3D City Database for CityGML

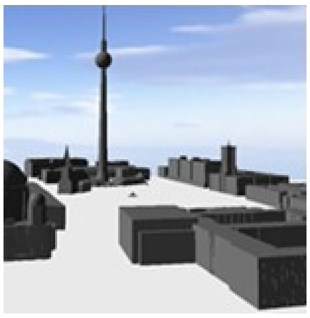
3D City Database Version 2.0.6-postgis

Importer/Exporter Version 1.5.0-postgis

Release Version

Tutorial

21 January 2013



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Content

Disclaimer:

1. Overview

Welcome to the release of the *3D City Database Version 2.0.6-postgis* and the *Importer/Exporter Version 1.5.0-postgis* for *PostGIS*. With the ability to now store and analyse CityGML documents in *PostGIS*, we are proud to present our free software in a fully OpenSource context.

Thanks to the continuous development of *PostGIS* 2.0 with new features for topology, raster and 3D support a long considered port became feasible. Except for version and history management all key features of the *3D City Database* incl. the *Importer/Exporter* have been translated to *PostgreSQL / PostGIS.* For a quick overview see table 1.

Please note that this document only gives a short introduction on the *PostGIS*-specific details. For a full overview of the *3DCityDB* and the *Importer/Exporter*, please refer to the version 2.0.1 documentation [1] and the addendum [2] for the recent release of the database and the *Importer/Exporter* tool (2.0.6 and 1.5.0).

Tab. 1: Port overview on supported key features of both versions

Key Features of the 3D City Database	**Oracle**	**PgSQL**
Semantically rich, hierarchically structured model	✓	✓
Five different Levels of Detail (LODs)	✓	✓
Appearance data in addition to flexible 3D geometries	✓	✓
Representation of generic and prototypical 3D objects	✓	✓
Free, also recursive aggregation of geo objects	✓	✓
Complex digital terrain models (DTMs)	✓	✓
Management of large aerial photographs	✓	✓
Version and history management	✓	**X**
Matching/merging of building features	✓	✓
Key Features of the Importer/Exporter		
Full support for CityGML 1.0 and 0.4.0	✓	✓
Exports of KML/COLLADA models	✓	✓
Generic KML information balloons	✓	✓
Reading/writing CityGML instance documents of arbitrary file size	✓	✓
Multithreaded programming facilitating high performance CityGML processing	✓	✓
Resolving of forward and backwards XLinks	✓	✓
XML validation of CityGML documents	✓	✓
User-defined Coordinate Reference Systems	✓	✓
Coordinate transformations for CityGML exports	✓	✓
Matching/merging of building features	✓	✓

✓= equivalent support, ✓= Oracle-specific support ✓= PostGIS-specific support **X** = not supported

3D City Database (abbreviated as *3DCityDB* in the following) [3]

- **Complex thematic modelling:**
  Description of thematic features by attributes, relations, nested aggregation hierarchies (part-whole-relations) between features in a semantic and a geometric manner which is useful for thematic queries, analyses, or simulations

- **Five different Levels of Detail (LODs)**
  Multi-representation of geo objects (including DTMs and aerial photographs) in five different LODs based on geometric precision and thematic refinement

- **Appearance data**
  Appearance of features can be used to represent textures and materials, but also non-visual properties like infra-red radiation, noise pollution, etc.

- **Complex digital terrain models (DTMs)**
  DTMs can be represented in four different ways: by regular grids, triangulated irregular networks (TINs), 3D mass points and 3D break lines. For each LOD a complex relief can be aggregated from any number of DTM components of different types. For example, 3D mass points and break lines can be used together to form complex terrain models.

- **Representation of generic and prototypical 3D objects**
  For efficient memory management, frequently occurring objects at different locations of the city model can be stored once for each LOD as a prototype and be referred to as an implicit geometry, e.g. pieces of street, furniture like lanterns, road signs, benches etc.

- **Free, also recursive aggregation of geo objects**
  Geo objects can be aggregated to a group according to user-defined criteria. Each group represents a geo object itself. Names and additional classifying attributes can be assigned to groups. Groups may contain other groups as members, resulting in aggregation hierarchies of arbitrary depth.

- **Flexible 3D geometries**
  Geometries of 3D objects can be represented through the combination of surfaces and solids as well as any, also recursive, aggregation of these elements.

- **Management of large aerial photographs**
  The database can handle aerial photographs of arbitrary size using the new *raster2pgsql* raster loader of *PostGIS*.

Importer/Exporter

- Import and export of even very large CityGML instance documents (> 4 GB)
- Export of buildings into the KML/COLLAD format
- Coordinate transformation and tiling for exports
- Multiple filter operations for im- and exports incl. a graphical select of a bounding box by a map widget
- Management of user-defined Coordinate Reference Systems (SRIDs)
- Matching and merging of redundant building objects in the database
- New functionalities can be incrementally added via Plugins

Further information, software downloads, ready-to-use demos, links to the source code repository, and much more can be found at:
http://opportunity.bv.tu-berlin.de/software/projects/3dcitydb-imp-exp/ [www2]
and at **the official website of the 3D City Database** [www3].

The *PostGIS* port was realized within a Master's thesis by Felix Kunde conducted at the University of Potsdam and was supported by the *3DCityDB* developer team of the IGG at the Technical University of Berlin as well as the company virtualcitySYSTEMS GmbH (Berlin, Germany). A previous translation of SQL scripts was done by Laure Fraysse in cooperation with IGO (Paris, France) which was the starting point for the further development.

