Comparing INSPIRE and OpenStreetMap data: how to make the most out of the two worlds

Marco Minghini, Alexander Kotsev & Michael Lutz

European Commission – Joint Research Centre (JRC), Ispra, Italy

Bucharest, 29/08/2019

FOSS4G BUCHAREST 2019

44.43555, 26.102347

European Commission

Introduction

- Recent changes in production, access & sharing of geospatial information:
  - until the end of last century: limited to professionals and National Mapping Agencies (NMAs)
  - 1994: Spatial Data Infrastructure (SDI)
    - driven by governments and NMAs
    - OGC standards for geospatial interoperability
    - from local to national/international scales
  - 2007: Volunteered Geographic Information (VGI)
    - crowdsourced geospatial data
    - enabled by mobile, Web & remote sensing technology
    - several projects in several disciplines

Purpose of the work

- Analyze the most relevant initiatives for Europe related to SDIs and VGI:
  - Infrastructure for Spatial Information in Europe (INSPIRE)
  - OpenStreetMap (OSM)
- Compare them for a number of characteristics & outline pros & cons:
  1. Overall approach
  2. Spatial scope
  3. Data structure and encoding
  4. Data access
  5. Licensing
- Review available FOSS4G solutions specific to INSPIRE and OSM
- Discuss on the combination/integration of the two initiatives

INSPIRE

DIRECTIVE 2007/2/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 14 March 2007

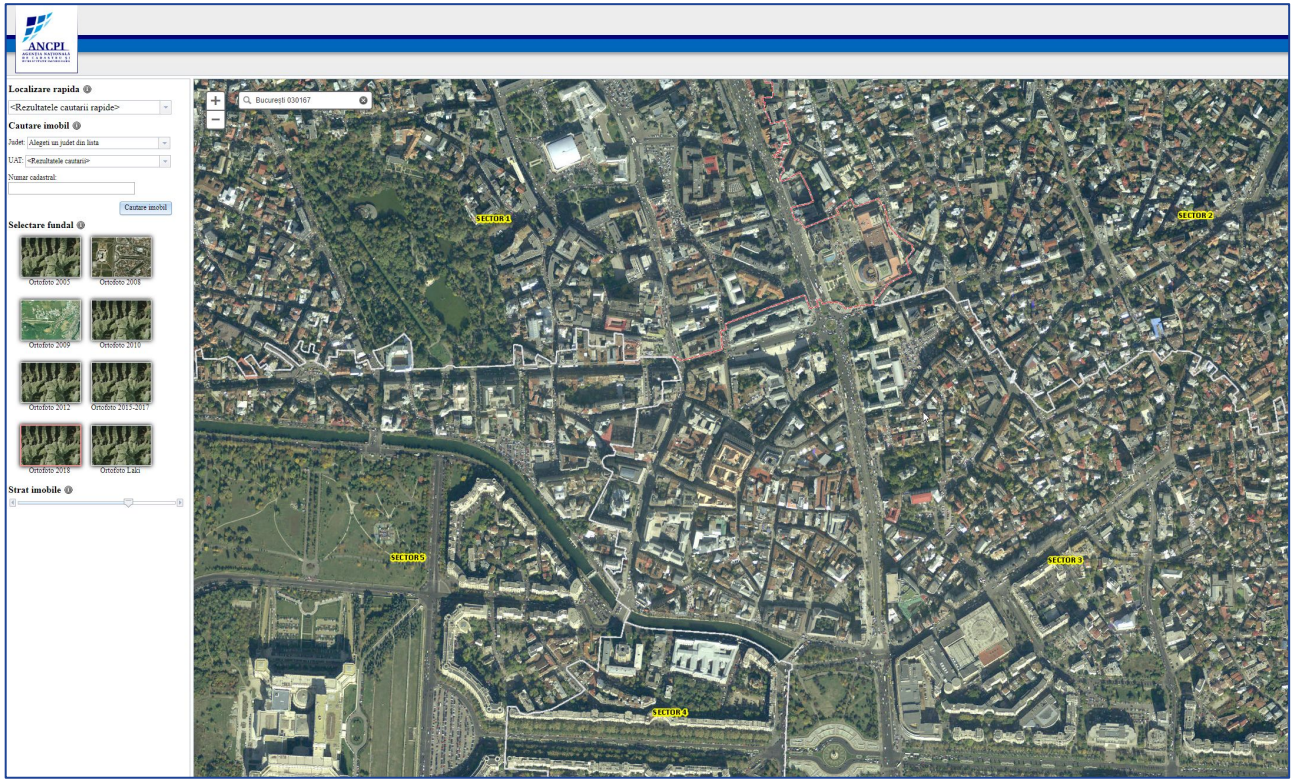
establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

- Aims to create a European SDI for the purposes of EU environmental policies.
- Provides a comprehensive framework for interoperability of spatial data:
  - environmental spatial data sharing
  - assisting in cross-boundary policy-making
- In force since 2007 and implemented in various stages, with full implementation required by 2020

https://inspire.ec.europa.eu

INSPIRE

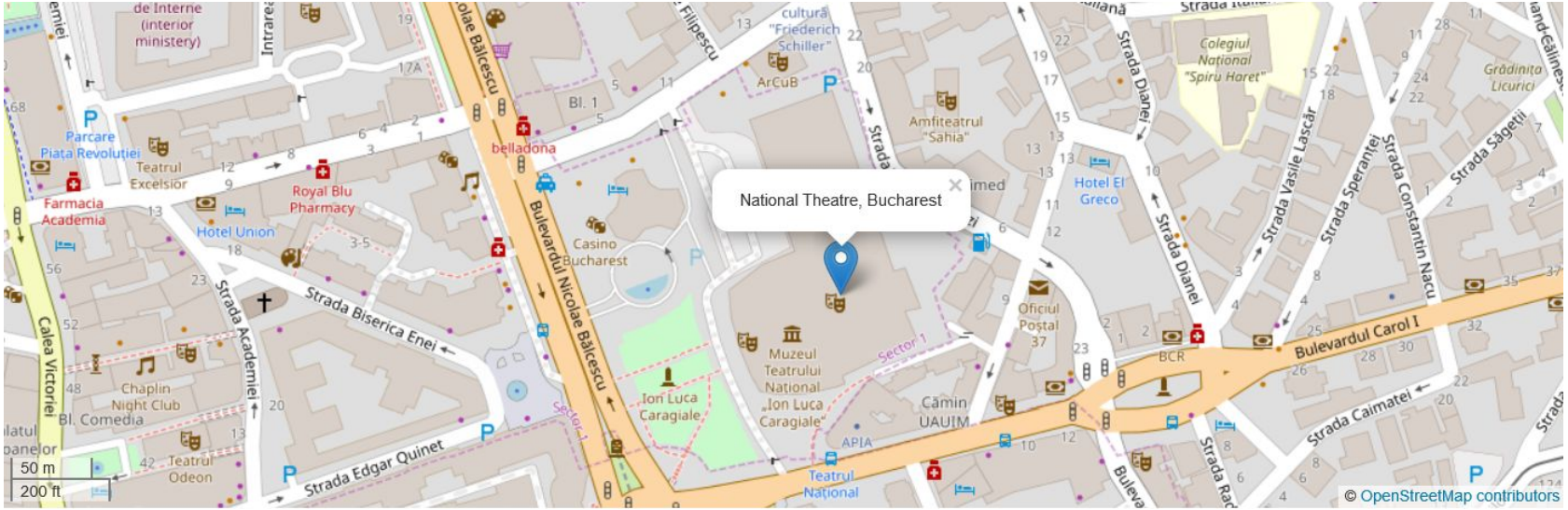
- Based on the SDIs established and operated by EU Member States



European Commission

OpenStreetMap (OSM)

- The most popular VGI project to date:
  - started by Steve Coast in UK in 2004
  - a free, editable geospatial database of the world edited by volunteers

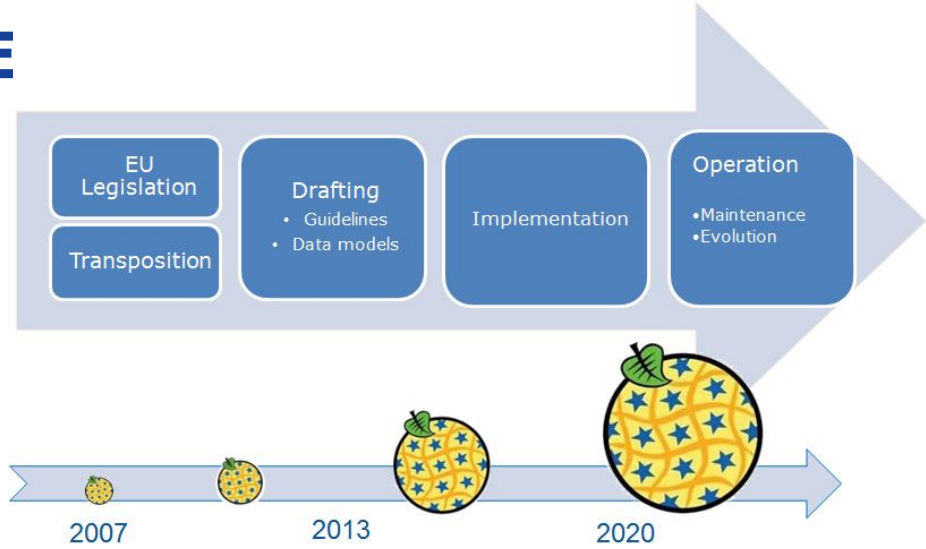


https://www.openstreetmap.org
https://wiki.openstreetmap.org/wiki/About_OpenStreetMap

European Commission

1. Approach – INSPIRE

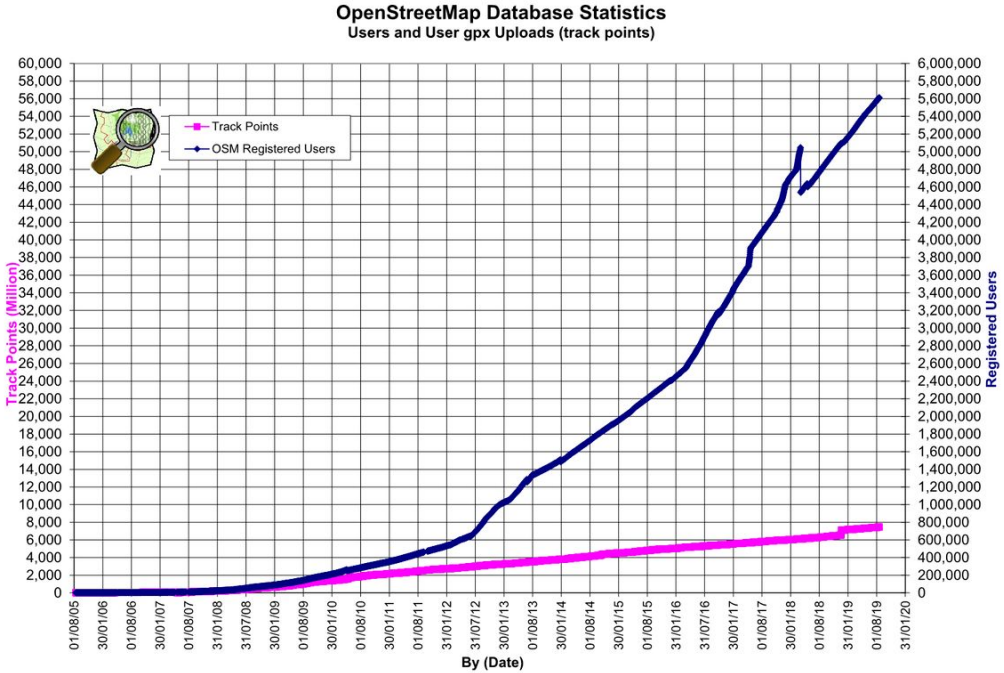
- Top-down initiative:
  - Public sector data
  - Legislatively defined
  - Transposition in MS
  - Governance (CT, MIG)
- Implementation
- Maintenance and evolution
- Growing community:
  - 7200+ providers
  - Broader than the EU
  - Annual conference
    - Helsinki 2019
    - Dubrovnik 2020



INSPIRE CONFERENCE 2020
DUBROVNIK - CROATIA

1. Approach – OpenStreetMap

- Bottom-up initiative:
  - created, updated & maintained by 1M+ contributors



https://wiki.openstreetmap.org/wiki/Stats

1. Approach – OpenStreetMap

- Bottom-up initiative:
  - created, updated & maintained by 1M+ contributors
- Supported (not controlled) by the OpenStreetMap Foundation (OSMF):
  - Board
  - several Working Groups

https://wiki.osmfoundation.org/wiki/Main_Page

1. Approach – OpenStreetMap

- Bottom-up initiative:
  - created, updated & maintained by 1M+ contributors
- Supported (not controlled) by the OpenStreetMap Foundation (OSMF):
  - Board
  - several Working Groups
- Annual "State of the Map" community conference:

https://2019.stateofthemap.org

2. Spatial scope – INSPIRE

- 34 spatial data themes for environmental applications:
  - 340 spatial object types
  - incl. raster, historical, spatio-temporal

ANNEX: 1

- Addresses
- Administrative units
- Cadastral parcels
- Coordinate reference systems
- Geographical grid systems
- Geographical names
- Hydrography
- Protected sites
- Transport networks

ANNEX: 2

- Elevation
- Geology
- Land cover
- Orthoimagery

ANNEX: 3

- Agricultural and aquaculture facilities
- Area management / restriction / regulation zones & reporting units
- Atmospheric conditions
- Bio-geographical regions
- Buildings
- Energy resources
- Environmental monitoring facilities
- Habitats and biotopes
- Human health and safety
- Land use
- Meteorological geographical features
- Mineral resources
- Natural risk zones
- Oceanographic geographical features
- Population distribution and demography
- Production and industrial facilities
- Sea regions
- Soil
- Species distribution
- Statistical units
- Utility and governmental services

https://inspire.ec.europa.eu/Themes/Data-Specifications/2892

2. Spatial scope – OpenStreetMap

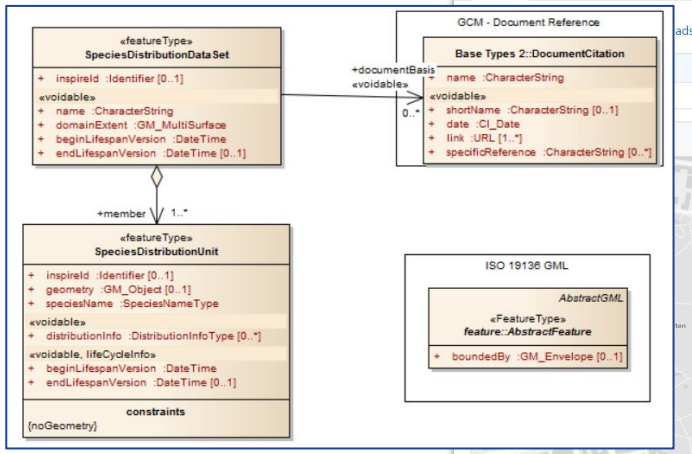
- The richest and most diverse geospatial database:
  - any verifiable object with a physical location can be mapped
  - several hundreds spatial object types, but no historical events
  - list maintained & updated collaboratively on the Map Features wiki page

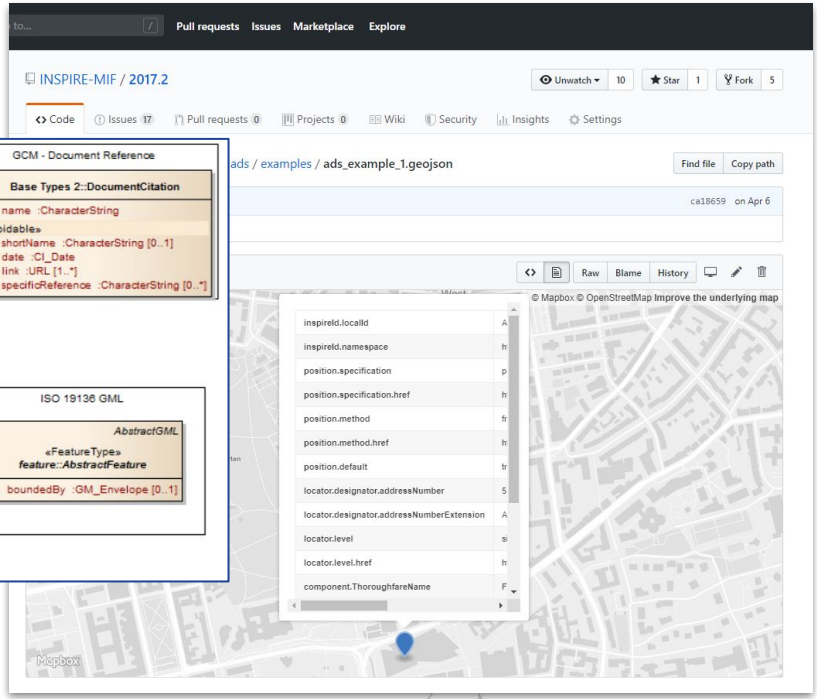
building	cathedral		A building that was built as a cathedral. Used in conjunction with amenity=place_of_worship, religion=*, denomination=* and landuse=religious for the cathedral grounds where it is in current use.	
building	chapel		A building that was built as a chapel. Used in conjunction with amenity=place_of_worship, religion=*, denomination=* and landuse=religious for the chapel grounds where it is in current use.	
building	church		A building that was built as a church. Used in conjunction with amenity=place_of_worship, religion=* , denomination=* and landuse=religious for the church grounds where it is in current use.	
building	mosque		A mosque. Used in conjunction with amenity=place_of_worship, religion=*, denomination=* and landuse=religious for the grounds where it is in current use.	

https://wiki.openstreetmap.org/wiki/Map_Features

3. Data structure and encoding – INSPIRE

- Conceptual data model (UML class diagrams) allows complex data structures
  - 300+ predefined spatial object types
- Encoding based on same conceptual model
- Default encoding
  - GML
- Alternative encodings
  - GeoJSON
  - Geopackage (tbd)
- Central component
  - Registry
- Validation
  - Abstract & Executable test suites
  - INSPIRE Reference Validator





https://inspire.ec.europa.eu/Data-Models/Data-Specifications/2892

European Commission

3. Data structure and encoding – OpenStreetMap

- Conceptual data model is based on a flat data structure
- Any object is described by:
  - an element (geometry) – node, way or relation
  - one or more tags (simple attributes based on key-value pairs)
- Tags are flexible – contributors can introduce new ones!
- Only basic data validation (e.g. on topology) available

```
<node id="3654216212" visible="true" version="1" changeset="32673542"
      timestamp="2015-07-16T13:09:34Z" user="alexs68" uid="3068291" lat="45.8101242" lon="9.0830260">
 <tag k="addr:city" v="Como"/>
 <tag k="addr:country" v="IT"/>
 <tag k="addr:housenumber" v="34"/>
 <tag k="addr:postcode" v="22100"/>
 <tag k="addr:street" v="Via Bernardino Luini"/>
</node>
```

https://wiki.openstreetmap.org/wiki/Elements
https://wiki.openstreetmap.org/wiki/Tags

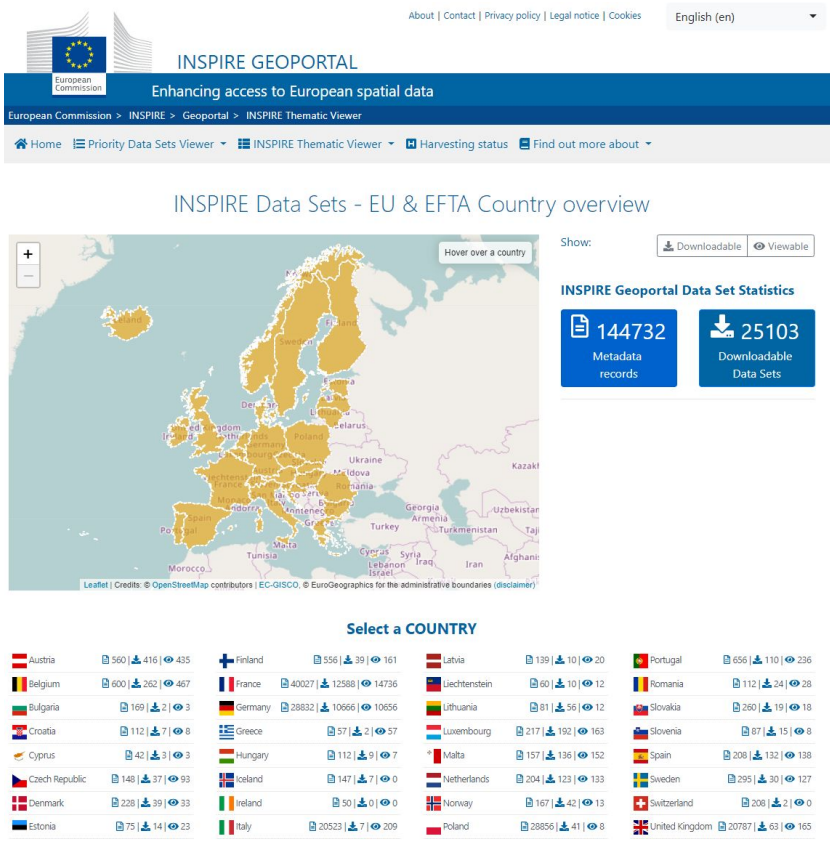
3. Data Coordinate Reference System

- **INSPIRE**
  - Specific 2D and 3D pan-European CRSs are required:
    - based on both geodetic and plane coordinates
  - Provision of data sets in additional CRSs under current discussion
    - would lower the implementation burden
    - CRS transformation to be implemented using FOSS4G tools (e.g. proj4, GDAL)

- **OpenStreetMap**
  - All data provided in WGS84 (with no 3D component):
    - intrinsic CRS compatibility

4. Data access – INSPIRE

- Based on
  - OGC standards
  - Distributed SOA approach
- APIs (aka Network Services)
  - Discovery (CSW)
  - View (WMS, WMTS)
  - Download (ATOM, WFS, SOS, WCS)
- INSPIRE Geoportal
  - Single access point of view
  - One of many perspectives on INSPIRE data

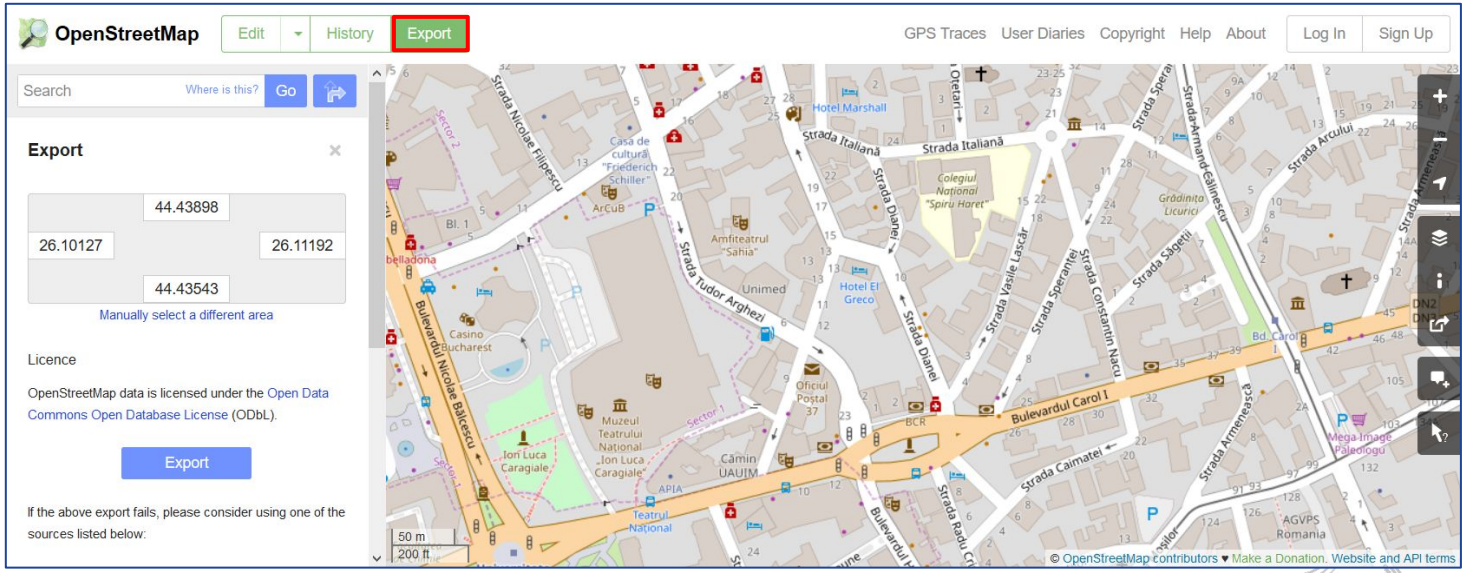


https://inspire-geoportal.ec.europa.eu

European Commission

4. Data access – OpenStreetMap

- No metadata catalogues, search is only based on tags
- Several ways to access data:
  - Export button from the OSM website

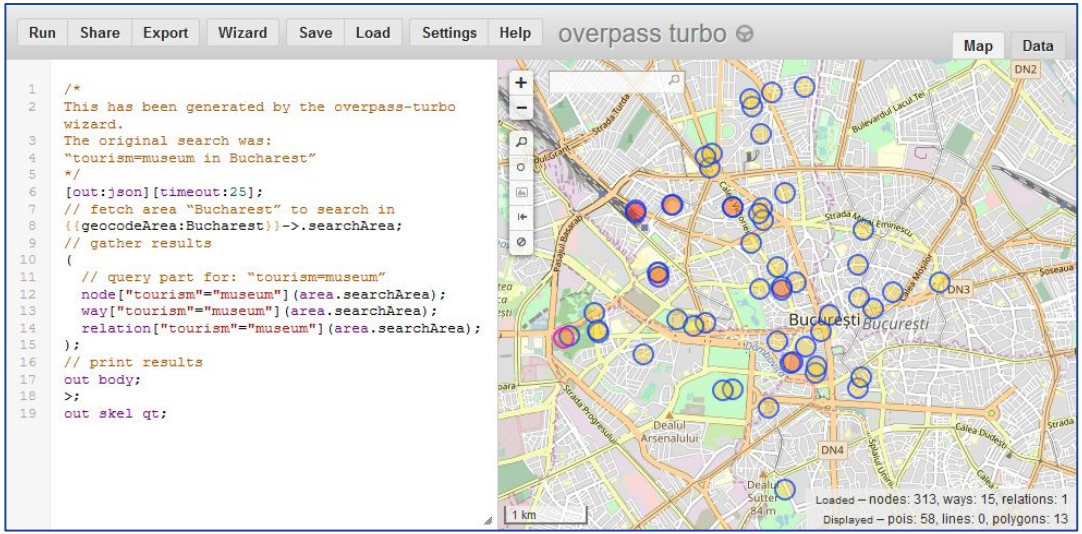


https://www.openstreetmap.org/export

European Commission

4. Data access – OpenStreetMap

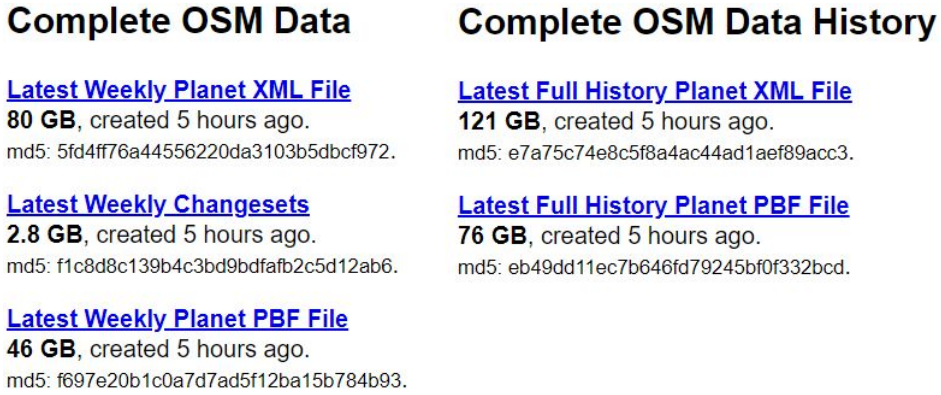
- No metadata catalogues, search is only based on tags
- Several ways to access data:
  - Export button from the OSM website
  - APIs
    - OSM API
    - Overpass API
    - Ohsome platform



https://wiki.openstreetmap.org/wiki/API
https://wiki.openstreetmap.org/wiki/Overpass_API
https://heigit.org/big-spatial-data-analytics-en/ohsome

4. Data access – OpenStreetMap

- No metadata catalogues, search is only based on tags
- Several ways to access data:
  - Export button from the OSM website
  - APIs
    - OSM API
    - Overpass API
    - Ohsome platform
  - Planet & Full History Planet



Complete OSM Data

Latest Weekly Planet XML File
80 GB, created 5 hours ago.
md5: 5fd4ff76a44556220da3103b5dbcf972.

Latest Weekly Changesets
2.8 GB, created 5 hours ago.
md5: f1c8d8c139b4c3bd9bdfafb2c5d12ab6.

Latest Weekly Planet PBF File
46 GB, created 5 hours ago.
md5: f697e20b1c0a7d7ad5f12ba15b784b93.

Complete OSM Data History

Latest Full History Planet XML File
121 GB, created 5 hours ago.
md5: e7a75c74e8c5f8a4ac44ad1aef89acc3.

Latest Full History Planet PBF File
76 GB, created 5 hours ago.
md5: eb49dd11ec7b646fd79245bf0f332bcd.

https://planet.openstreetmap.org
https://planet.openstreetmap.org/planet/full-history

4. Data access – OpenStreetMap

- No metadata catalogues, search is only based on tags
- Several ways to access data:
  - Export button from the OSM website
  - APIs
    - OSM API
    - Overpass API
    - Ohsome platform
  - Planet & Full History Planet
  - predefined OSM extracts
    - by Geofabrik, Interline, HR University of Applied Science, etc.

http://download.geofabrik.de
https://www.interline.io/osm/extracts
https://osmaxx.hsr.ch

5. Data license

- **INSPIRE**
  - No obligation set on the data license:
    - the infrastructure is very heterogeneous
    - partially open access
    - multiple languages
    - View/Download services restricted under certain conditions

- **OpenStreetMap**
  - Database available under the Open Database License (ODbL)
    - since late 2012 (CC BY-SA 2.0 before)
    - fully open access

https://www.openstreetmap.org/copyright

FOSS4G tools – INSPIRE

- A very rich INSPIRE-compliant ecosystem:
  - data serving (WMS/WMTS, WFS, WCS, SOS):

  - data/metadata catalogues (CSW)

  - data consumption

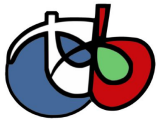
  - ETL (Extract-Transform-Load) tools

https://inspire-reference.jrc.ec.europa.eu/tools

FOSS4G tools – OpenStreetMap

- Many open source solutions for editing, download, visualization, routing & QA
- OSM's flat data structure makes OSM data usable by default in GIS software
- OSM-specific software mostly available for client applications:

  - plugins to download OSM data/basemaps: *QuickOSM*, *OSMDownloader*, *OpenLayers Plugin*, *QuickMapServices*



  - *OSMDownloader* application to download raw OSM data and use it to train classification models

  - download OSM data and correct topology

  - load OSM basemaps

  - load OSM basemaps as TMS layers

INSPIRE-OSM integration

- Combining data from the two would benefit several stakeholders:
  - public authorities, professionals, businesses, researchers, humanitarian organisations, and the same INSPIRE/OSM communities
- BUT the two initiatives are very different by nature, each with pros & cons:
  - INSPIRE
    - legal, technical & organisational reference
    - rigorous & complex requirements, slow implementation
    - service oriented architecture
    - license heterogeneity
  - OSM
    - simplicity & flexibility, huge data availability
    - heterogeneity of content
    - modern technologies & license interoperability

INSPIRE-OSM integration

- FOSS4G offers mature solutions for INSPIRE/OSM integration:
  - data search, access & download in client applications
  - data transformation to align data models
  - data encoding and web publication
- Only isolated, case study-specific examples of integration
  - benefits largely unexplored
  - need to establish an integrated framework
    - knowledge (technical, managerial, legal)
    - awareness (involvement of stakeholders)
- An effort is required!
- It is our shared interest to make the most out of INSPIRE & OSM

Minghini M., Kotsev A. & Lutz M. (2019) Comparing INSPIRE and OpenStreetMap data: How to make the most out of the two worlds. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XLII-4/W14, 167–174. https://doi.org/10.5194/isprs-archives-XLII-4-W14-167-2019

Thank you!

Questions?

marco.minghini@ec.europa.eu | alexander.kotsev@ec.europa.eu

@MarcoMinghini | @Alex_Kotsev

Inspire Helsinki 2019

22–24 October, Finland

- Organised by the Finnish National Land Survey and Ministry of Agriculture and Forestry & supported by the JRC of the European Commission and Spatineo.
- A technical event focused on new technologies for geospatial data:
  - keynote presentations
  - hands-on workshops
  - data challenges
    - team registration open until September 8, 2019
    - prizes and benefits worth more than 20’000€!

https://www.inspire-helsinki-2019.fi

Stay in touch

EU Science Hub: ***ec.europa.eu/jrc***

Twitter: ***@EU_ScienceHub***

Facebook: ***EU Science Hub - Joint Research Centre***

LinkedIn: ***Joint Research Centre***

YouTube: ***EU Science Hub***

European Commission