



Politecnico di Milano

Maria Antonia Brovelli, Candan Eylül Kilsedar, Daniele Oxoli

Data Collection and Visualization Regarding Urbanization

PRIN PROJECT: *URBAN GEOmatics for Bulk Information Generation, Data Assessment and Technology Awareness*



MINISTERO DELL'ISTRUZIONE DELL'UNIVERSITÀ E DELLA RICERCA



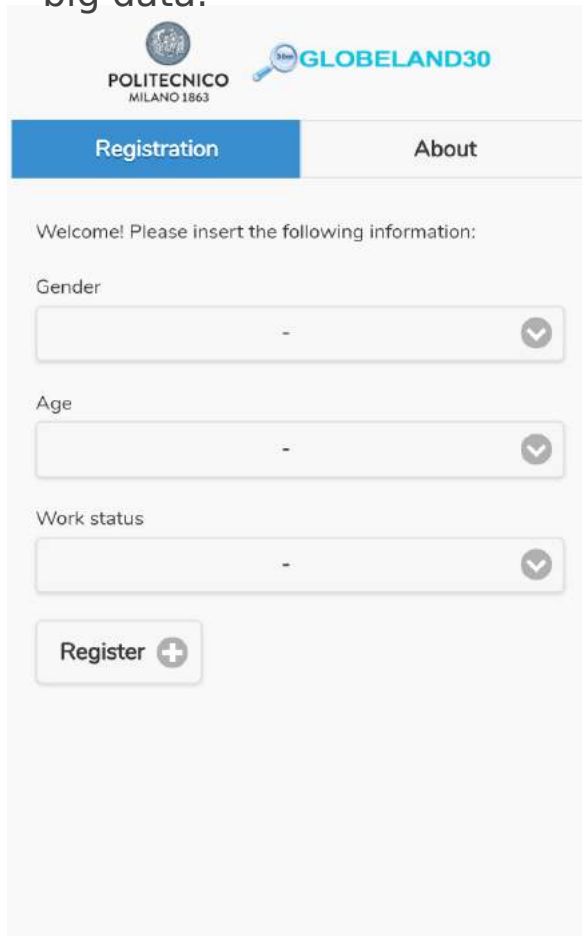
Big raster data of soil consumption

- ▶ The display of the soil consumption evolution in time on web, with statistical information.
- ▶ The data will be stored in **rasdaman** (raster data manager), which is developed for storing and querying massive multi-dimensional raster data, such as sensor, image, simulation, and statistics data.
- ▶ The web display is planned to be in 2 and 3 dimensions.

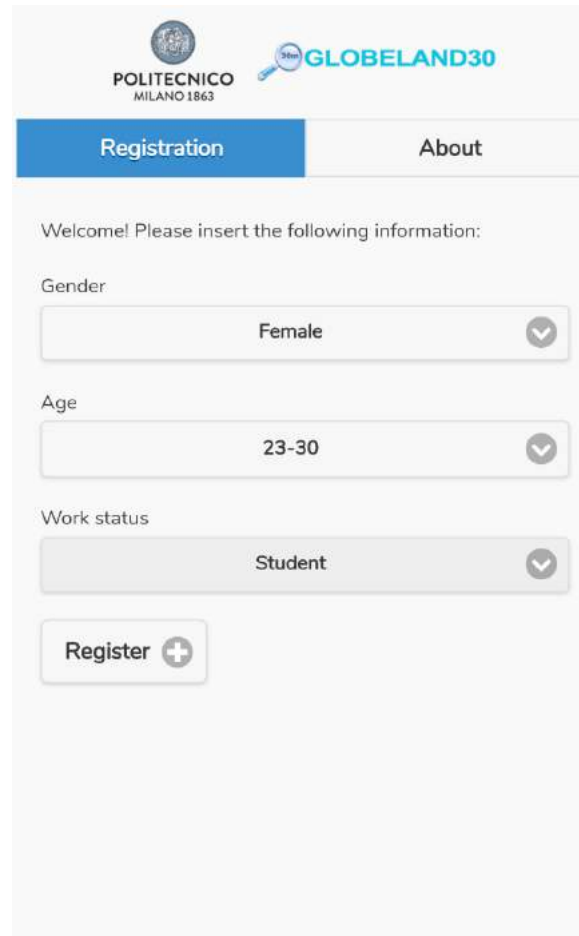


GlobeLand30 Validation - Registration

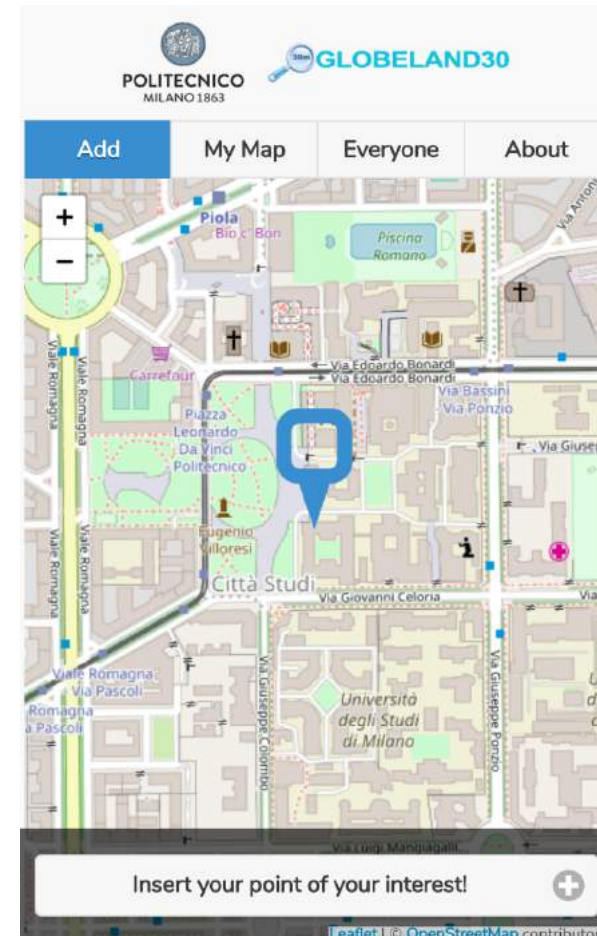
- **Crowdsourcing** application available on browsers (131.175.143.84/glc30, so far tested on Google Chrome and Mozilla Firefox), and as Android and iOS applications (**cross-platform**).
- Data is stored in a NoSQL database, **CouchDB**, which in need can be set up to be distributed to support big data.