2. Major Changes to the Oracle version

Data modelling and relational schema

The data model behind the relational database schema of the *3DCityDB* was kept unchanged. Supporting UML diagrams and their relational mapping can be found in the main *3DCityDB* documentation [1]. Only two *Oracle*-specific attribute types had to be changed. First, for polygonal geometries the spatial data type SDO_GEOMETRY was replaced by ST_GEOMETRY (see [1]: 18), and second, the ORDImage data type for storing texture images was substituted by a simple BLOB (see [1]: 20).

When referring to the relational schema several differences in data types will always occur when using a different Database Management Systems (DBMS). Their internal structure is mostly following the same purpose, so only the name has to be switched. The following table lists the differences between *Oracle Spatial* and *PostgreSQL / PostGIS*:

Tab. 2: Differences in data types

Oracle Spatial	**PostgeSQL/PostGIS**	**further explanation**
varchar2	varchar	
number	numeric	integer used for referential id_columns because of serial
binary_double	double precision	
blob, clob	bytea, text	
	serial (integer)	implicitly creates a sequence named `tablename_columnname_seq`
ORDImage	bytea	PostGIS raster might be an option
sdo_geometry	(st_)geometry	st_geometry also exists in Oracle
sdo_raster	raster	formerly known as WKT Raster
sdo_georaster	raster	

Creating geometric columns and spatial indexes

PostGIS 2.0 introduces the *PostgreSQL* type modifier definition of geometry columns inside of CREATE TABLE statements [www4]. It was used in the SQL scripts instead of the older but still common function `AddGeometryColumn`.

Unlike the explicit definition for `USER_SDO_GEOM_METADATA` in *Oracle Spatial*, both methods implicitly insert a tuple of metadata in the `geometry_columns` view.

```
CREATE TABLE surface_geometry(
  id          NUMBER NOT NULL,
  geometry    SDO_GEOMETRY,
  . . .
)

INSERT INTO USER_SDO_GEOM_METADATA (TABLE_NAME, COLUMN_NAME, DIMINFO, SRID)
  VALUES ('SURFACE_GEOMETRY', 'GEOMETRY',
    MDSYS.SDO_DIM_ARRAY
      (MDSYS.SDO_DIM_ELEMENT('X', 0.000, 10000000.000, 0.0005),
       MDSYS.SDO_DIM_ELEMENT('Y', 0.000, 10000000.000, 0.0005),
       MDSYS.SDO_DIM_ELEMENT('Z', -1000, 10000, 0.0005)) , 3068);
```

```
CREATE TABLE surface_geometry(
  id          SERIAL NOT NULL,
  geometry    GEOMETRY(PolygonZ,3068),
  . . .
)
```

or

```
CREATE TABLE surface_geometry(
  id          SERIAL NOT NULL,
  . . .
)

SELECT AddGeometryColumn('surface_geometry', 'geometry', 3068, 'POLYGON', 3);
```

The columns that store 3D geometries are indexed using an n-dimensional GiST index. It is a common practice to force *PostgreSQL* to get rid of dead rows and update table statistics for the spatial columns after bulk inserts or updates and not wait until the "autovaccum-deamon" of *PostgreSQL* will do that [www5] [4]. This is done by the VACUUM ANALYZE command:

```
VACUUM ANALYZE [table_name] [(column_name)];
```

The SQL planner will use these statistics to evaluate if a GiST index should be used for spatial queries. A SQL script is provided to save the user from having to manually write SQL commands for all affected columns. It is shipped within the folder 3dcitydb/postgis/UTIL.

Raster data management

The raster data management is much simpler than in *Oracle Spatial*. In *Oracle* a SDO_GeoRaster object must relate to a "raster data table" (RDT) with SDO_Raster objects which store the actual raster files. The *Oracle* version of the *3DCityDB* also contains tables for initial imports of image tiles which can be merged to one raster file in a second step (IMP tables). They are necessary for a raster import tool that was developed for version 1.0 of the *3DCityDB* [5]. *PostGIS 2.0* offers a simple but powerful tool for importing raster files into the database called *raster2pgsql*. It is executed from the command line and creates a proper SQL insert command for the selected raster file. Operators can and should be used for defining the target table and column, setting the reference system and a tiling factor (see example below). In the *PostGIS* approach every stored tile is regarded as a single raster object itself, even the raster overviews (pyramid layers). This concept would make the RDT and IMP tables obsolete. Therefore they were dropped for the *PostGIS* version of the *3DCityDB*. Like with geometry columns metadata of raster columns is implicitly managed in a separate view.

An import into the `raster_relief` table could look like this:

```
raster2pgsql -a -f rasterproperty -s 3068 -I -M -t 128x128 rasterfile.tif
     raster_relief > rastrelief.sql
```

`-a`	this operator is used to append raster(s) to an existing table (default is `-c` for 'create')
`-f`	sets the name of the target column (in this case `rasterproperty`), the target table is specified at last (`raster_reflief`)
`-s`	sets the srid for the raster
`-I`	creates an GiST index on the raster column
`-M`	does a VACUUM ANALYZE on the raster table
`-t`	tiling operator

For further readings please refer to the *PostGIS* documentation on raster data management [www6]. Please note that the generated SQL file does not contain all necessary input parameters for a proper insert command into the `raster_relief` table. The file has to be edited within a text editor. Check the defining SQL file of the `raster_relief` table for more details.

