Web Mapping and Geovisualisation

Data Architecture and Formats

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Today

- Spatial Data
- Spatial Data Formats (old and new)
- Selecting the right format

Spatial Data

The data we use to represent space falls into one of two categories:

- **Vector**
- **Raster**

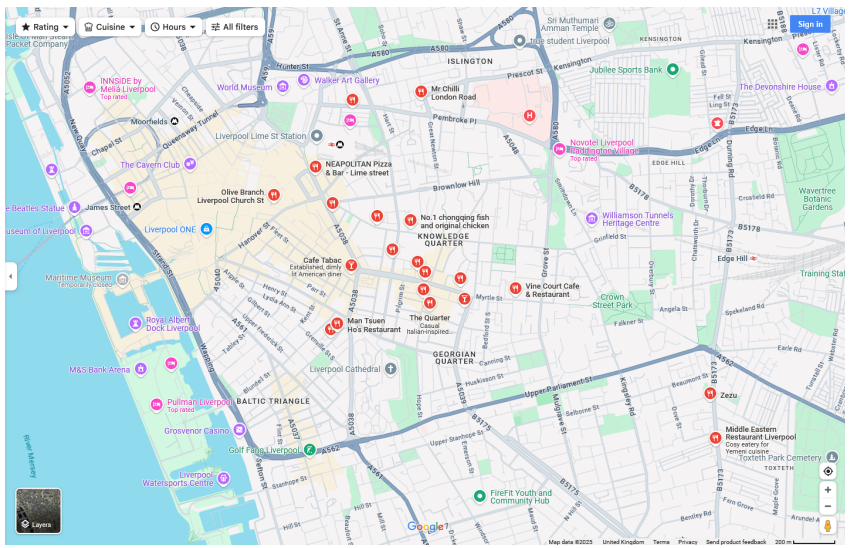
Vector

Space is divided into a finite set of entities, each of which is represented by a shape or geometry…

