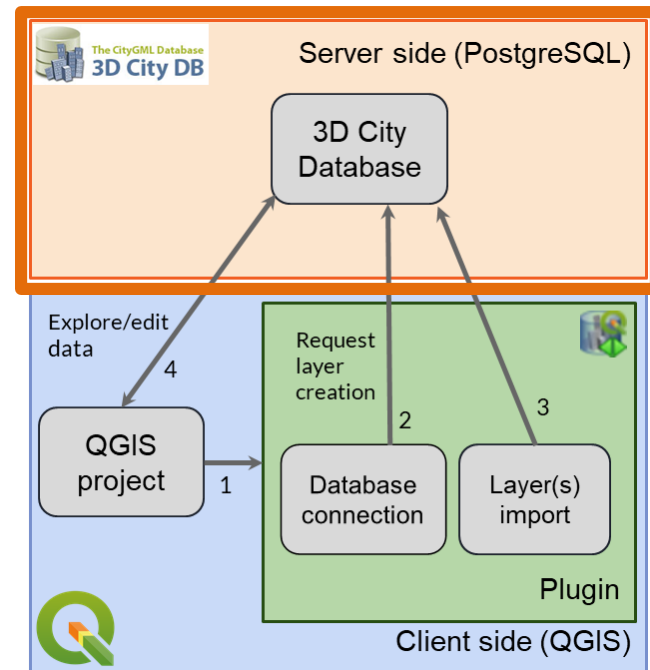
Plugin overview

Motivation
Plugin overview
 Demo
 Conclusions
 Resources

Server-side

PostgreSQL "QGIS Package"

- Creates and manages layers as views (for attributes) linked to materialized views (for geometry) following the SFS model
- Manages
 - users and privileges
 - multiple citydb schemas
- Adds default users with ro & rw privileges