History Management

Based on the *Oracle Workspace Manager* it is possible to manage concurrent versions or planning scenarios of the *3DCityDB* within one user schema. They are organized as views of the original dataset or of their parent version. The *Oracle* version of the *3DCityDB* delivers scripts to enable or disable versioning support for the database tables as well as a bundle of scripts and tools for managing planning alternatives called the *Planning Manager.* Unfortunately, as *PostgreSQL* does not offer any equivalent facility, the *Planning Manager* and related scripts could not be ported. Corresponding elements in the graphical user interface (GUI) of the *Importer/Exporter* were removed.

A few free projects exist which implement script-based solutions [www7, www8], but for features like the *Planning Manager* they would need a lot of code rework to get the same results like with Oracle's *Workspace Manager*. It will be considered for future releases of the *PostGIS* version.

Oracle packages vs. PostgreSQL schemas

The *3DCityDB* provides PL/pgSQL stored procedures which are used by the *Importer/Exporter* tool. Fortunately *PostgreSQL*'s procedural language of SQL PL/pgSQL comes close to Oracle's PL/SQL grammar which facilitated the porting of scripts. Note that previous self-developed scripts for the *Oracle* version will not work with *3DCityDB v2.0.6-postgis*. They have to be translated to PL/pgSQL first.

For the *Oracle* version the procedures and functions were grouped into packages. However, regarding *PostgreSQL* the package concept only exists in the commercial *Plus Advance Server* by EnterpriseDB. An alternative grouping mechanism for stored procedures that is suggested by the *PostgreSQL* documentation [www9] and which has been implemented in the end, is the usage of schemas. A schema is a separate namespace with own tables, views, sequences, functions etc. The packages from the *Oracle* release are represented in one *PostgreSQL* schema called `geodb_pkg` and not in several schemas for each package (see also figure 2 on page 16). But for a better overview the functions were given name prefixes:

Tab. 3: Function grouping in Oracle and PostgreSQL

former package name	**Prefix**	**Count**	**Source** (PL_pgSQL/GEODB_PKG/)
geodb_delete_by_lineage	del_by_lin_	1	DELETE/DELETE_BY_LINEAGE.sql
geodb_delete	del_	48	DELETE/DELETE.sql
geodb_idx	idx_	16	INDEX/IDX.sql
geodb_match	match_	12	MATCHING/MATCH.sql
geodb_merge	merge_	9	MATCHING/MERGE.sql
geodb_stat	stat_	1	STATISTICS/STAT.sql
geodb_util	util_	9	UTIL/UTIL.sql

3. Requirements

This chapter provides an overview of the minimum requirements for the *3DCityDB* and the *Importer/Exporter* tool. Please carefully review these requirements.

3D City Database

As illustrated in chapter 2 some of the features of *PostGIS 2.0* are used. Thus the SQL scripts would only work with version *2.0* or higher. *PostGIS 2.0* requires *PostgreSQL 8.4* or higher. For 64-bit Windows OS only *9.0* or higher can be used. An empty *3DCityDB* requires 14 MB of disk space (11 MB *PostGIS* + 3 MB *3DCityDB*).

Importer/Exporter

The *Importer/Exporter* tool can run on any platform providing support for at least Java 6. It has been successfully tested on (but is not limited to) the following operating systems: Microsoft Windows XP, Vista, 7; Apple Mac OS X 10.6; Ubuntu Linux 9, 10, 11.

Prior to the setup of the *Importer/Exporter* tool, the Java 6 Runtime Environment (JRE version 1.6.0_05 or higher) or Java 7 Runtime Environment (JRE version 1.7.0_03 or higher) must be installed on your system. The necessary installation package can be obtained from [www10].

The *Importer/Exporter* tool is shipped with a universal installer that will guide you through the steps of the setup process. A full installation of the *Importer/Exporter* including documentation and example CityGML files requires approx. 110 MB of hard disk space. Installing only the mandatory application files will use approx. 16 MB of hard disk space. Installation packages can be chosen during the setup process.

The *Importer/Exporter* requires at least 256 MB of main memory. For the import and export of large CityGML respectively KML/COLLADA files, a minimum of 1 GB of main memory is recommended.

4. How to set up a 3DCityDB in PostGIS

1. Installed RDBMS and configuration

Make sure that the *PostgreSQL* server installation is of version 8.4 or higher. For the right settings of the configuration files check the according *PostgreSQL* online documentation [www11]. **The *PostGIS* extension must be of version 2.0.0 or higher!** It has to be considered that both projects are under continuous development, but it is recommended that only officially released installers should be used.