- (Multi-)Points
- (Multi-)Lines
- (Multi-)Polygons

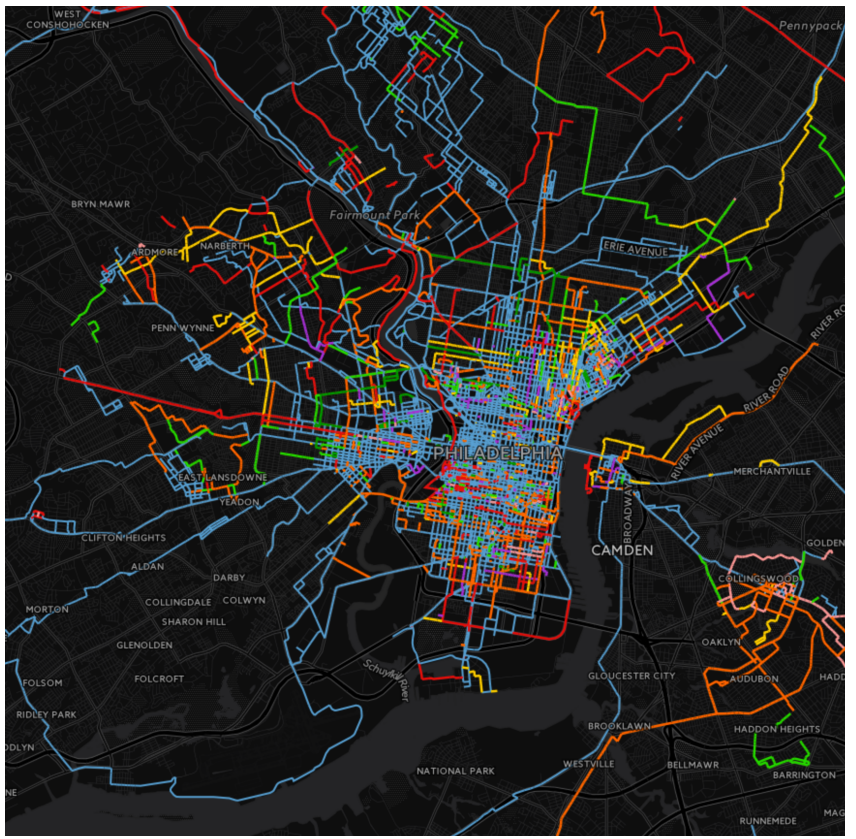
A few examples

Points



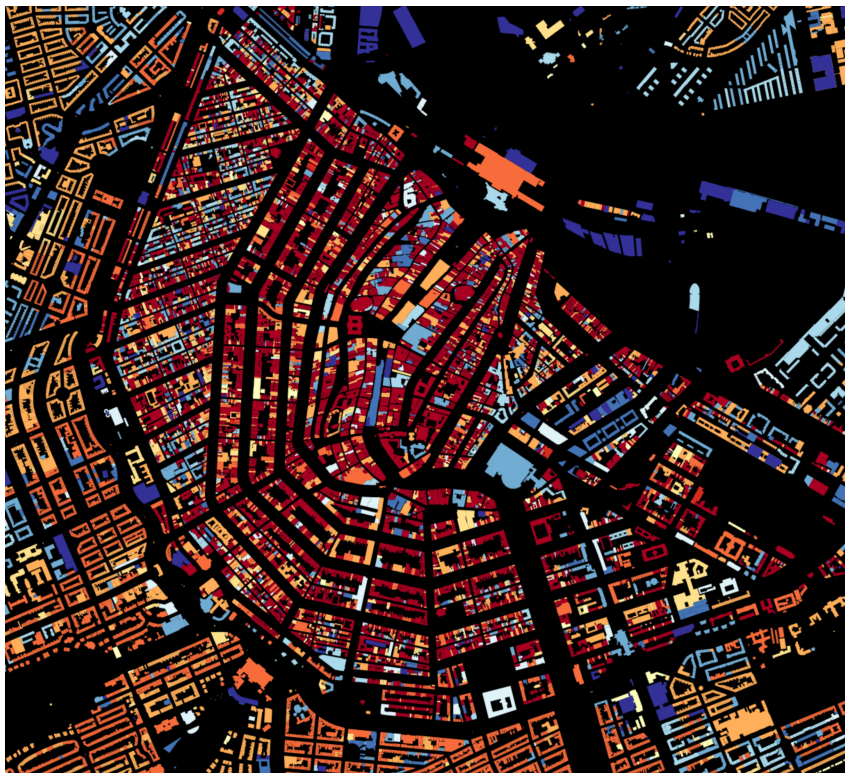
Source

Lines



Source

Polygons



Source

Combinations

Source

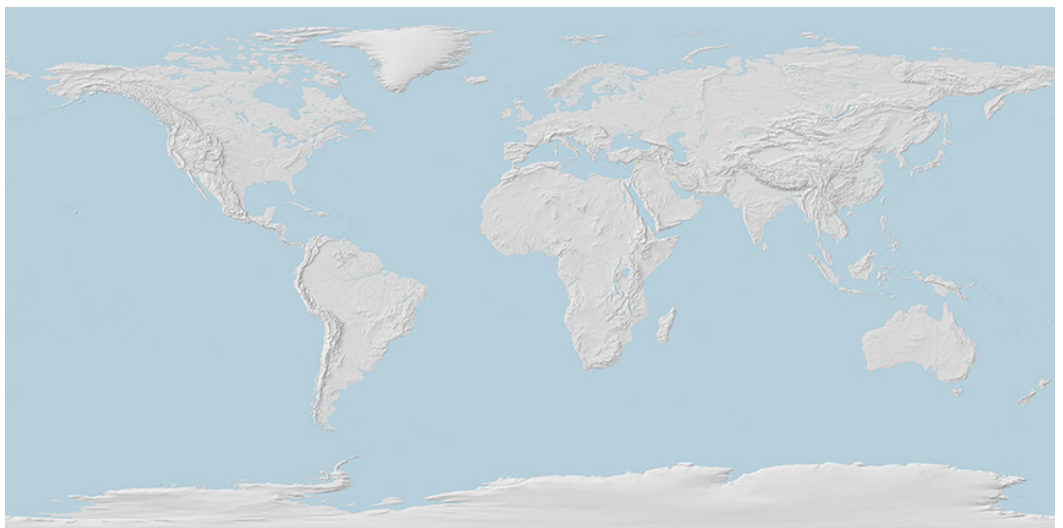
Raster

Use an image and control pixel colors to encode value

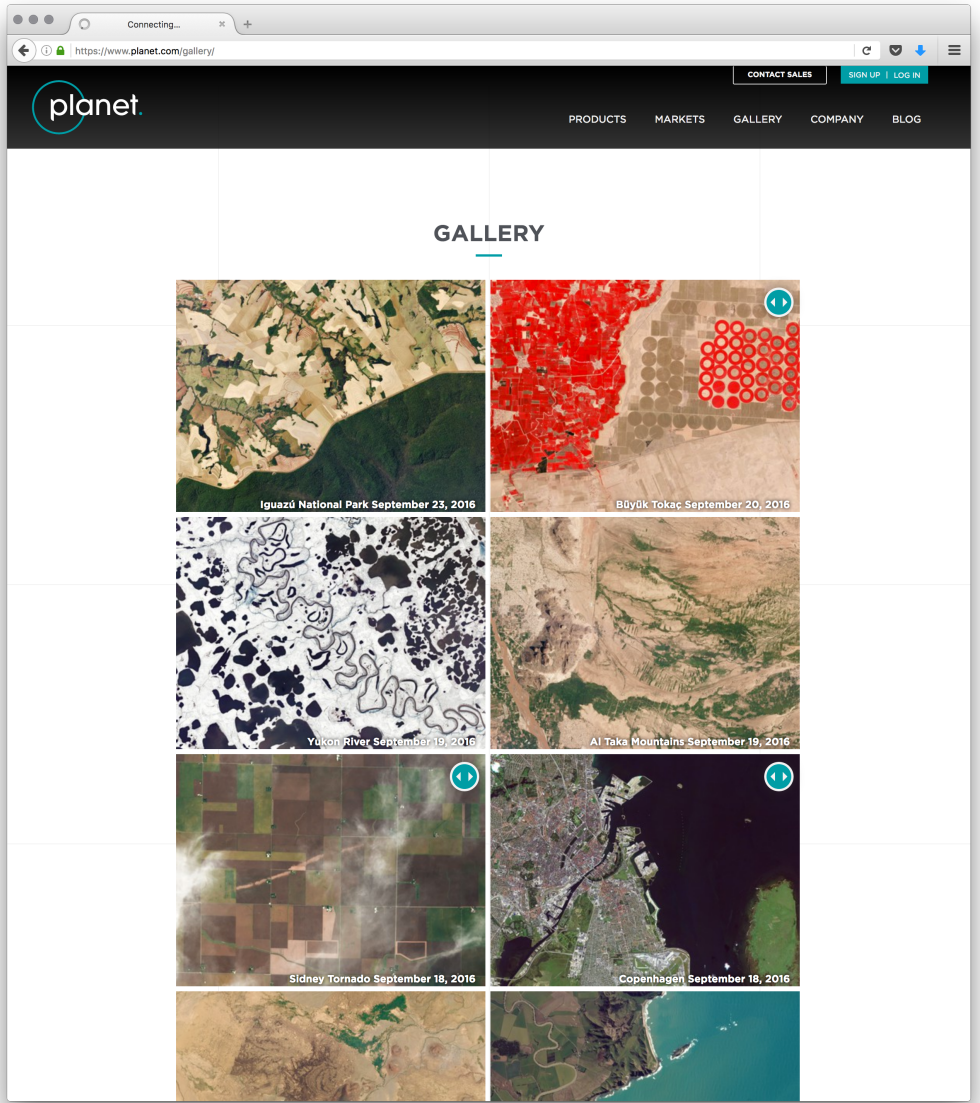
The value assigned for each cell represents the attribute of that cell, i.e:

- Continuous variables (temperature,elevation etc.)
- Satellite Imagery (e.g. land use/cover)

Continuous Example



Satellite Example



Spatial Data Formats

In general…

- Points, lines, polygons -> Vector Formats
- Images, surfaces -> Raster Formats

Traditional formats

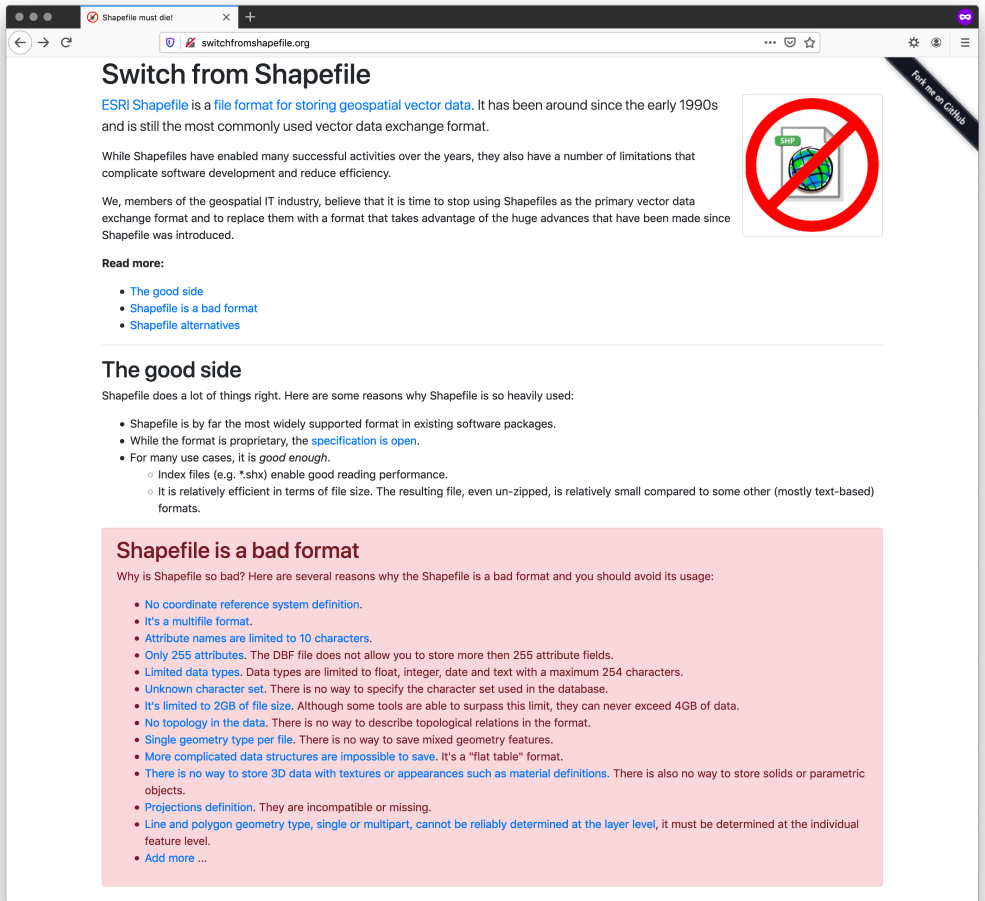
Vector - Individual entity type files: `shapefiles` etc.

Raster - Mostly (single) image formats: `GeoTIFFs` etc.

However…

many of these formats were designed for an *offline* world, so display some (or all) of the following:

- Binary
- “Unqueriable”
- complex structures



Switch from shapefile

Modern Formats

New formats have appeared aiming to *“fix”* those issues, but also responding to web needs:

- Streamable(e.g. `GeoJSON`)
- Queriable (e.g. `PostGIS/Geopackage`)
- Single files (e.g. `.mbtiles`)

We’ll be focusing on 2 specific examples…

GeoJSON

Source

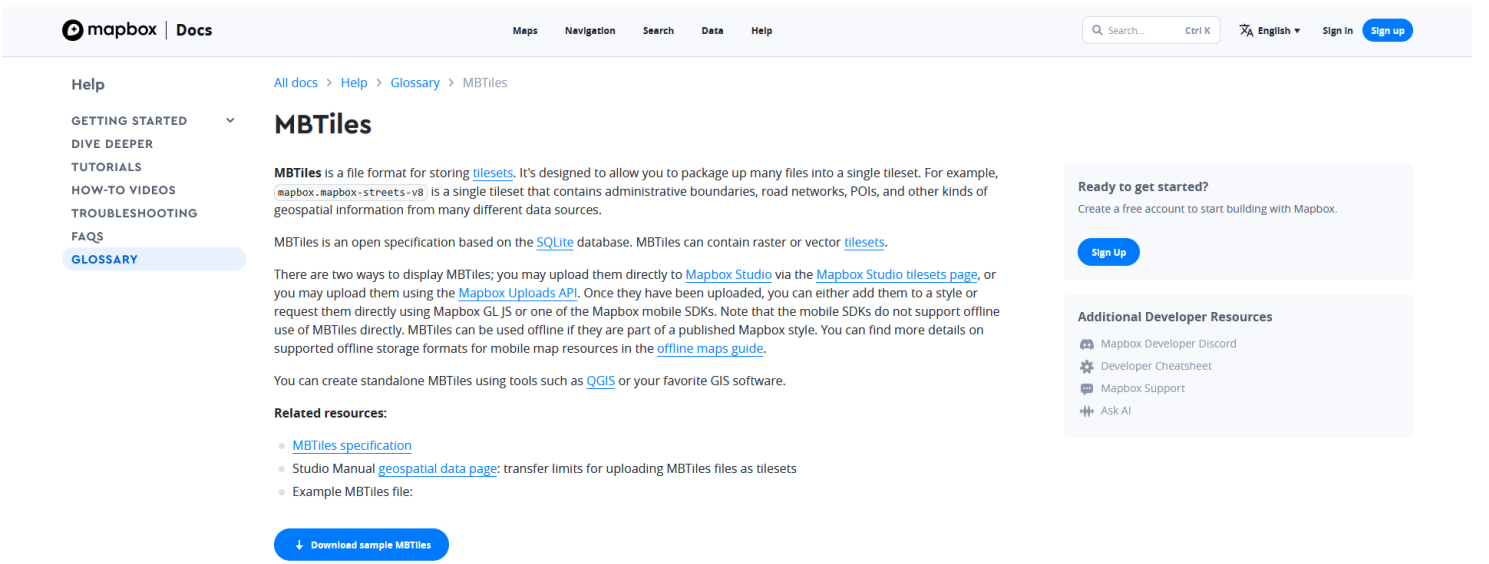
Advantages

- Plain text (Human readable)
- Streamable
- Well intergrated with web standards (`JSON`)

Disadvantages

- Plain text (inefficent)
- Non-queriable
- Vector only

Tilesets (.mbtiles)



Source

Why do we use tiles?

Tiles à la Google Maps: Coordi

https://www.maptiler.com/google-maps-coordinates-tile-bounds-projection/

How does a zoomable map work?

People are using coordinate systems and map projections to transform the shape of Earth into usable flat maps for centuries.

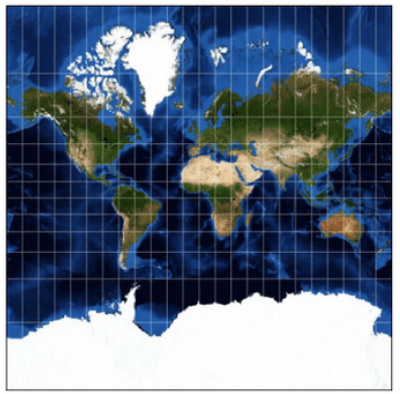
A map of the entire world is too big to be directly displayed in a computer so there is a clever mechanism for quick browsing and zooming on maps: the map tiles.

The world is divided into small squares, each with fixed geographic area and scale. This clever trick allows you to browse just a small part of the planet without loading the whole map - and you still get an illusion of exploring a single huge document.

Degrees
Geodetic coordinates
WGS84 (EPSG:4326)

Longitude and latitude coordinates used by GPS devices for defining position on Earth using World Geodetic System defined in 1984 (WGS84).

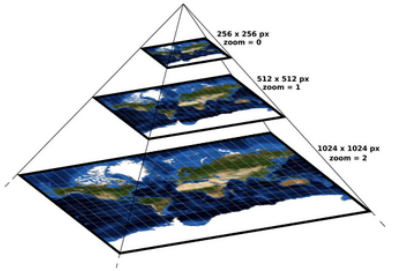
HINT: WGS84 geodetic datum specify lon/lat (lambda/phi) coordinates on defined ellipsoid shape with defined origin ([0,0] on a prime meridian).



Meters
Projected coordinates
Spherical Mercator
(EPSG:3857)

Global projected coordinates in meters for entire planet. Used for raster tile generation in GIS and WM(T)S services.

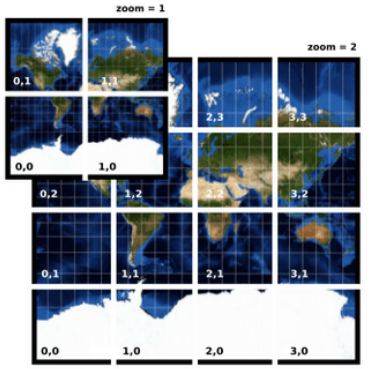
HINT: Simpler spherical calculation are used instead of ellipsoidal. Mercator map projection deforms size (Greenland vs Africa) and never shows poles.



Pixels
Screen coordinates
XY pixels at zoom

Zoom-specific **pixel coordinates** for each level of the pyramid. Top level (zoom=0) has usually 256x256 pixels, next level 512x512, etc.

Devices calculate pixel coordinates at defined zoom level and determine visible viewport for area which should be loaded from servers.



Tiles
Tile coordinates
Tile Map Service (ZXY)

Coordinates of a **tile in the pyramid.** There is one tile on the top of the pyramid, than 4 tiles, 16 tiles, etc. All tiles have the same size, usually 256x256 pixels.

Only the relevant tiles loaded and displayed for the area of interest / viewport.

Advantages

- Queriable (SQLite)
- Fast access to large maps with limited resources (client/server model + queriable format)
- Some (vector tiles) are stylable

Disadvantages

- Designed for webmap services *not* analysis (e.g. rasters are just images)
- A dataset needs to be stored at several zoom levels
- Once created, hard to modify (e.g. reproject)

Selecting a format

No silver bullet…

- What type of data do you want to store? Vector or raster
- What are you going to do with the file? Analysis or serving
- What environment are you working? Locally or web

