URBAN-GEO BIG DATA

POLITECNICO MILANO 1863

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

Politecnico di Milano

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Data Collection and Visualization Regarding Urbanization

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

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Big raster data of soil consumption

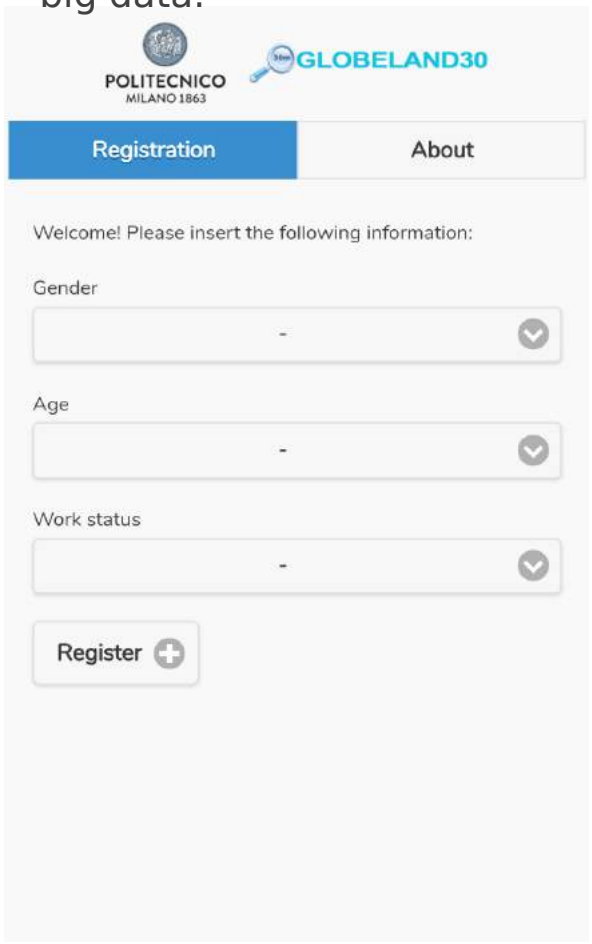
- The display of the soil consumption evolution in time on web, with statistical information.

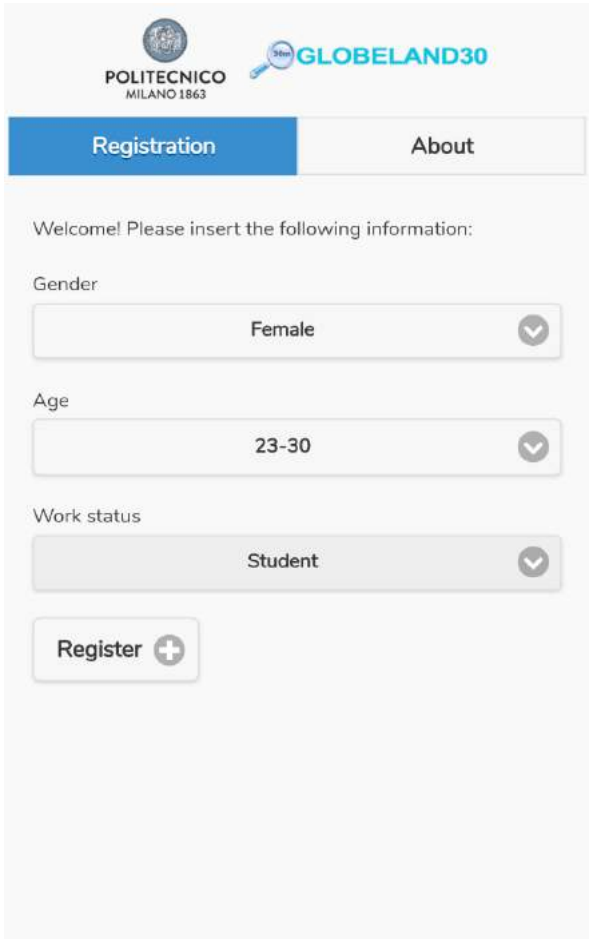
- The data will be stored in rasdaman (raster data manager), which is developed for storing and querying massive multi-dimensional raster data, such as sensor, image, simulation, and statistics data.

- 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.





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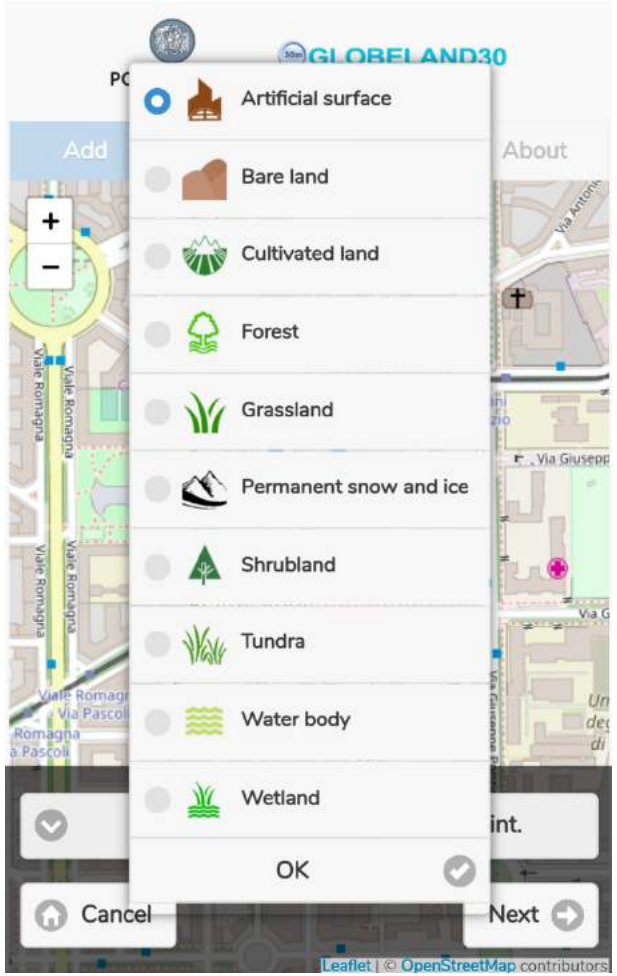
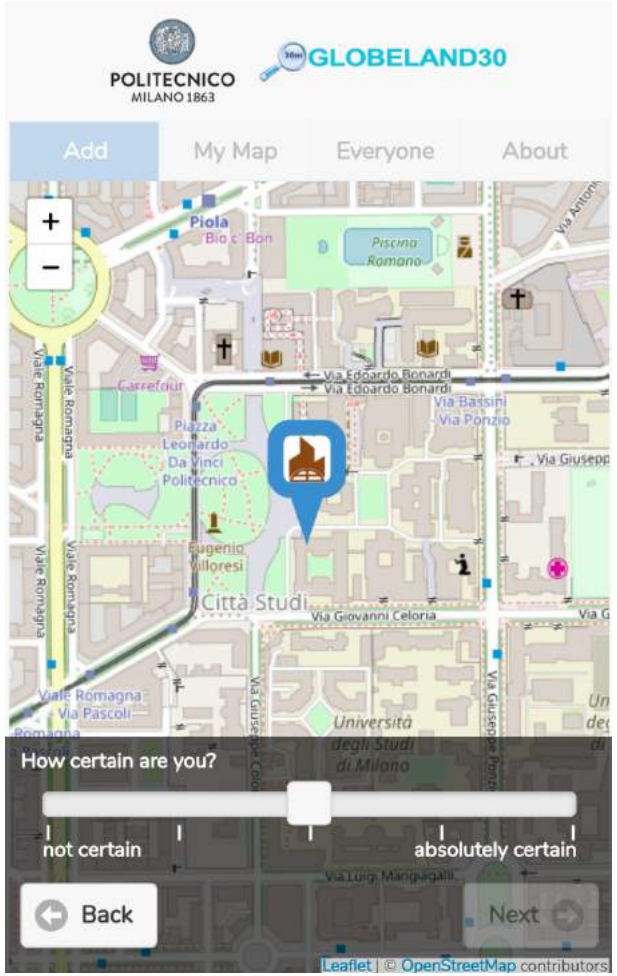
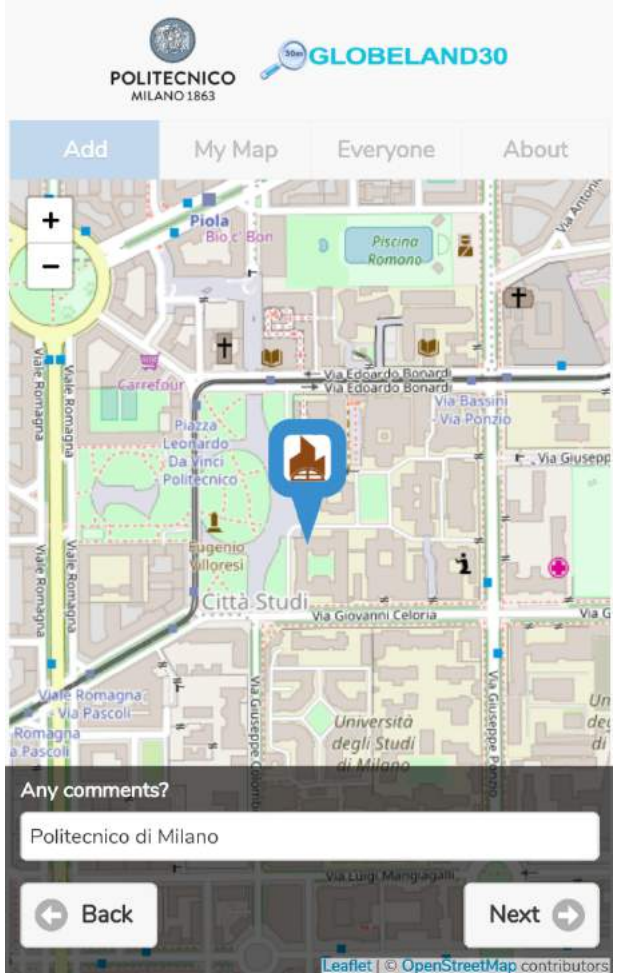
GlobeLand30 Validation – Add a POI







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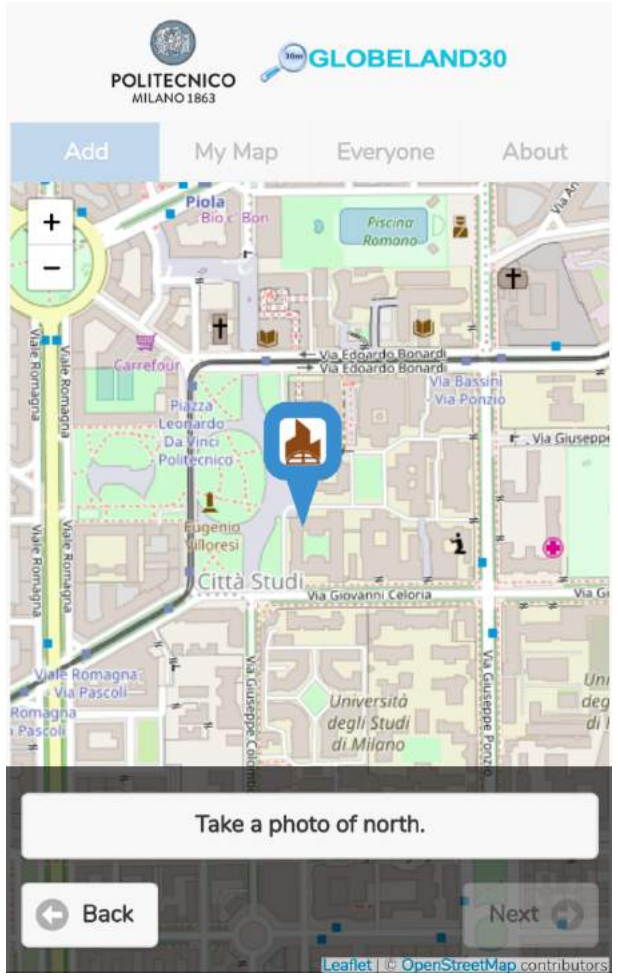

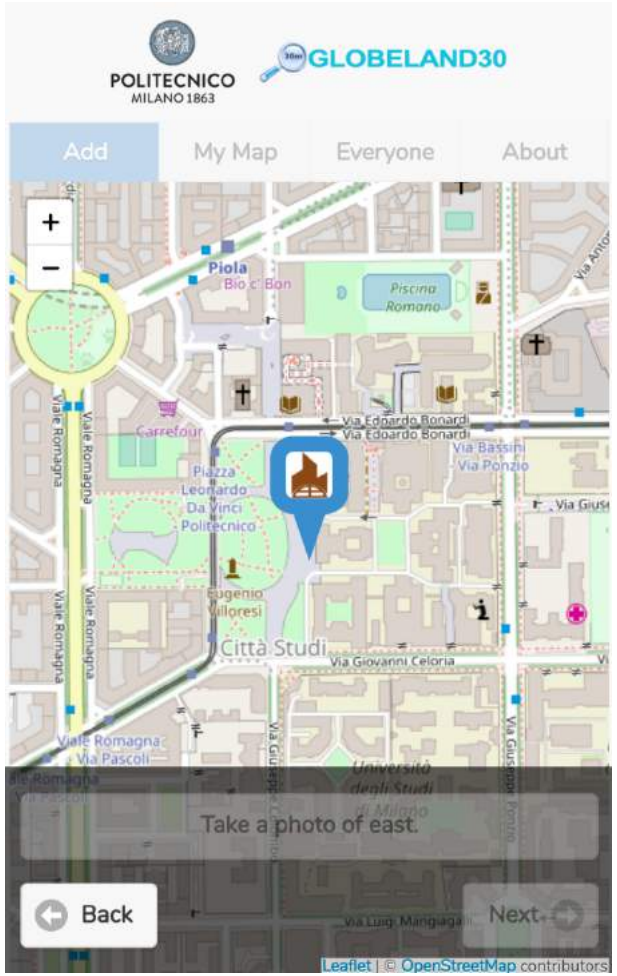

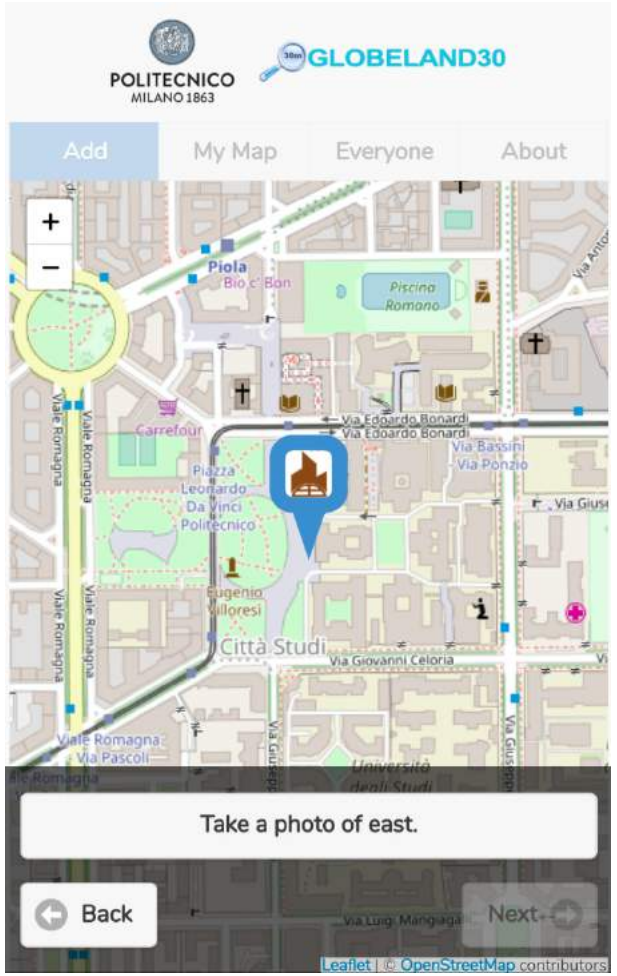

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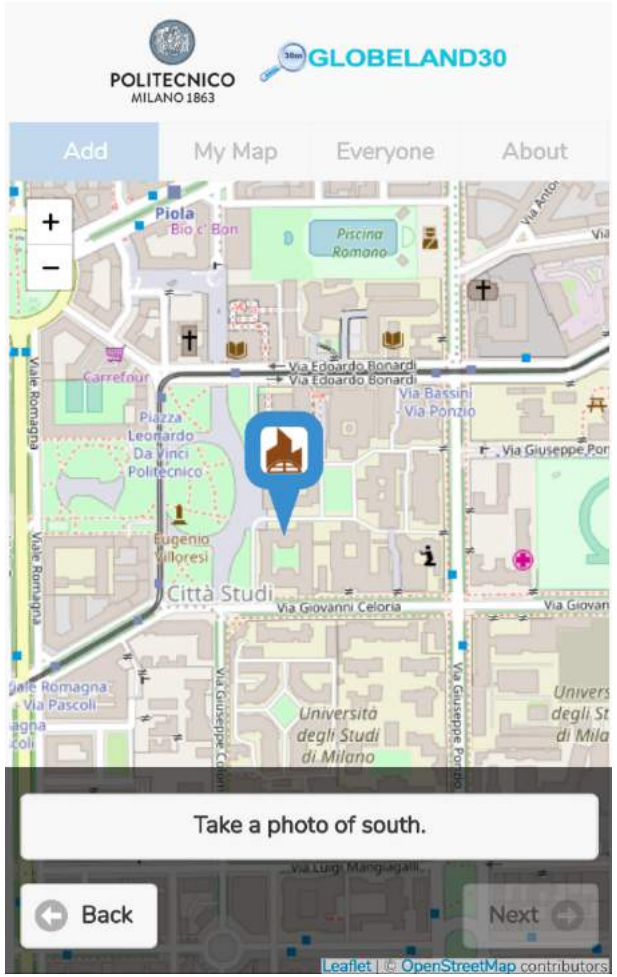

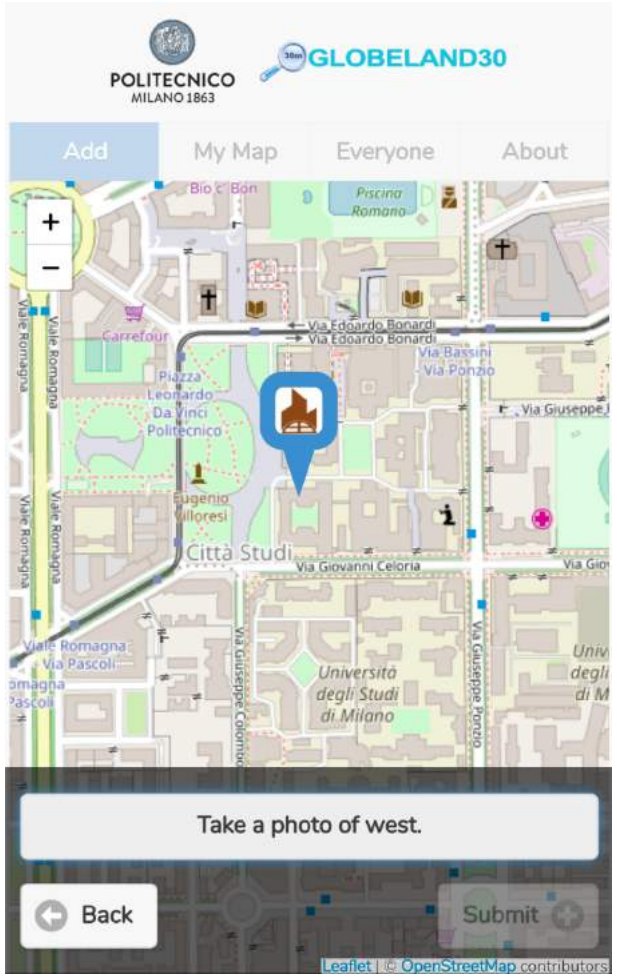

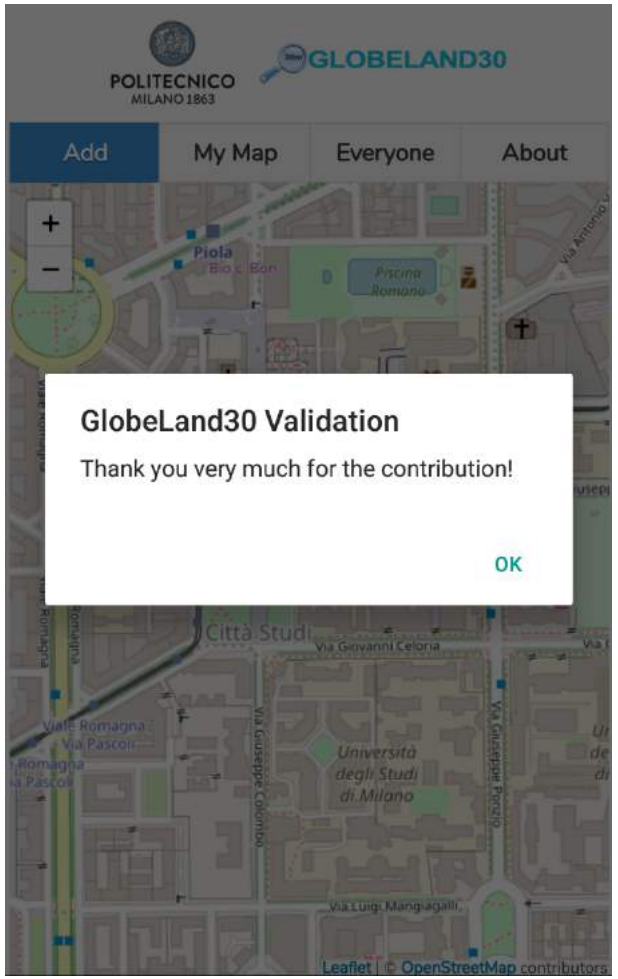

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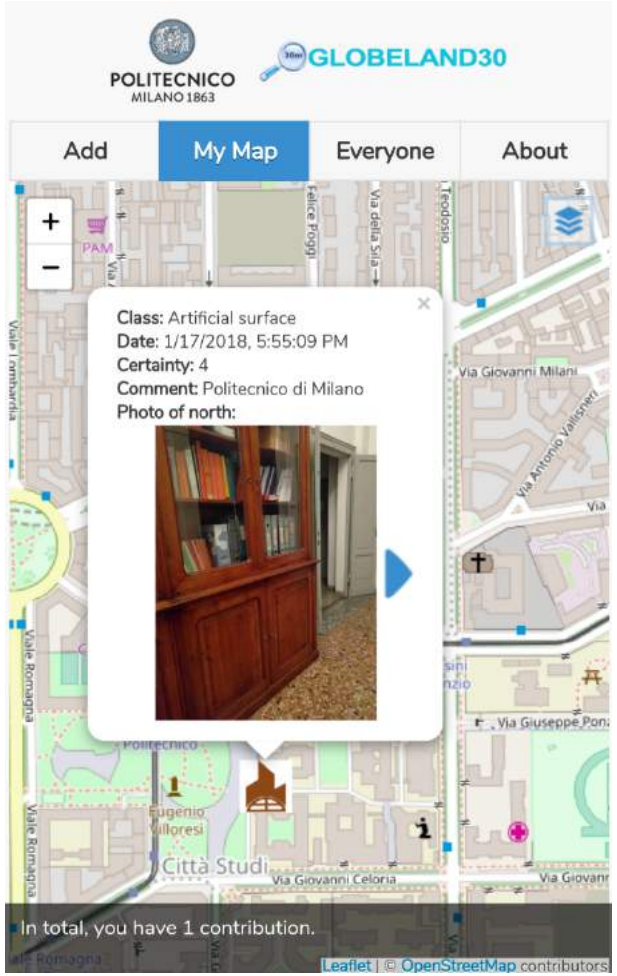
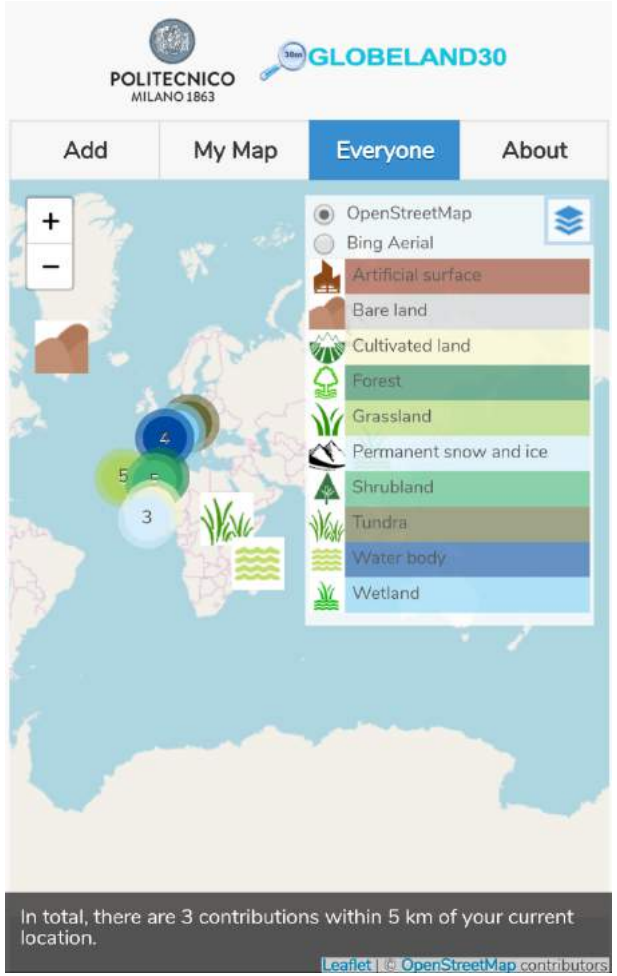
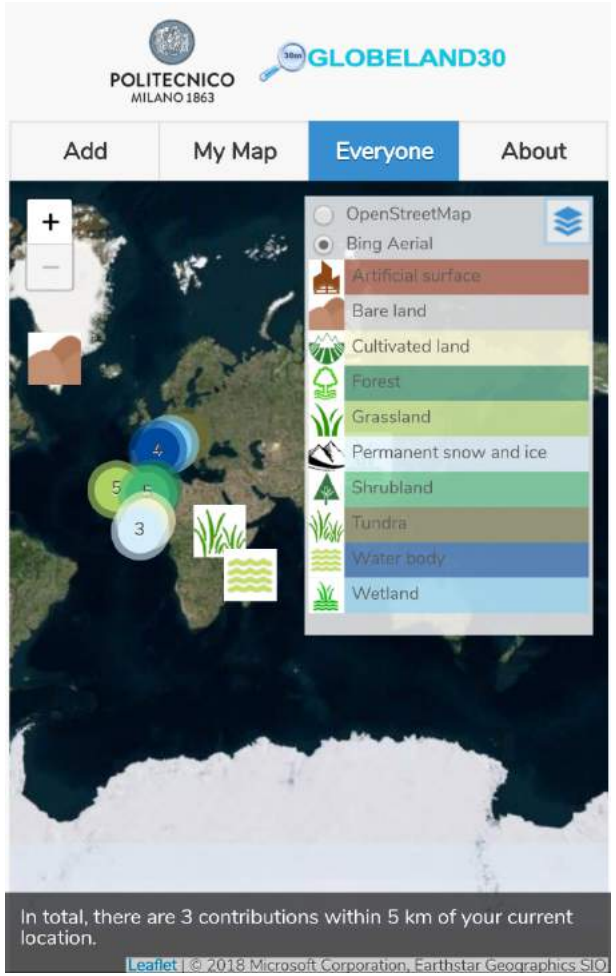
GlobeLand30 Validation – Look at the data







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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.

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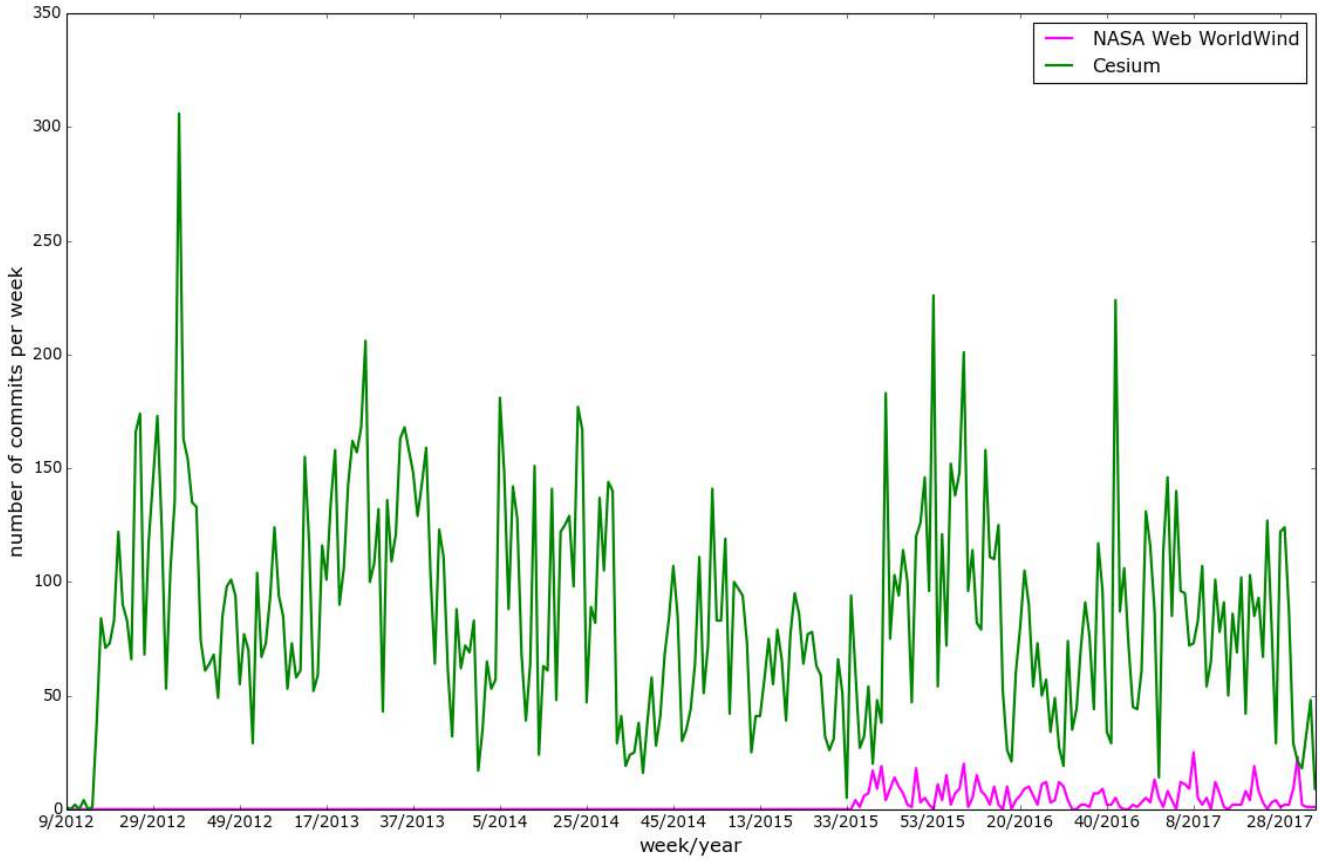
Virtual Globes
NASA Web WorldWind vs Cesium

- 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)



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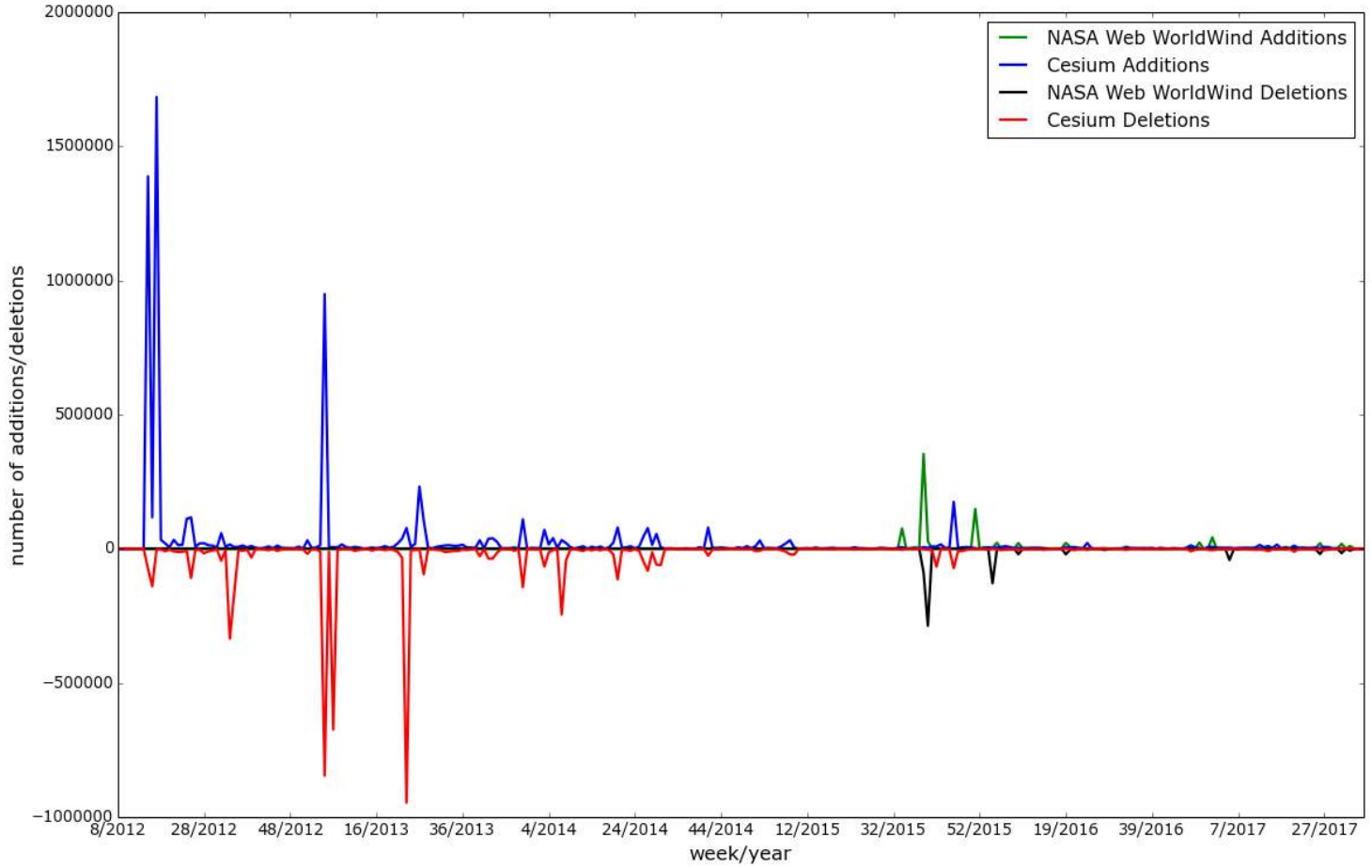
Virtual Globes
NASA Web WorldWind vs Cesium

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



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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		√

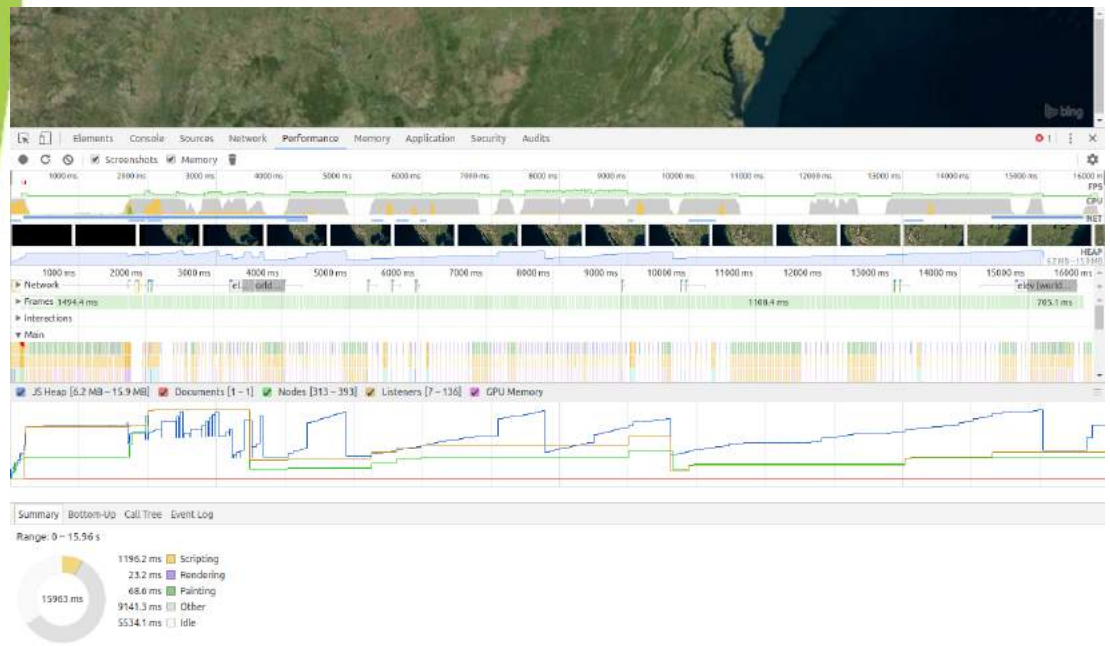
Virtual Globes
NASA Web WorldWind vs Cesium

- 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

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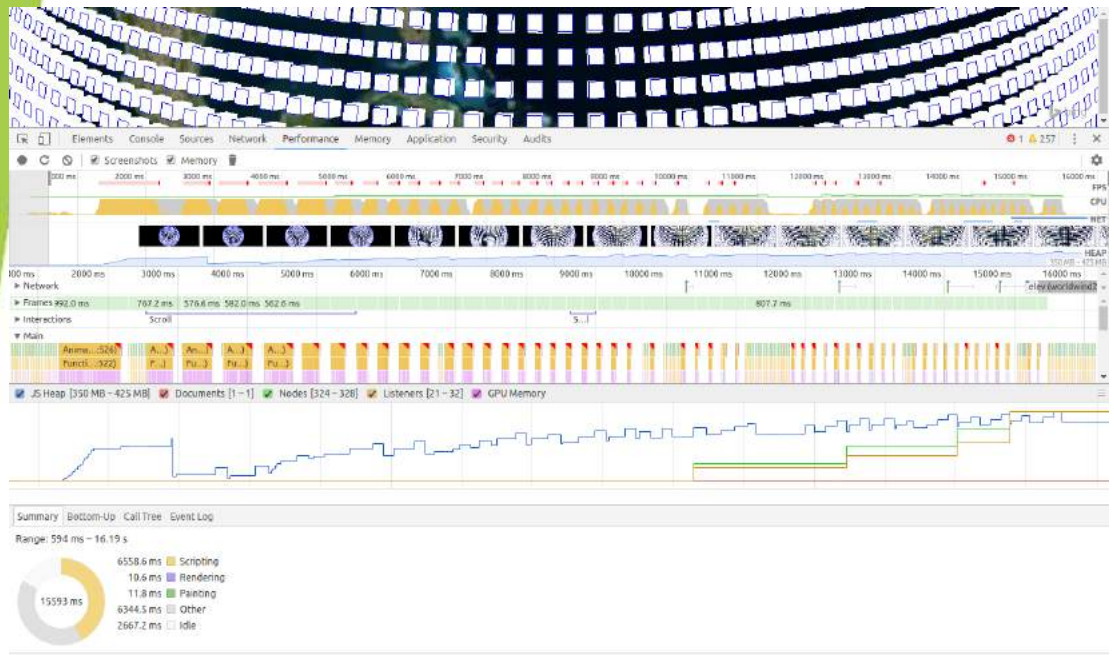
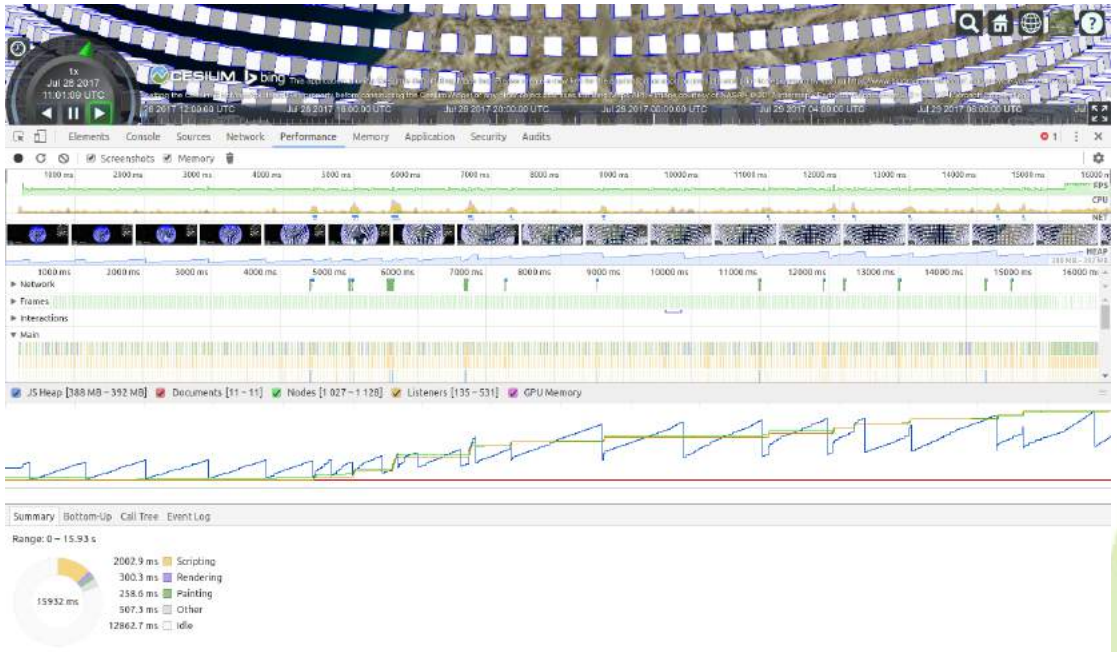
Virtual Globes
NASA Web WorldWind vs Cesium

- 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

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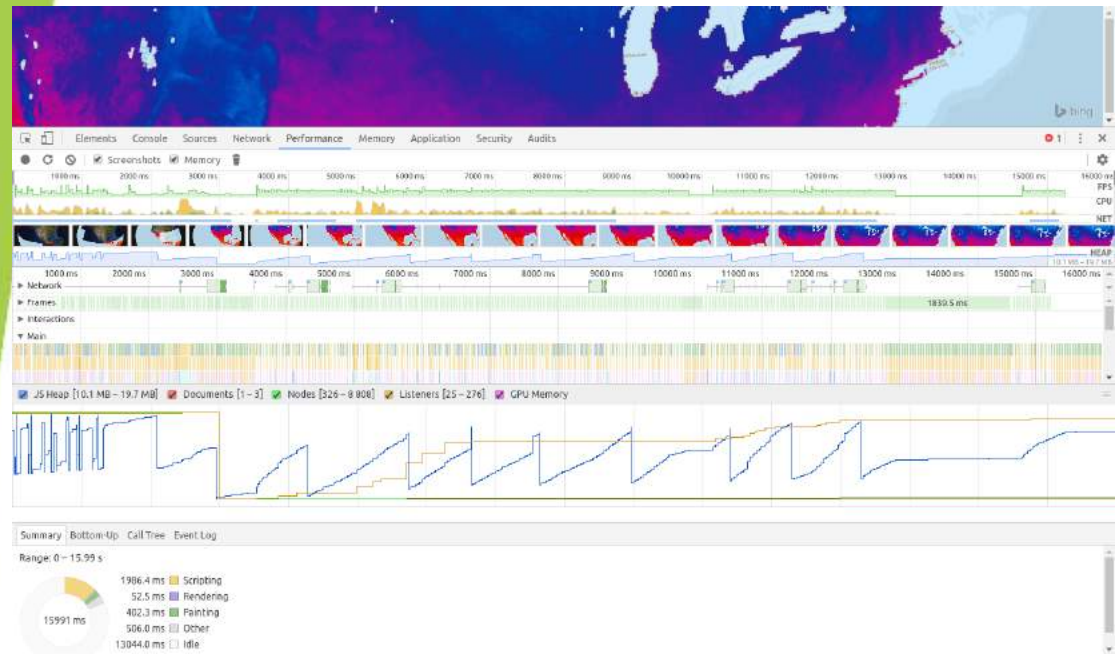
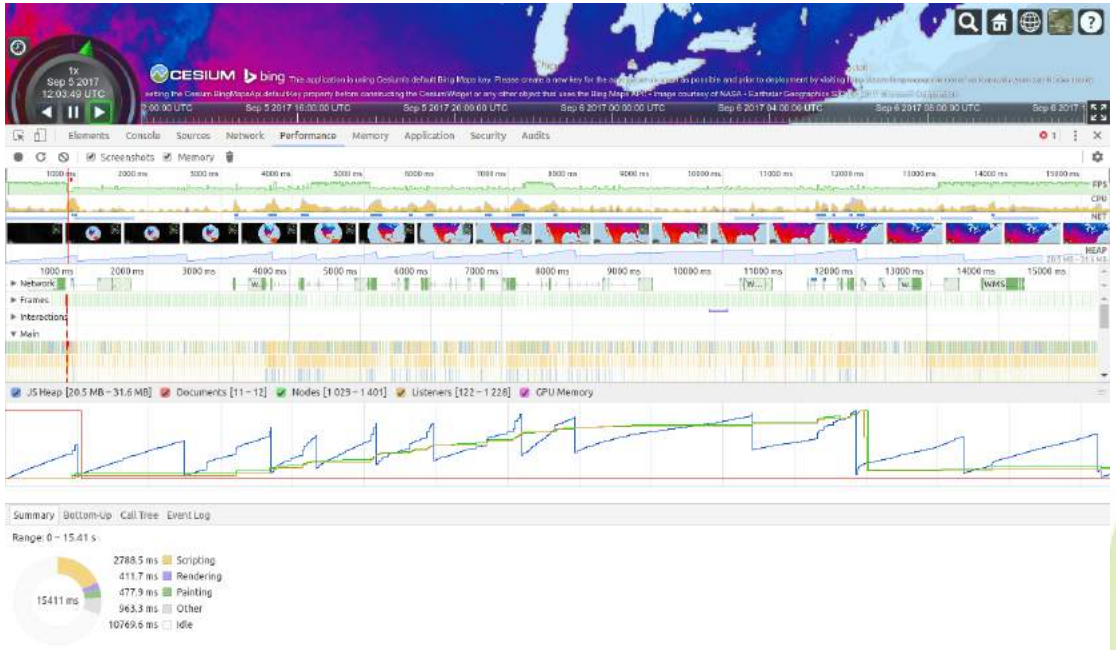
Virtual Globes
NASA Web WorldWind vs Cesium

- 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

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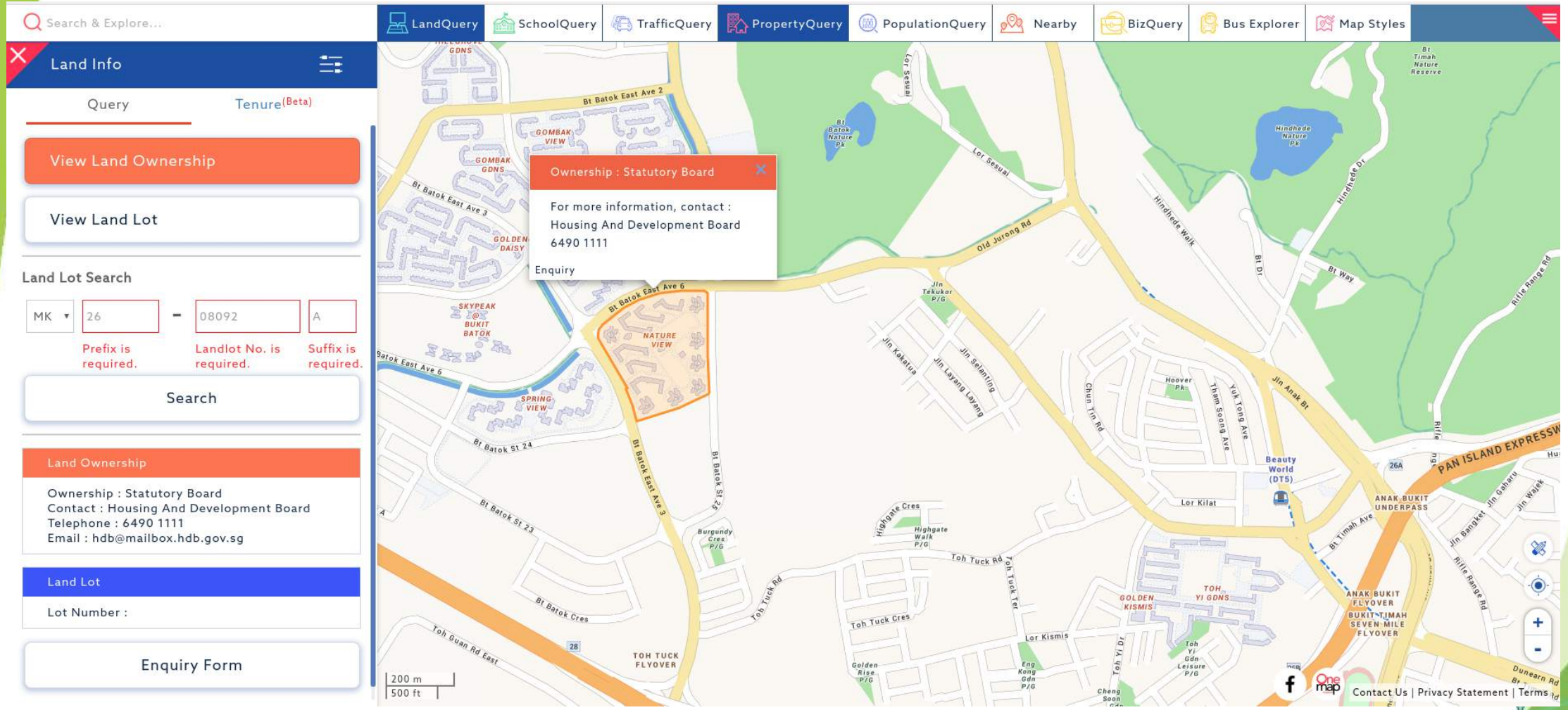
Big Mobility Data Visualization

- 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)



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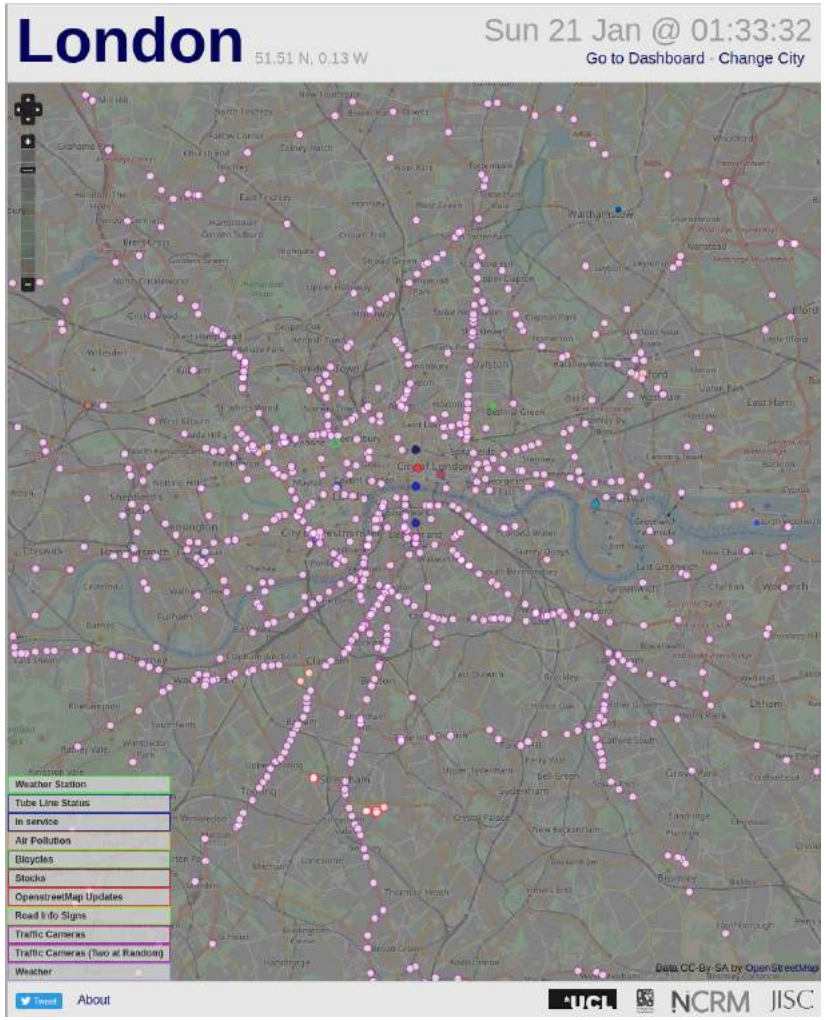
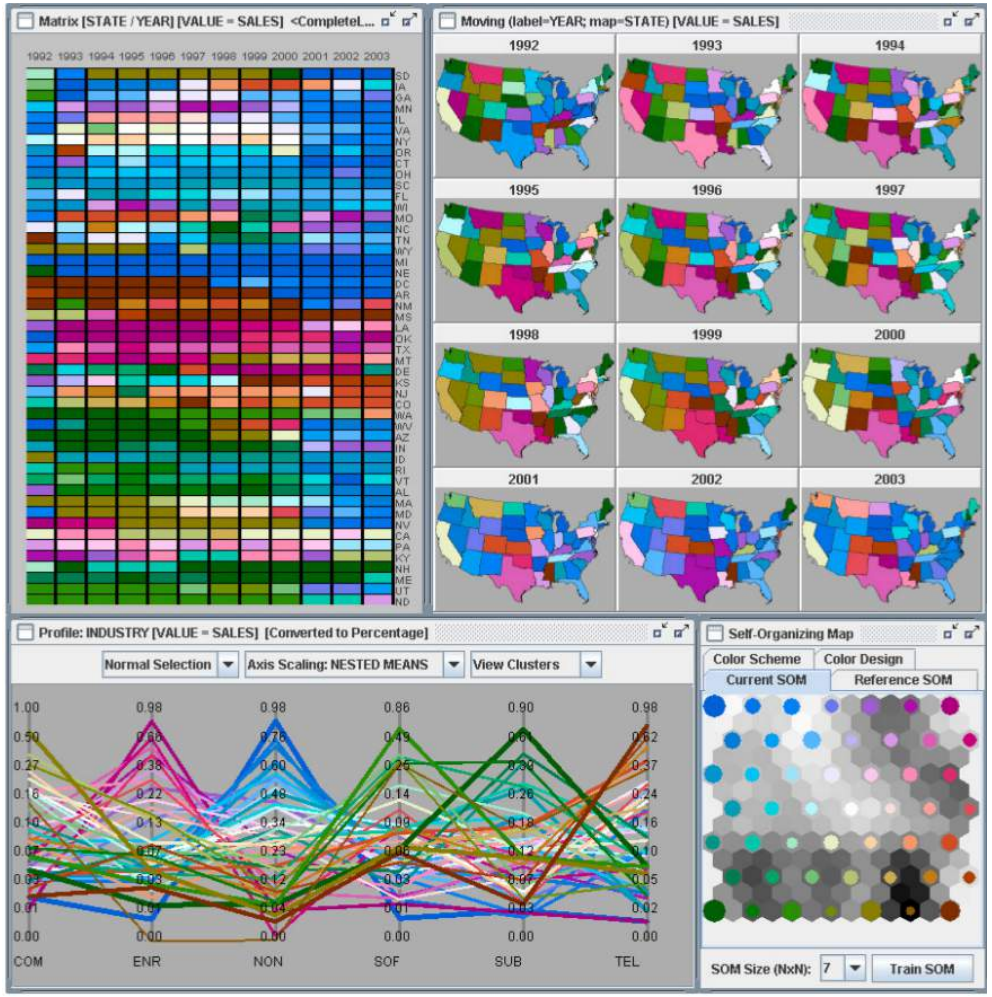
City dashboard of London (http://citydashboard.org/london/map/)



An interesting way to visualize spatiotemporal data

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



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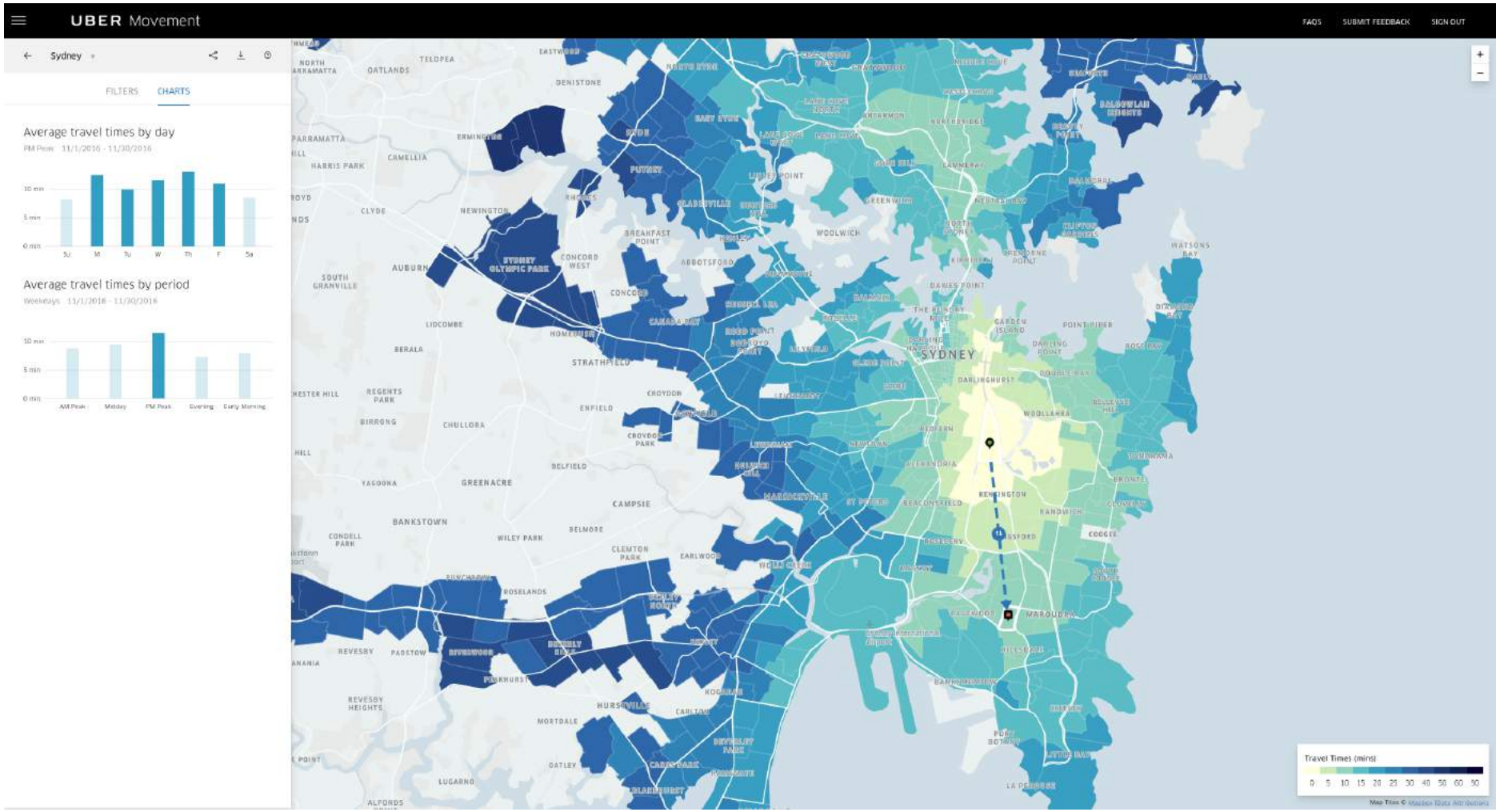
Examples from Industry
Uber Movement, average travel times



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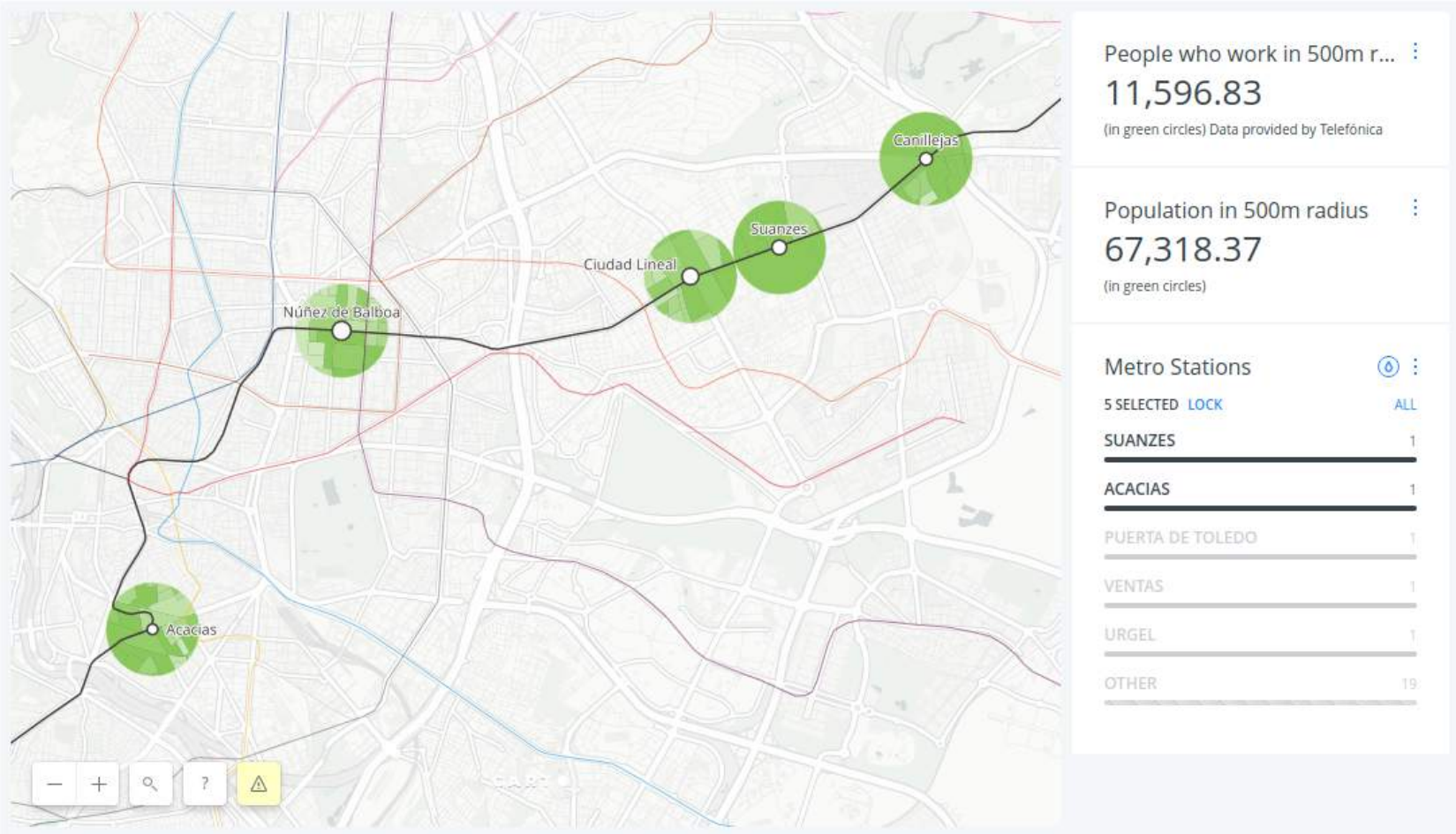
Examples from Industry
CARTO, mapping the impact of Madrid's line 5 shutdown



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Examples from Industry
Strava

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Examples from Industry
CityScience, cycling accessibility

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istituto per il rilevamento elettromagnetico dell'ambiente

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Thank you for listening.
Time for discussion.

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