2. Run the 3DCityDB-Importer-Exporter-1.4-postgis-Setup

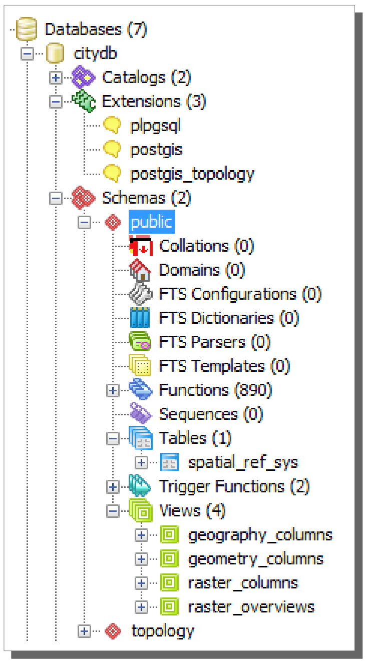
The installer setup of the software is mostly self-explaining. The SQL and PL/pgSQL scripts of the *3DCityDB* are grouped in the 3dcitydb folder at the target installation path. The folder structure is explained shortly with the next table:

Tab. 4: Folder hierarchy of the *3DCityDB* installation package

📁		**3dcitydb/postgis**	**Explanation**
⚙		CREATE_DB.bat	batchfile that calls CREATE_DB.sql (Microsoft Windows family)
⚙		DROP_DB.bat	batchfile that calls DROP_DB.sql (Microsoft Windows family)
⚙		CREATE_DB.sh	shell script that calls CREATE_DB.sql (UNIX/Linux and derivates, MacOS X)
⚙		DROP_DB.sh	shell script that calls DROP_DB.sql (UNIX/Linux and derivates, MacOS X)
📄		CREATE_DB.sql	calls SQL scripts for setting up the relational schema of the 3DCityDB
📄		CREATE_GEODB_PKG.sql	creates a separate schema in the database named geodb_pkg with stored procedures, called by CREATE_DB.sql
📄		DROP_DB.sql	drops all the schema elements cascadingly, called by DROB_DB.bat / .sh
📁		**SCHEMA**	called by CREATE_DB.sql
	📁	CONSTRAINTS	contains a file that sets the referential foreign keys between tables
	📁	INDEXES	contains files for setting sequential (B-Tree) and spatial indexes (GiST)
	📁	TABLES	contains files for creating the database tables
📁		**PL_pgSQL/GEODB_PKG**	called by CREATE_GEODB_PKG.sql
	📁	DELETE	contains scripts that help to delete single features from the database. Used by the Matching-Merging-Plugin for the Importer/Exporter.
	📁	INDEX	contains scripts with index functions. Only used by the Importer/Exporter.
	📁	MATCHING	contains scripts for the Matching-Merging-Plugin.
	📁	STATISTICS	contains a script that generates a database report for Importer/Exporter
	📁	UTIL	contains several helper functions, mostly for Importer/Exporter
📁		**UTIL**	called by CREATE_DB.sql
	📁	CREATE_DB	contains additional scripts for CREATE_DB.sql
	📁	RO_USER	contains a script that creates a read-only user for the database
	📁	VACUUM	contains a script that collects table statistics (vacuum) for spatial columns

3. CREATE an empty PostGIS database

Before starting the Importer/Exporter an empty *PostGIS* database has to be created first on the *PostgreSQL* server. Therefore select a user with privileges to create an empty database with *PostGIS* Extension. No violation of access rights should occur when working as a superuser. The empty database should look like in figure 1. The *3DCityDB* will be stored in the public schema, which also contains the *PostGIS* elements like functions, views for spatial metadata and the `spatial_ref_sys` table.



- Databases (7)
  - citydb
    - Catalogs (2)
    - Extensions (3)
      - plpgsql
      - postgis
      - postgis_topology
    - Schemas (2)
      - public
        - Collations (0)
        - Domains (0)
        - FTS Configurations (0)
        - FTS Dictionaries (0)
        - FTS Parsers (0)
        - FTS Templates (0)
        - Functions (890)
        - Sequences (0)
        - Tables (1)
          - spatial_ref_sys
        - Trigger Functions (2)
        - Views (4)
          - geography_columns
          - geometry_columns
          - raster_columns
          - raster_overviews
      - topology

Fig. 1: Empty PostGIS 2.0 database in the pgAdminIII tool

4. Set up a 3DCityDB

Afterwards, a blank *PostGIS* database is ready to be set up with the relational schema of the *3DCityDB*. There are two possibilities to do this:

Step 1, Option 1 – Calling CREATE_DB with psql from command line:

The CREATE_DB SQL script in the main folder 3dcitydb/postgis can be executed using *psql* from command line. Please open your favourite shell and change to the "3dcitydb/postgis" subfolder within the installation directory of the *Importer/Exporter* and enter the following command:

```
psql -h your_host_address -p 5432 -d your_database -U your_username -f CREATE_DB.sql
```

Step 1, Option 2 – Calling CREATE_DB executing a script:

A more comfortable way is offered with shell scripts CREATE_DB.bat for Microsoft Windows family or CREATE_DB.sh for UNIX/Linux and derivates as well as MacOS X. They have to be edited with a text editor in order to connect with the server (see text boxes below). The same applies to the shell scripts DROP_DB.bat and DROP_DB.sh.

Unedited CREATE_DB.bat

```
set PGPORT=5432
set PGHOST=your_host_address
set PGUSER=your_username
set CITYDB=your_database
set PGBIN=path_to_psql.exe
```

Edit the file, e.g. like this:

```
set PGPORT=5432
set PGHOST=localhost
set PGUSER=postgres
set CITYDB=citydb
set PGBIN=C:\PostgreSQL\bin
```

The Windows batchfiles are then executed simply by double clicking.