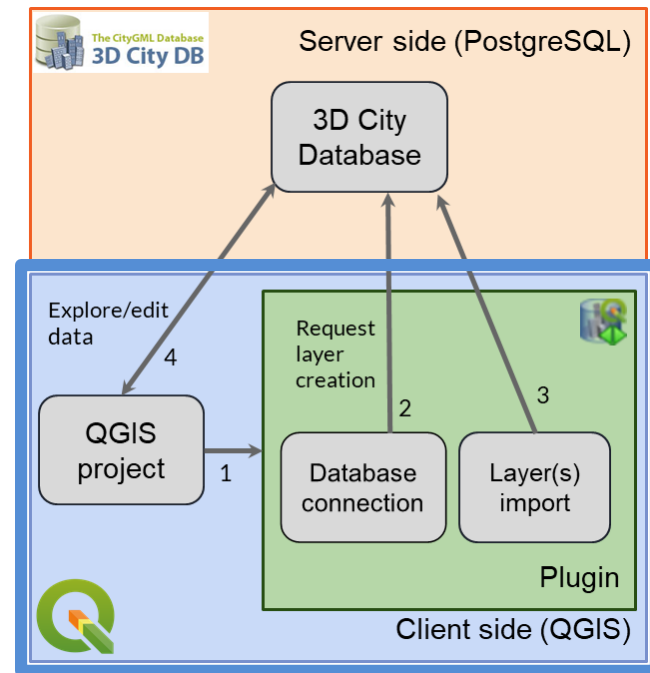
Plugin overview

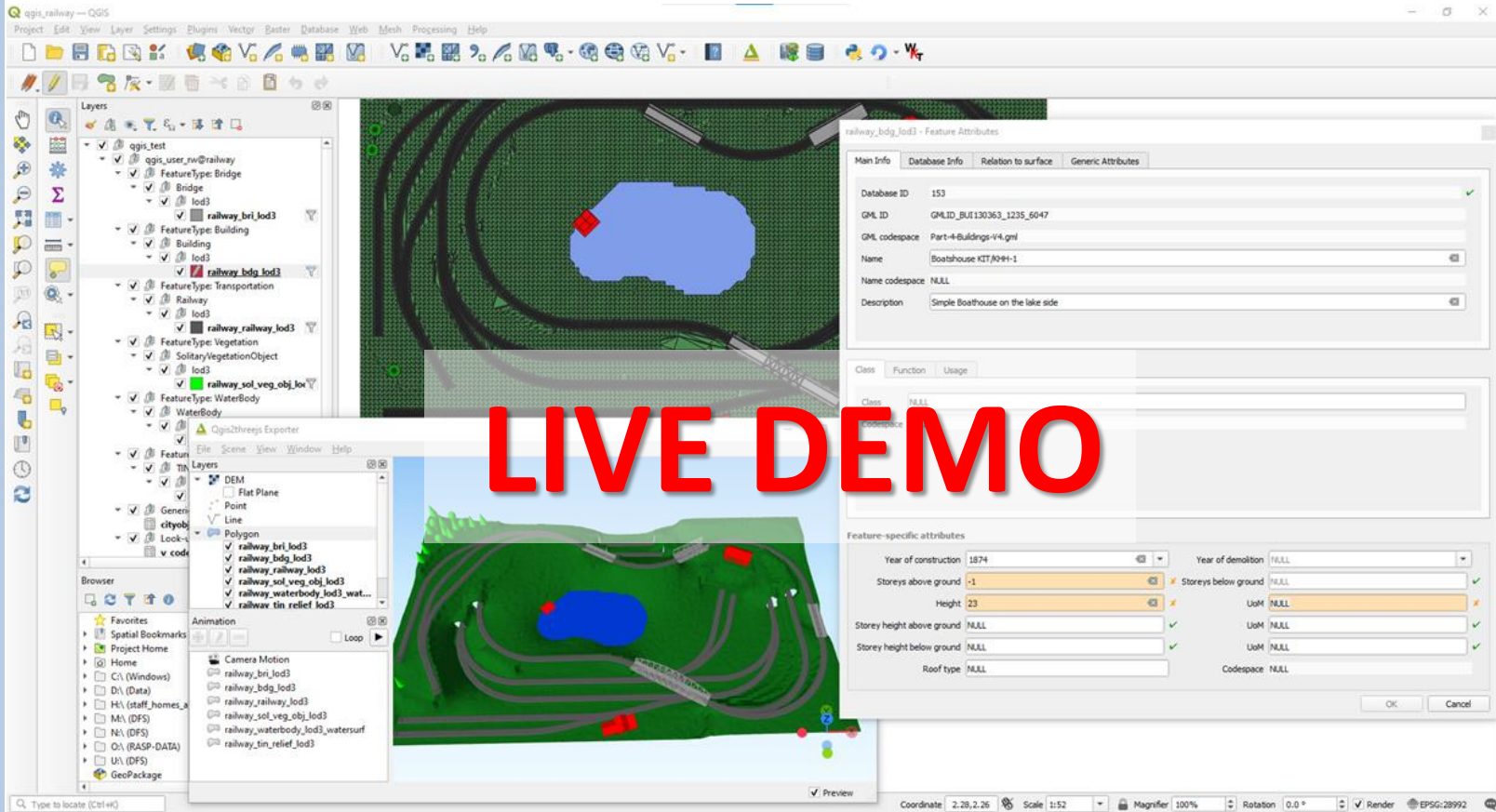
Motivation
Plugin overview
 Demo
 Conclusions
 Resources

Client-side

QGIS plugin “3DCityDB-Loader”

- Manages db connections + installation of the **QGIS Package**
- Allows for GUI-based
 - layer creation and management
 - management of multiple citydb schemas
 - editing of feature attributes
- GUI includes
 - support for children tables (e.g. generic attributes)
 - CityGML enumerations
 - (optionally) codelists
- Creates a hierarchical Table of Contents



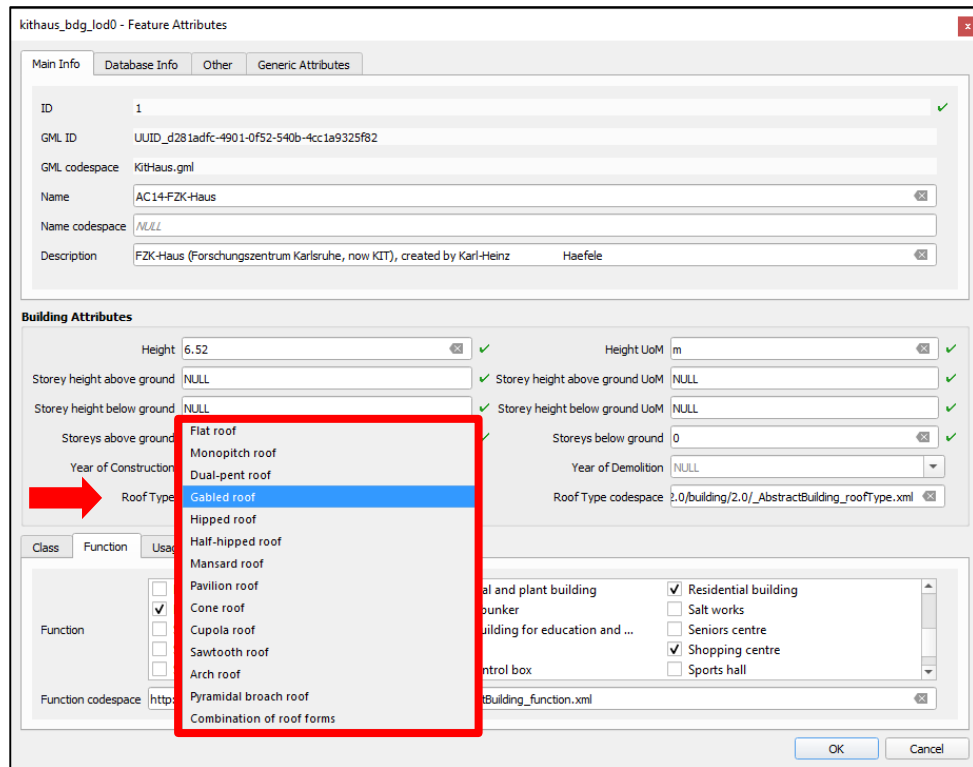


Optional: Codelists and look-up tables

Motivation
 Plugin overview
Demo
 Conclusions
 Resources

In the case of a CityGML property with cardinality **[0..1]**, the associated codelist values can be presented as a drop-down list.

