TECHNISCHE UNIVERSITÄT DRESDEN

Institute of Traffc Telematics, Chair of Traffic Control Systems and Process Automation

Modeling Mobility with Open Data

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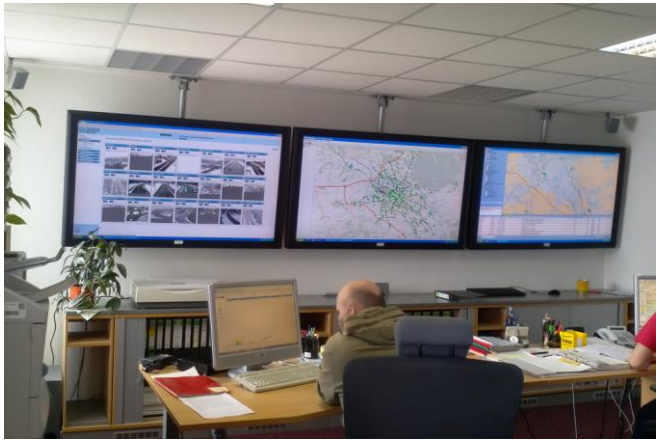


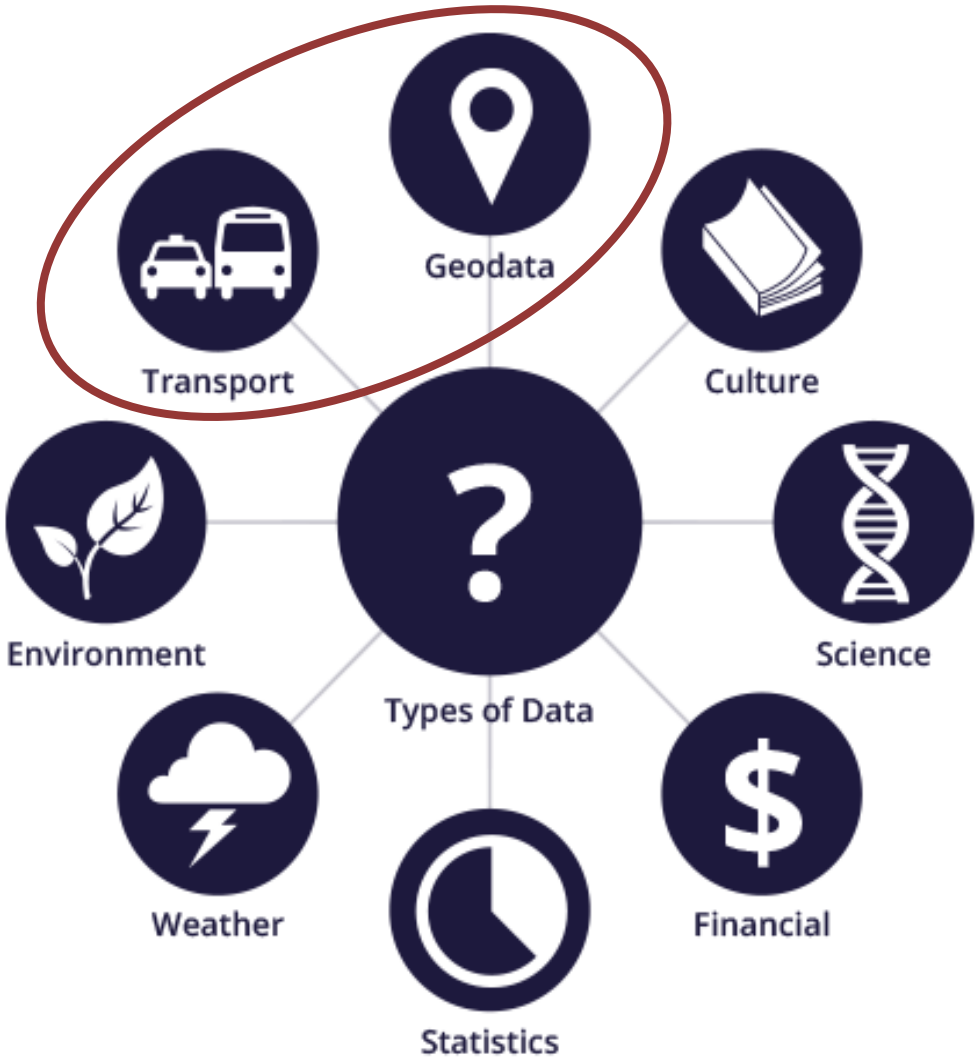
Dresden, Traffic Management Center

Open Data

Definition

“A piece of data or content is open if anyone is free to use, reuse, and redistribute it […]” [opendefinition.org]

Open data is the idea that certain data should be freely available to everyone to use and republish as they wish, without restrictions from copyright, patents or other mechanisms of control. [Wikipedia.org]

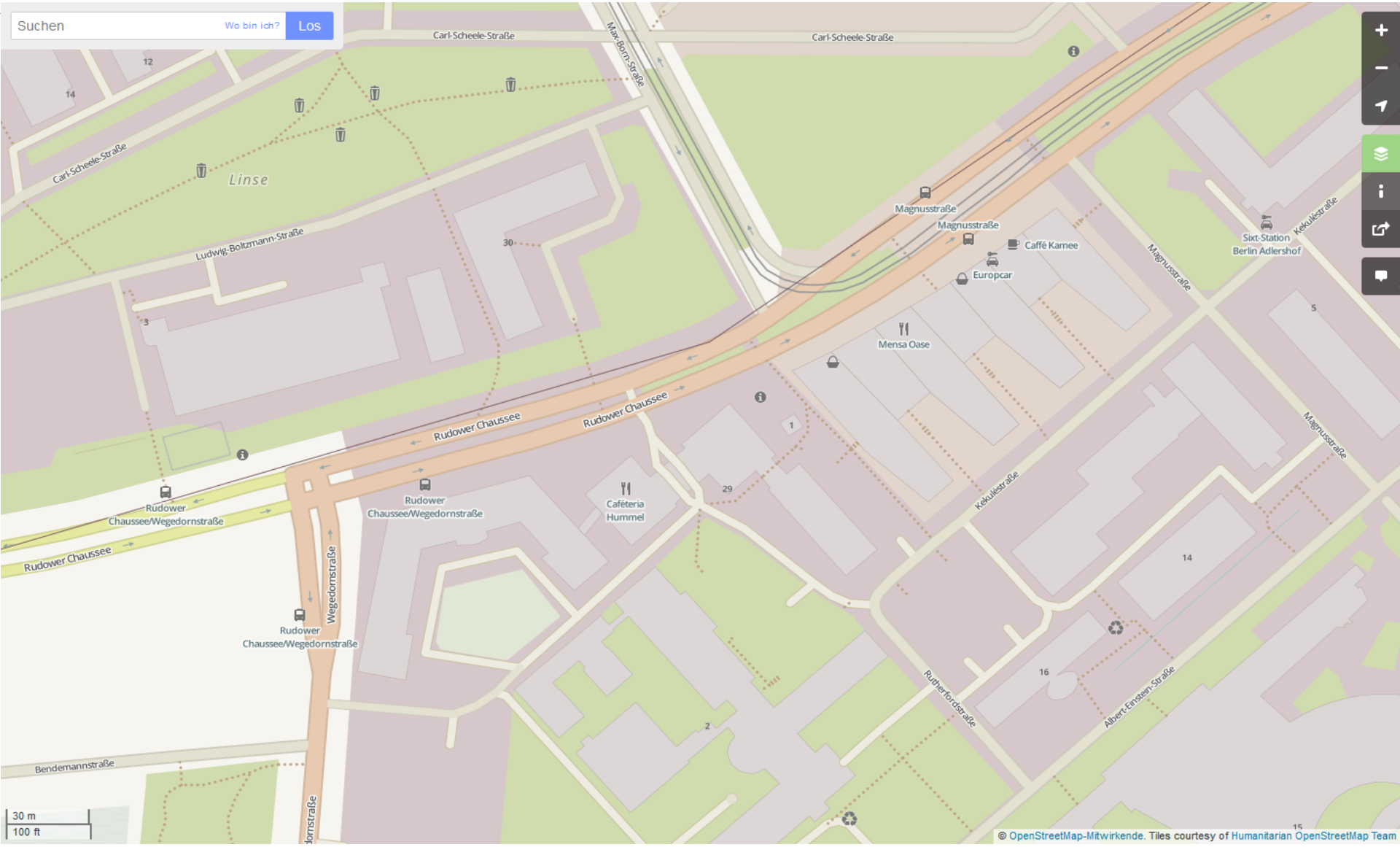


Source: http://okfn.de/opendata

***OpenStreetMap**, the project that creates and distributes free geographic data for the world*

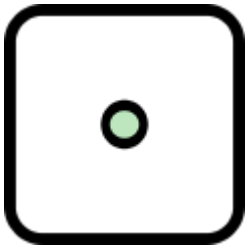
CC BY SA

Open Street Map



Source: openstreetmap.org

OSM data primitives



NODE

WAY

AREA

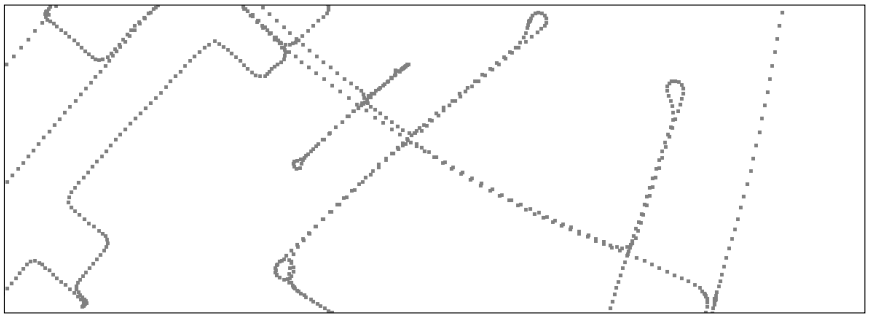
RELATION

Source: openstreetmap.org

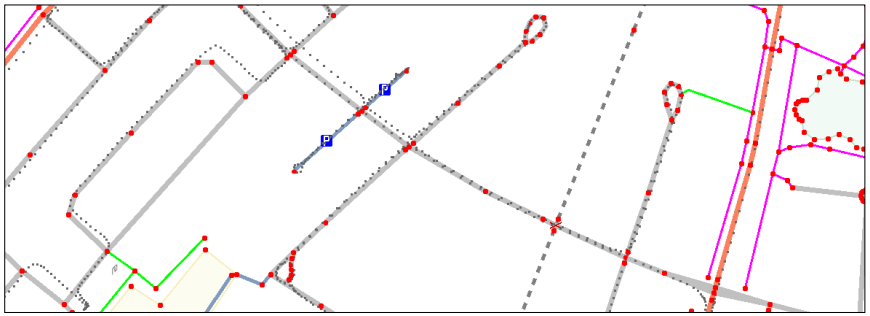
KEY & VALUE

Key	Value	Element	Comment	Rendering	Photo
			Track		
railway	rail		Full sized passenger or freight trains in the standard gauge for the country or state		
railway	tram		One or two carriage rail vehicles, usually sharing motor road (Other languages)		
railway	light_rail		A higher-standard tram system, normally in its own right-of-way. Often it connects towns and thus reaches a considerable length (tens of kilometer).		