If working with a UNIX or Mac OS the .sh scripts can be run from within a shell environment. Open a shell, change to the "3dcitydb/postgis" subfolder within the installation directory of the *Importer/Exporter and* enter the following command to make the CREATE_DB.sh script executable for the owner of the file:

```
chmod u+x CREATE_DB.sh
```

Afterwards, simply run the CREATE_DB.sh script by typing:

```
./ CREATE_DB.sh
```

Step 2 – CREATE_DB.sql is executed

When executed the user might be asked for his *PostgreSQL* login password first. The setup requires two mandatory user inputs:

1. Spatial Reference Identifier for newly created geometry objects (SRID),
2. corresponding GML conformant URN encoding for gml:srsName attributes

Make sure to only provide the numeric identifier of the spatial reference system as SRID (e.g., the EPSG code). When prompted for input, the values provided in parentheses are only examples but no default values! The SRID will be checked for its existence in the spatial_ref_sys table of *PostGIS* and if it is appropriate for spatial functions. If the SRID is accepted the user is given the feedback “SRID ok”. Otherwise an error will occur which forces the setup to stop.

A successful test session for Berlin will look like this:

```
path_to_your_importer_exporter_installation\resources\3dcitydb\postgis>
"C:\PostgreSQL\bin\psql" -d "citydb" -f "CREATE_DB.sql"
Password:
SET
Please enter a valid SRID (e.g., 3068 for DHDN/Soldner Berlin): 3068
Please enter the corresponding SRSName to be used in GML exports (e.g.
urn:ogc:def:crs,crs:EPSG::3068,crs:EPSG::5783):
urn:ogc:def:crs,crs:EPSG:6.12:3068,crs:EPSG:6.12:5783

CREATE FUNCTION
 check_srid
------------
 SRID ok
(1 row)

CREATE TABLE
ALTER TABLE
INSERT 0 1
CREATE TABLE
ALTER TABLE
ALTER TABLE
...
CREATE INDEX
CREATE INDEX
...
INSERT 0 1
INSERT 0 1
...
CREATE SCHEMA
CREATE FUNCTION
CREATE FUNCTION
...
CREATE TYPE
CREATE FUNCTION
CREATE FUNCTION
CREATE FUNCTION
DROP TABLE
CREATE TABLE
INSERT 0 1
...
CREATE FUNCTION

3DCityDB creation complete!

path_to_your_importer_exporter_installation\resources\3dcitydb\postgis>
pause
Press any key to continue . . .
```

Error case – Unknown identifiers of local reference system for the city of Potsdam:

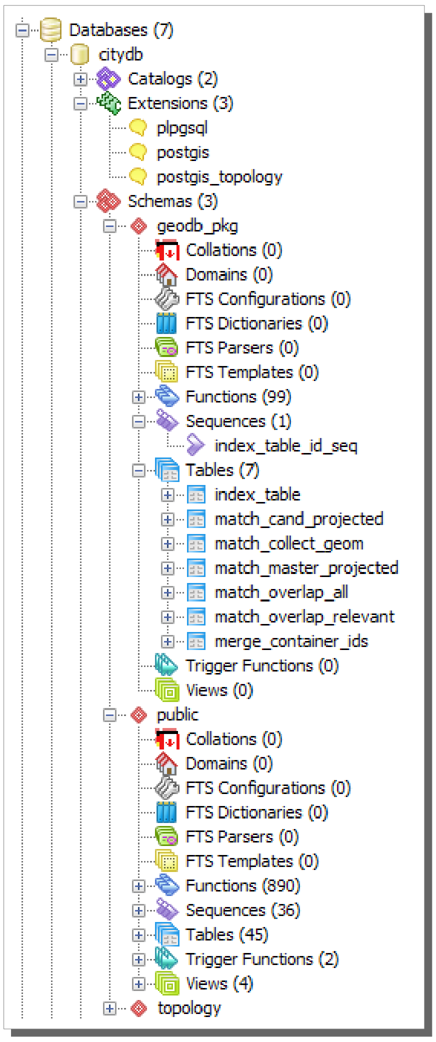
```
path_to_your_importer_exporter_installation\resources\3dcitydb\postgis>
"C:\PostgreSQL\bin\psql" -d "citydb" -f "CREATE_DB.sql"
Password:
SET
Please enter a valid SRID (e.g., 3068 for DHDN/Soldner Berlin): 96734
Please enter the corresponding SRSName to be used in GML exports (e.g.
urn:ogc:def:crs,crs:EPSG::3068,crs:EPSG::5783):
urn:ogc:def:crs:EPSG::325833

CREATE FUNCTION
psql:CREATE_DB.sql:47:  ERROR:  Table  spatial_ref_sys  does  not  contain
the SRID 96734. Insert commands for missing SRIDs can be found at
spatialreference.org

path_to_your_importer_exporter_installation\resources\3dcitydb\postgis>
pause
Press any key to continue . . .
```