Example: property **Roof type**

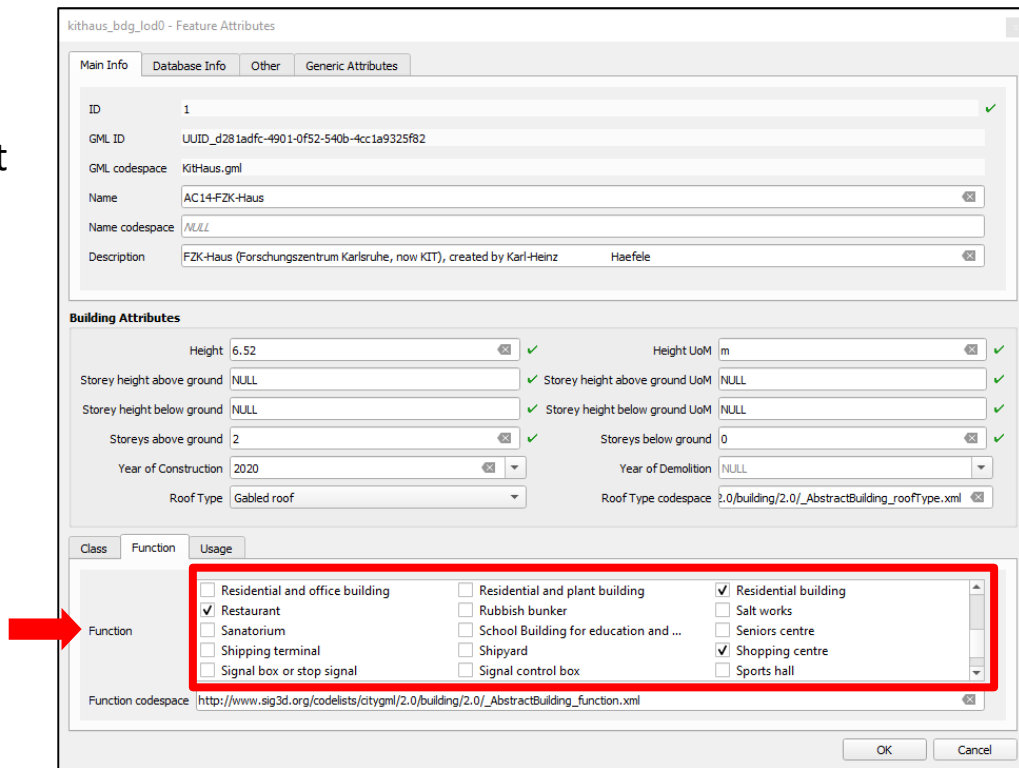


Optional: Codelists and look-up tables

Motivation
Plugin overview
Demo
Conclusions
Resources

In the case of a CityGML property with cardinality **[0..*]**, the associated codelist values can be presented as a multiple-selection list.

Example: property (Building)
function



kithaus_bdg_lod0 - Feature Attributes

Main Info Database Info Other Generic Attributes

ID 1 ✓

GML ID UUID_d281adfc-4901-0f52-540b-4cc1a9325f82

GML codespace Kithaus.gml

Name AC14-FZK-Haus

Name codespace NULL

Description FZK-Haus (Forschungszentrum Karlsruhe, now KIT), created by Karl-Heinz Haeefe

Building Attributes

Height 6.52 ✓ Height UoM m ✓

Storey height above ground NULL ✓ Storey height above ground UoM NULL ✓

Storey height below ground NULL ✓ Storey height below ground UoM NULL ✓

Storeys above ground 2 ✓ Storeys below ground 0 ✓

Year of Construction 2020 ✓ Year of Demolition NULL

Roof Type Gabled roof ✓ Roof Type codespace 2.0/building/2.0/_AbstractBuilding_roofType.xml ✓

Class Function Usage

Function

- ☐ Residential and office building
- ☒ Restaurant
- ☐ Sanatorium
- ☐ Shipping terminal
- ☐ Signal box or stop signal
- ☐ Residential and plant building
- ☐ Rubbish bunker
- ☐ School Building for education and ...
- ☐ Shipyard
- ☐ Signal control box
- ☒ Residential building
- ☐ Salt works
- ☐ Seniors centre
- ☒ Shopping centre
- ☐ Sports hall

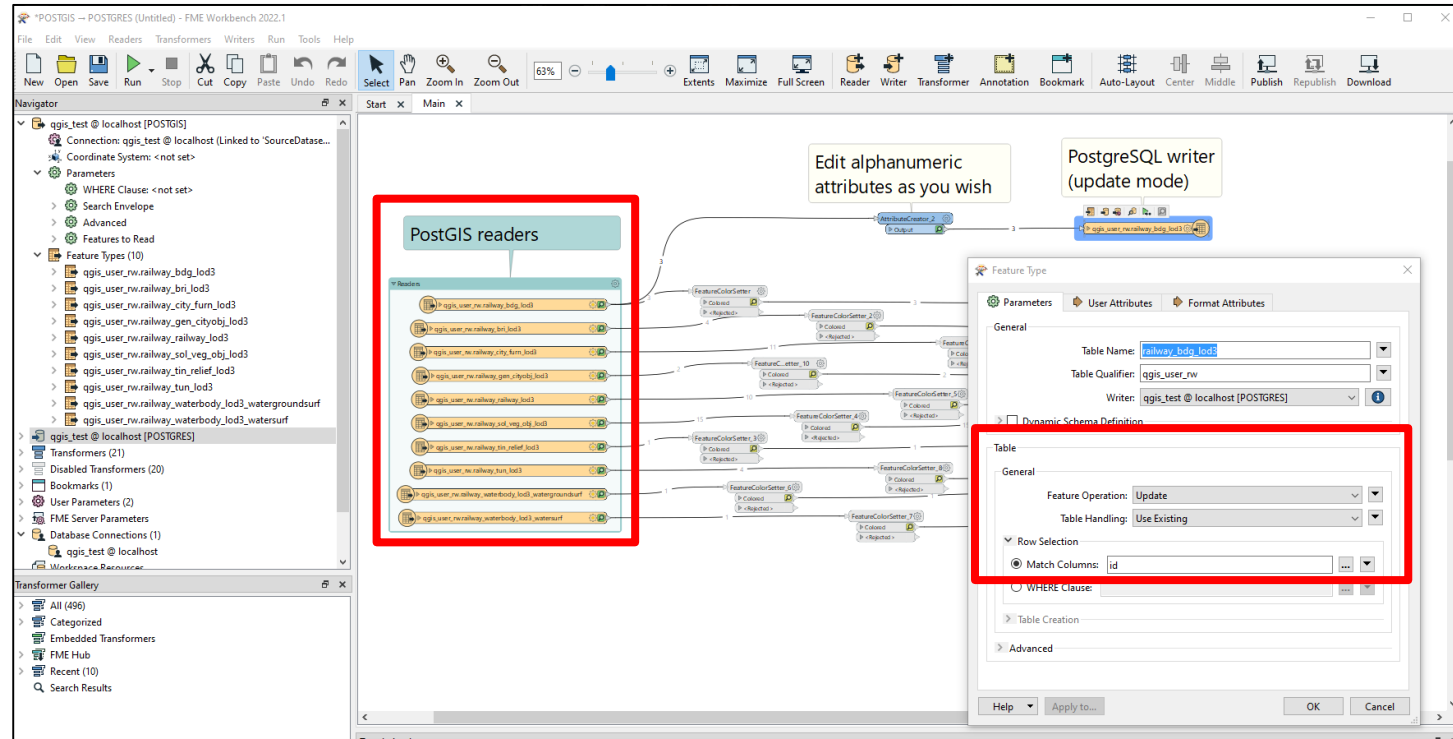
Function codespace http://www.sig3d.org/codelists/citygml/2.0/building/2.0/_AbstractBuilding_function.xml

OK Cancel

QGIS Package (server-side only)

- This is a simple example of how the QGIS Package can be used via FME
 - Simply connect to the 3D City Database and import the views with **PostGIS readers**
 - Updates can be stored using **PostgreSQL writers in update mode**

Motivation
 Plugin overview
 Demo
 Conclusions
 Resources



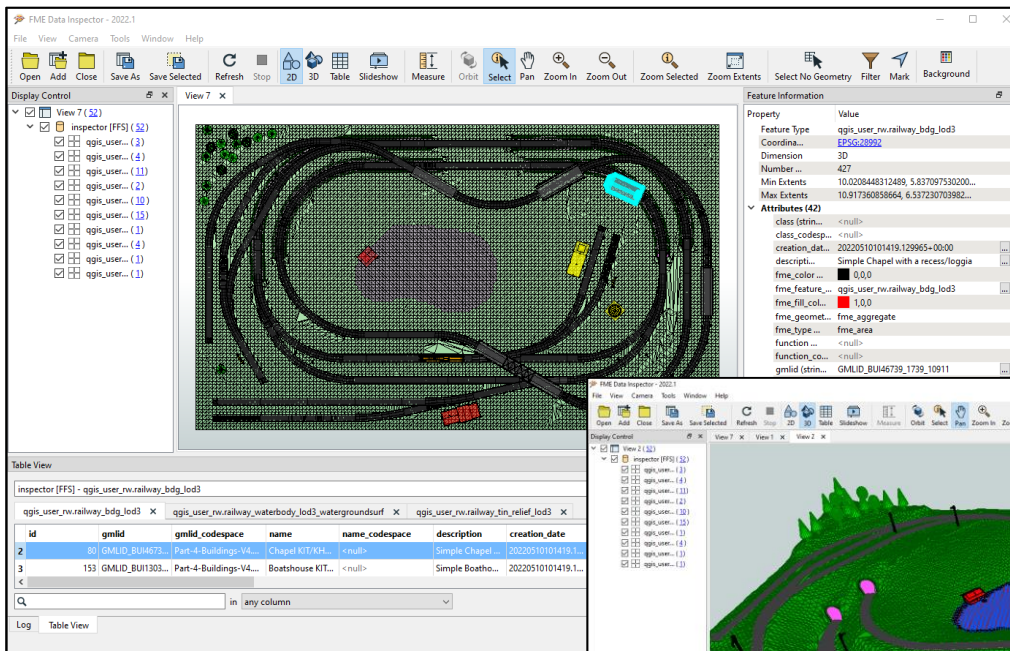
The screenshot displays the FME Workbench interface with a workflow designed to update a PostgreSQL database using QGIS data. The workflow is as follows:

- PostGIS readers:** A list of 10 readers is shown in the Navigator, all connected to the 'qgis_test @ localhost [POSTGIS]' connection. These readers import various views from the 'qgis_user_rw' schema, including 'railway_bdg_lod3', 'railway_bri_lod3', 'railway_city_furn_lod3', 'railway_gen_cityobj_lod3', 'railway_railway_lod3', 'railway_sol_veg_obj_lod3', 'railway_tin_relief_lod3', 'railway_tun_lod3', 'waterbody_lod3_watergroundsurf', and 'waterbody_lod3_watersurf'.
- Feature Types:** The 'Feature Types' dialog is open, showing the 'railway_bdg_lod3' table. The 'Table Name' is 'railway_bdg_lod3', the 'Table Qualifier' is 'qgis_user_rw', and the 'Writer' is 'qgis_test @ localhost [POSTGIS]'. The 'Feature Operation' is set to 'Update', and 'Table Handling' is 'Use Existing'. The 'Match Columns' section is checked, with 'id' selected as the matching column.
- Workflow:** The main workspace shows a series of transformers. The 'PostGIS readers' are connected to 'FeatureColorSetter' transformers, which then feed into 'FeatureCollector' transformers. These collectors are connected to a 'PostgreSQL writer (update mode)' transformer. Annotations include 'Edit alphanumeric attributes as you wish' and 'PostgreSQL writer (update mode)'.

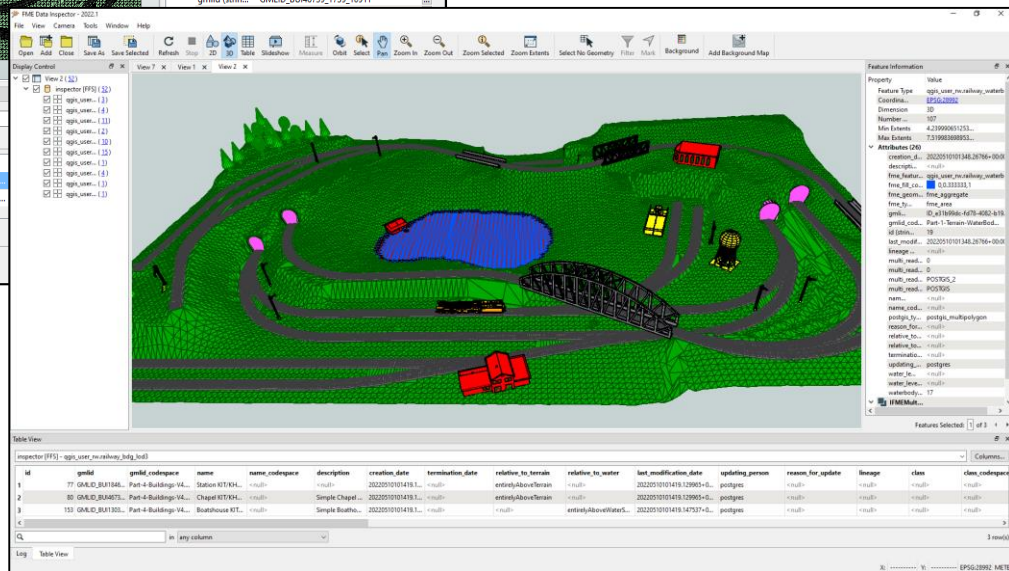
QGIS Package

Motivation
Plugin overview
Demo
Conclusions
Resources

2D visualisation
via FME Data Inspector



3D visualisation
via FME Data Inspector

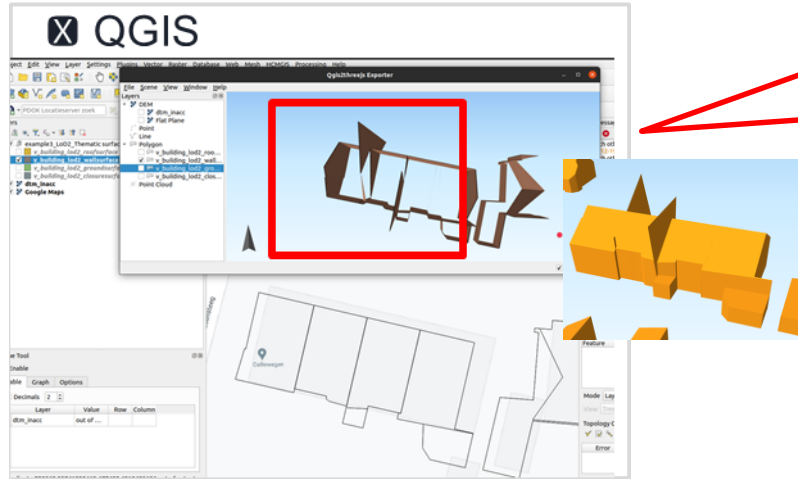


Conclusions

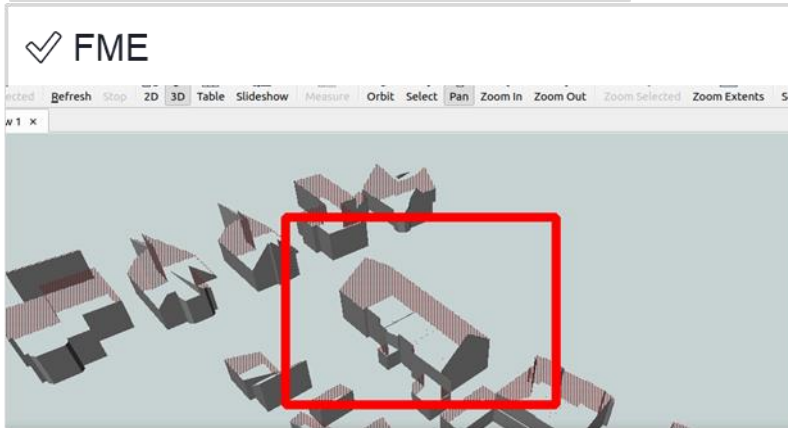
- 3DCityDB-Loader provides:
 - Easier interaction with CityGML data stored in the 3DCityDB via QGIS
 - FOSS addition to the CityGML / 3D City Database software "archipelago"
- Still some issues using QGIS native 3D Map
 - Sometimes artefacts and crashes...

3D visualisation issues

Motivation
 Plugin overview
 Demo
Conclusions
 Resources



Such artefacts are a 3D visualisation issue (QGIS 3D renderer?) and *not* related to the actual data. 3D visualisation in FME and in Google Earth shows correct results.



✓
 Google
 earth
 (as KML)

Conclusions

- 3DCityDB-Loader provides:
 - Easier interaction with CityGML data stored in the 3DCityDB via QGIS
 - FOSS addition to the CityGML / 3D City Database software "archipelago"
- Still some issues using QGIS native 3D Map
- User can interact via QGIS, or directly with the QGIS Package via FME, python, etc.

Conclusions

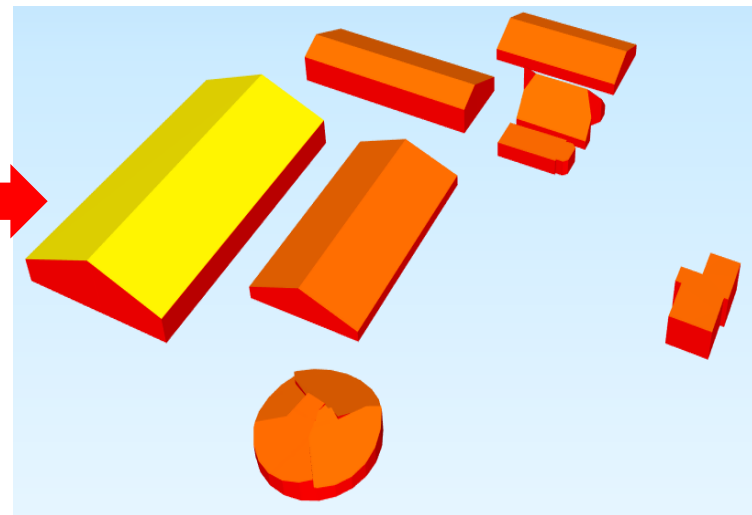
"Plain"
3DCityDB

Example: query of all (building) roofs constructed since 2015

```

1 SELECT
2     ts.id AS roof_id,
3     co_ts.gmlid AS roof_gmlid,
4     b.id AS building_id,
5     co.gmlid AS building_gmlid,
6     b.year_of_construction,
7     ST_Collect(sg.geometry) AS roof_geom
8 FROM
9     citydb.thematic_surface AS ts
10    INNER JOIN citydb.cityobject AS co_ts
11        ON (co_ts.id = ts.id)
12    INNER JOIN citydb.surface_geometry AS sg
13        ON (ts.lod2_multi_surface_id = sg.root_id)
14    INNER JOIN citydb.building AS b
15        ON (b.id = ts.building_id)
16    INNER JOIN citydb.cityobject AS co
17        ON (co.id = b.id)
18 WHERE
19     ts.objectclass_id = 33 AND -- roofsurfaces
20     b.objectclass_id = 26 AND -- buildings
21     b.year_of_construction >= '2015-01-01'::date
22 GROUP BY
23     ts.id,
24     co_ts.gmlid,
25     b.id,
26     co.gmlid,
27     b.year_of_construction
28 ORDER BY
29     b.id,
30     ts.id;

```



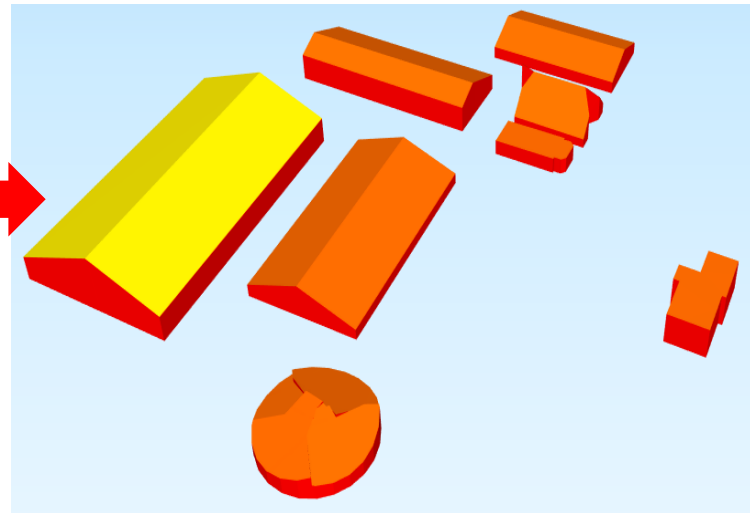
Conclusions

QGIS Package

Example: query of all (building) roofs constructed since 2015

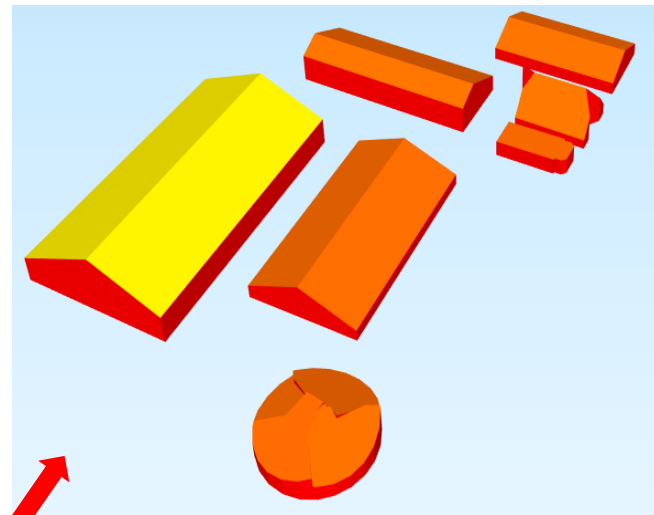
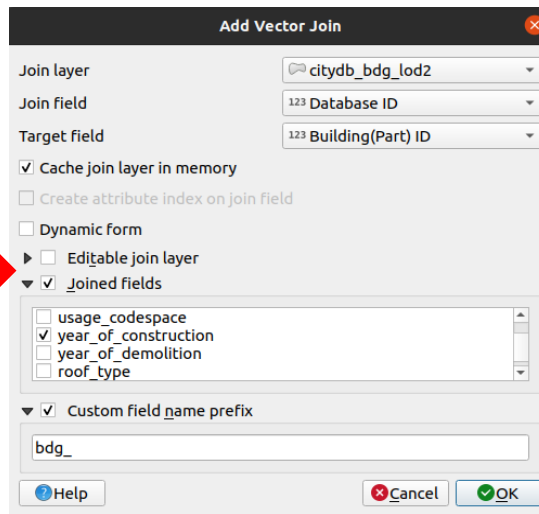
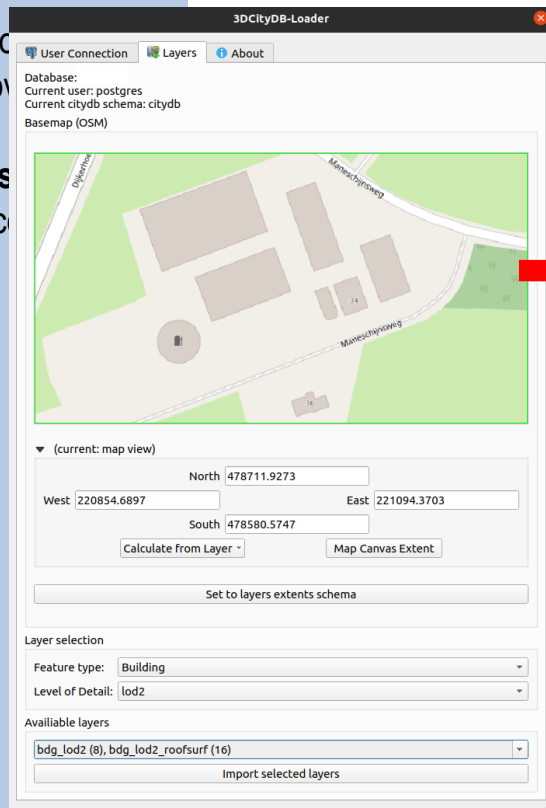
Motivation
Plugin overview
Demo
Conclusions
Resources

```
1 SELECT
2     rs.id AS roof_id,
3     rs.gmlid AS roof_gmlid,
4     rs.building_id AS bldg_id,
5     b.gmlid AS bldg_gmlid,
6     b.year_of_construction,
7     rs.geom AS roof_geom
8 FROM
9     qgis_user_ro.citydb_bdg_lod2_roofsurf AS rs
10    INNER JOIN qgis_user_ro.citydb_bdg_lod2 AS b
11        ON b.id = rs.building_id
12 WHERE
13     b.year_of_construction >= '2015-01-01'::date
14 ORDER BY
15     b.id,
16     rs.id;
```



Example: query of all (building) roofs constructed since 2015

Motivation
Plugin or
Demo
Conclusions
Resources



```
'bdg_year_of_construction' >= make_date(2015,1,1)
```

Conclusions

- 3DCityDB-Loader provides:
 - Easier interaction with CityGML data stored in the 3DCityDB via QGIS
 - FOSS addition to the CityGML / 3D City Database software "archipelago"
- Still some issues using QGIS native 3D Map
- User can interact via QGIS, or directly with the QGIS Package via FME, python, etc.
- Some current limitations
 - GUI lacks some advanced functionalities (e.g. user management)
 - Appearances not supported
 - Point-, breakline- and raster-based Relief features not supported (yet)

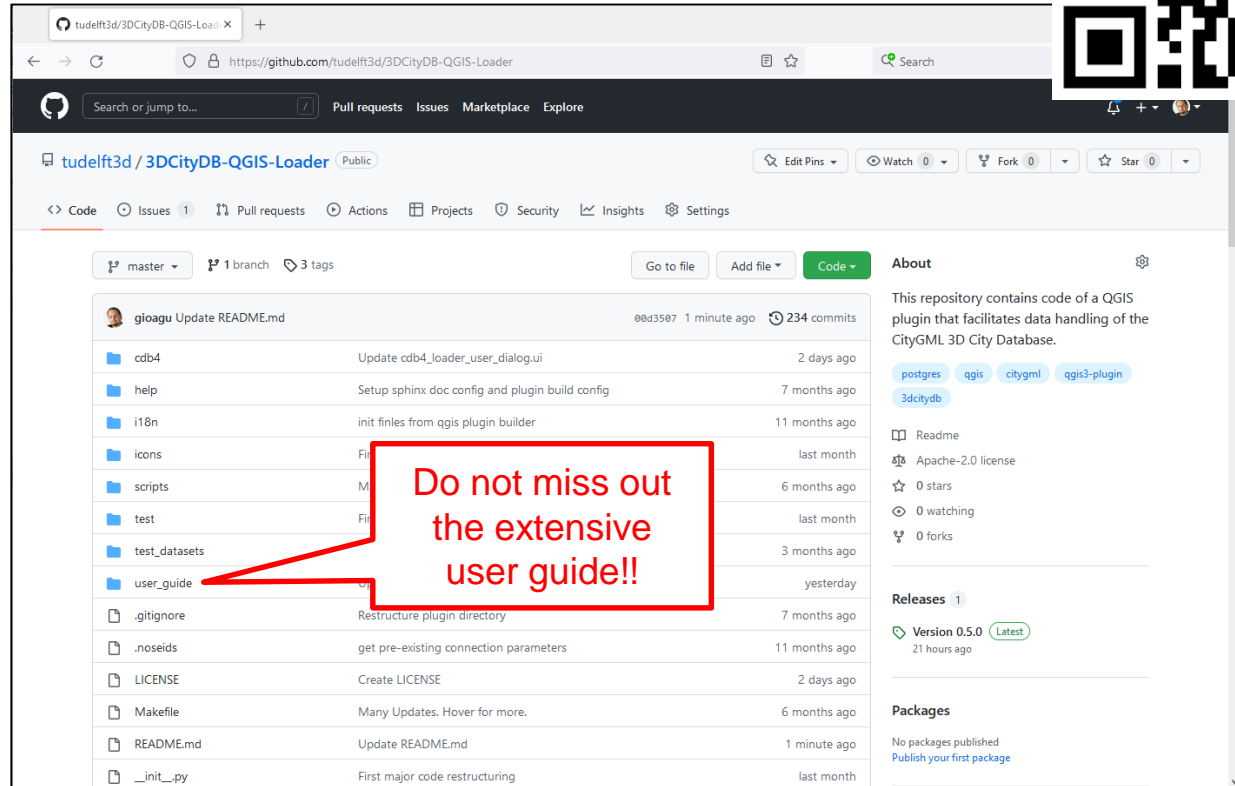
- Overall GUI improvements (learning by doing, and from users' feedback!)
- Support for:
 - Appearances (if possible)
 - ADEs (e.g. the **Energy ADE**, to start with)
- Test the upcoming **3DCityDB v. 5.0** (...and therefore **CityGML v. 3.0**)

Want to test? Want to contribute?

You are **welcome to try the software**, provide feedback... and submit bug issues!! 😊

Source code and GitHub repository

- GitHub: <https://github.com/tudelft3d/3DCityDB-QGIS-Loader>

The screenshot shows the GitHub repository page for `tudelft3d/3DCityDB-QGIS-Loader`. The repository is public and has 234 commits. The file list includes:

- `cdb4`: Update cdb4_loader_user_dialog.ui (2 days ago)
- `help`: Setup sphinx doc config and plugin build config (7 months ago)
- `i18n`: init files from qgis plugin builder (11 months ago)
- `icons`: (last month)
- `scripts`: (6 months ago)
- `test`: (last month)
- `test_datasets`: (3 months ago)
- `user_guide`: (yesterday)
- `.gitignore`: Restructure plugin directory (7 months ago)
- `.noseids`: get pre-existing connection parameters (11 months ago)
- `LICENSE`: Create LICENSE (2 days ago)
- `Makefile`: Many Updates. Hover for more. (6 months ago)
- `README.md`: Update README.md (1 minute ago)
- `__init__.py`: First major code restructuring (last month)

A red callout box with the text "Do not miss out the extensive user guide!!" points to the `user_guide` file in the list.

Thank you for your attention!



Dr. Giorgio Agugiaro

g.agugiaro@tudelft.nl

3D Geoinformation Group

TU Delft

The Netherlands

<https://3d.bk.tudelft.nl/gagugiaro>



Konstantinos Pantelios

konstantinospantelios@yahoo.com

MSc Geomatics graduate

TU Delft

The Netherlands



Camilo León-Sánchez

c.a.leonsanchez@tudelft.nl

3D Geoinformation Group

TU Delft

The Netherlands

<https://3d.bk.tudelft.nl/cleon>

Acknowledgements

Claus Nagel and Zhihang Yao (Virtual City Systems GmbH) for their suggestions and fruitful discussions.