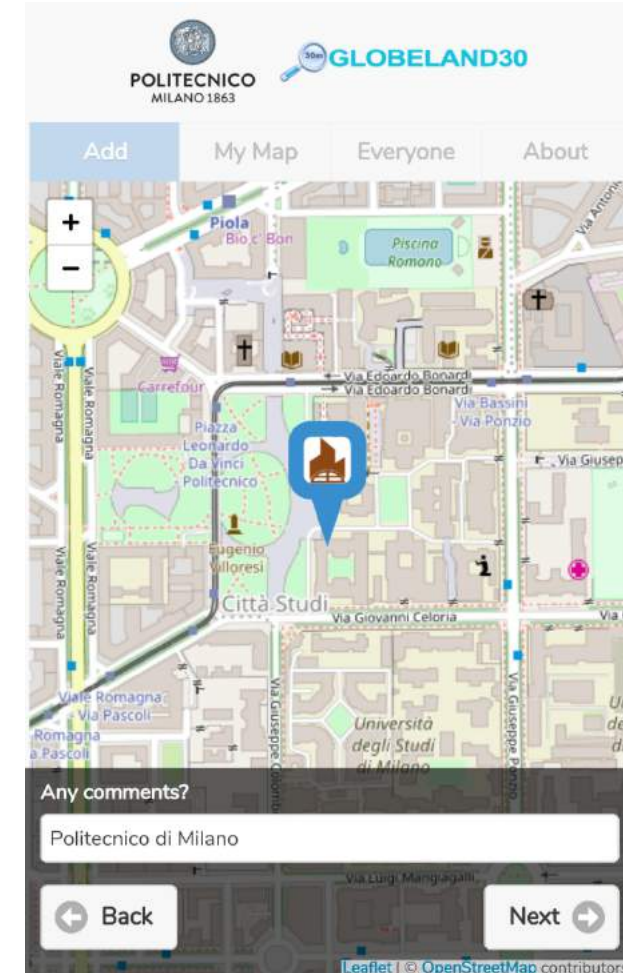
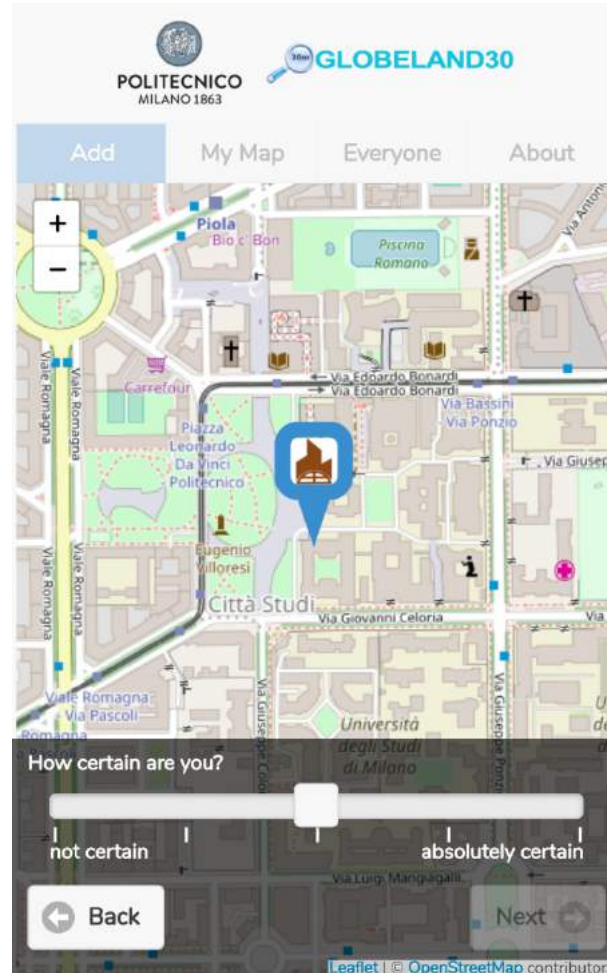
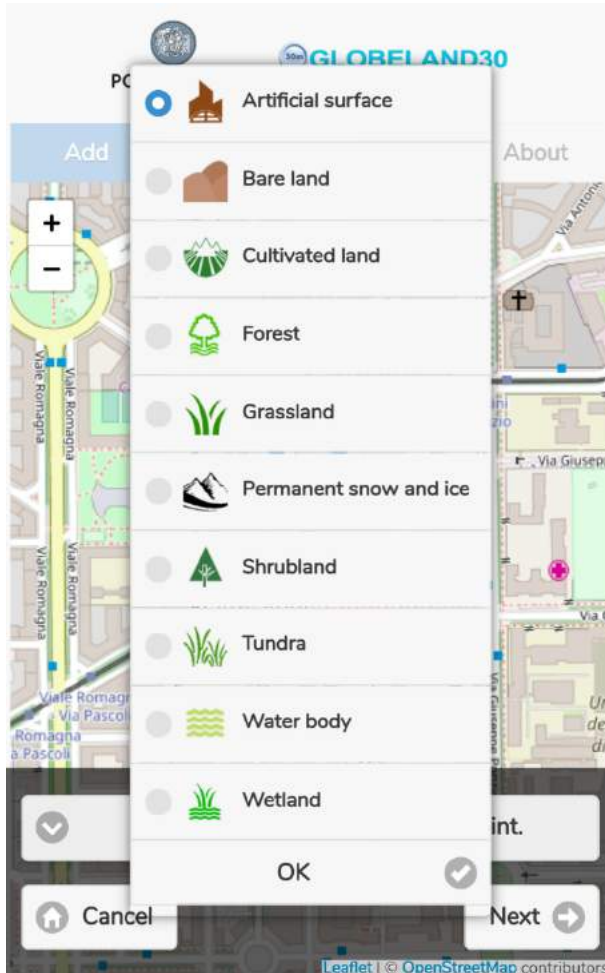
The image shows the initial state of the registration form. At the top, there is a header with the Politecnico Milano 1863 logo and the GLOBELAND30 logo. Below the header, there are two tabs: "Registration" (active) and "About". The main content area contains a welcome message: "Welcome! Please insert the following information:". Below this, there are three dropdown menus for "Gender", "Age", and "Work status", each with a "-" symbol and a downward arrow. At the bottom, there is a "Register +" button.



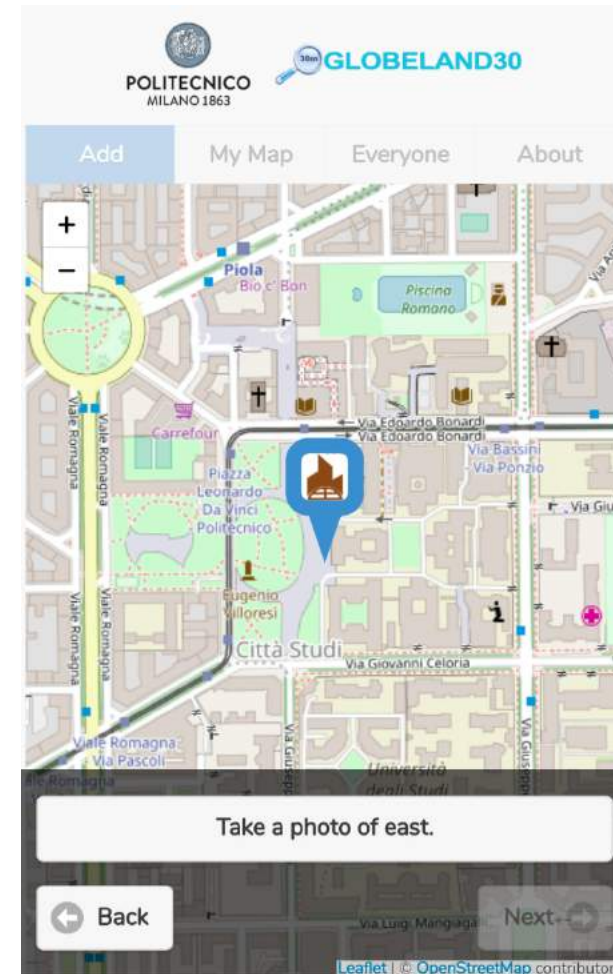
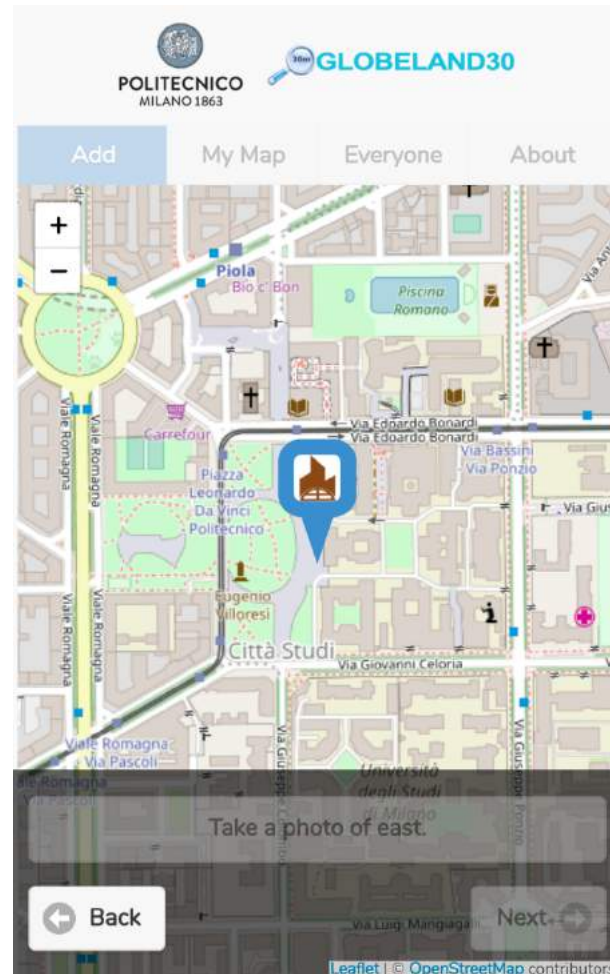
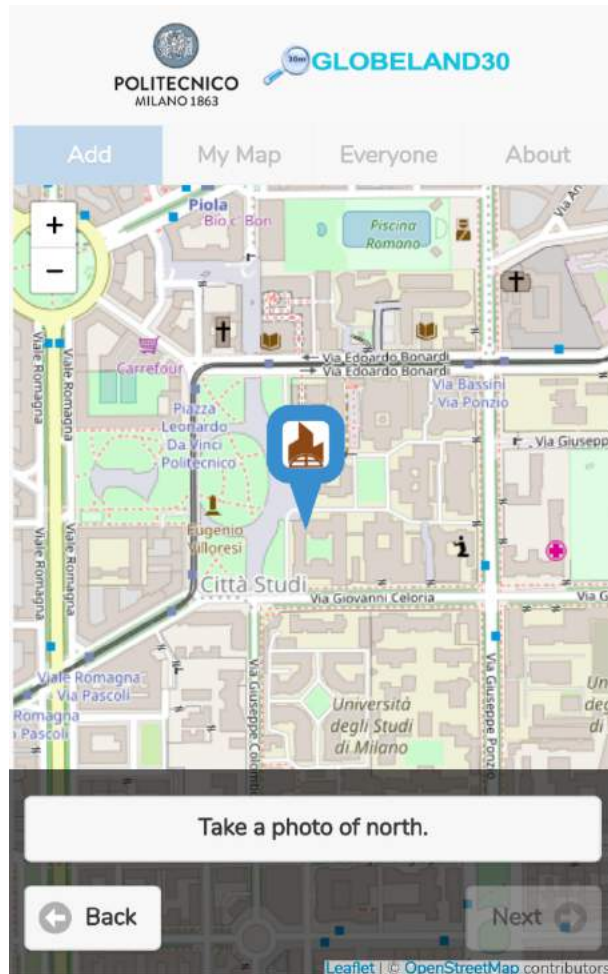
The image shows the registration form with the dropdown menus filled. The "Gender" dropdown is set to "Female", the "Age" dropdown is set to "23-30", and the "Work status" dropdown is set to "Student". The "Register +" button remains at the bottom.



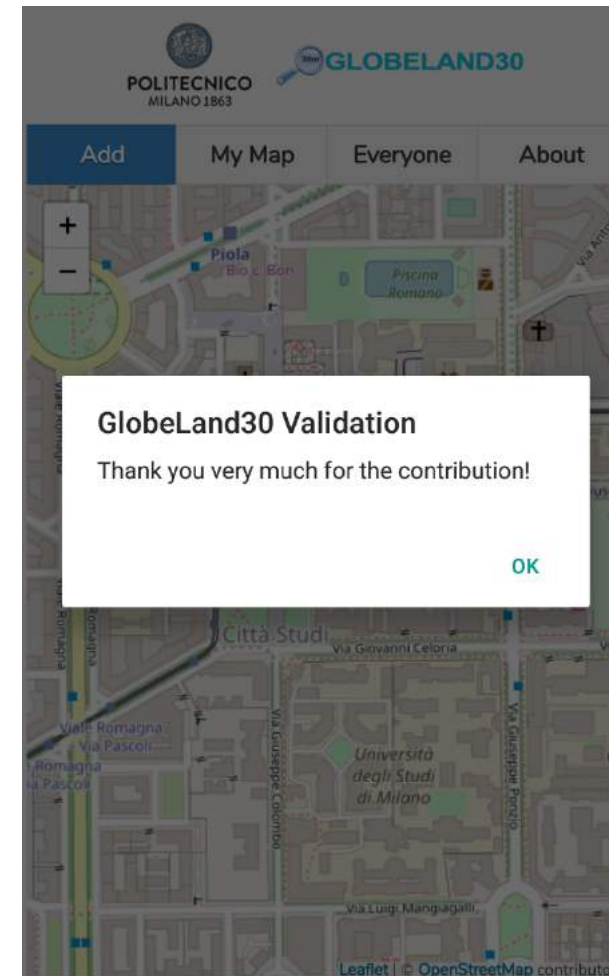
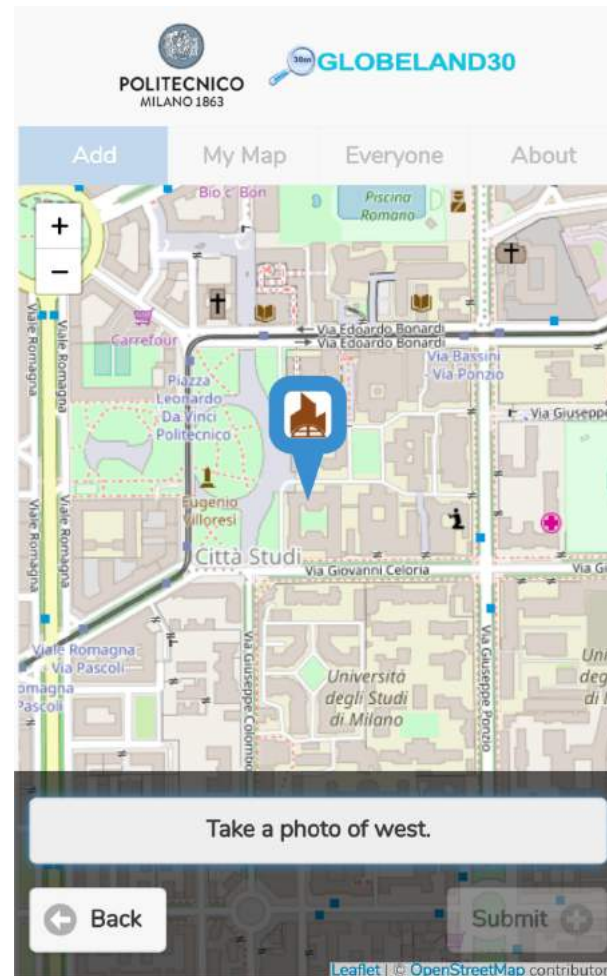
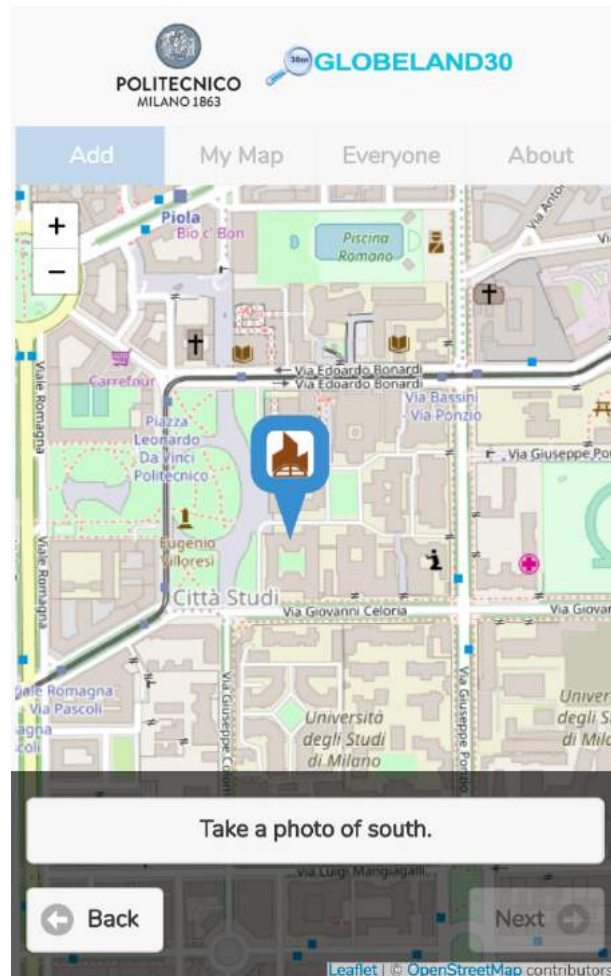
GlobeLand30 Validation – Add a POI



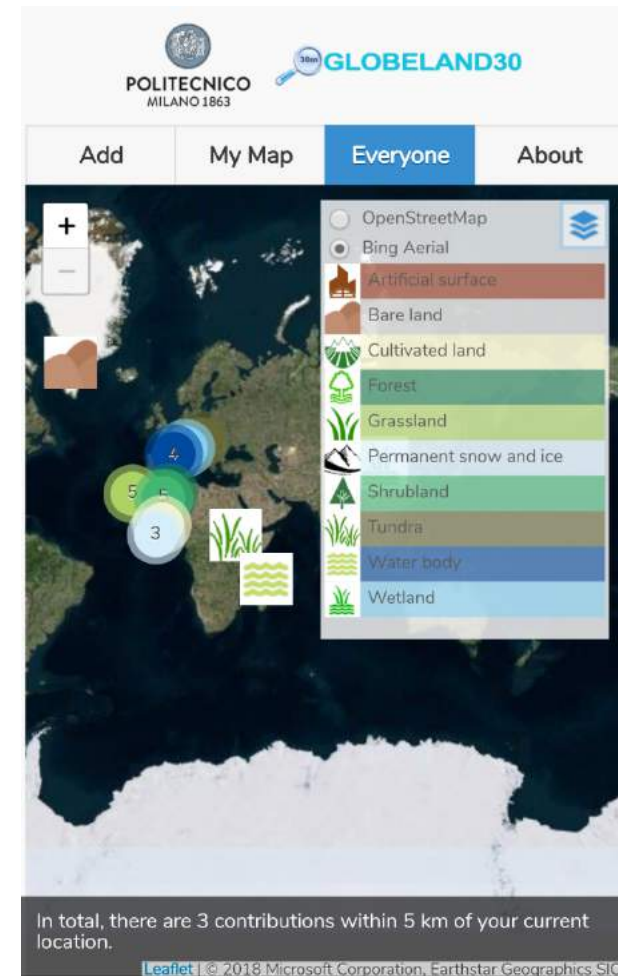
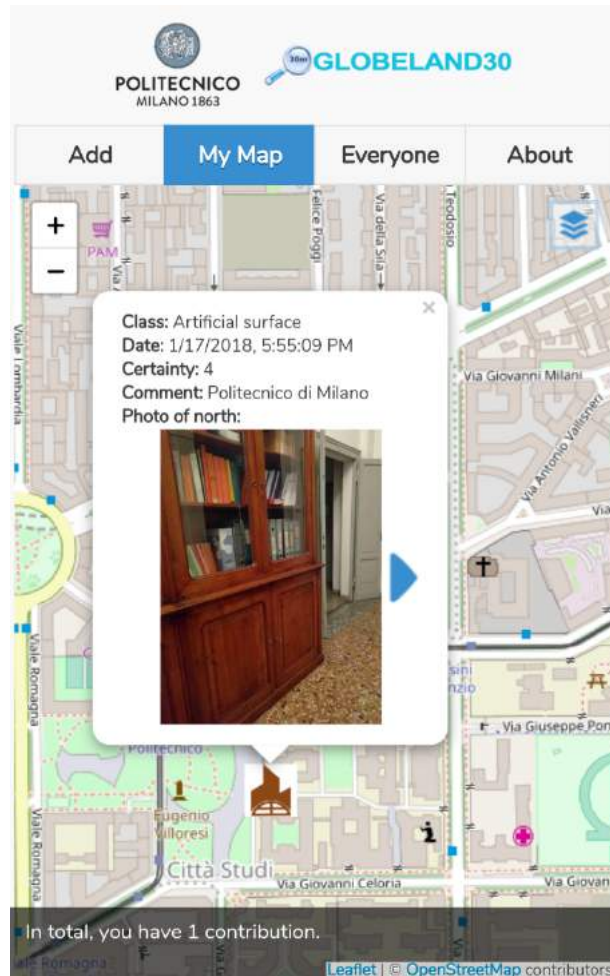
GlobeLand30 Validation - Add a POI



GlobeLand30 Validation – Add a POI



GlobeLand30 Validation – Look at the data



3D Buildings

- ▶ CityGML → KML/glTF → 3DCityDB-Web-Map-Client and Cesium virtual globe (<https://github.com/3dcitydb/3dcitydb-web-map>)
- ▶ MapBox, 2.5D OSM buildings, including OSM heights with good performance thanks to vector tiling (paid after 50000 map views per month)



3D Buildings

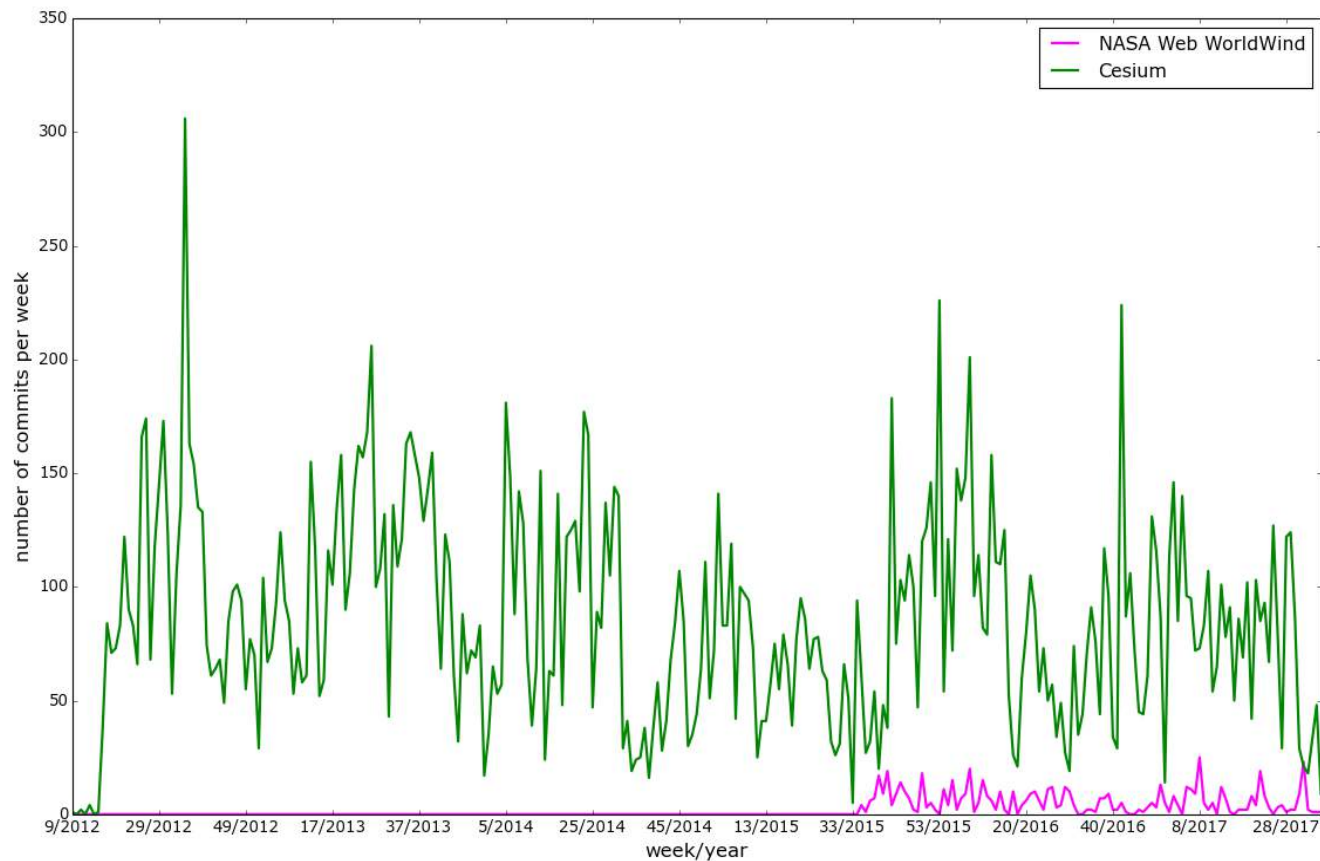
- ▶ NASA Web WorldWind → Using the plugin API developed in 2017 GSoC project. Individual buildings' height can be set using LiDAR data or GeoJSON can be edited manually, on top of the height data of OSM. However doesn't implement tiling, which results in poor performance for large areas. The API can also create a heatmap based on the heights of the buildings.



Virtual Globes

NASA Web WorldWind vs Cesium

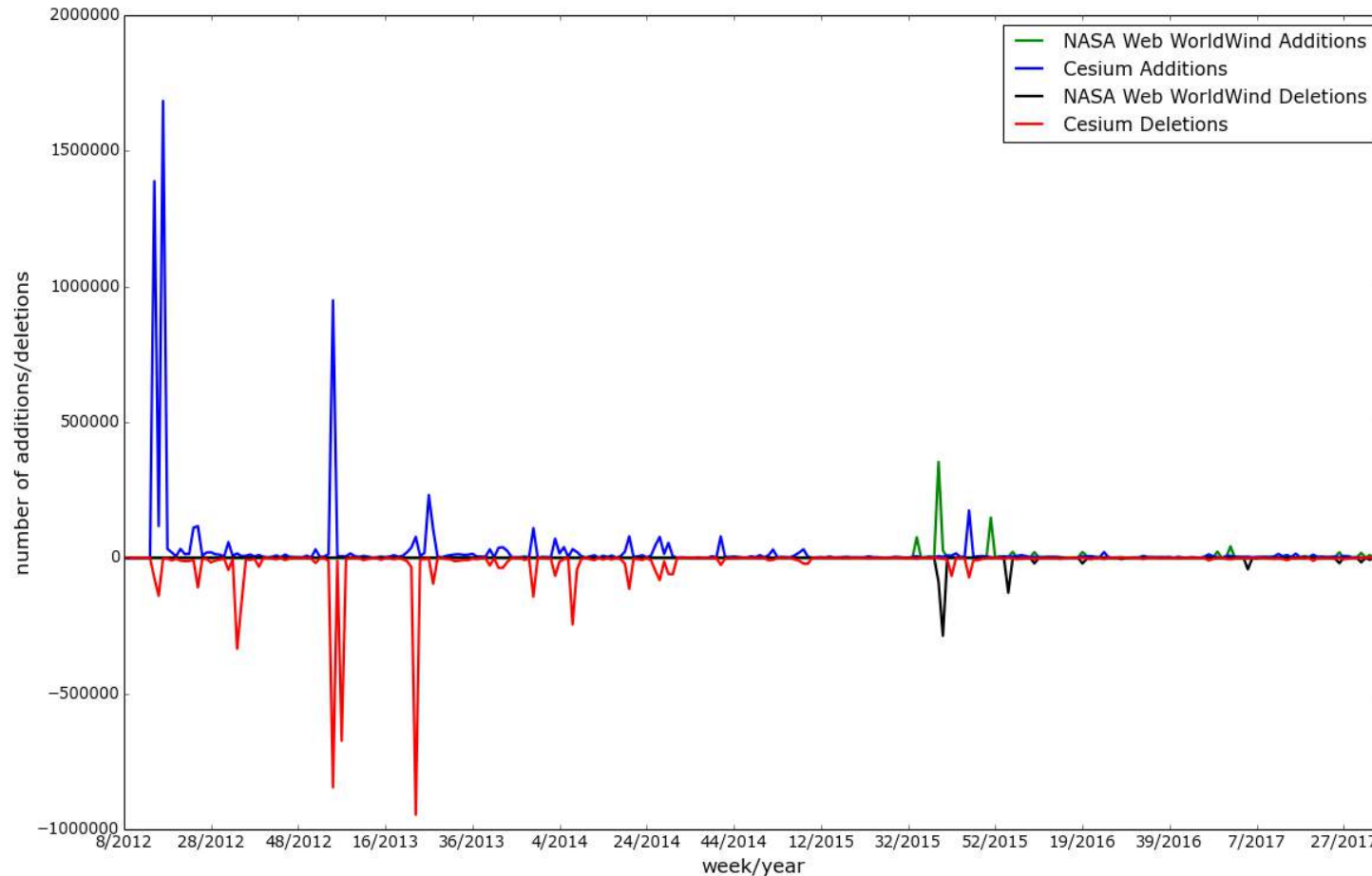
- ▶ Both software are free and open source and both require preservation of the copyright notice.
- ▶ Distribution of commits over time for NASA Web WorldWind and Cesium (04/09/2017)



Virtual Globes

NASA Web WorldWind vs Cesium

- Code frequency for NASA Web WorldWind and Cesium (04/09/2017)



Virtual Globes

NASA Web WorldWind vs Cesium

- Features comparison in terms of *geospatial visualization*:

Features	NASA Web WorldWind	Cesium
high-resolution terrain visualization	✓	✓
WMS	✓	✓
WMTS	✓	✓
Blue Marble image layer	✓	
a combined Blue Marble and Landsat image layer	✓	
Bing Maps	✓	✓
OpenStreetMap	✓	✓
DigitalGlobe	✓	
MapBox		✓
Google Earth Enterprise		✓
ArcGIS MapServer		✓



Virtual Globes

NASA Web WorldWind vs Cesium

- Features comparison in terms of *geospatial visualization*:

Features	NASA Web WorldWind	Cesium
GeoTIFF	✓	
JPEG	✓	
PNG	✓	
KML	✓	✓
GeoJSON	✓	✓
TopoJSON		✓
Shapefile	✓	
Collada	✓	
glTF		✓
shadows (including self-shadows and soft-shadows for terrain, 3D models, and geometries, based on the sun position)		✓



Virtual Globes

NASA Web WorldWind vs Cesium

- Features comparison in terms of *geospatial visualization*:

Features	NASA Web WorldWind	Cesium
3D globe	✓	✓
2D map	✓	✓
2.5D (Columbus view)		✓
cluster points, labels and billboards		✓

Virtual Globes

NASA Web WorldWind vs Cesium

- Features comparison in terms of *widgets*:

Features	NASA Web WorldWind	Cesium
base layer picker widget for selecting imagery and terrain		✓
turn on/off the layers already added to the map (base layers and overlay layers)	✓	
selection and info box widgets for highlighting objects and displaying information		✓
geocoder widget for flying to addresses and landmarks	✓	✓
home view widget to fly to the default camera view		✓
scene mode picker (widget to morph between all the projections (3D and 2D) - 3D, 2D, and Columbus view)	✓	✓
fullscreen widget for toggling fullscreen mode		✓



Virtual Globes

NASA Web WorldWind vs Cesium

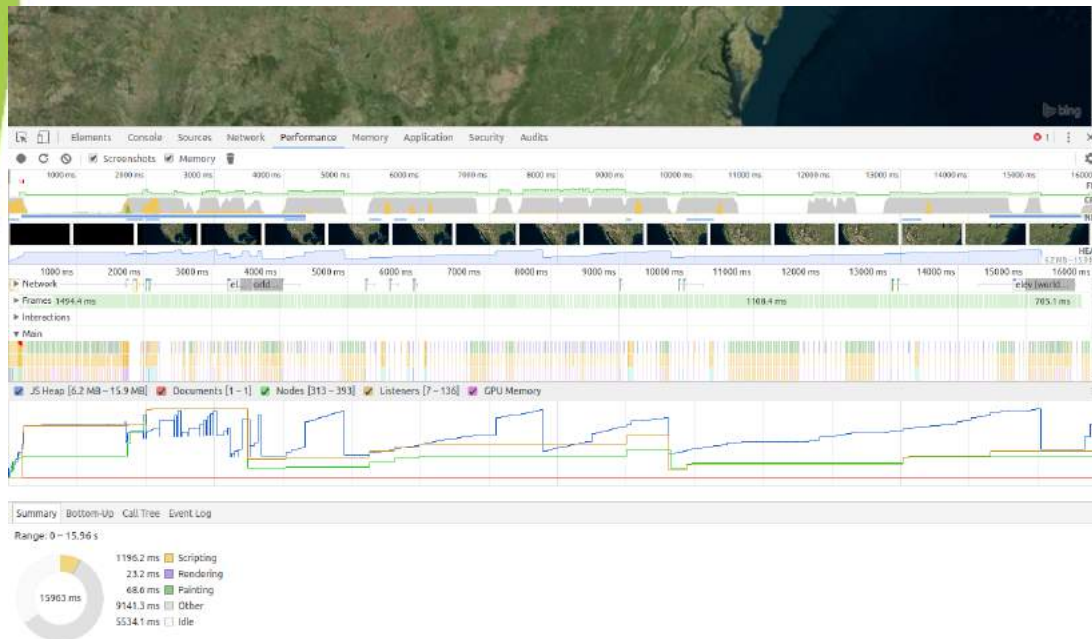
- Features comparison in terms of *widgets*:

Features	NASA Web WorldWind	Cesium
navigation help widget for providing mouse and touch instructions	√	√
compass	√	
coordinates display	√	
view controls to navigate (zoom in & out, tilt up & down, rotate left & right, vertical exaggeration increase & decrease)	√	

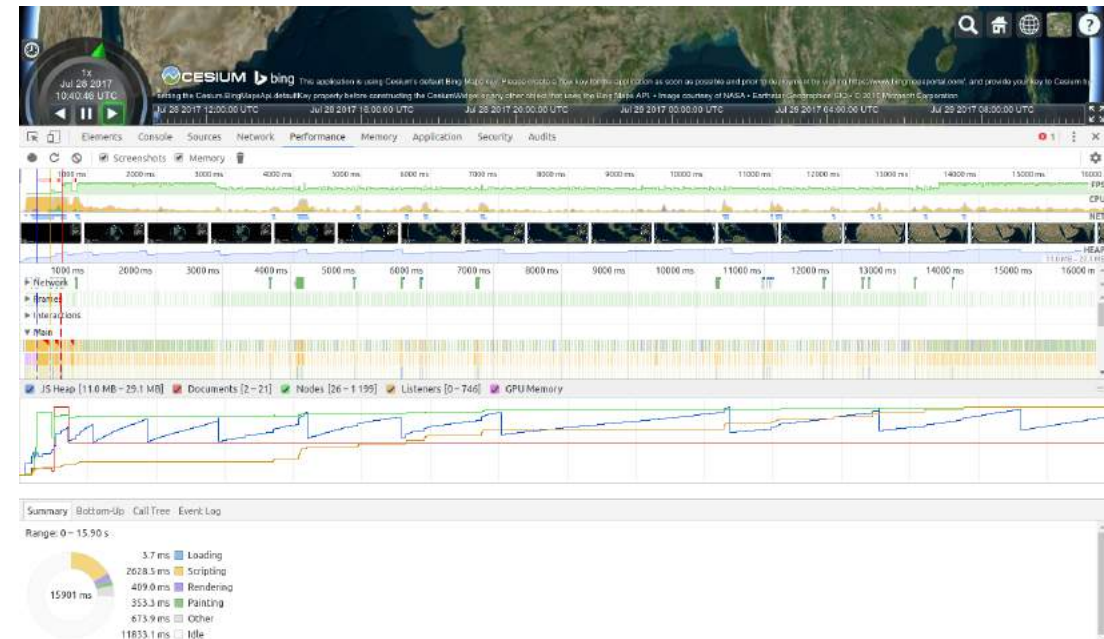
Virtual Globes

NASA Web WorldWind vs Cesium

- ▶ Performance comparison
 - ▶ Globe: The test reveals that NASA Web WorldWind takes less loading, scripting, rendering and painting time, as a result the interaction with the globe is smoother, which makes the user experience better.



NASA Web WorldWind globe loading for approximately 15 seconds

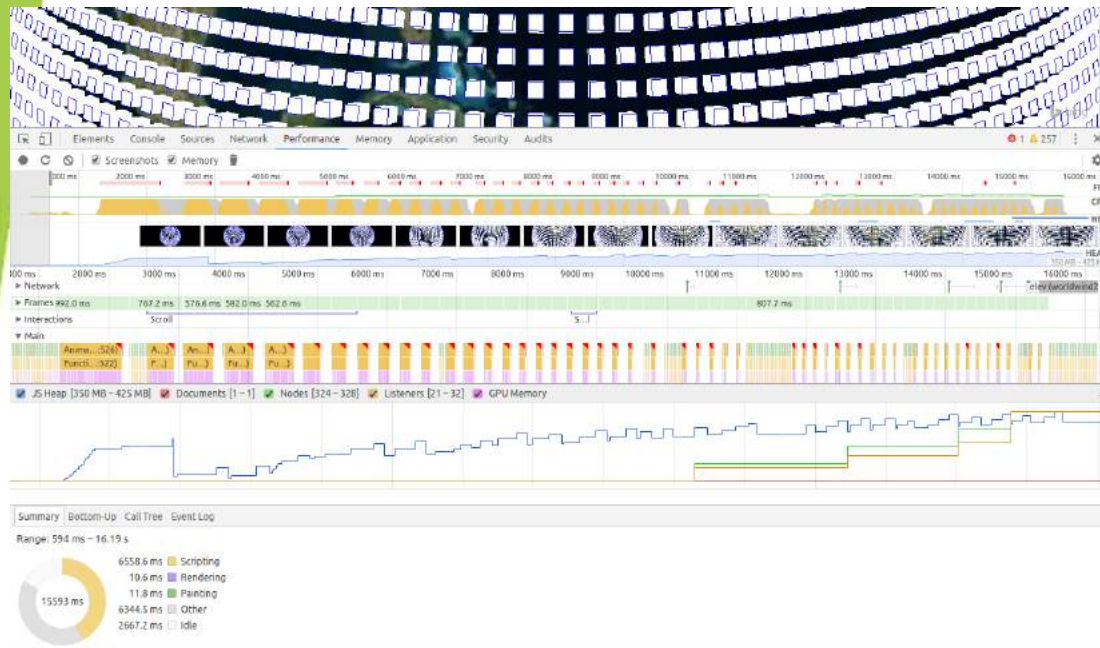


Cesium globe loading for approximately 15 seconds

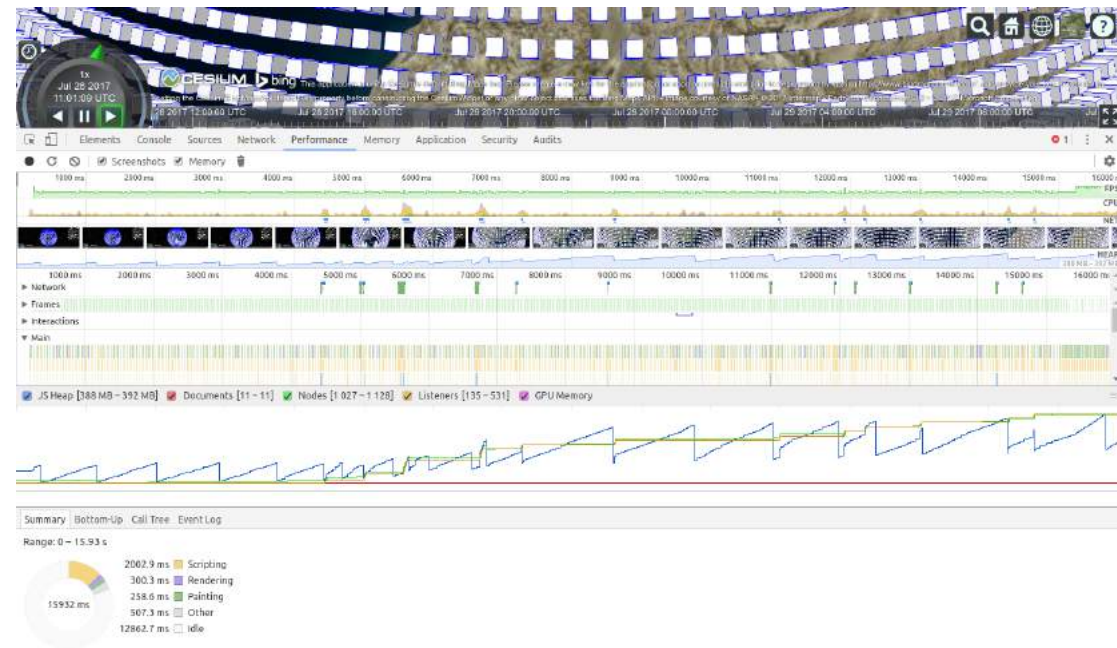
Virtual Globes

NASA Web WorldWind vs Cesium

- Performance comparison
 - Polygons: NASA Web WorldWind takes more scripting time, but much less rendering and painting time. It is observed that NASA Web WorldWind has much smoother rendering as a result, leading to a better user experience. The number of polygons is 16200.



NASA Web WorldWind globe with 16200 extruded polygons loading for approximately 15 seconds

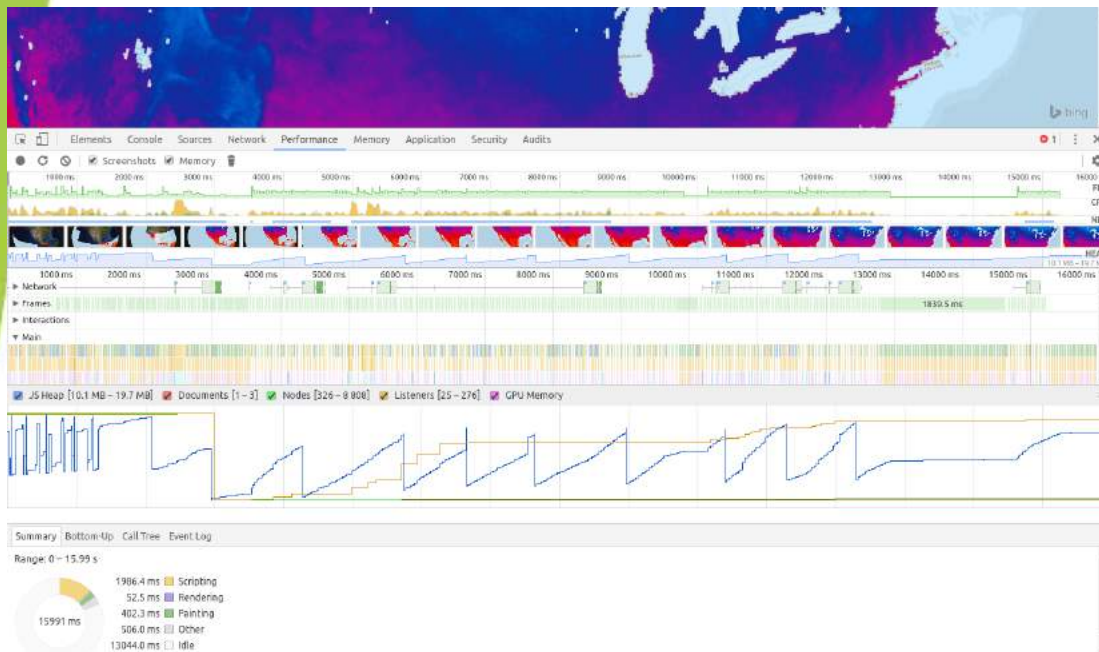


Cesium globe with 16200 extruded polygons loading for approximately 15 seconds

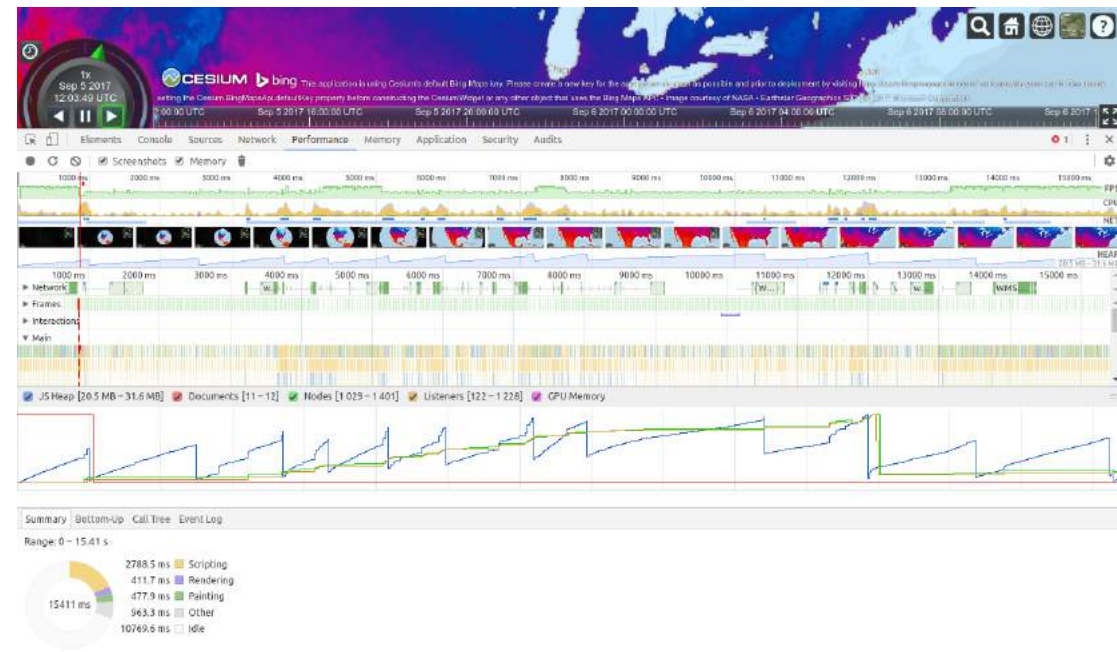
Virtual Globes

NASA Web WorldWind vs Cesium

- ▶ Performance comparison
 - ▶ WMS: Two WMS layers are added to both of the globes created using NASA Web WorldWind and Cesium. The first WMS is topographic map of US from USGS. The second WMS is the average surface temperature of the world from NASA Earth Observations (NEO). It is observed that in terms of all aspects, which are scripting, rendering and painting NASA Web WorldWind performs better.



Two WMS layers on NASA Web WorldWind globe



Two WMS layers on Cesium globe

Big Mobility Data Visualization

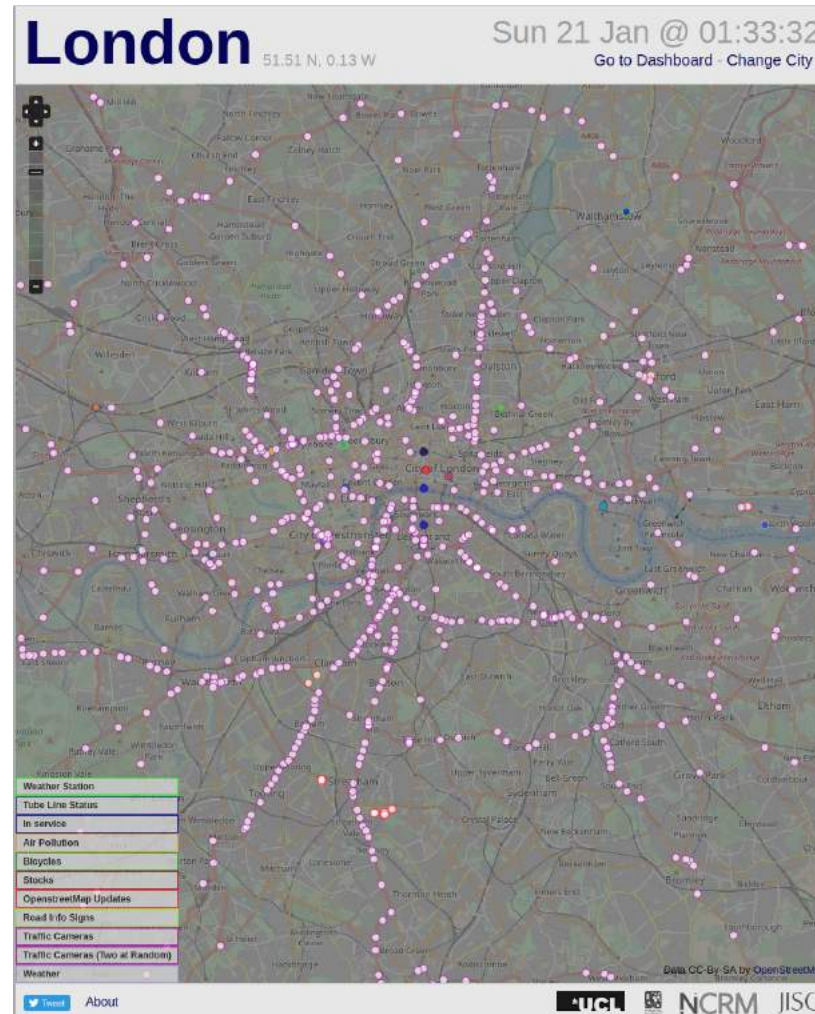
- ▶ In case the data is massive and computation on the database will be performed Apache Hadoop, which combines a distributed file system, namely Hadoop Distributed File System(HDFS) with MapReduce programming paradigm, Apache Spark or a similar technology can be used.
- ▶ Derive insights (probability distributions of overall displacements, radius of gyrations, inbound and outbound travels, hot spots, ...) regarding mobility using social media data/open data, both in multi spatial and temporal (daily, monthly, seasonal) scales.
- ▶ The visualization of the results through a 2D/3D Web GIS will be realized. (For 2D visualization the API can be OpenLayers or Mapbox.)

Geospatially-enabled smart Singapore (<https://www.onemap.sg>)

The screenshot displays the OneMap Singapore web application interface. The top navigation bar includes a search bar and various query tools: LandQuery, SchoolQuery, TrafficQuery, PropertyQuery, PopulationQuery, Nearby, BizQuery, Bus Explorer, and Map Styles. The left sidebar is titled 'Land Info' and features a 'Query' tab and a 'Tenure (Beta)' tab. Under the 'Query' tab, there are buttons for 'View Land Ownership' and 'View Land Lot'. Below these is a 'Land Lot Search' section with input fields for 'MK' (set to 26), 'Landlot No.' (set to 08092), and 'Suffix' (set to A). A 'Search' button is located below the search fields. The 'Land Ownership' section displays the following information: Ownership : Statutory Board, Contact : Housing And Development Board, Telephone : 6490 1111, and Email : hdb@mailbox.hdb.gov.sg. The 'Land Lot' section has a 'Lot Number' input field and an 'Enquiry Form' button. The main map area shows a residential area with various streets and landmarks. A red callout box over the map provides additional information: 'Ownership : Statutory Board', 'For more information, contact : Housing And Development Board 6490 1111', and an 'Enquiry' button. The map includes a scale bar (200 m / 500 ft) and a 'Contact Us | Privacy Statement | Terms' link at the bottom right.

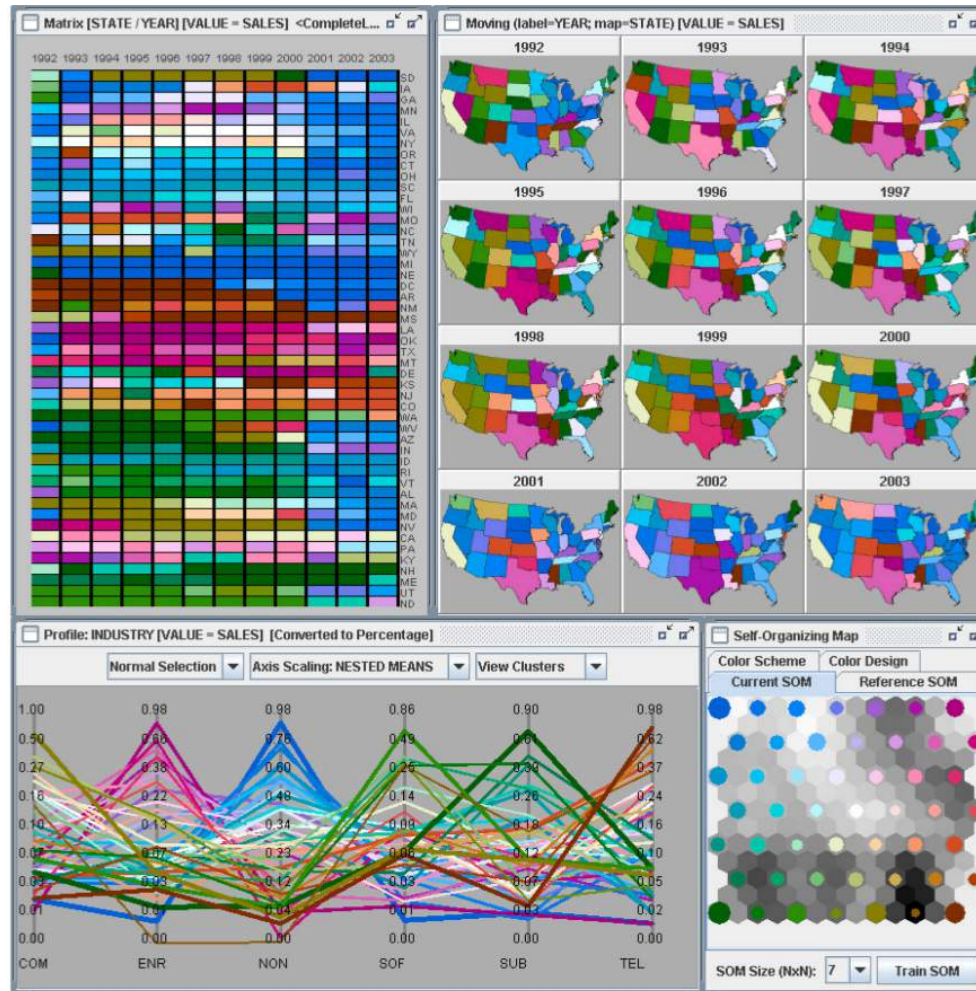
City dashboard of London

(<http://citydashboard.org/london/map/>)



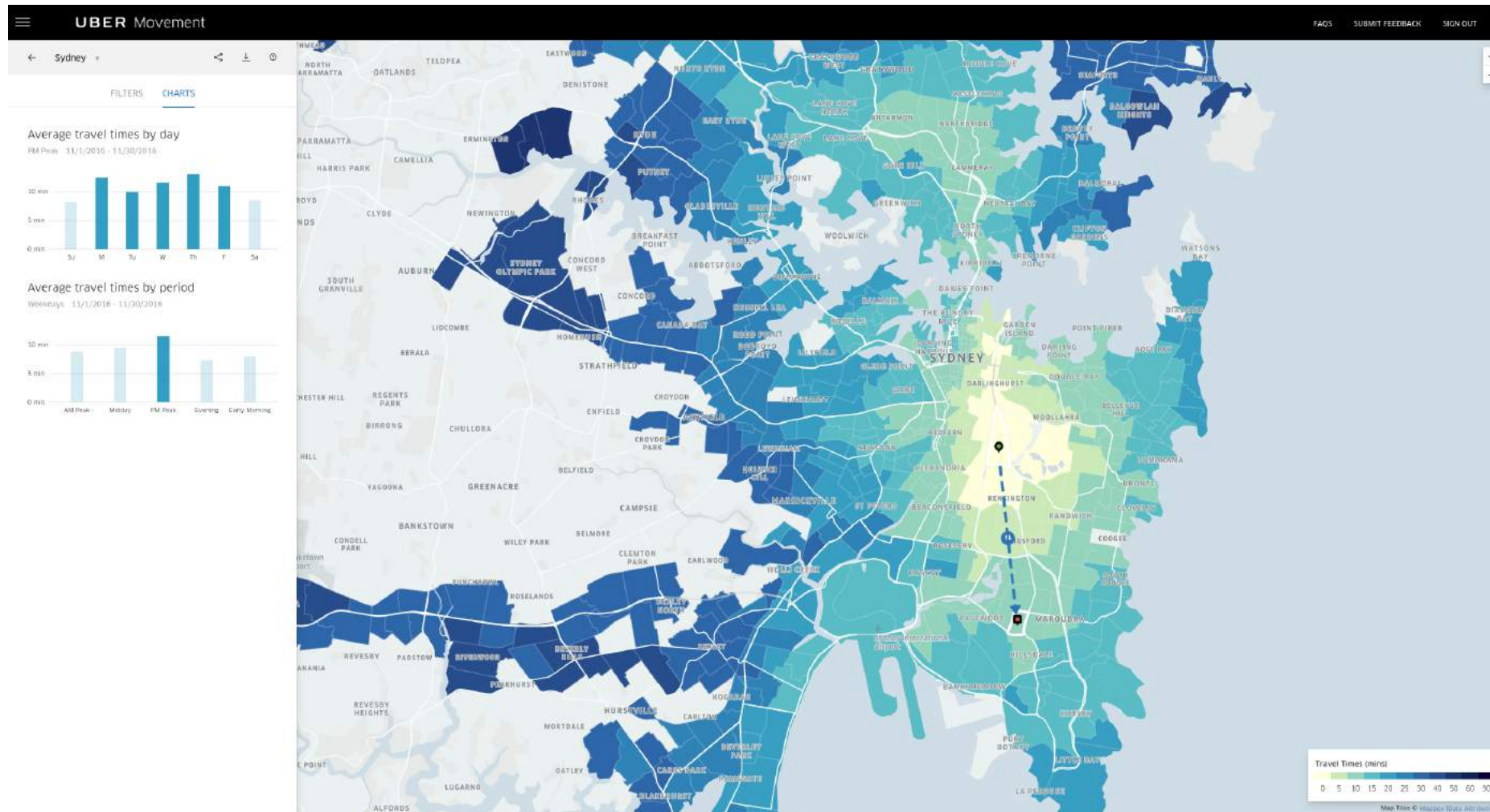
An interesting way to visualize spatiotemporal data