Step 3 – Check out the created 3DCityDB

After running the CREATE_DB SQL script the *3DCityDB* should look like in figure 2. By the counters you can check if the setup is complete.



```
Databases (7)
  citydb
    Catalogs (2)
    Extensions (3)
      plpgsql
      postgis
      postgis_topology
    Schemas (3)
      geodb_pkg
        Collations (0)
        Domains (0)
        FTS Configurations (0)
        FTS Dictionaries (0)
        FTS Parsers (0)
        FTS Templates (0)
        Functions (99)
        Sequences (1)
          index_table_id_seq
        Tables (7)
          index_table
          match_cand_projected
          match_collect_geom
          match_master_projected
          match_overlap_all
          match_overlap_relevant
          merge_container_ids
        Trigger Functions (0)
        Views (0)
      public
        Collations (0)
        Domains (0)
        FTS Configurations (0)
        FTS Dictionaries (0)
        FTS Parsers (0)
        FTS Templates (0)
        Functions (890)
        Sequences (36)
        Tables (45)
        Trigger Functions (2)
        Views (4)
      topology
```

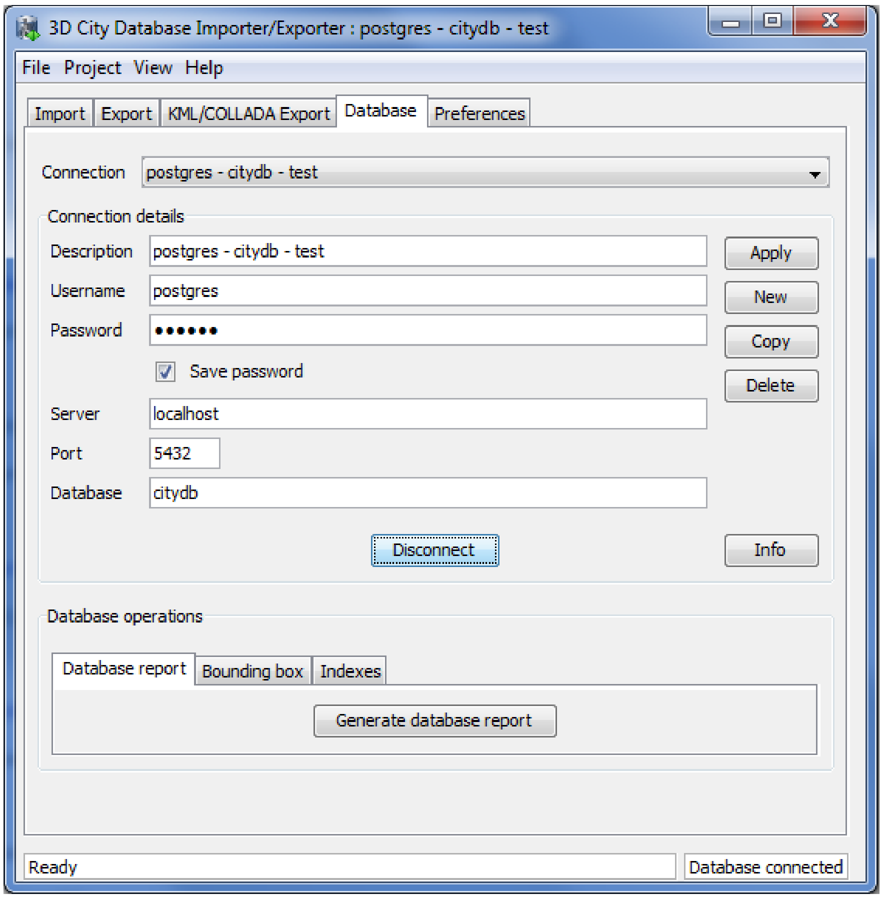
Fig. 2: 3DCityDB in the pgAdminIII tool

If a wrong reference system was chosen when creating the *3DCityDB* it can still be changed with the function `util_change_db_srid(srid NUMERIC, gml_ident VARCHAR)` found in the GEODB_PKG schema. Of course, the database should still be empty when the SRID is changed to avoid any false projections, errors or loss of data. It is also possible to reuse an empty *3DCityDB* as a template database for any city model to skip the previous steps when creating another database. In case that the SRID is different, just apply the `util_change_db_srid` function to the new database. The function is executed like this:

```sql
SELECT geodb_pkg.util_change_db_srid(4326,'urn:ogc:def:crs:EPSG:4326');
```

5. Start the Importer/Exporter

Now that the *3DCityDB* is ready to use, start the *Importer/Exporter* batchfile. After a few seconds the GUI should pop up. Switch to the database panel and enter your connection details. If you have worked with the *Importer/Exporter* before you will notice that the functionalities are similar to in the *Oracle* version. One difference on the connection details appears at the textfield for the database name. In the *Oracle* version this parameter refers to the instance SID, but for *PostgreSQL / PostGIS* simply use the name of the database you have created in step 3. If the connection could be established the console window should look like this:



3D City Database Importer/Exporter : postgres - citydb - test

File Project View Help

Import | Export | KML/COLLADA Export | Database | Preferences

Connection: postgres - citydb - test

Connection details

Description: postgres - citydb - test
Username: postgres
Password: ••••••
[✓] Save password
Server: localhost
Port: 5432
Database: citydb