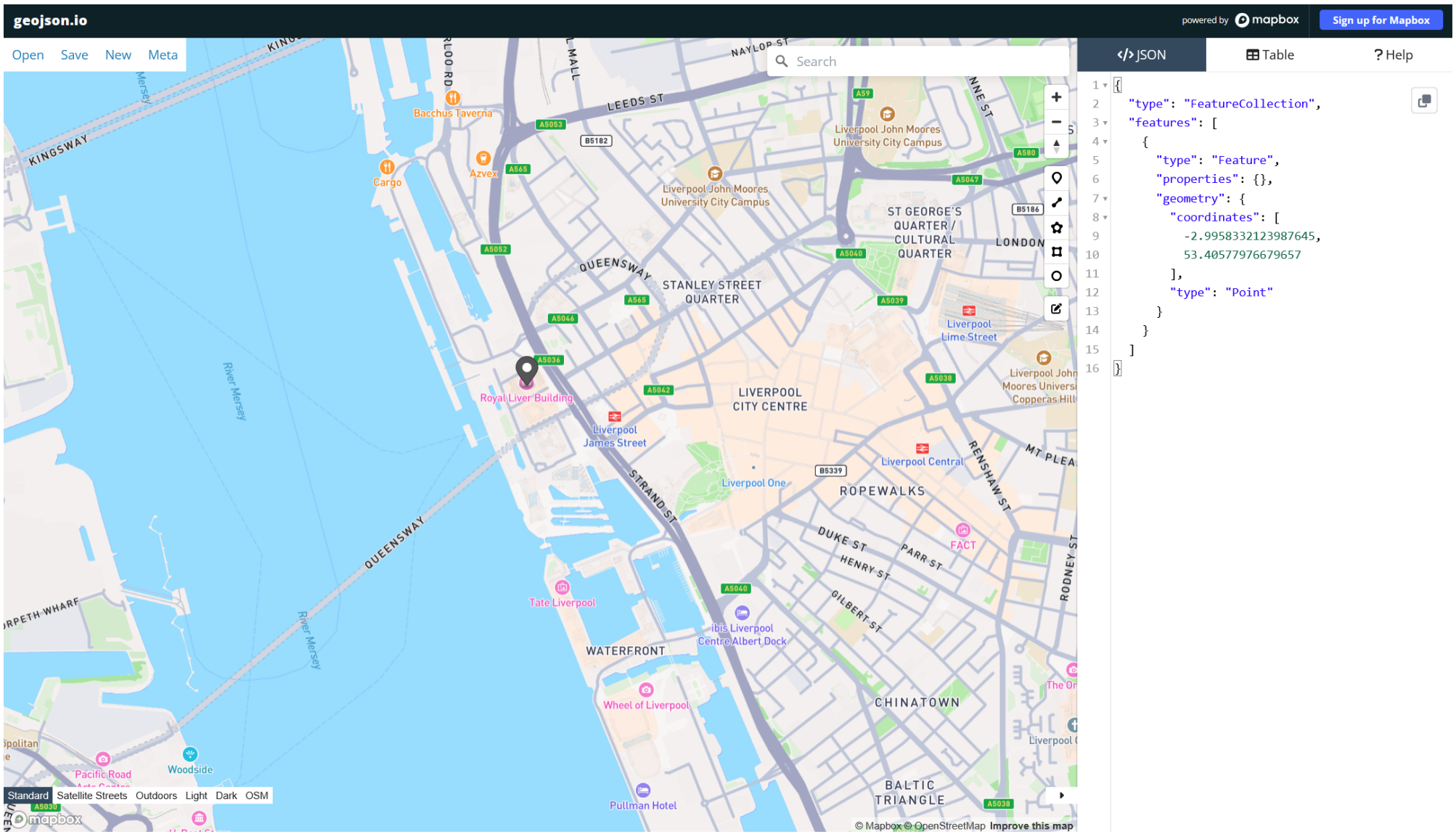
Examples

- Analysing a large geotagged dataset of social media posts? ‘PostGIS/Geopackage’
- Presenting drone imagery at a workshop? ‘MBTiles’
- A small dataset of greenspace areas in a neighborhood you want to upload to the web? ‘GeoJSON’