Guo et al. - 2005 - A Visual Inquiry System for Space-Time and Multivariate Patterns (VIS-STAMP)



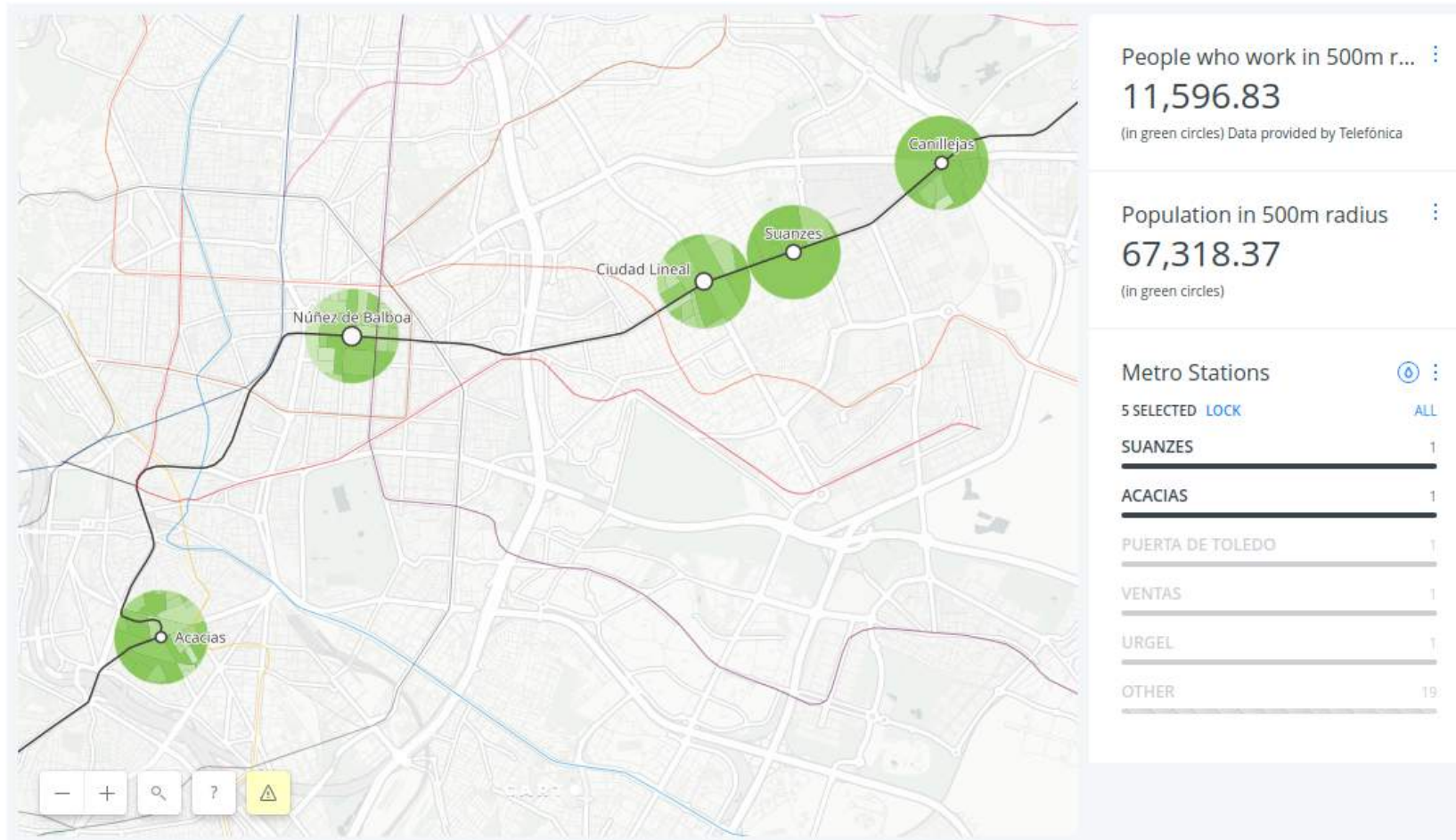
Examples from Industry

Uber Movement, average travel times

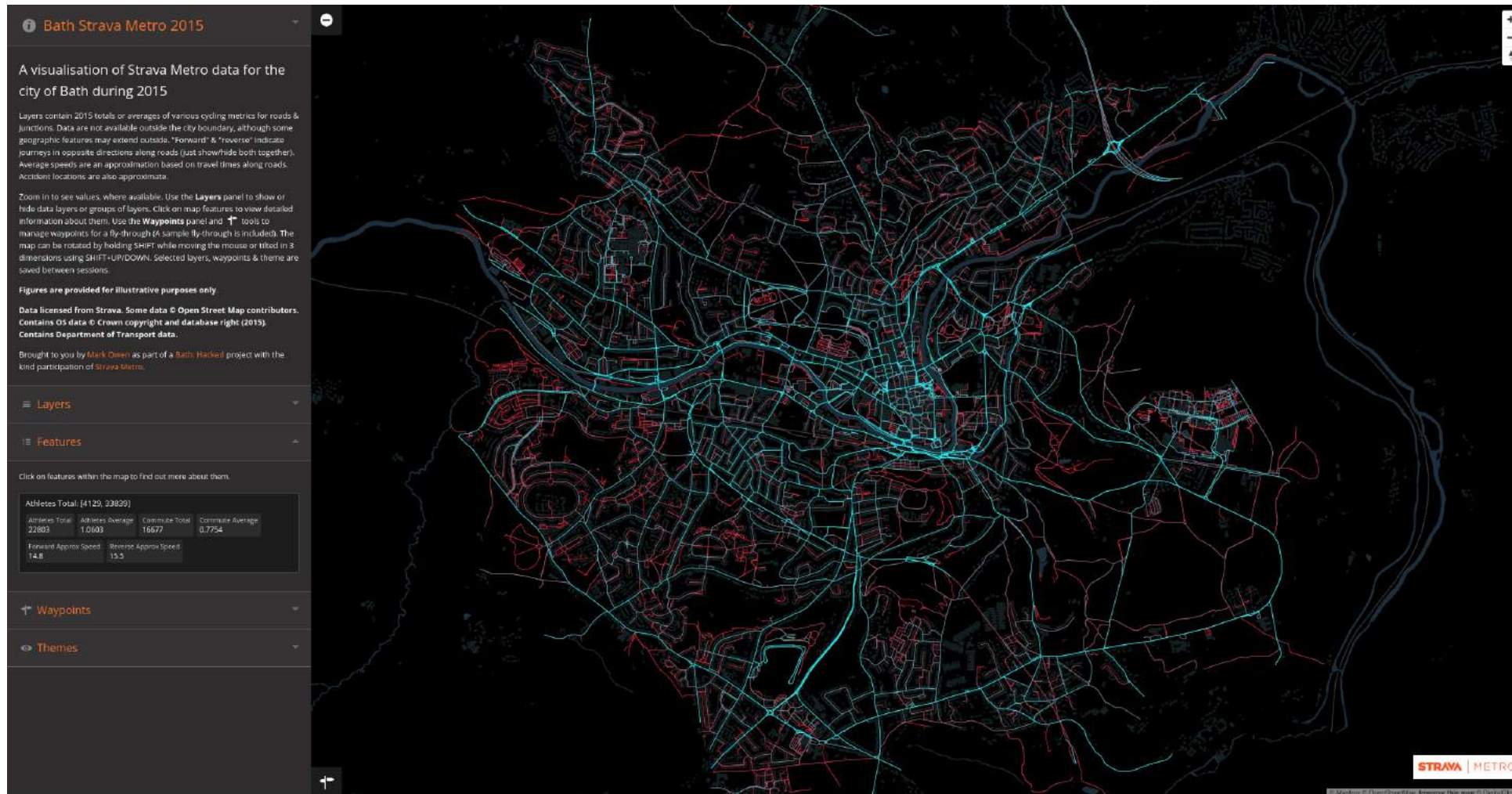


Examples from Industry

CARTO, mapping the impact of Madrid's line 5 shutdown



Examples from Industry Strava



Examples from Industry

CityScience, cycling accessibility





Thank you for listening.
Time for discussion.

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