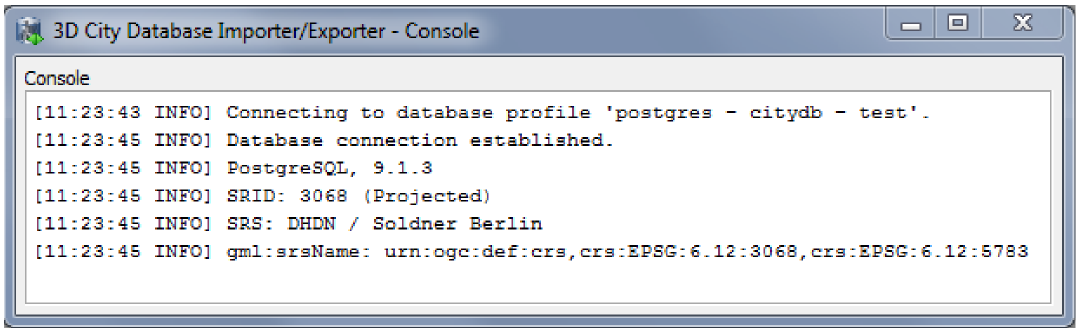
Apply | New | Copy | Delete | Disconnect | Info

Database operations

Database report | Bounding box | Indexes

Generate database report

Ready | Database connected



3D City Database Importer/Exporter - Console

Console

```
[11:23:43 INFO] Connecting to database profile 'postgres - citydb - test'.
[11:23:45 INFO] Database connection established.
[11:23:45 INFO] PostgreSQL, 9.1.3
[11:23:45 INFO] SRID: 3068 (Projected)
[11:23:45 INFO] SRS: DHDN / Soldner Berlin
[11:23:45 INFO] gml:srsName: urn:ogc:def:crs,crs:EPSG:6.12:3068,crs:EPSG:6.12:5783
```

Fig. 3: Importer/Exporter successfully connected to the database (console window detached)

Again: For further instructions on how to work with the *Importer/Exporter* please read the official *3DCityDB* documentation [1] and the recent addendum [2].

6. DROP the 3DCityDB

To drop an existing database instance of the *3DCityDB* call the SQL script DROP_DB.sql to be found in the top-level SQL folder of the distribution package. Similar to the setup procedure, the convenience scripts DROP_DB.bat and DROP_DB.sh can be used instead. Please follow the above steps to enter your database details in these scripts and to run them on your machine. Note that DROP_DB.sql only removes the relational schema of the *3DCityDB* as well as all PL/pgSQL functions and utilities. The database itself is not dropped.

5. FAQ

I can not get a connection from the Importer/Exporter to the database. Any help?

Check if you have misspelled some parameter of the connection details. If you are working in a network, check if the *PostgreSQL* configuration file hba.conf contains the address of your client.

Which version of CityGML is supported?

The relational database schema is derived from CityGML version 1.0.0 [6] and is also backwards compatible with the OGC Best Practices version 0.4.0. The recent release of CityGML 2.0.0 [7] and any Application Domain Extension (ADE) are not yet supported.

How good or bad is the performance of the PostGIS version compared to the Oracle version?

Fair enough. Several im- and exports of CityGML documents of various sizes and contents were tested with both versions. Different city models were exported to KML/COLLADA, too. In most cases the execution times for the *PostGIS* version reached the same level like the *Oracle* version even with default settings for *PostgreSQL*. It could be noted that untextured CityGML exports were much quicker in *Oracle*. For very large datasets (> 10 GB) *PostgreSQL/PostGIS* scales better for CityGML im- and exports. A detailed analysis comparing the performance of both version is part of the Master's thesis by Felix Kunde [8].

Is there a detailed documentation how the port to PostGIS was realized?

A detailed documentation for porting PL/SQL scripts and *Oracle*-specific parts of the Java code is also shipped with this release [9] [10]. These documents may also provide an introduction for porting own developed features or functions. The Master's thesis will also discuss all aspects on the *PostGIS* port in detail.

Which external tools can I use for visualizing my database?

With the *KML-Exporter* the *Importer/Exporter* took advantage of the widespread *Google Earth* client. You are able to export and watch footprints, extruded footprints, geometries and COLLADA files of your buildings on the virtual globe. You can also switch on a mouse-over highlighting and information balloons for the buildings in the preferences for the *KML-Exporter*.

For CityGML you can use several free viewers e.g. *FZKViewer* or *LandXplorer.* If you want to visualize your data directly from the database you can use the *FME-inspector* in connection with *FME PostGIS reader*. The next version of the OpenSource GIS *gvSIG* (1.12) will be able to load 3D models from a *PostGIS* database.

It happens, that external programs with *PostGIS* drivers try to read the geometries with the deprecated *PostGIS* function `asewkb`, which is now called `ST_AsEwkb`. A bundle of lately deprecated functions can be loaded back into your database by executing the legacy.sql file found in the folder PostgreSQL/share/contrib/postgis-2.0. It can be expected that this mismatch will not appear in recent software releases

After the KML export buildings are flying above the ground. What is going wrong?

Use the default settings in the preferences for the *KML-Exporter* for altitude and terrain. The *KML-Exporter* fetches the heights of Google's elevation model to calculate the right offset to the buildings in the database. This is also written to the console window. It is only done once for each building, as the offset is inserted as an generic attribute for the city objects. If you are using CityGML instance documents which were formerly stored in an *Oracle 10g* DBMS and used for KML exports, these entries are holding heights that will not fit *Oracle 11g* or *PostGIS* databases. The coordinate transformation to WGS 84 leads to different height results between *Oracle 10g* and *11g*. *PostGIS*' `ST_Transform` calculates the same values than *Oracle 11g*. To sum it up: Delete the affected rows in the table `Cityobject_GenericAttrib` (with `attrname` 'GE_LoD[1,2,3 or 4]_zOffset') and restart the KML export. If facing the message `OVER_QUERY_LIMIT` the Limit (2500) for requesting heights from Google's elevation service was exceeded and no values will be written in the database. The user has to wait 24 hours to be able to send new requests to the web service with the same client.