LAB 4

GeoJSONs

Creating


geojson.io
powered by mapbox
Sign up for Mapbox
Open
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New
Meta
Search
JSON
Table
Help
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KINGSWAY
QUEENSWAY
LEEDS ST
NAYLOR ST
Bacchus Taverna
Cargo
Azvex
Liverpool John Moores University City Campus
ST GEORGE'S QUARTER / CULTURAL QUARTER
STANLEY STREET QUARTER
LONDON
Liverpool Lime Street
Royal Liver Building
Liverpool James Street
LIVERPOOL CITY CENTRE
Liverpool Central
Liverpool One
ROPEWALKS
RENSHAW ST
DUKE ST
HENRY ST
PARR ST
GILBERT ST
FACT
STRAND ST
Tate Liverpool
ibis Liverpool Centre Albert Dock
WATERFRONT
Wheel of Liverpool
CHINATOWN
BALTIC TRIANGLE
Pullman Hotel
Woodside
Pacific Road
River Mersey
Standard
Satellite Streets
Outdoors
Light
Dark
OSM
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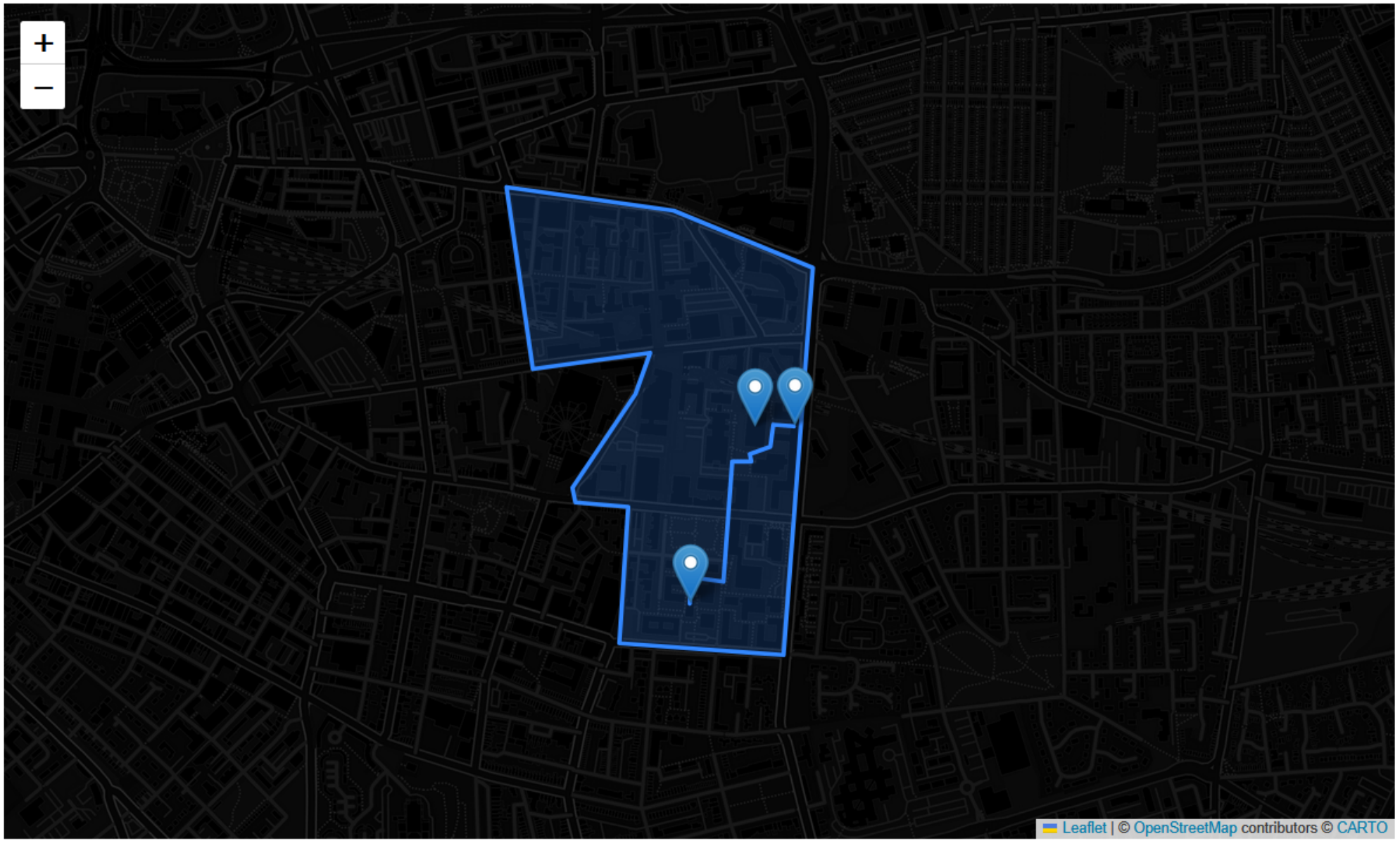
geojson.io

Mapping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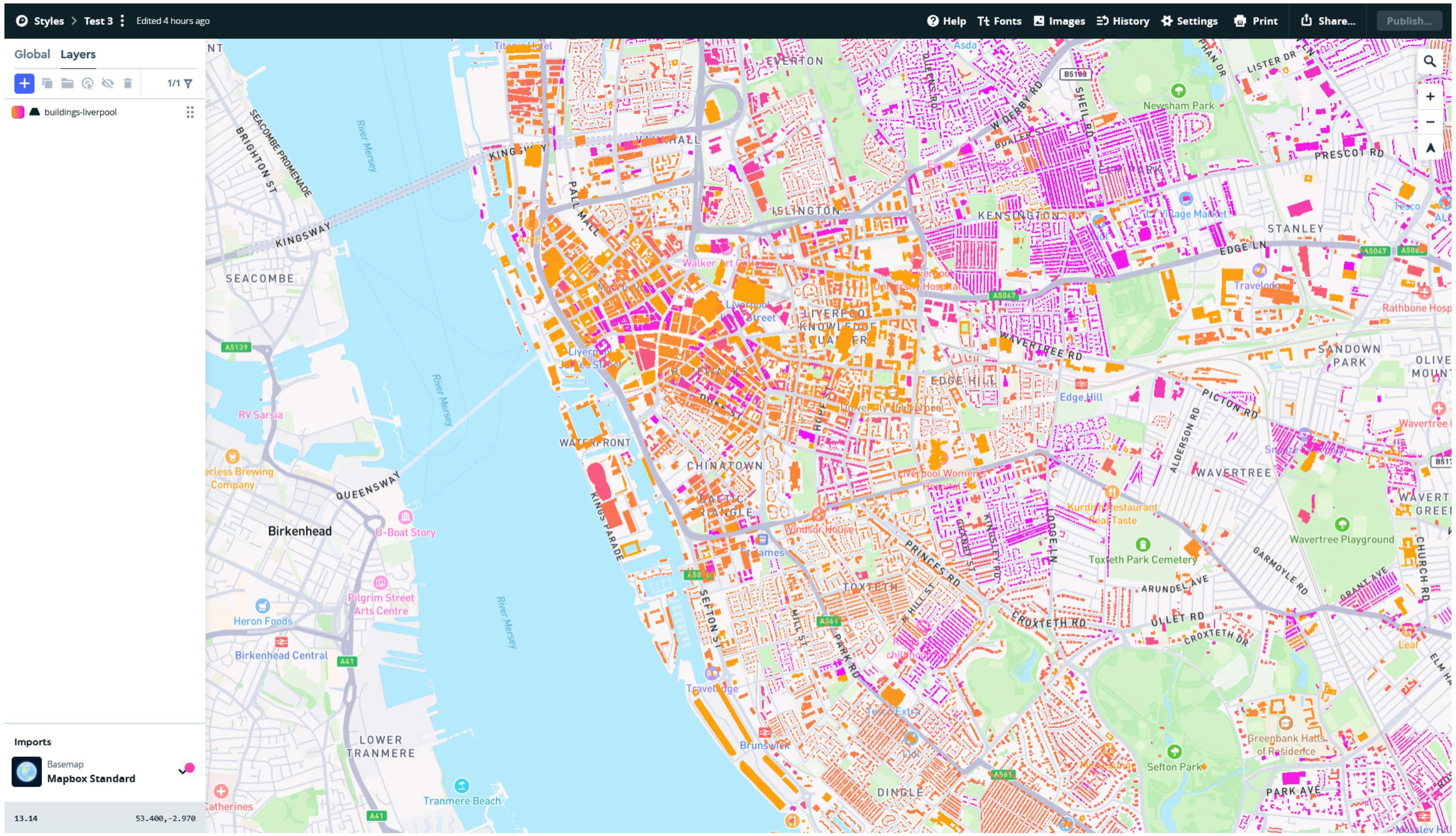
Leaflet | © OpenStreetMap contributors © CARTO

Mapbox and mbtiles

Creating .mbtiles and uploading

- Creating is **optional**, but if you can get it to work will greatly enhance your map.
- Upload either by the API (Again optional), or manually through the Mapbox Studio

Styles tool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Test 3
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Help
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Images
History
Settings
Print
Share...
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SEACOMBE
Birkenhead
KINGSWAY
QUEENSWAY
River Mersey
EVERTON
ISLINGTON
KENSINGTON
STANLEY
PRESCOT RD
EDGE LN
WAVERTREE RD
EDGE HILL
PICTON RD
WAVERTREE
CHINATOWN
WATERFRONT
TOXTETH
PRINCES RD
CROXTETH RD
ULLET RD
DINGLE
LOWER TRANMERE
SANDOWN PARK
Newsham Park
Birkenhead Central
Heron Foods
Tranmere Beach
Toxteth Park Cemetery
Wavertree Playground
Sefton Park
Rathbone Hosp
PARK AVE