Source: openstreetmap.org



Import of GPS traces (Track, GPX file)

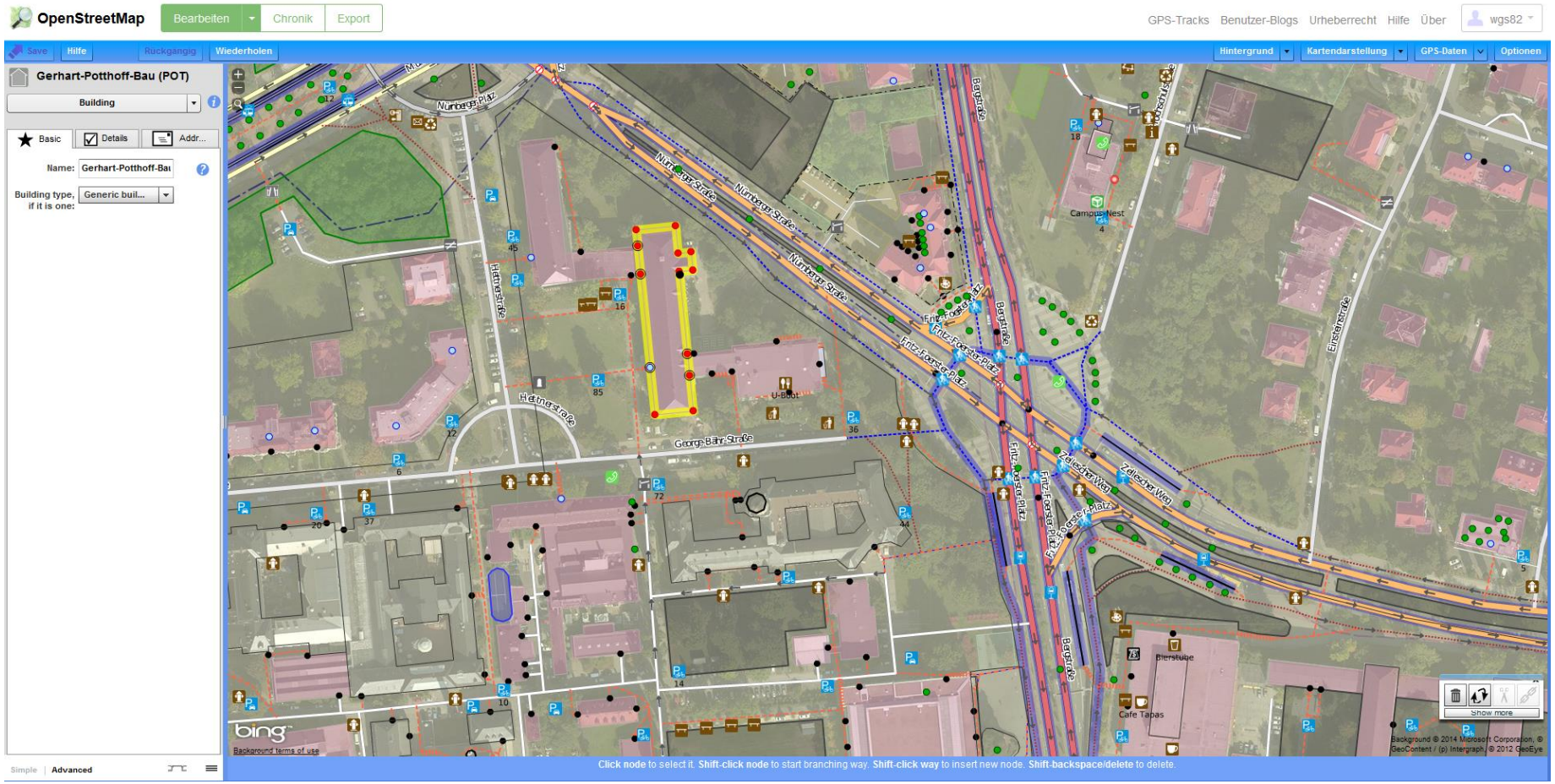


Add additional information to the recorded tracks

Rendering the geospatial data and publish it to a WMS

Source: openstreetmap.org

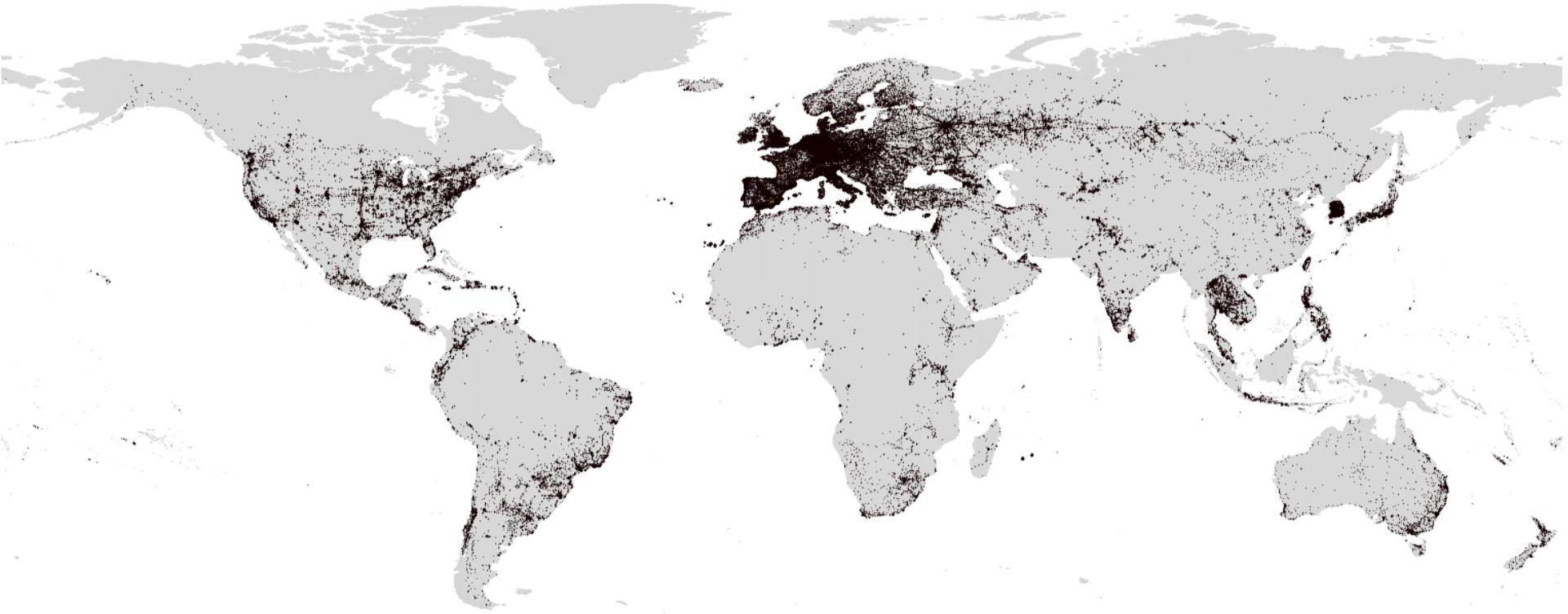
Online Editor: Potlatch



Source: openstreetmap.org

Open Street Map (OSM)

- Source: **http://planet.openstreetmap.org**
- > 400 GB XML data (compressed 34 GB with Bzip2)



● 180 000 locations of fuel stations available in OSM

OSM API

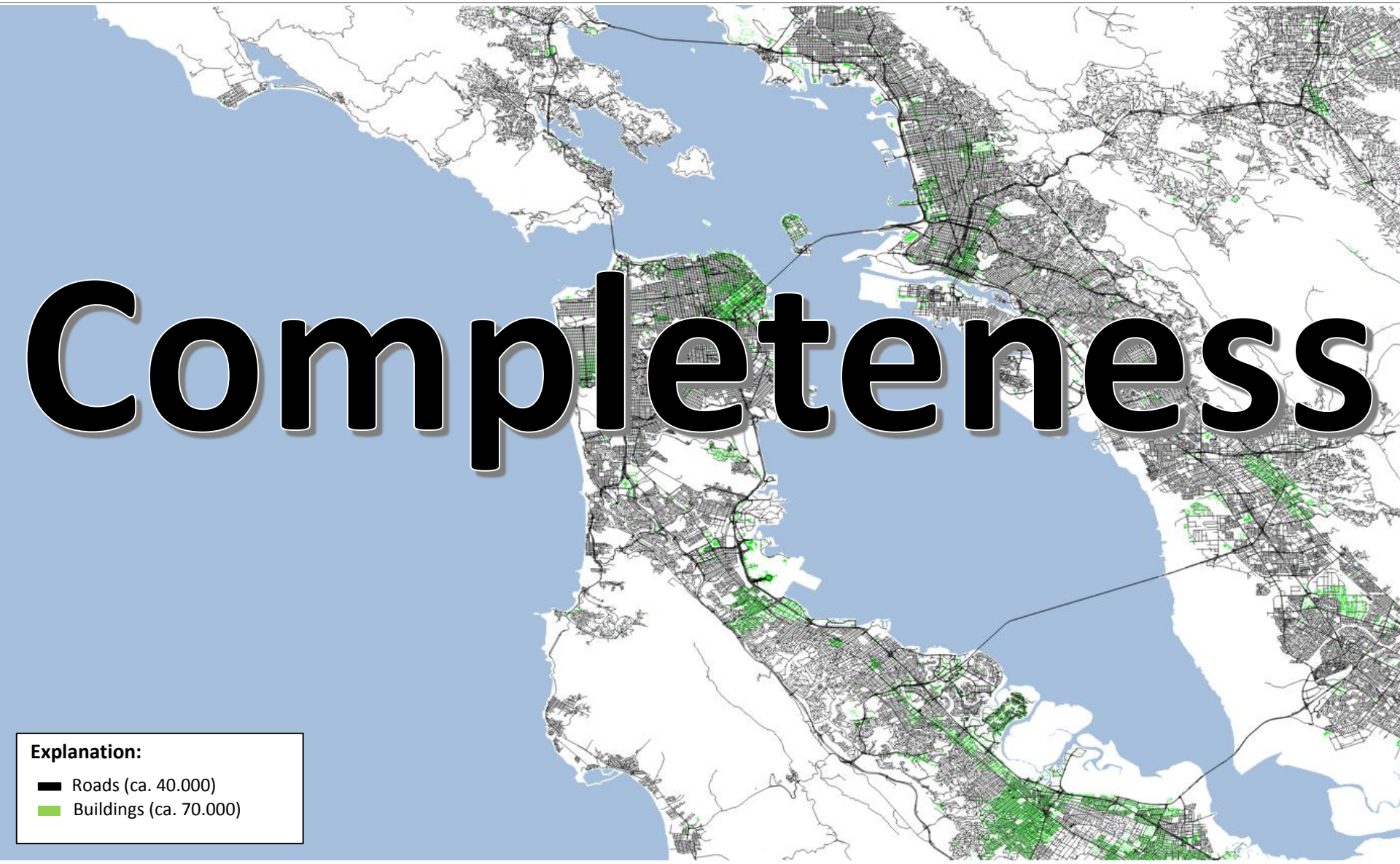
- Using rendered images directly from website (WMS) as PNG, JPEG

- Using raw data
  - XAPI (e.g. http://www.informationfreeway.org/api/0.6)
  - OSM dump (world file)

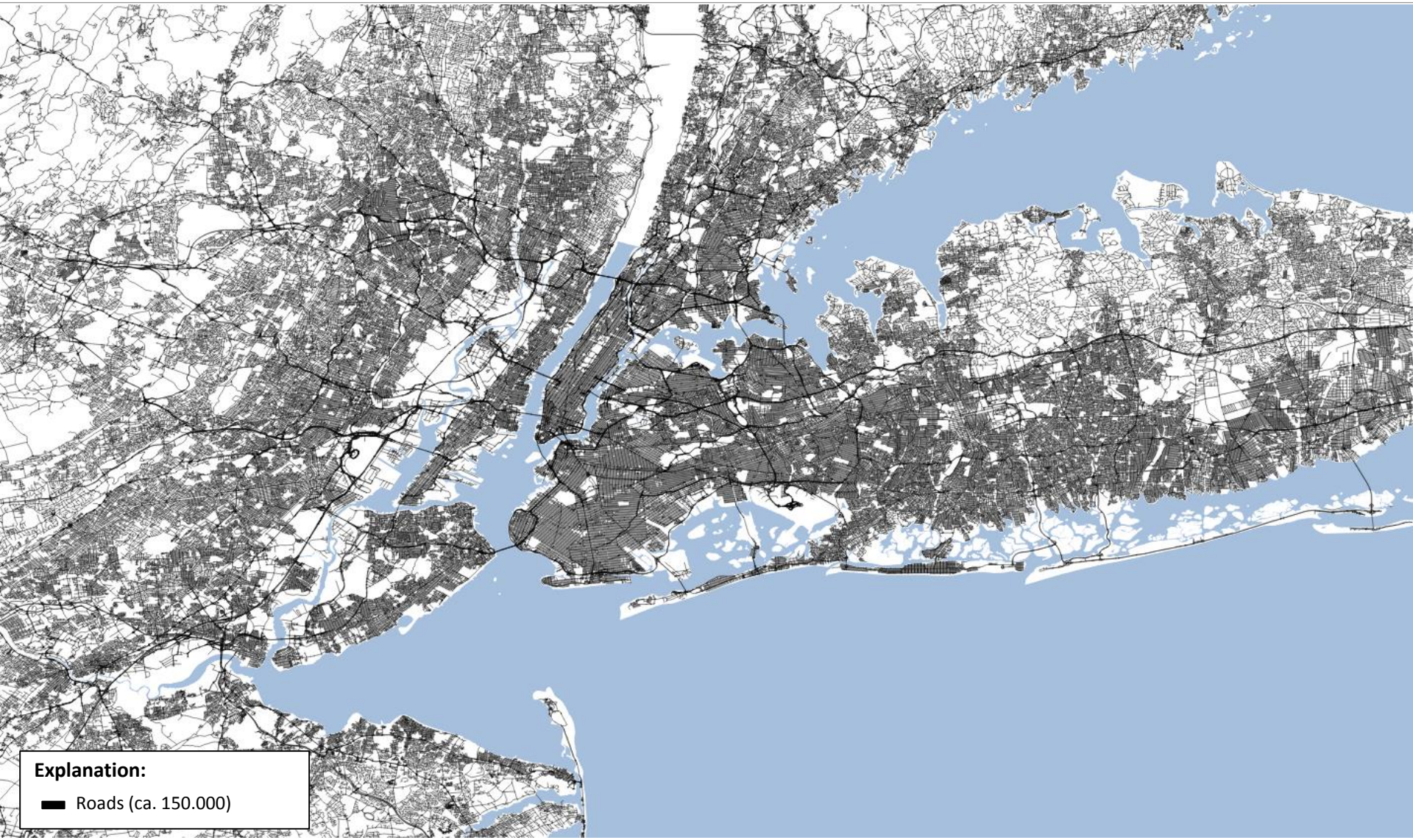
```
<?xml version='1.0' standalone='no'?>
<osm version='0.6' generator='xapi: OSM Extended API'
 xmlns:xapi='http://www.informationfreeway.org/xapi/0.6'
 xapi:uri='/api/0.6/node[amenity=hospital]'
 xapi:planetDate='200803150826'
 xapi:copyright='2008 OpenStreetMap contributors'
 xapi:instance='zappy2'>
  <node id='672180' lat='48.2111685091189' lon='16.3035366605548' timestamp='2006-09-11T16:28:25+01:00' version='1' changeset='10968'>
    <tag  k='amenity' v='hospital'/>
    <tag  k='name' v='Wilhelminenspital'/>
  </node>
  <node id='3596186' lat='53.4633699598014' lon='-2.22667910006381' timestamp='2007-06-21T17:10:58+01:00' version='2' changeset='2213'>
    <tag  k='amenity' v='hospital'/>
    <tag  k='name' v='Manchester Royal Infirmary'/>
  </node>
  ...
</osm>
```

OSM details

Completeness



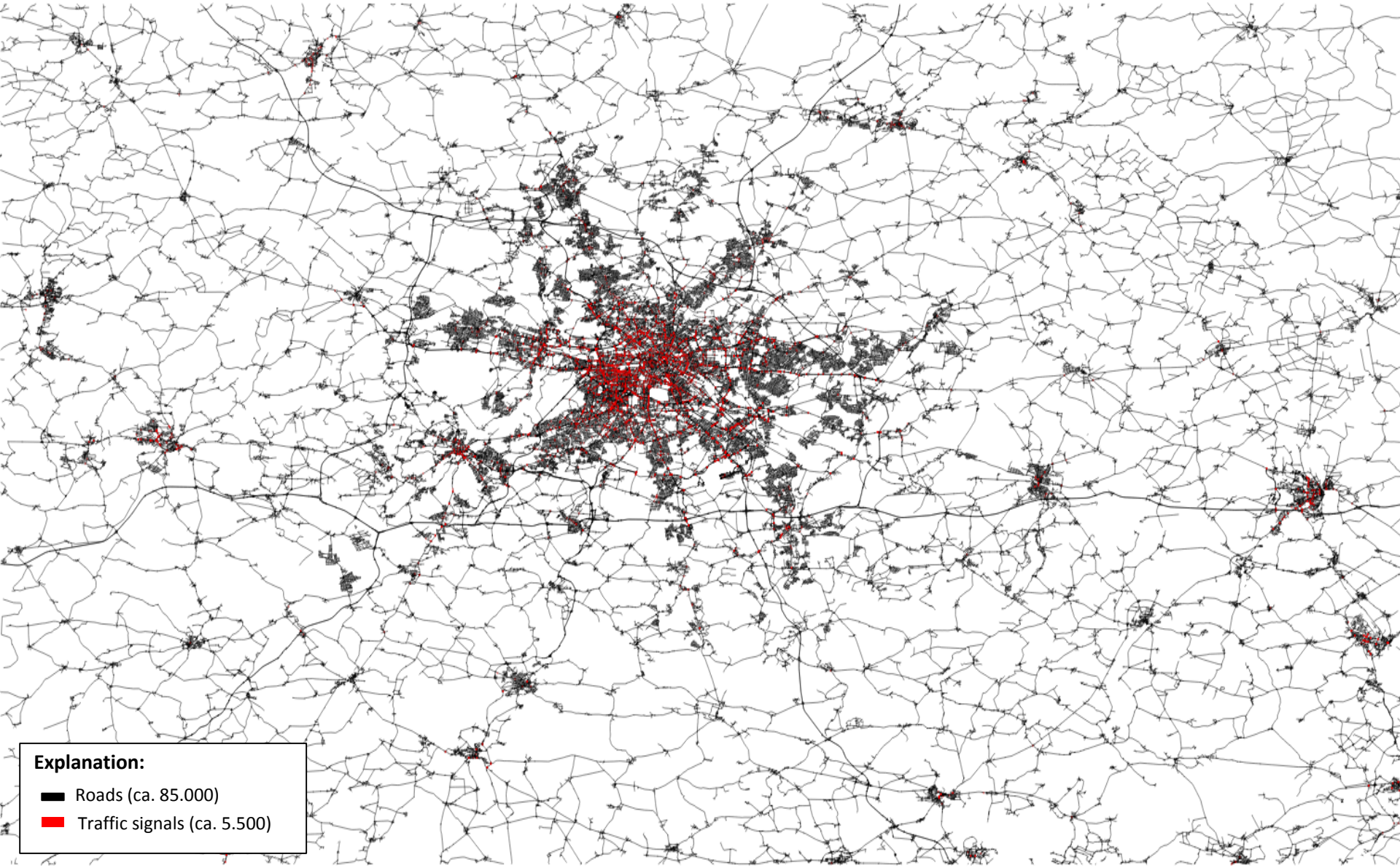
New York



Accuracy

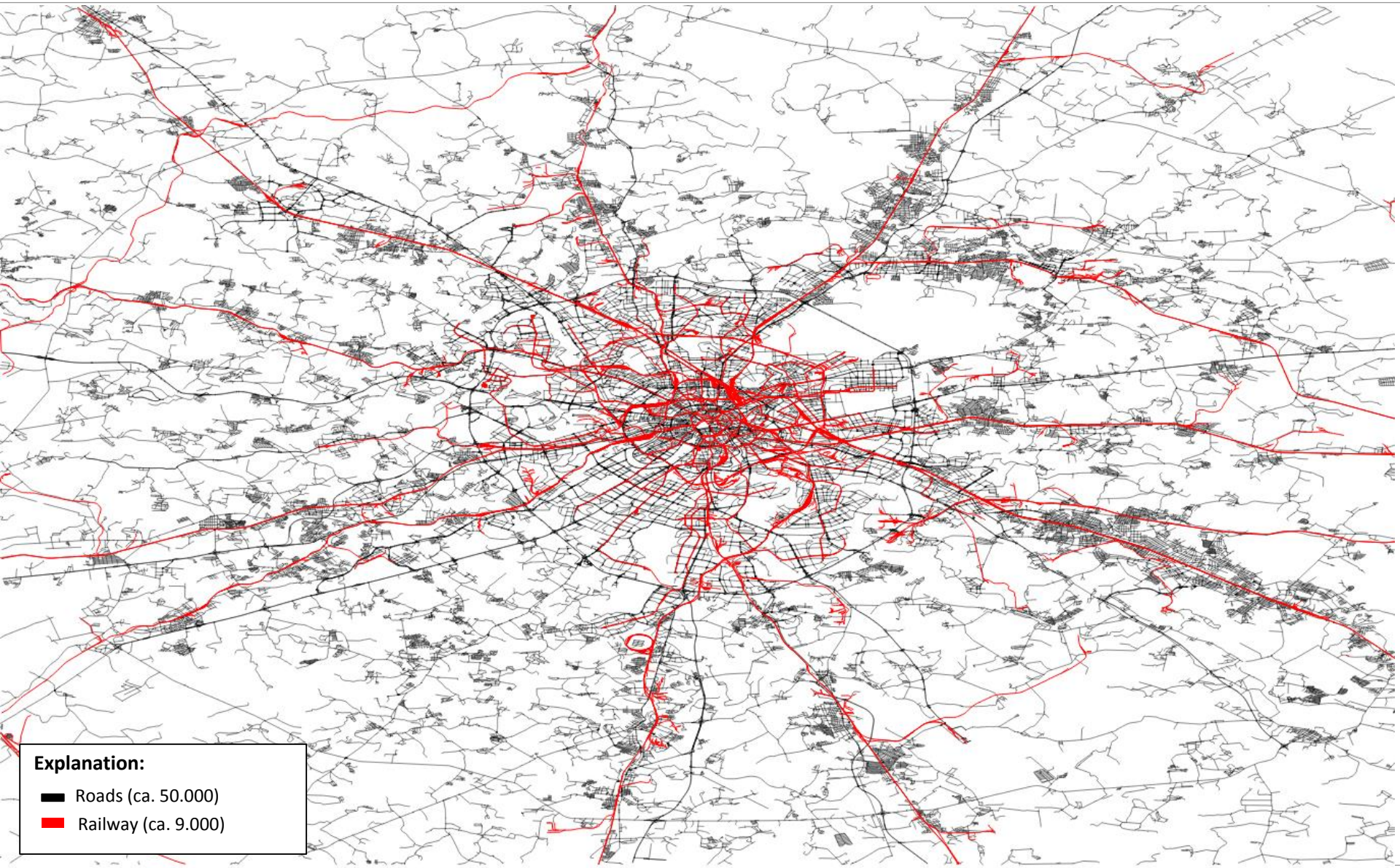
Coverage
Explanation:
Roads (ca. 270.000)

Berlin



Knowledge
Explanation:
Roads (ca. 85.000)
Traffic signals (ca. 5.500)

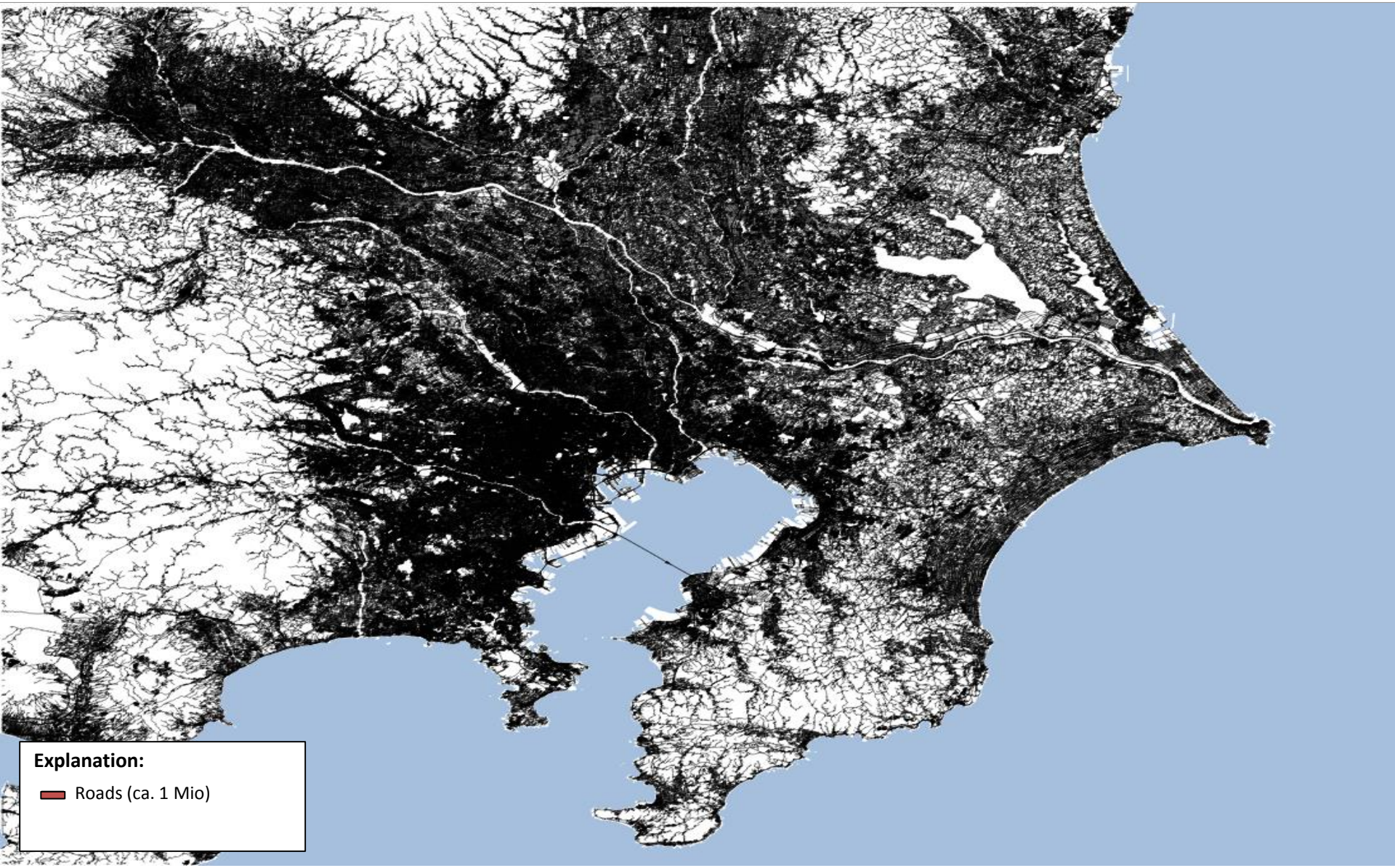
Moscow



Specifics

Source: Google Maps (aerial image)

Tokyo

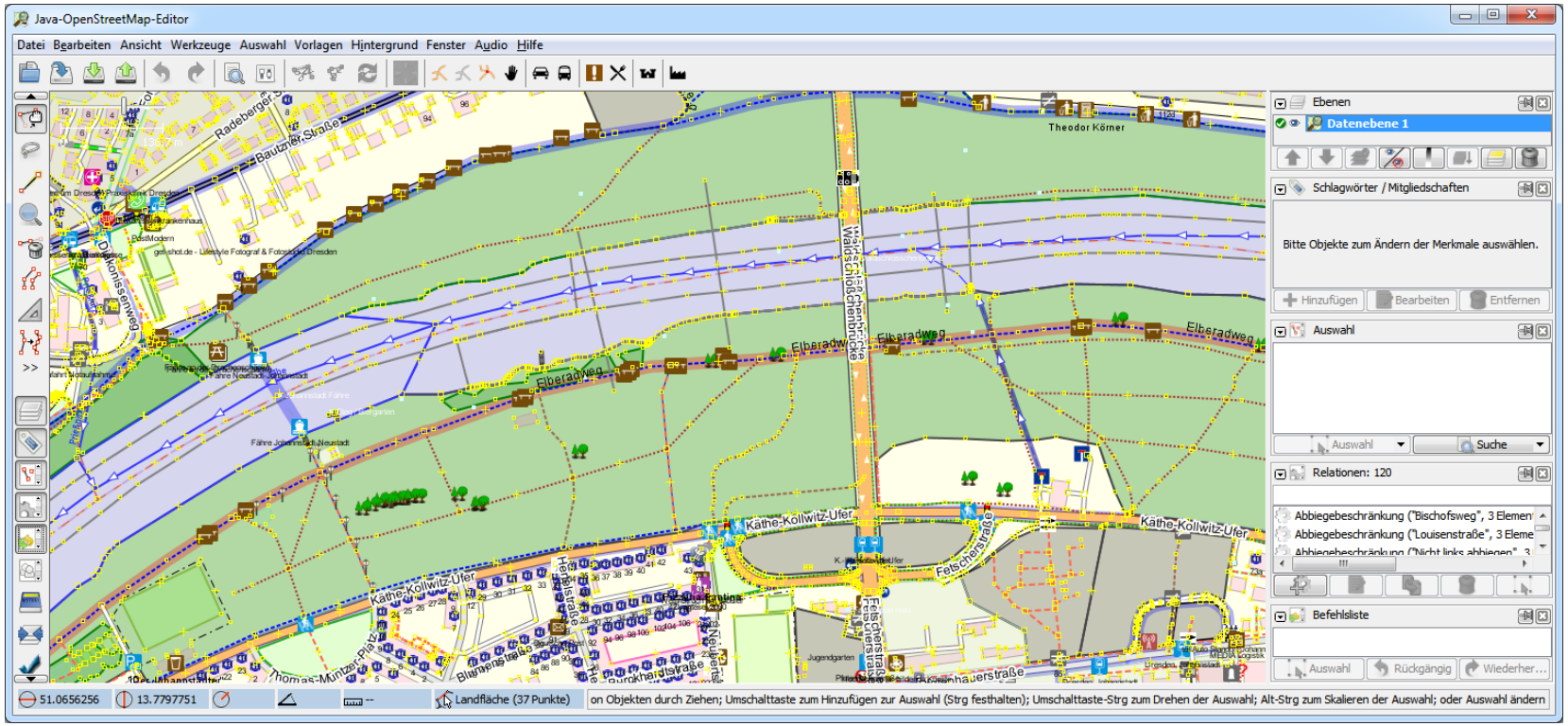


Source: Google Maps (aerial image)

Open Modeling Tools

JOSM - extensible editor for OSM

- Offline editor for OSM data
- Direct upload to OSM server possible



https://josm.openstreetmap.de

OSMOSIS – Processing OSM data

Osmosis is a command line Java application for processing OSM data. The tool consists of pluggable components that can be chained to perform a larger operation. For example, it has components for reading/writing databases and files, deriving/applying changes to data sources, and sorting data, (etc.). It has been written to easily add new features without re-writing common tasks such as file and database handling.

Some examples of the things it can currently do are:

- Generate planet dumps from a database
- Load planet dumps into a database
- Produce change sets using database history tables
- Apply change sets to a local database
- Compare two planet dump files and produce a change set
- Re-sort the data contained in planet dump files
- Extract data inside a bounding box or polygon

Osmosis can also be included as a library in other Java applications.[1]

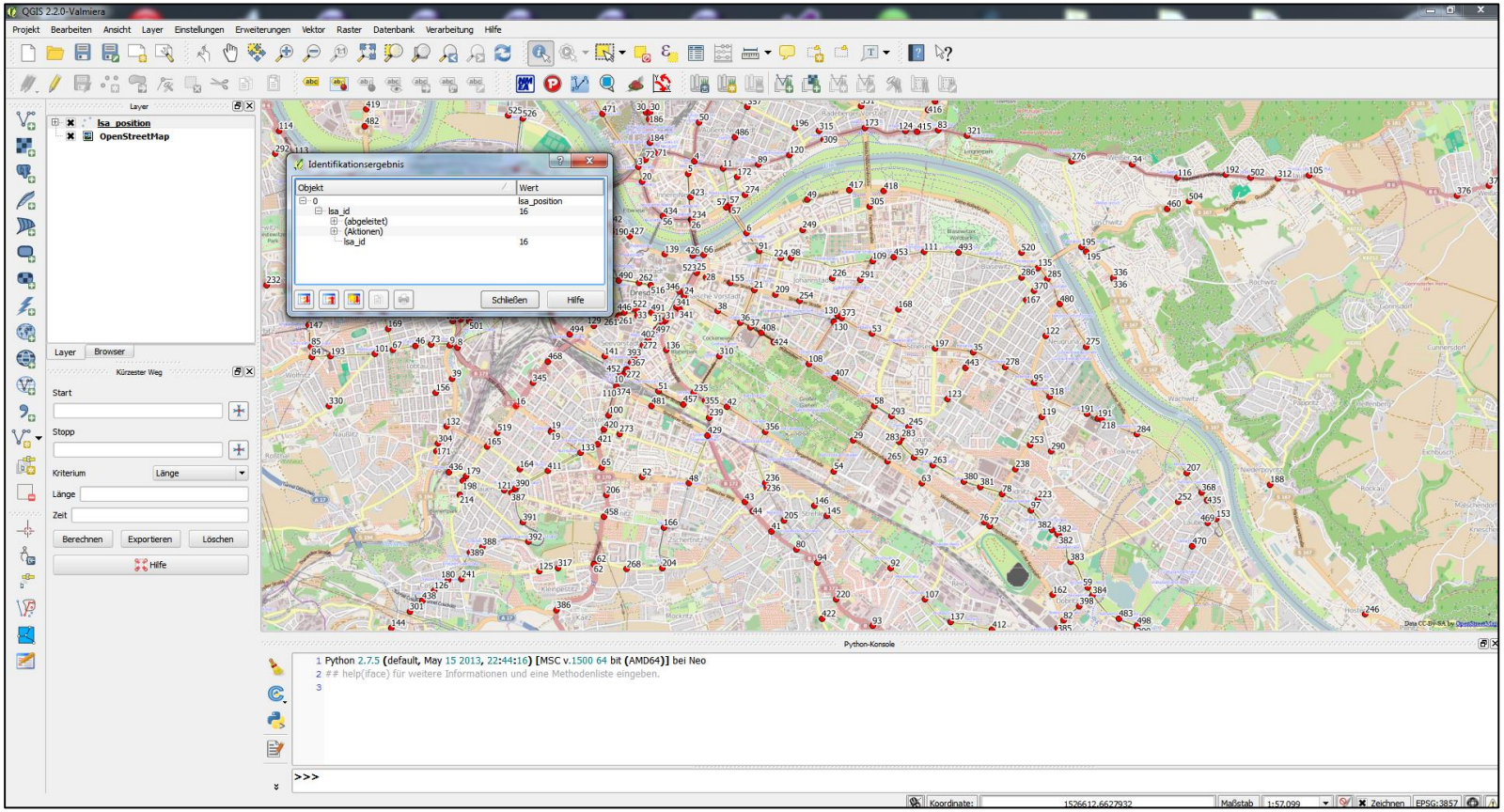
```
osmosis --read-xml city.osm --tf accept-ways highway=* --used-node --write-xml highways.osm
```

```
osmosis --read-apidb host="x" database="x" user="x" password="x" --write-xml file="planet.osm"
```

http://wiki.openstreetmap.org/wiki/Osmosism.openstreetmap.de

QGIS – GIS editor

- Free editor/viewer for GIS data
- Python extensions available



http://www.qgis.org

open source

GeoTools – Java GIS toolkit

- Java Library for GIS operations (queries, matching, projection, …)
- Reading/writing of different GIS formats (Shape, Postgis, Spatialite, KML, …)

http://www.geotools.org

open source

PostGIS – GIS extension for PostgreSQL

PostGIS adds extra types (geometry, geography, raster and others) to the PostgreSQL database. It also adds functions and indexes that apply to those types. It does this by:

- Building a C library that PostgreSQL can load into a `postgres` backend.
- Binding the functions and structures in that library to SQL types and functions.

Since PostGIS is in C, it can make use of other libraries in C, and it does so liberally. PostGIS depends on:

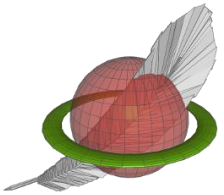
- GEOS for many geometry processing algorithms
- Proj.4 for coordinate re-projection functions
- GDAL for raster processing and format support
- LibXML2 for XML parsing
- JSON-C for JSON parsing

http://postgis.net

open source™

SpatiaLite – GIS Database

- Spatial extension of SQLite
- Very fast



SpatiaLite is an **open source** library intended to extend the SQLite core to support fully fledged Spatial SQL capabilities.
SQLite is intrinsically simple and lightweight:

- a single lightweight library implementing the full SQL engine
- standard SQL implementation: almost complete SQL-92
- no complex client/server architecture
- a whole database simply corresponds to a single monolithic file (no size limits)
- any DB-file can be safely exchanged across different platforms, because the internal architecture is universally portable
- no installation, no configuration

SpatiaLite is smoothly integrated into SQLite to provide a complete and powerful Spatial DBMS (mostly OGC-SFS compliant).
Using SQLite + SpatiaLite you can effectively deploy an alternative *open source* Spatial DBMS roughly equivalent to PostgreSQL + PostGIS.

SpatiaLite is licensed under the MPL tri-license terms; you are free to choose the best-fit license between:

- the MPL 1.1
- the GPL v2.0 or any subsequent version
- the LGPL v2.1 or any subsequent version

http://www.gaia-gis.it/gaia-sins

open source™

Live Example

Example: San Francisco

Source: Wikipedia

- Download OSM raw data

GEOFABRIK *downloads*

OpenStreetMap Data Extracts

New site layout - we've tried to make it so that any old saved links still work; do tell us if there's a problem!

Welcome to Geofabrik's free download server. This server has data extracts from the OpenStreetMap project which are normally updated every day. Select your continent and then your country of interest from the list below. (If you have been directed to this page from elsewhere and are not familiar with OpenStreetMap, we highly recommend that you read up on OSM before you use the data.) This download service is offered for free by Geofabrik GmbH.

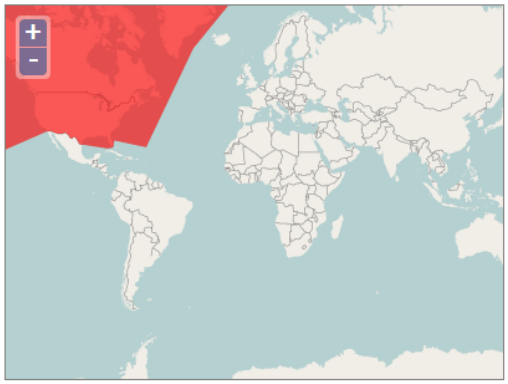
Neue Webseiten-Struktur - Alle alten gespeicherten Links sollten aber trotzdem noch funktionieren.

Willkommen auf dem Geofabrik-Downloadserver. Hier gibt es Daten-Auszüge aus dem OpenStreetMap-Projekt, die normalerweise täglich aktualisiert werden. Wählen Sie aus dem Verzeichnis unten den Kontient und ggf. das Land, für die Sie Daten benötigen. (Wenn Sie von anderswo auf dieser Seite gelandet sind und von OpenStreetMap nichts wissen, dann ist es empfehlenswert, sich mit dem Projekt vertraut zu machen, bevor Sie mit den Daten arbeiten.) Diese Downloads werden von der Geofabrik GmbH kostenlos angeboten.

Click on the region name to see the overview page for that region, or select one of the file extenstion links for quick access.

Sub-Region	Quick Links		
	.osm.pbf	.shp.zip	.osm.bz2
Africa	[.osm.pbf]	✖	[.osm.bz2]
Antarctica	[.osm.pbf]	[.shp.zip]	[.osm.bz2]
Asia	[.osm.pbf]	✖	[.osm.bz2]
Australia and Oceania	[.osm.pbf]	✖	[.osm.bz2]
Central America	[.osm.pbf]	✖	[.osm.bz2]
Europe	[.osm.pbf]	✖	[.osm.bz2]
North America	[.osm.pbf]	✖	[.osm.bz2]
South America	[.osm.pbf]	✖	[.osm.bz2]

Technical details about this download service.
Old, CC-BY-SA licensed data from before OpenStreetMap's license change.



Not what you were looking for? Geofabrik is a consulting and software development firm based in Karlsruhe, Germany specializing in OpenStreetMap services. We're happy to help you with data preparation, processing, server setup and the like. Check out our web site and contact us if we can be of service.

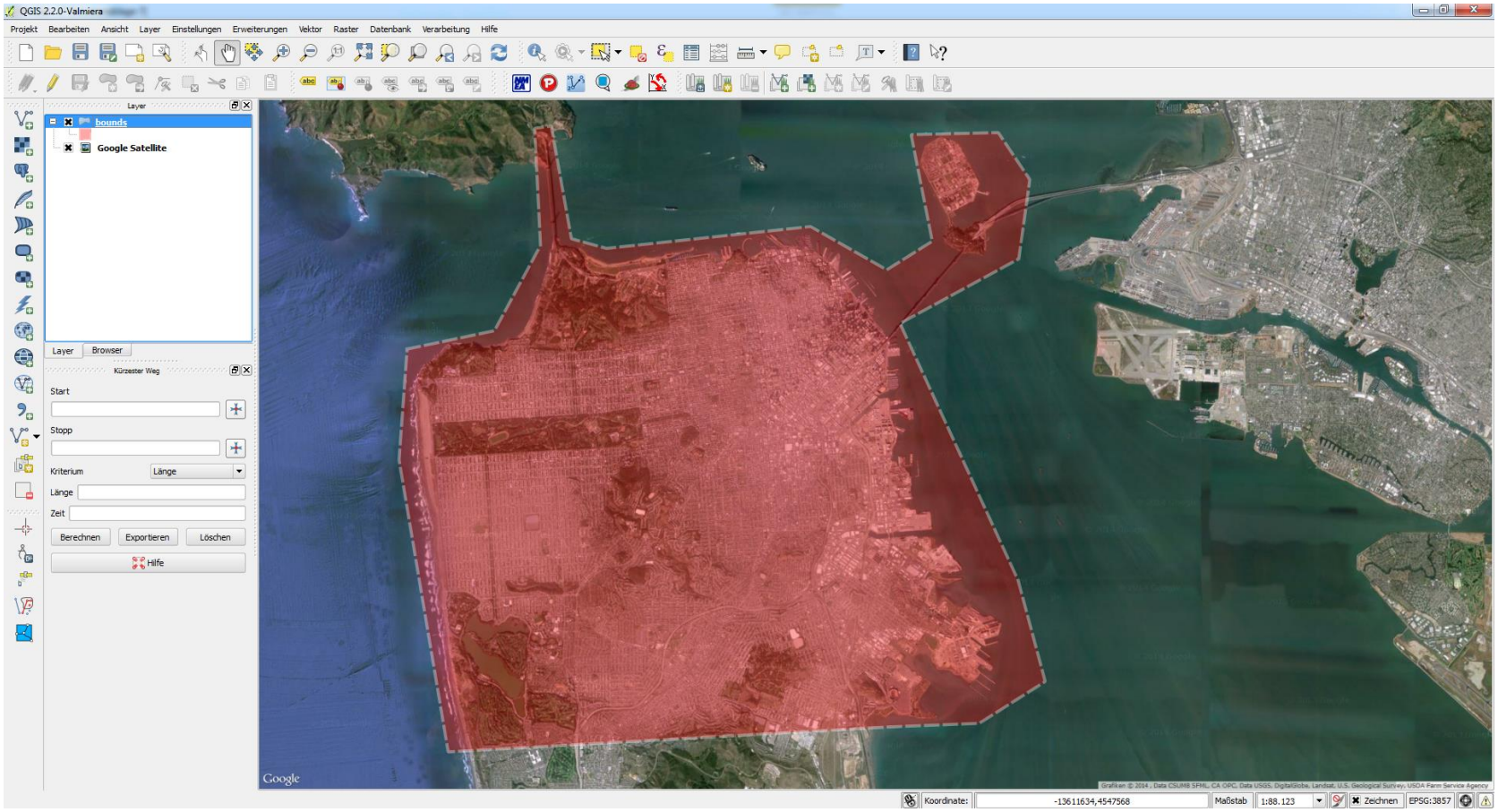
Nicht das Richtige dabei? Die Geofabrik ist ein auf OpenStreetMap spezialisiertes Beratungs- und Softwareentwicklungsunternehmen in Karlsruhe. Gern

http://download.geofabrik.de

Building Bounding Box

- Specify the area of interest

→ QGIS



Source: Google Maps (aerial image)

→ OSMOSIS

osmosis --read-pbf california-latest.osm.pbf
--bounding-box top=37.834611 left=-122.519747 bottom=37.7012021 right=-122.3454478
--write-xml san_francisco.osm

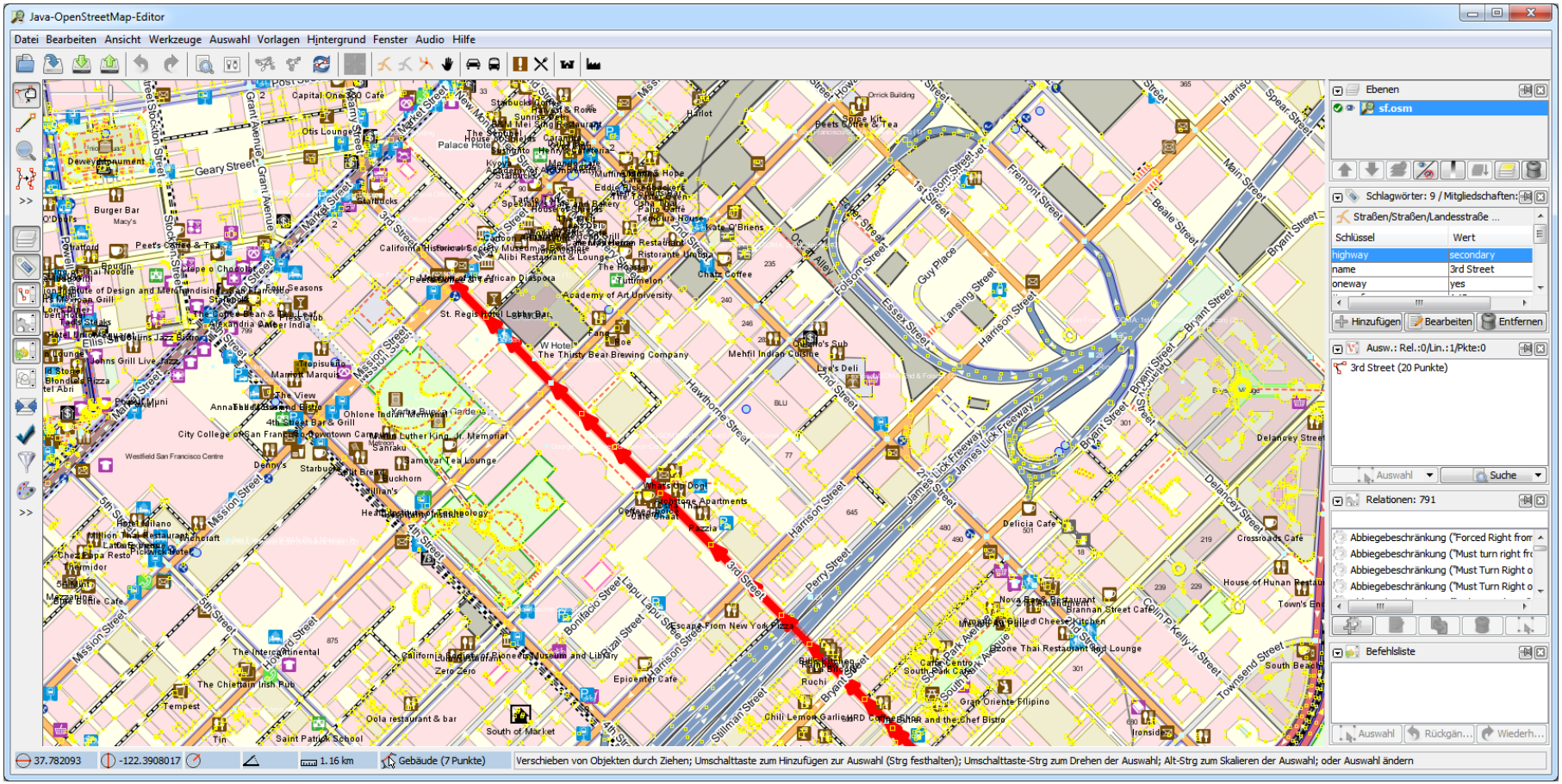
Output:

```
Mai 12, 2014 7:44:53 PM org.openstreetmap.osmosis.core.Osmosis run
INFORMATION: Osmosis Version 0.43.1
Mai 12, 2014 7:44:53 PM org.java.plugin.registry.xml.ManifestParser <init>
INFORMATION: got SAX parser factory - org.apache.xerces.jaxp.SAXParserFactoryImpl@35bbe5e8
Mai 12, 2014 7:44:53 PM org.java.plugin.registry.xml.PluginRegistryImpl configure
INFORMATION: configured, stopOnError=false, isValidating=true
Mai 12, 2014 7:44:54 PM org.java.plugin.registry.xml.PluginRegistryImpl register
INFORMATION: plug-in and fragment descriptors registered - 1
Mai 12, 2014 7:44:54 PM org.java.plugin.standard.StandardPluginManager activatePlugin
INFORMATION: plug-in started - org.openstreetmap.osmosis.core.plugin.Core@0.0.0.42-6-gf39a160-dirty
Mai 12, 2014 7:44:54 PM org.openstreetmap.osmosis.core.Osmosis run
INFORMATION: Preparing pipeline.
Mai 12, 2014 7:44:54 PM org.openstreetmap.osmosis.core.Osmosis run
INFORMATION: Launching pipeline execution.
Mai 12, 2014 7:44:54 PM org.openstreetmap.osmosis.core.Osmosis run
INFORMATION: Pipeline executing, waiting for completion.
Mai 12, 2014 7:45:32 PM org.openstreetmap.osmosis.core.Osmosis run
INFORMATION: Pipeline complete.
Mai 12, 2014 7:45:32 PM org.openstreetmap.osmosis.core.Osmosis run
INFORMATION: Total execution time: 38989 milliseconds.
```

Edit raw data

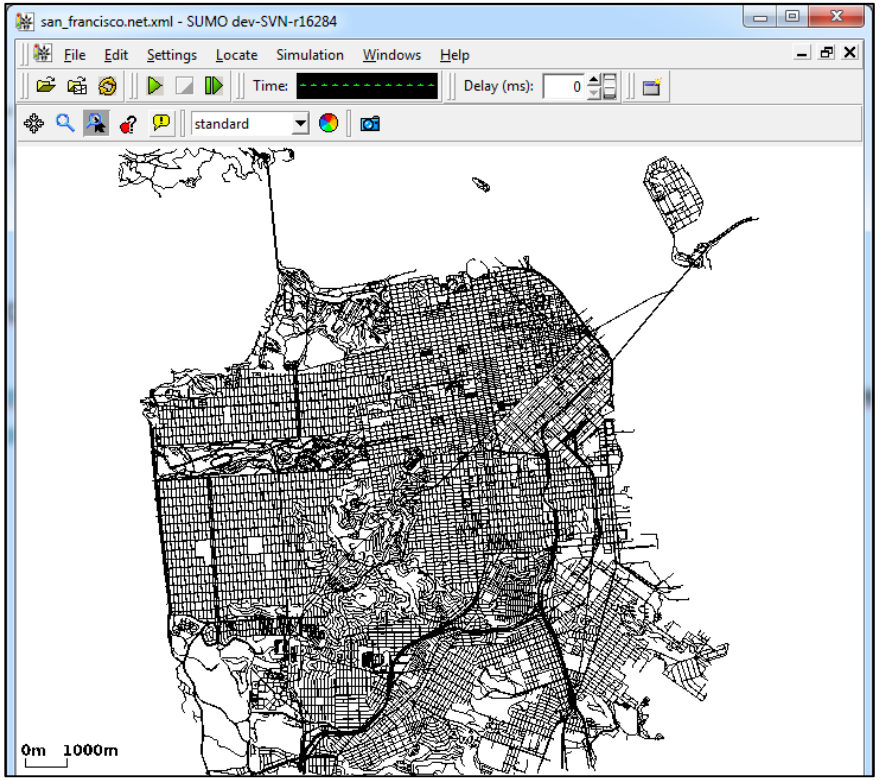
- Manipulation of imported OSM data if necessary

→ JOSM



Building the network

netconvert --osm-files san_francisco.osm
--osm.skip-duplicates-check
--osm.railway.oneway-default
--tls.join --tls.guess --junctions.join-dist 40
--remove-edges.isolated --no-turnarounds
--no-turnarounds.tls
-o san_francisco.net.xml



Output:

- More than 6000 warnings

```
Warning: The traffic light 'joinedS_46' has a high cycle time of 150.00.
Warning: The traffic light 'joinedS_464' has a high cycle time of 144.00.
Warning: The traffic light 'joinedS_50' has a high cycle time of 150.00.
Warning: The traffic light 'joinedS_58' has a high cycle time of 175.00.
Warning: The traffic light 'joinedS_61' has a high cycle time of 150.00.
Warning: The traffic light 'joinedS_631' has a high cycle time of 144.00.
Warning: The traffic light 'joinedS_68' has a high cycle time of 144.00.
Warning: The traffic light 'joinedS_683' has a high cycle time of 150.00.
Warning: The traffic light 'joinedS_709' has a high cycle time of 150.00.
Warning: The traffic light 'joinedS_737' has a high cycle time of 150.00.
Warning: The traffic light 'joinedS_793' has a high cycle time of 170.00.
Warning: The traffic light 'joinedS_801' has a high cycle time of 155.00.
Warning: The traffic light 'joinedS_826' has a high cycle time of 150.00.
Warning: The traffic light 'joinedS_924' has a high cycle time of 160.00.
Warning: The traffic light 'joinedS_93' has a high cycle time of 172.00.
Warning: The traffic light 'joinedS_95' has a high cycle time of 200.00.
Warning: Splitting vector close to end (pos: 0.08, length: 0.15)
Success.
```

Lanes: 194088
Edges: 19739
Junctions: 19436

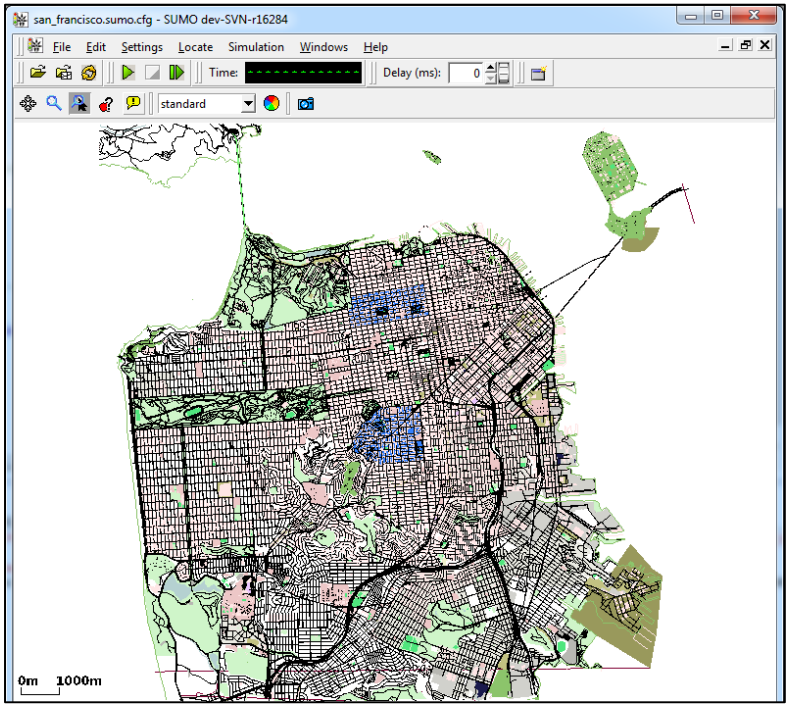
Building the network

polyconvert --net-file san_francisco.net.xml --osm.keep-full-type --osm-files san_francisco.osm --type-file typemap.xml -o san_francisco.poly.xml

Output:

- More than 3700 warnings

```
Warning: The referenced geometry information (ref='2802765586') is not known
Warning: The referenced geometry information (ref='2802765574') is not known
Warning: The referenced geometry information (ref='2802765517') is not known
Warning: The referenced geometry information (ref='2802765745') is not known
Warning: The referenced geometry information (ref='2802765537') is not known
Warning: The referenced geometry information (ref='2802765376') is not known
Warning: The referenced geometry information (ref='2802765381') is not known
Warning: The referenced geometry information (ref='2802765507') is not known
Warning: The referenced geometry information (ref='2802765314') is not known
Warning: The referenced geometry information (ref='2802765340') is not known
Warning: The referenced geometry information (ref='521076834') is not known
Success.
```




```
<?xml version="1.0" encoding="UTF-8"?>

<additional xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="http://sumo-sim.org/xsd/additional_file.xsd">
    <poly id="100136731" type="sport.basketball" color="51,128,255" fill="1" layer="-1.00" shape="4857.71,5616.04 4858.61,5600.61 4886.26,5602.20 4885.36,5617.63 4857.71,5616.04"/>
    <poly id="100136733" type="sport.tennis" color="51,128,255" fill="1" layer="-1.00" shape="4838.80,5652.45 4840.64,5616.97 4886.44,5619.32 4884.60,5654.82 4838.80,5652.45"/>
```

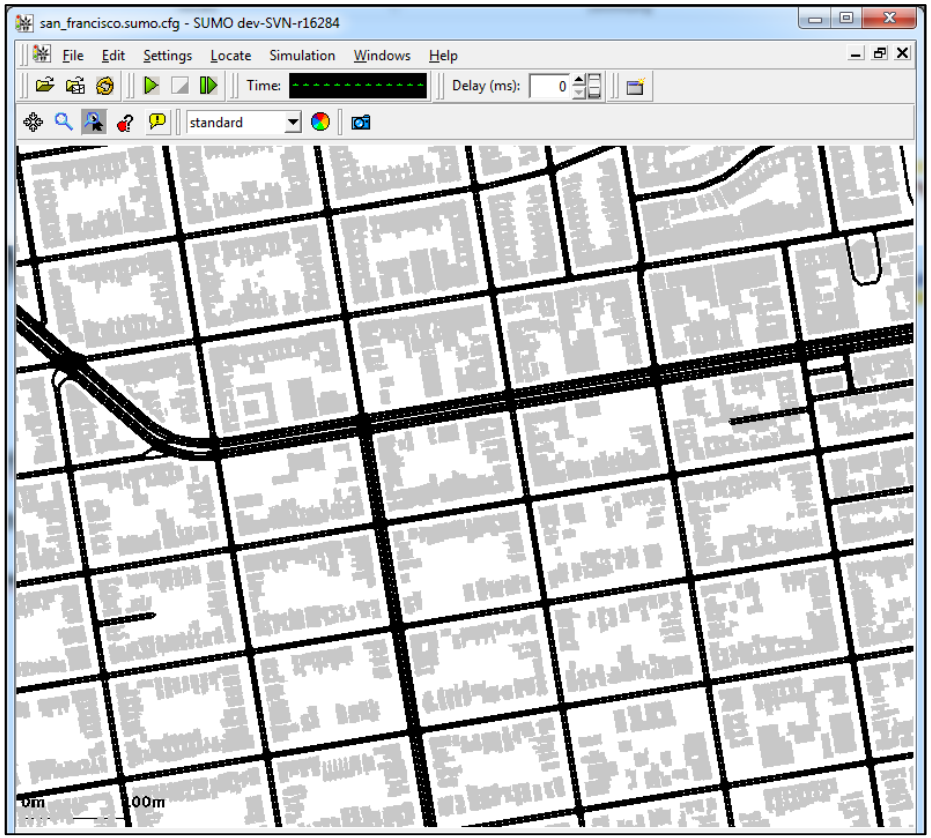
Improvements:

- copy content from OSM file to a spatial database e.g. Spatialite

- use SQL queries for the geometries

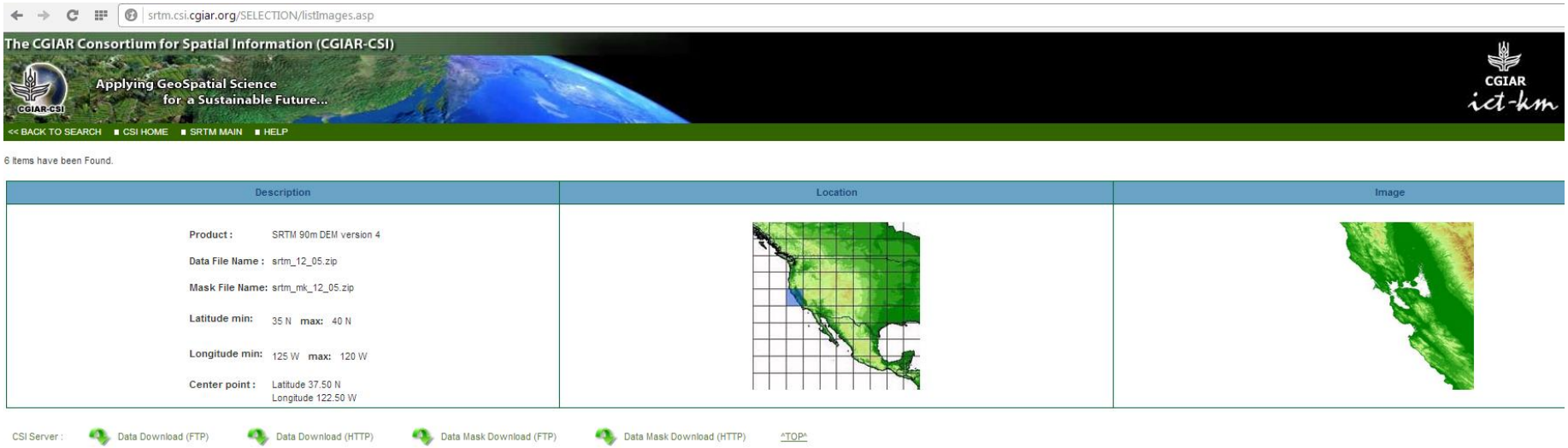
- write polygon XML file (e.g. DOM4J)

- decide the necessary accuracy level



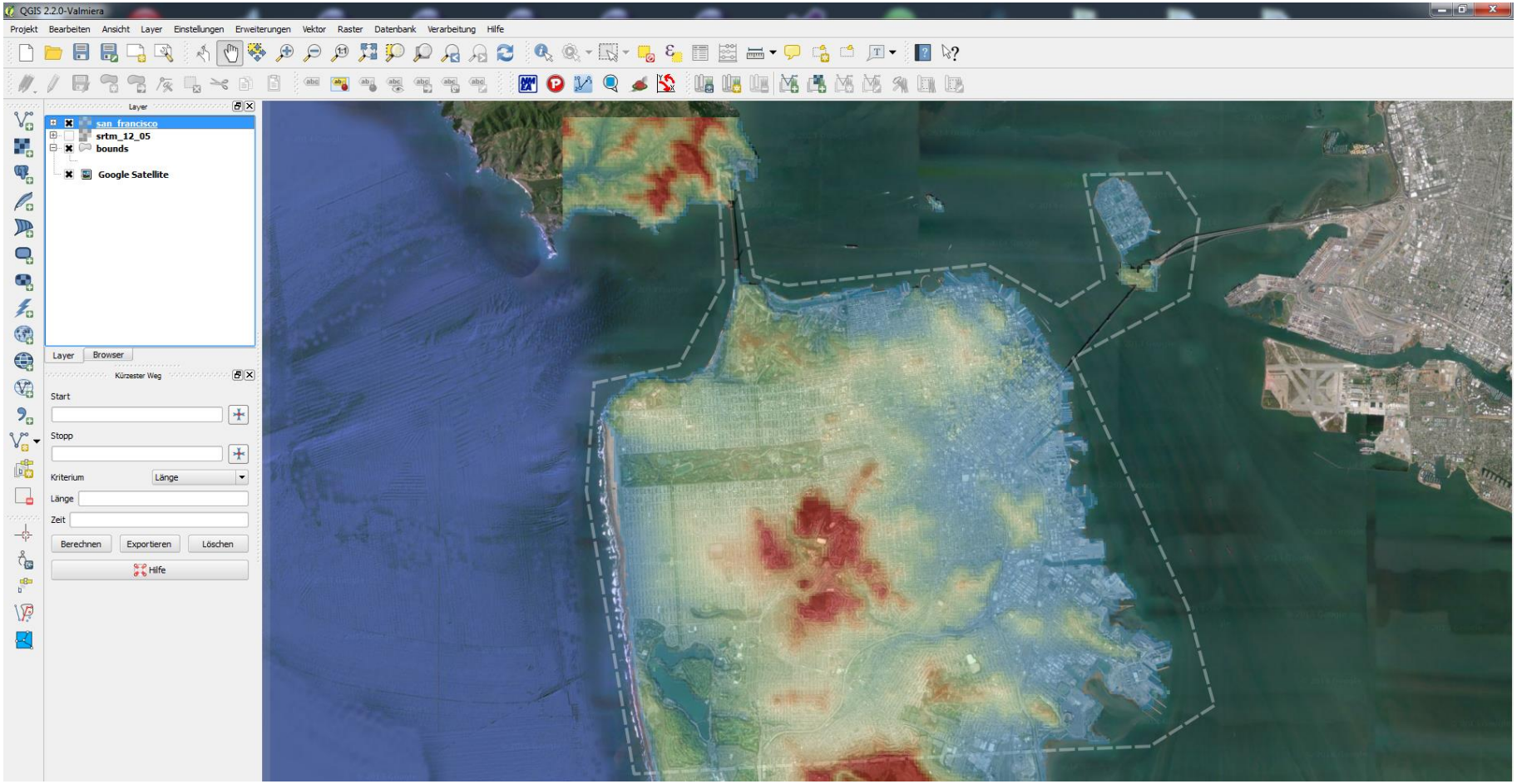
Add elevation data:

- download GeoTiff (image with embedded geographical/elevation data)
- Mapmatching with existing network



http://www.cgiar-csi.org/data/srtm-90m-digital-elevation-database-v4-1

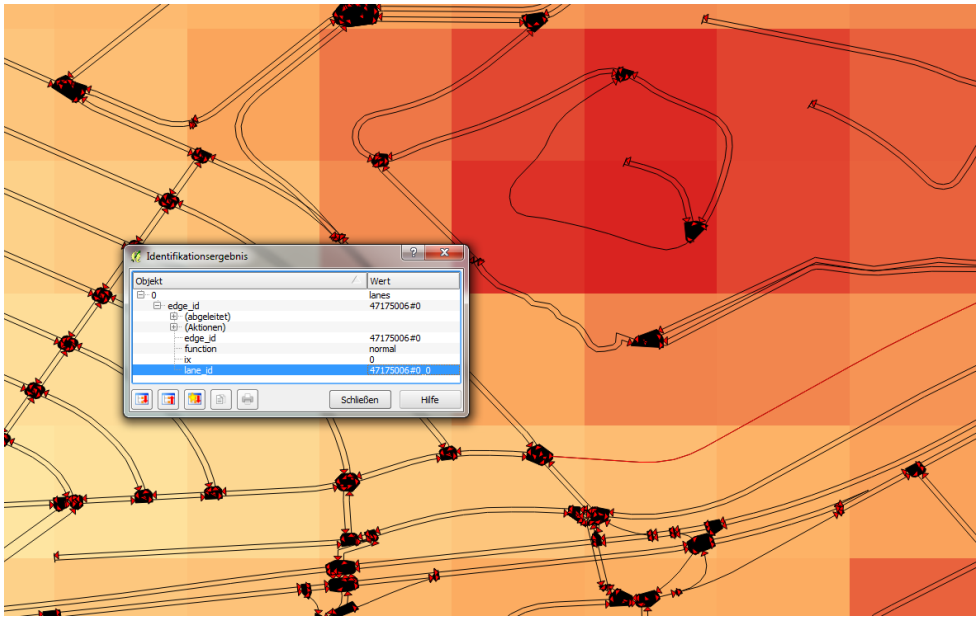
- Visualization of elevation data with QGIS

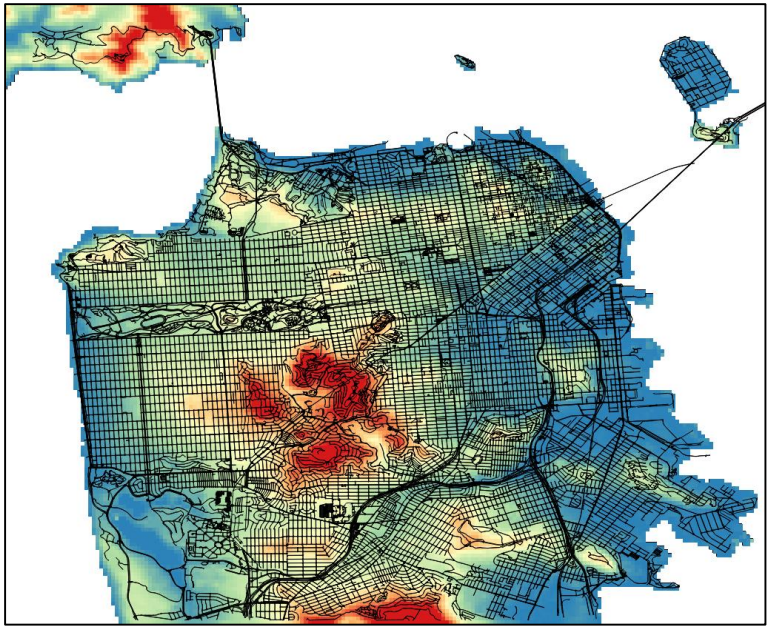


Source: Google Maps (aerial image)

Add elevation data

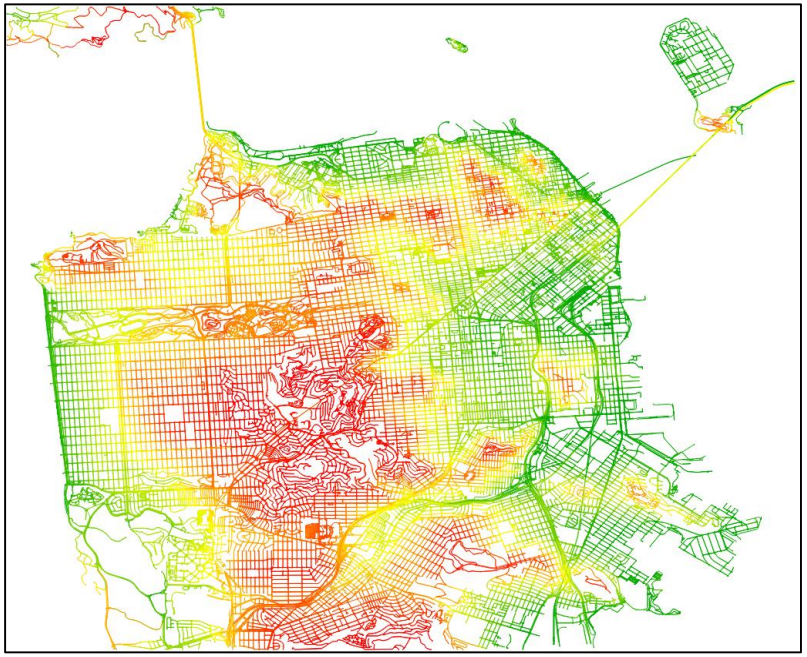
- Convert SUMO network to well-known spatial file format with Geotools
- Import spatial file in QGIS
- Add another layer for elevation data

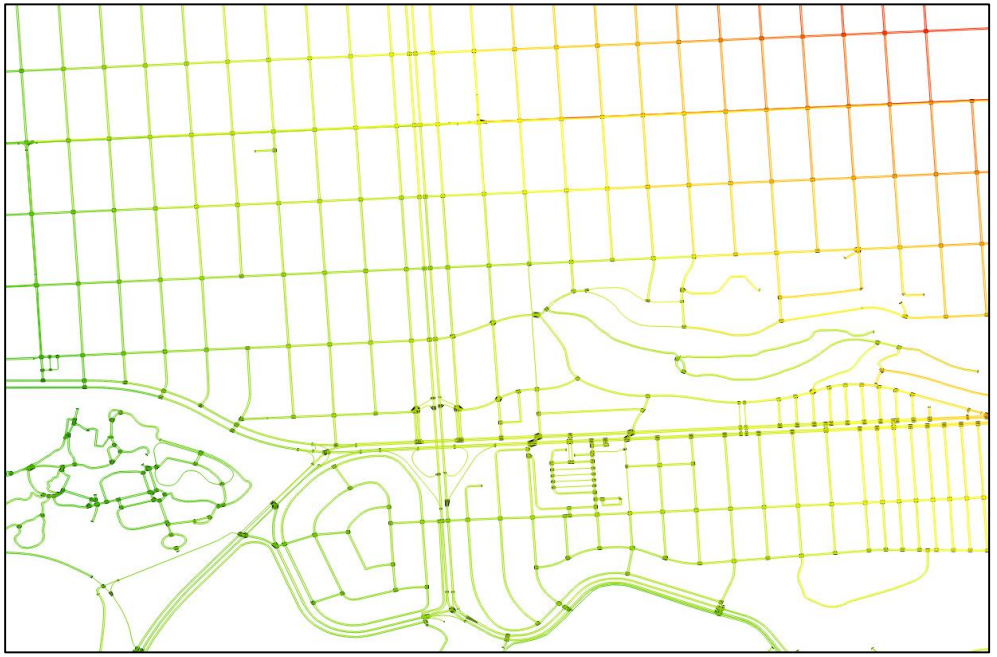




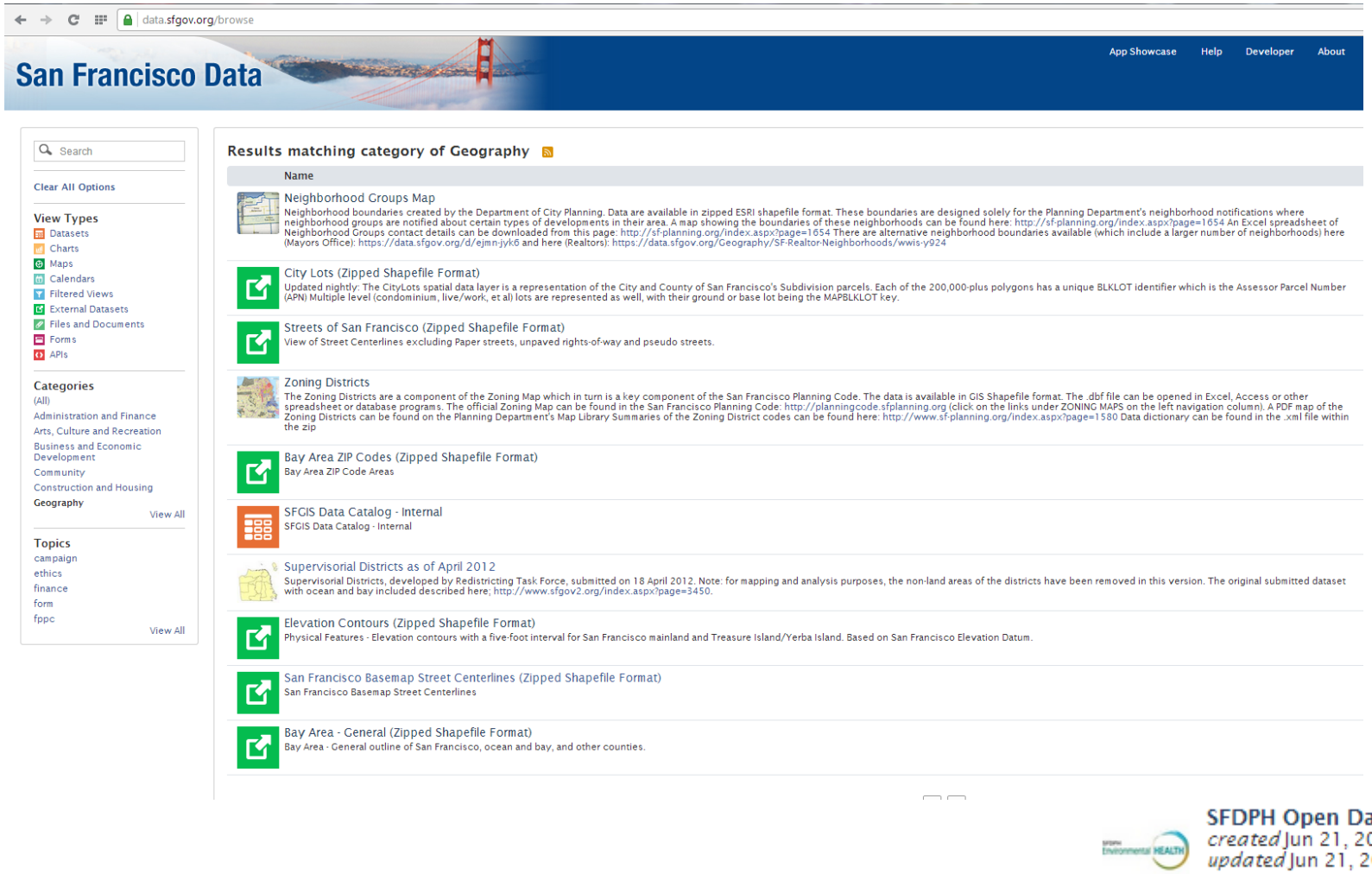
Add elevation data

- GIS processing (matching algorithm) to add an elevation value for each point
  - → QGIS
  - → Geotools
  - → ...
- Export to SUMO netfile





Import traffic related data



https://data.sfgov.org

- Import positions of traffic signals

Explanation:

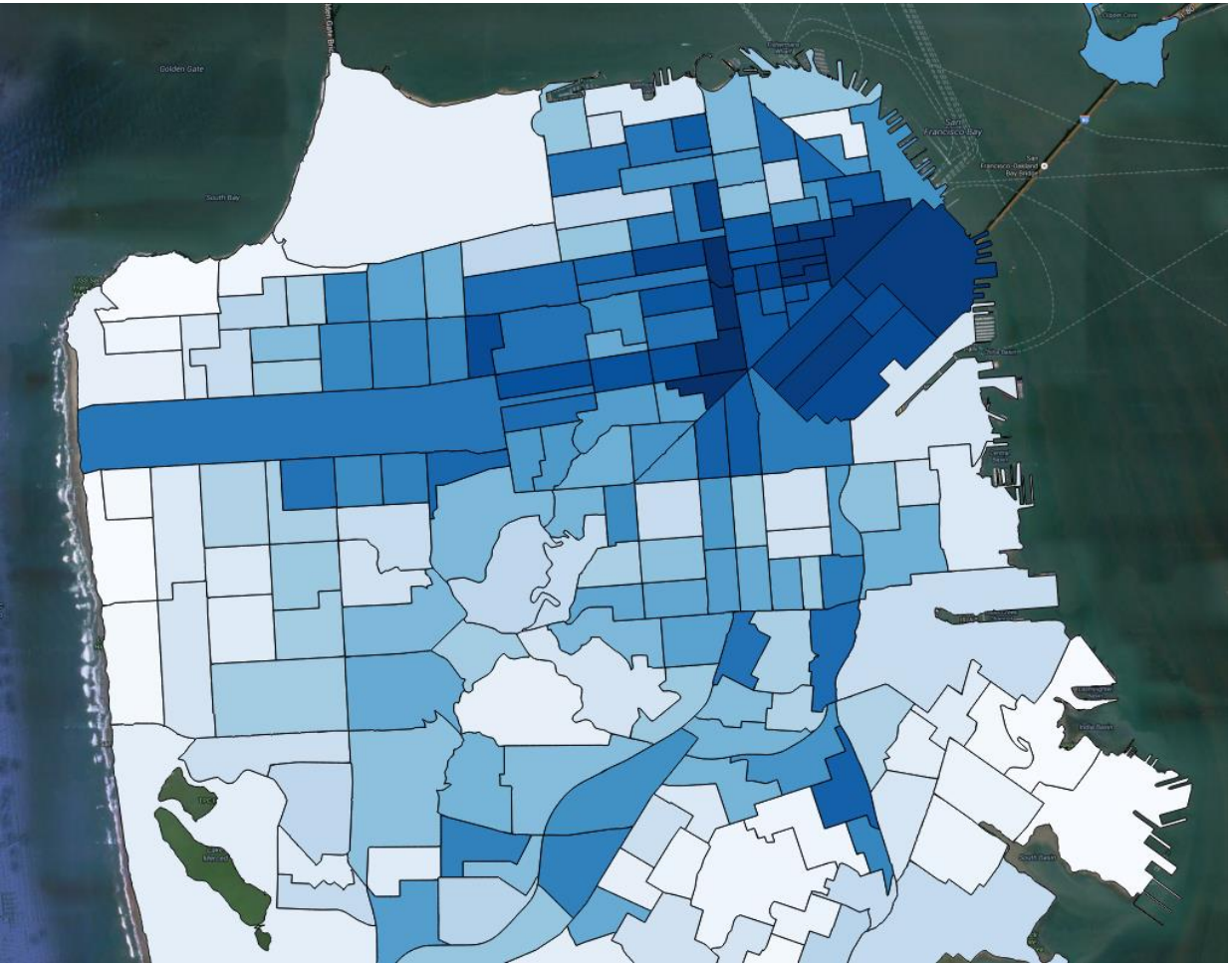
SF Government

OSM

Source: Google Maps (aerial image)

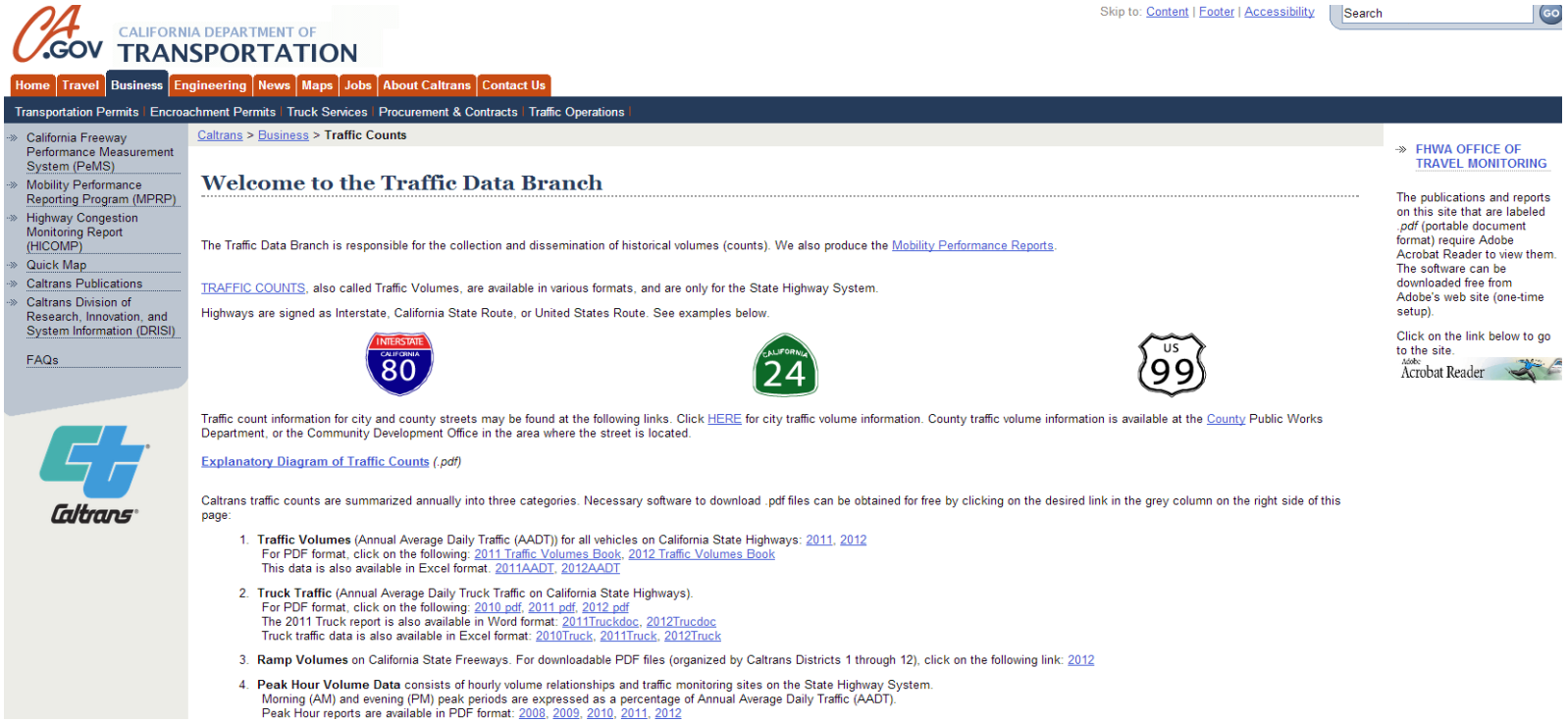
Import traffic related data

- Import traffic density
- → Try to build O/D matrices?



Source: Google Maps (aerial image)

- Import traffic volumes



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- FAQs

Caltrans > Business > Traffic Counts

Welcome to the Traffic Data Branch

The Traffic Data Branch is responsible for the collection and dissemination of historical volumes (counts). We also produce the Mobility Performance Reports.

TRAFFIC COUNTS, also called Traffic Volumes, are available in various formats, and are only for the State Highway System.

Highways are signed as Interstate, California State Route, or United States Route. See examples below.

INTERSTATE CALIFORNIA 80 CALIFORNIA 24 US 99

Traffic count information for city and county streets may be found at the following links. Click HERE for city traffic volume information. County traffic volume information is available at the County Public Works Department, or the Community Development Office in the area where the street is located.

Explanatory Diagram of Traffic Counts *(.pdf)*

Caltrans traffic counts are summarized annually into three categories. Necessary software to download .pdf files can be obtained for free by clicking on the desired link in the grey column on the right side of this page:

1. **Traffic Volumes** (Annual Average Daily Traffic (AADT)) for all vehicles on California State Highways: 2011, 2012
   For PDF format, click on the following: 2011 Traffic Volumes Book, 2012 Traffic Volumes Book
   This data is also available in Excel format. 2011AADT, 2012AADT
2. **Truck Traffic** (Annual Average Daily Truck Traffic on California State Highways).
   For PDF format, click on the following: 2010 pdf, 2011 pdf, 2012 pdf
   The 2011 Truck report is also available in Word format: 2011Truckdoc, 2012Trucdoc
   Truck traffic data is also available in Excel format: 2010Truck, 2011Truck, 2012Truck
3. **Ramp Volumes** on California State Freeways. For downloadable PDF files (organized by Caltrans Districts 1 through 12), click on the following link: 2012
4. **Peak Hour Volume Data** consists of hourly volume relationships and traffic monitoring sites on the State Highway System.
   Morning (AM) and evening (PM) peak periods are expressed as a percentage of Annual Average Daily Traffic (AADT).
   Peak Hour reports are available in PDF format: 2008, 2009, 2010, 2011, 2012

FHWA OFFICE OF TRAVEL MONITORING

The publications and reports on this site that are labeled *.pdf* (portable document format) require Adobe Acrobat Reader to view them. The software can be downloaded free from Adobe's web site (one-time setup).

Click on the link below to go to the site.

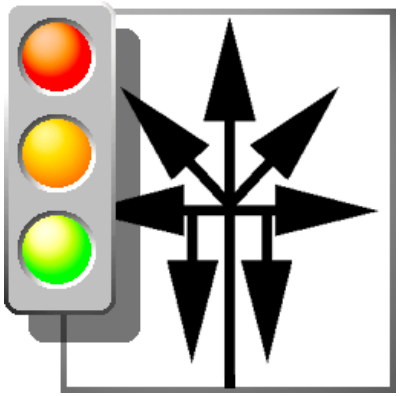
Adobe Acrobat Reader

Dist	Route	County		Postmile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak AADT	Ahead AADT
4	1	SF	R	0	SAN MATEO/SAN FRANCISCO COUNTY LINE				7600	111000	109000
4	1	SF	R	0,105	SAN FRANCISCO, ALEMANY BLVD	7600	111000	109000	7000	103000	101000
4	1	SF	R	0,312	BROTHERHOOD WAY/STANLEY DR	7000	103000	101000	6600	96000	94000

https://data.sfgov.org

- Traffic simulation with SUMO

TRAAS



Your Code ⟷ **TraCI Client** ⟷ **SUMO**

Conclusion

Open Data is/becomes available in various fields

- Pro: free to use, edit, share
- Contra:
  - Crowd based (different skills)
  - Completeness, accuracy …

- Combination of different data sources possibly increase the quality
- Checks/filters are highly recommended

→ **Open Source matters!**

Thank you for your attention