I've tried out the *raster2pgsql* tool but can't execute the generated SQL file?

With the proposed *raster2pgsql* command on page 10 the generated SQL file will try to insert values only in the raster column. But the tables `orthophoto` and `raster_relief` contain more columns, most of them with NOT NULL constraints. `raster_relief` is also connected to the `relief` table so another entry is needed there. Check out the corresponding SQL files for those tables (3dcitydb/postgis/SCHEMA/TABLES/...). A short introduction of how to edit the generated SQL files is given in the file headers.

We know that this solution is not the most user-friendliest yet. It is planned to rework the whole raster data management of the *3DCityDB* within the next major release of the software. Hopefully a new raster importer both for *Oracle* and *PostgreSQL/PostGIS* can be realized for the *Importer/Exporter* tool.

I think I've found a bug ...

If so, please report this bug to us. If you have any further issues on the software performance, results of im- and exports or just questions please tell us. We're glad to receive any feedback. Please note that even though the software was tested thoroughly with various datasets of different size and content we cannot guarantee that no more errors occur during imports and exports. It is strongly recommended running the *PostGIS* port in a dedicated testing environment first before managing all your CityGML data with our software.

6. References

Documents:

[1] Kolbe, T.H. ; König, G. ; Nagel, C. ; Stadler, A. (2009): 3D-Geo-Database for CityGML. Version 2.0.1. Documentation. Berlin.
Accessible under: http://www.3dcitydb.net/index.php?id=1897

[2] Kolbe, T.H. ; Nagel, C. ; Herreruela, J. (2013): 3D City Database for CityGML. Addendum to the 3D City Database Documentation Version 2.0.1. Berlin.
Accessible under: http://www.3dcitydb.net/index.php?id=1897

[3] Stadler, A. ; Nagel, C. ; König, G. ; Kolbe, T.H. (2009): Making interoperability persistent: A 3D geo database based on CityGML. In: Lee, J. ; Zlatanova, S. (Ed.): 3D Geoinformation Sciences. Lecture Notes in Geoinformation and Cartography. Springer, Berlin / Heidelberg. 175-192.

[4] Obe, R.O. ; Hsu, L. (2010): PostGIS in Action. Manning, New York.

[5] Plümer, l. ; Gröger, G. ; Kolbe, T.H. ; Schmittwilken, J. ; Stroh, V. ; Poth, A. ; Taddeo, U. (2005): 3D Geodatenbank Berlin, Dokumentation V1.0. (in german language only). Institut für Kartographie und Geoinformation der Universität Bonn (IKG), lat/lon GmbH.
Accessible under:
www.businesslocationcenter.de/imperia/md/content/3d/dokumentation_3d_geo_db_berlin.pdf

[6] Gröger, G. ; Kolbe, T.H. ; Czerwinski, A. ; Nagel, C. (2008): OpenGIS City Geography Markup Language (CityGML) Encoding Standard. Version 1.0.0. OGC 08-007rl.
Accessible under: http://www.opengeospatial.org/standards/citygml

[7] Gröger, G. ; Kolbe, T.H. ; Nagel, C. ; Häfele, K-H. (2012): OGC City Geography Markup Language (CityGML) Encoding Standard. Version 2.0.0. OGC 12-019.
Accessible under: http://www.opengeospatial.org/standards/citygml

[8] Kunde, F. (2012): CityGML in PostGIS – Portierung, Anwendung und Performanz-Analyse am Beispiel der 3D City Database von Berlin. Master Thesis (in german only).
Accessible under: Link following soon at www.3dcitydb.net.

[9] Kunde, F. ; Asche, H. ; Kolbe, T.H. ; Nagel, C. ; Herreruela, J. ; König, G. (2013): 3D City Database for CityGML: Port documentation: PL/SQL to PL/pgSQL.
Accessible under:
http://opportunity.bv.tu-berlin.de/software/projects/3dcitydb-imp-exp/documents

[10] Kunde, F. ; Asche, H. ; Kolbe, T.H. ; Nagel, C. ; Herreruela, J. ; König, G. (2013): 3D City Database for CityGML: Port documentation: Java.
Accessible under:
http://opportunity.bv.tu-berlin.de/software/projects/3dcitydb-imp-exp/documents

Links:

www1	http://www.gnu.org/licenses/
www2	http://opportunity.bv.tu-berlin.de/software/projects/3dcitydb-imp-exp
www3	http://www.3dcitydb.net
www4	http://postgis.refractions.net/docs/AddGeometryColumn.html
www5	http://postgis.refractions.net/documentation/manualsvn/using_postgis_dbmanagement.html#gist_indexes
www6	http://www.postgis.org/documentation/manual-svn/using_raster.xml.html
www7	http://www.kappasys.ch/cms/index.php?id=23
www8	http://pgfoundry.org/projects/temporal/
www9	http://www.postgresql.org/docs/9.1/static/plpgsql-porting.html
www10	http://www.java.com/de/download
www11	http://www.postgresql.org/docs/

Appendix:

List of tables and figures: