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Geoprocessing Services and Applications
(WebMGS 2013)

Global Spatial Grids and Cloud-based Services

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8th International Workshop on Dynamic
Multidimensional GIS (DMGIS 2013)

The power of virtual globes for valorising cultural heritage and enabling sustainable tourism: NASA World Wind applications

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Introduction

- ❖ Use of the Web for disseminating geospatial data
 - watershed in the history of cartography
 - new **opportunities** vs new **challenges**
 - from **static** to **dynamic** maps
 - from **2D** to **3D** viewers
- ❖ Virtual globes
 - **software** allowing to **explore the Earth** in three dimensions while streaming satellite imagery, elevation and other data from the Internet
 - crucial for achieving the **Digital Earth** vision (Gore, 1998) as a multi-resolution, three dimensional representation of the planet allowing to find, visualize and make sense of vast amounts of georeferenced information, navigating through both space and time

Virtual globes

❖ Main features:

- user freedom to move around the globe and **interact** with it
- multi-disciplinary, multi-resolution and **multi-dimensional** (even 4D)
- context capability, **ease of use**, realistic user experience
- growing **popularity** due to increased Internet availability of accurate geospatial data (e.g. aerial and satellite imagery, topographic maps and DTMs)



Virtual globes

- ❖ Many of them are available

Google earth



WebGL Earth

erdas



World Wind



osgEarth
Terrain on demand.

bing maps



CESIUM



Skyline®



esri®
ArcGlobe

Norkart



OpenWebGlobe

TerraExplorer®



MARBLE



EARTH3D



Virtual globes



- ❖ Many of them are available
- ❖ They can be classified according to different properties

Virtual globes

- ❖ Many of them are available
- ❖ They can be classified according to different properties

- license type:

- ✗ Free and Open Source Software (FOSS)



MARBLE



- ✗ proprietary (closed source) software

- ✓ purchase license



- ✓ freeware/paid license



Virtual globes

- ❖ Many of them are available
- ❖ They can be classified according to different properties
 - supported platform(s):
 - x one specific OS required



- x available for multiple OS



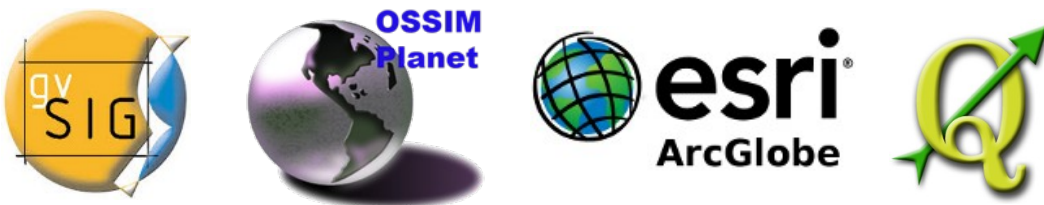
- x platform-independent



Virtual globes

- ❖ Many of them are available
- ❖ They can be classified according to different properties
 - type of application:

x desktop application



x Web application



x both desktop and Web application



Virtual globes

- ❖ Many of them are available
- ❖ They can be classified according to different properties
 - default available layers:
 - ✗ satellite/aerial imagery, DEMs (e.g. SRTM and ASTER), thematic maps
 - external loadable data
 - ✗ layers from proprietary data servers



- ✗ layers available in standard formats (e.g. OGC KML/KMZ and WMS)



World Wind



Virtual globes



- ❖ Many of them are available
- ❖ They can be classified according to different properties
 - available functionalities:
 - ✗ navigation, geometric measurement, route computation, geocoding, etc.
 - customization
 - ✗ use of external APIs

Google earth bingTM maps TerraExplorer[®]

- ✗ modification/enrichment of source code



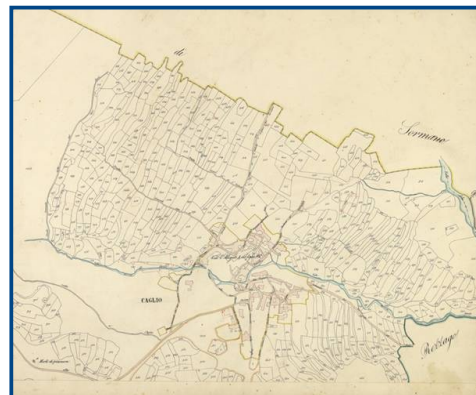
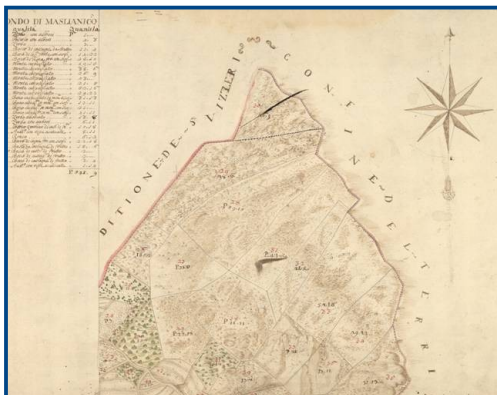
❖ NASA's virtual globe

- <http://goworldwind.org>
- free and open source under the NASA Open Source Agreement (NOSA) license
- Java Software Development Kit (SDK)
- multi-platform (Java: "Write once, run anywhere")
- JOGL (Java OpenGL 3D – Engine)
- 3D Web visualization as Java Application, Java Applet or Java Web Start Application
- based on open standards, accommodates any desired data format

❖ Main features

- quality/accuracy control of horizontal (texture) and vertical (DTM) components
- upload layers from OGC-compliant WMS servers
- default WMS layers (i.e. satellite imagery and DTMs) from NASA and USGS
- 2D objects (e.g. lines, polygons, markers) and 3D objects (e.g. parallelepipeds, spheres, extruded polygons) can be placed on the globe or in its surroundings

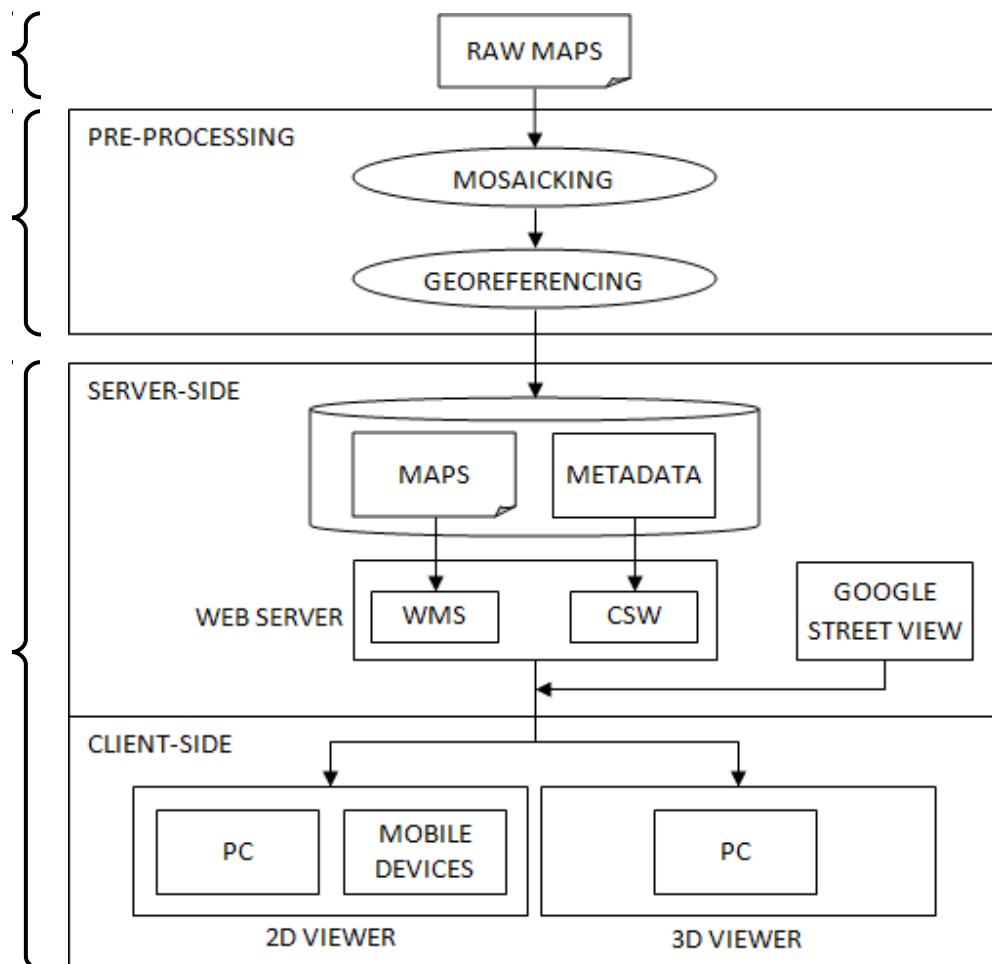
- ❖ In the State Archive of Como (Northern Italy) about **15000 historical maps** (scale 1:2000) are preserved, belonging to four cadastral series:
 - Theresian Cadastre (1718-1722)
 - Lombardo-Veneto Cadastre (1854-1858) with **Updates** (1898)
 - New Lands Cadastre (1905)
- ❖ The Web C.A.R.T.E. project (Web Catalog and Archive of the Territory and its Evolutions Representations) was born to enhance this **cultural and historical heritage** using GIS FOSS for processing and Web publishing.



<http://webcarte.como.polimi.it>

❖ Maps undergo a set of well-defined procedures for:

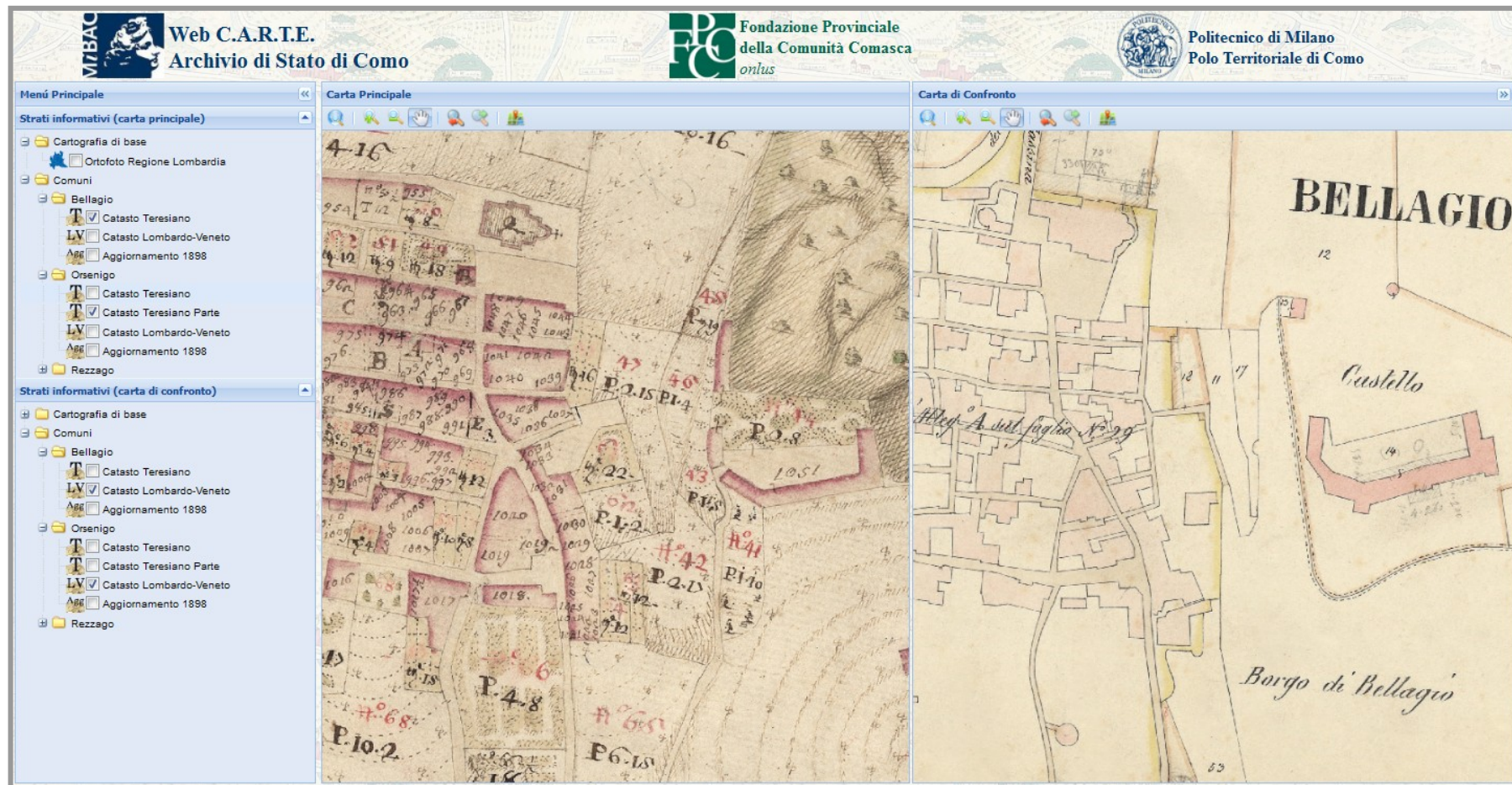
- digitization
- pre-processing
(mosaicking + georeferencing)
- creation of a metadata
Web geocatolog
- Web publication
(2D and 3D, PC and mobile devices)



❖ 2D visualization



MapServer
open source web mapping

The screenshot displays the Web C.A.R.T.E. interface. The top header includes the MIBAC logo, the text 'Web C.A.R.T.E. Archivio di Stato di Como', the logo of the Fondazione Provinciale della Comunità Comasca onlus, and the logo of the Politecnico di Milano Polo Territoriale di Como. The interface is divided into three main sections: a left sidebar menu, a central map area, and a right comparison map area.

Left Sidebar Menu:

- Menù Principale
- Strati informativi (carta principale)
 - Cartografia di base
 - Ortofoto Regione Lombardia
 - Comuni
 - Bellagio
 - ☒ Catasto Teresiano
 - ☒ Catasto Lombardo-Veneto
 - ☐ Aggiornamento 1898
 - Ossenigo
 - ☒ Catasto Teresiano
 - ☒ Catasto Teresiano Parte
 - ☒ Catasto Lombardo-Veneto
 - ☐ Aggiornamento 1898
 - Rezzago
- Strati informativi (carta di confronto)
 - Cartografia di base
 - Comuni
 - Bellagio
 - ☐ Catasto Teresiano
 - ☒ Catasto Lombardo-Veneto
 - ☐ Aggiornamento 1898
 - Ossenigo
 - ☐ Catasto Teresiano
 - ☐ Catasto Teresiano Parte
 - ☒ Catasto Lombardo-Veneto
 - ☐ Aggiornamento 1898
 - Rezzago

Central Map Area: Displays a historical cadastral map of Bellagio, showing property boundaries, buildings, and various annotations in red and black ink. The map is labeled with '4-16' in the top left corner.

Right Comparison Map Area: Displays a modern map of Bellagio, showing the town's layout, including the 'Castello' and 'Borgo di Bellagio'. The map is labeled with 'BELLAGIO' in large letters.

❖ 3D visualization

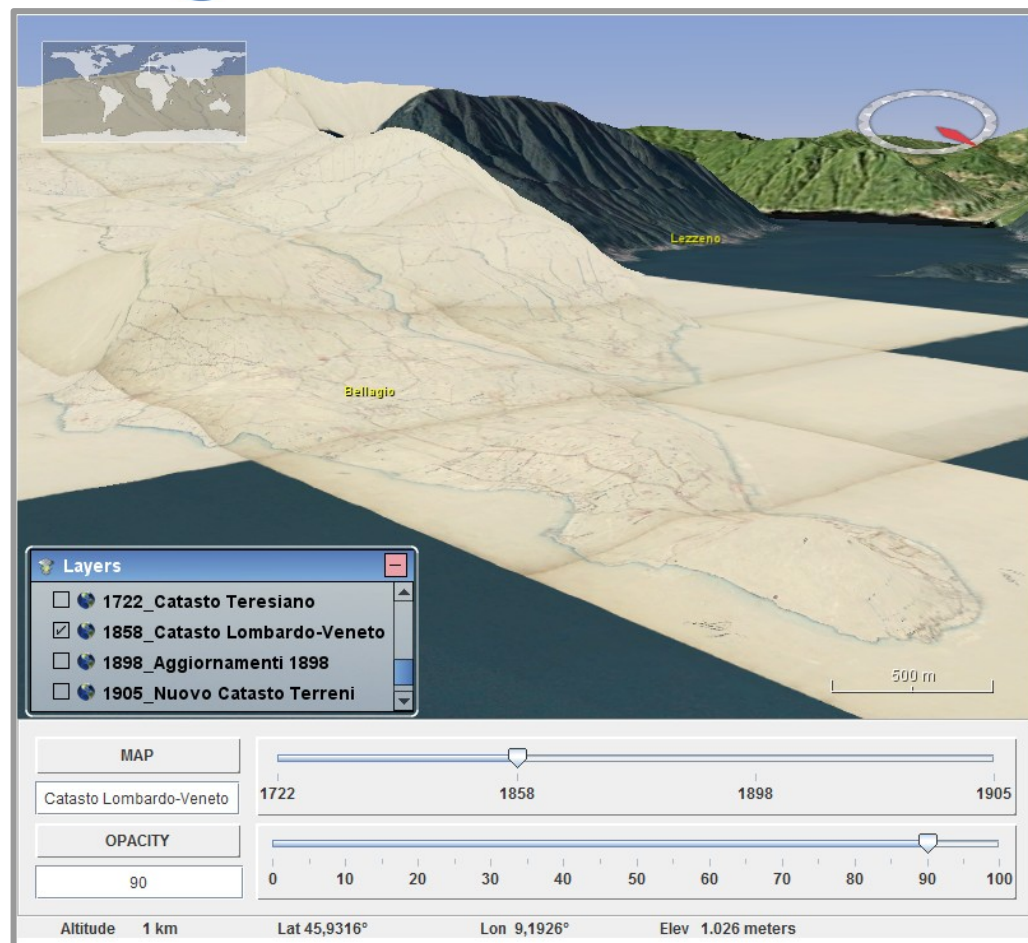


MapServer
open source web mapping



World Wind

- use of specific layers
(local orthophoto and DTM)
- creation of a temporal slidebar
to provide 4D navigation
- creation of an opacity slidebar
to favor map comparison



Historical maps

- ❖ Multi-frame and multi-dimensional Web visualization of historical maps
 - buildings time-varying features visualized on synchronized 2D and 3D viewers



<http://historicalmaps.como.polimi.it>

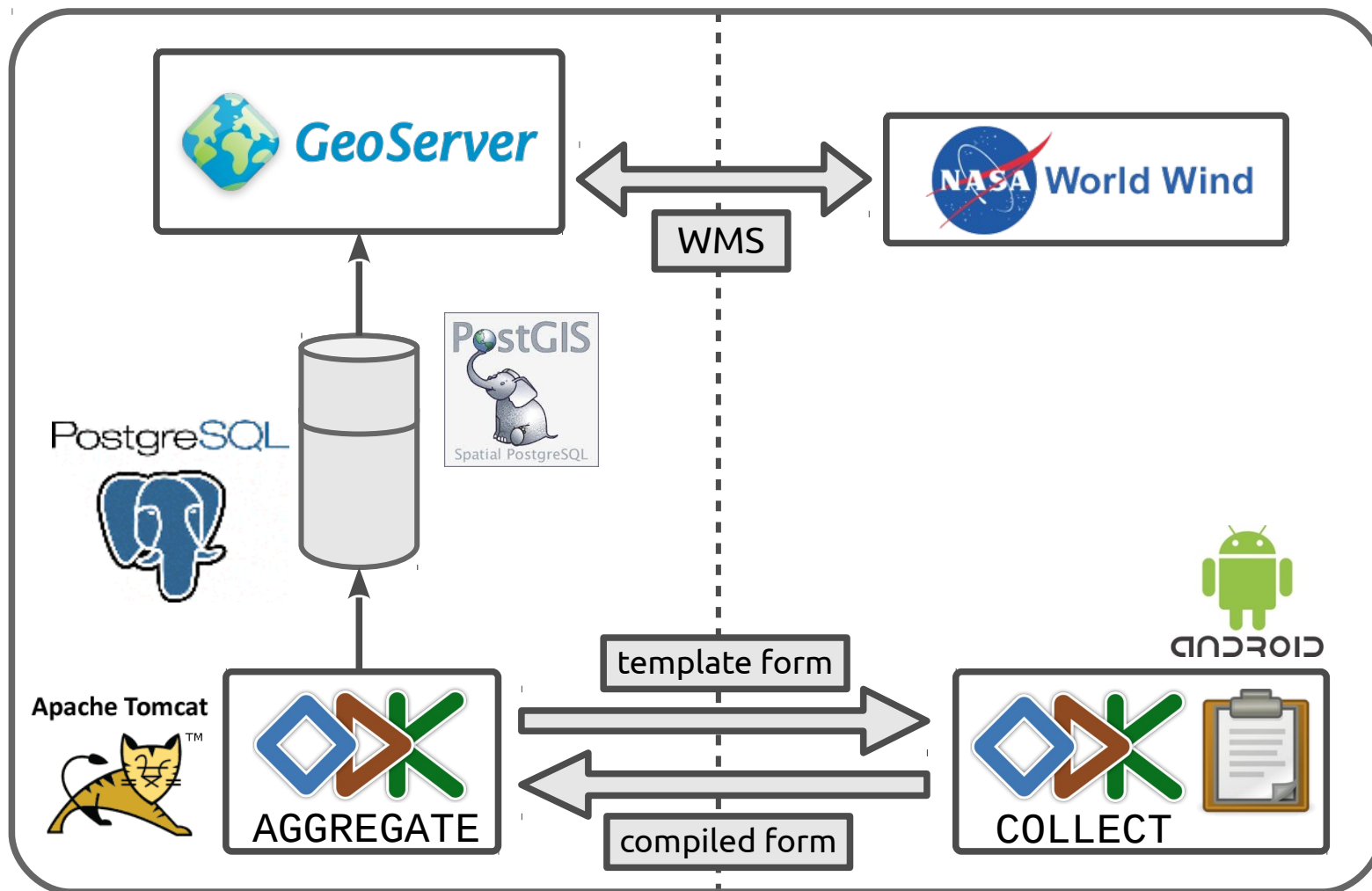
- ❖ PoliCrowd is a Web-based 3D Participatory GIS platform
 - born to promote **tourism and cultural heritage**
 - interaction with user **mobile devices** for uploading Points Of interest (POIs)
 - POIs **three-dimensional visualization** on World Wind virtual globe
 - user **collaborative contribution** in POIs characterization
 - creating, saving and sharing **customized maps** with the community



<http://geomobile.como.polimi.it/policrowd>

SERVER

CLIENT





Data collection



PoliCrowd



ODK Collect > Point Of Interest

Date of report of the point of interest
Insert the current date or the date the report is referred to.

| | | |
|----|-----|------|
| + | + | + |
| 13 | Jun | 2013 |
| - | - | - |

10:25



Data collection




PoliCrowd




ODK Collect > Point Of Interest

Type of point of interest
Specify which kind of point of interest you wish to report by choosing one of the following options.


☐ point with panoramic view



☐ monument



☒ historical/monumental building



☐ place of worship

10:36



Data collection




PoliCrowd




ODK Collect > Point Of Interest

Classification of the point of interest
Classify the point of interest you wish to report by choosing one of the following options.


☐ castle



☒ villa



☐ palace



☐ lighthouse

10:36



Data collection




PoliCrowd



ODK Collect > Point Of Interest

Name of the point of interest
Type the name of the point of interest you wish to report.

Villa Olmo



1 2 3 4 5 6 7 8 9 0
q w e r t y u i o p
a s d f g h j k l
↑ z x c v b n m ⌫
⌨️ 🌐 @#_ _ , . ⬅️
✓ 🏠 📄 ☰ 10:37 📶 🔋



Data collection



PoliCrowd



ODK Collect > Point Of Interest

Position of the point of interest

Be sure to be outdoors and check that the device GPS is on. Alternatively, you can also determine the position by connecting to a wi-fi network.

Replace Location

Latitude: N 45°48'6"
Longitude: E 9°5'43"
Altitude: 0m
Accuracy: 5m

Navigation icons: back, home, recent apps, menu, camera, gallery, files, settings, battery, 10:40, signal, Wi-Fi, battery



Data collection



PoliCrowd



ODK Collect > Point Of Interest

Picture showing the point of interest

Take a picture of the point of interest using the device camera or upload a picture available on the device.

Take Picture

Choose Image



10:45





Data collection



PoliCrowd



ODK Collect > Point Of Interest

You are at the end of Point Of Interest.

Name this form

Point Of Interest

☒ Mark form as finalized

Save Form and Exit

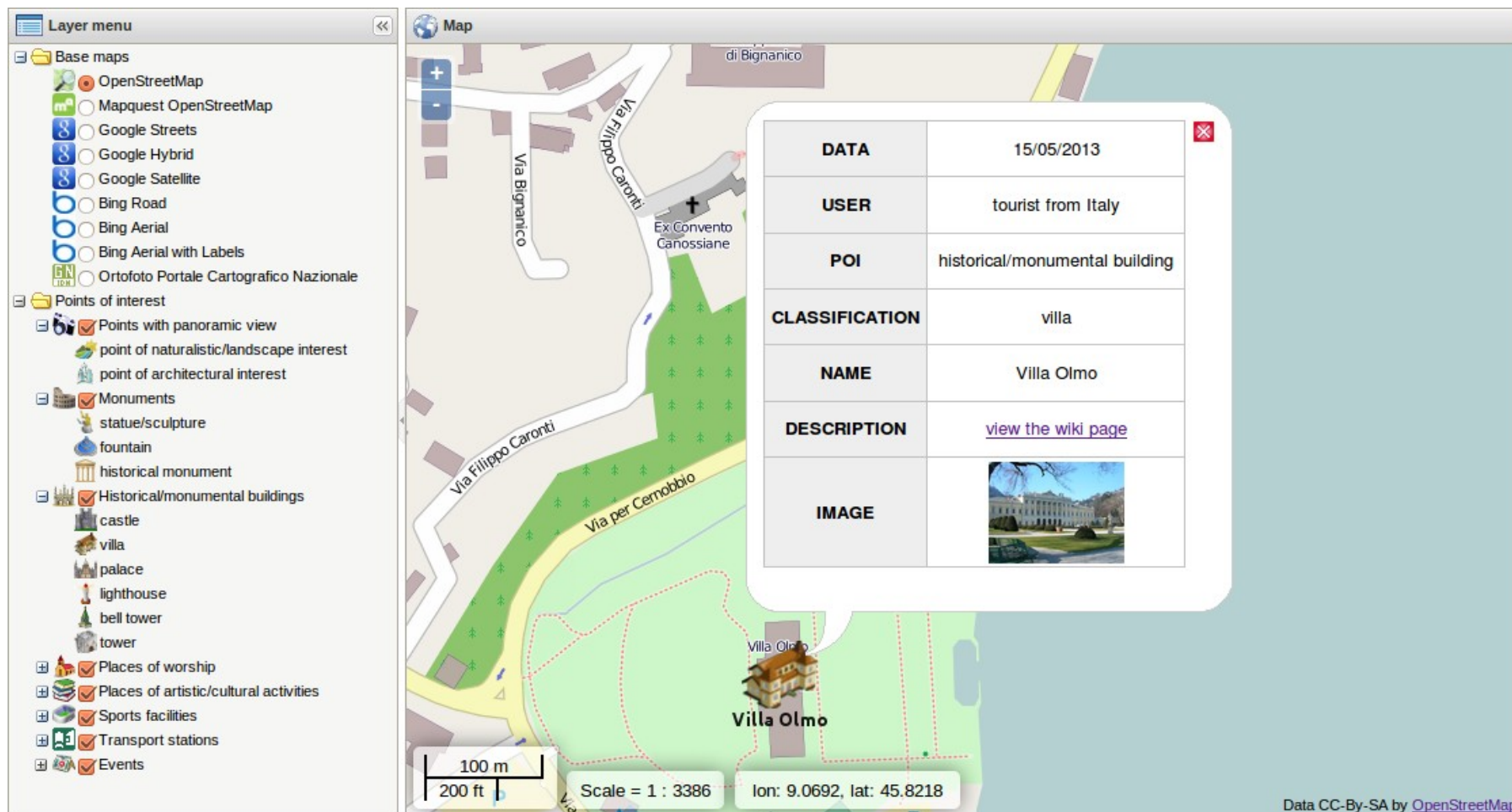
10:46

❖ 2D visualization - computers




GeoExt

ExtJS

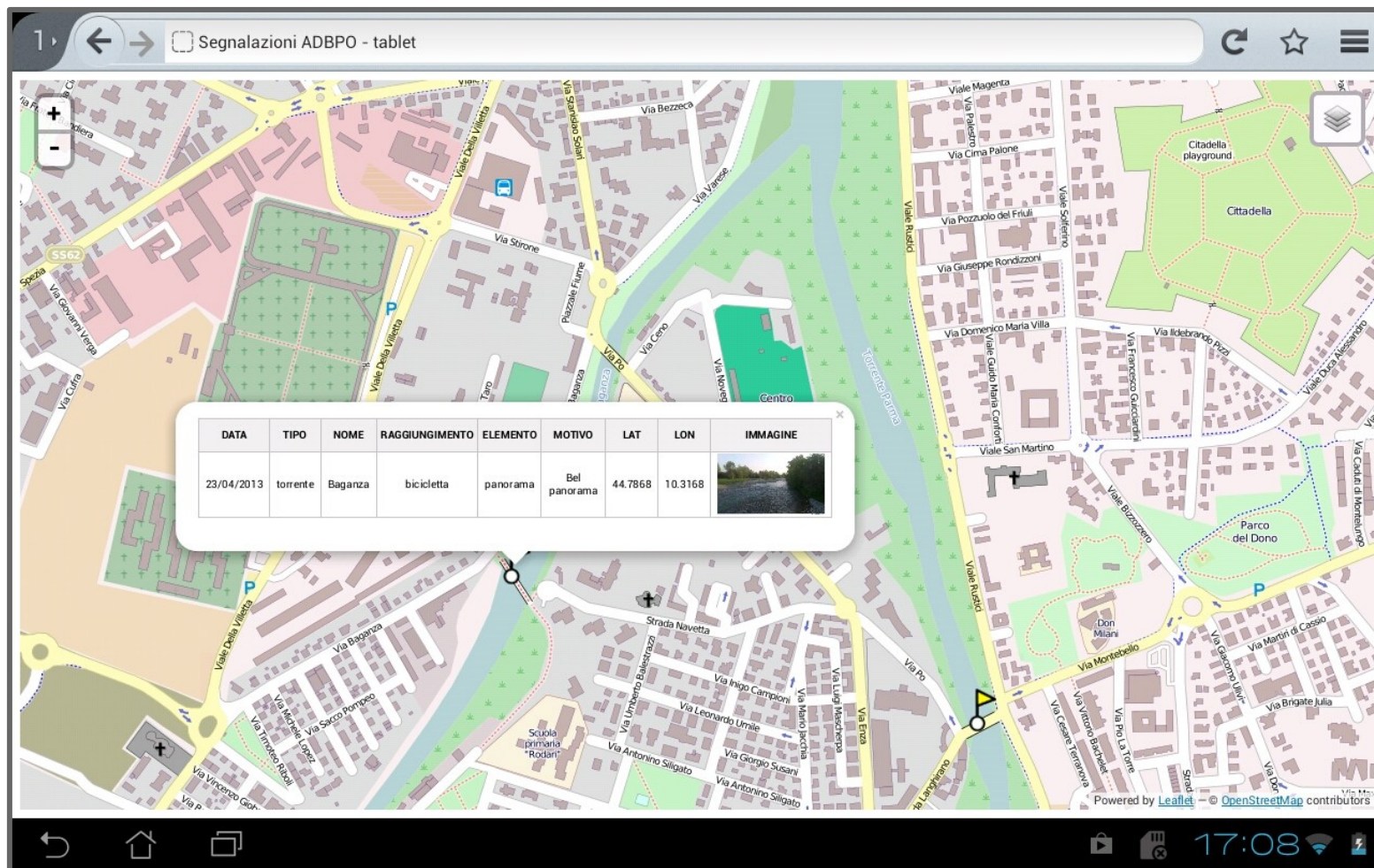


The screenshot displays the PoliCrowd web application interface. On the left is a 'Layer menu' with categories like 'Base maps' (OpenStreetMap, Mapquest, Google Streets, etc.) and 'Points of interest' (Monuments, Historical/monumental buildings, etc.). The main area shows a map of Villa Olmo with a popup window displaying the following data:

| | |
|----------------|---|
| DATA | 15/05/2013 |
| USER | tourist from Italy |
| POI | historical/monumental building |
| CLASSIFICATION | villa |
| NAME | Villa Olmo |
| DESCRIPTION | view the wiki page |
| IMAGE |  |

At the bottom of the map, there is a scale bar (100 m / 200 ft), a scale indicator (Scale = 1 : 3386), and coordinates (lon: 9.0692, lat: 45.8218). The data is attributed to CC-BY-SA by OpenStreetMap.

❖ 2D visualization - tablets *Leaflet*



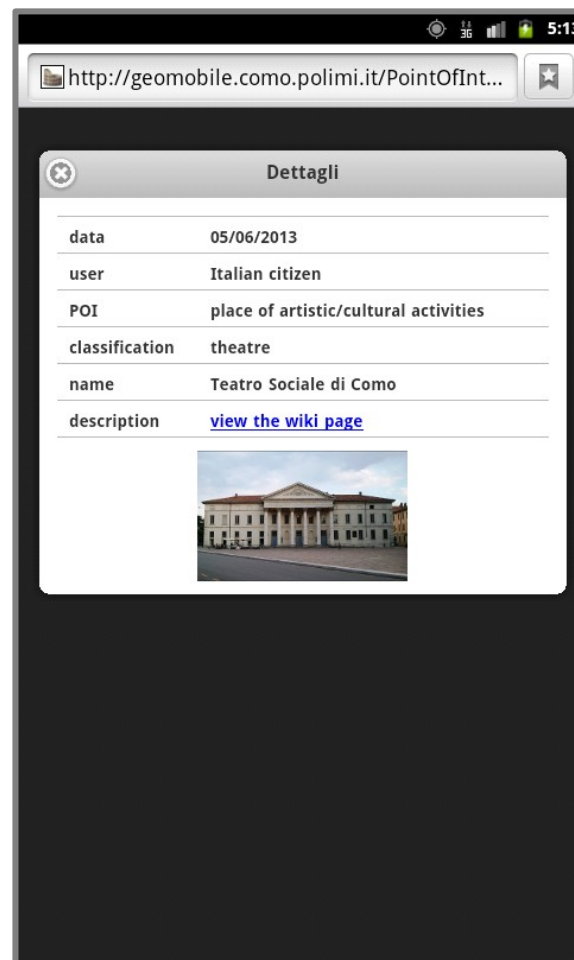
❖ 2D visualization - smartphone



OpenLayers™



jQuery
mobile



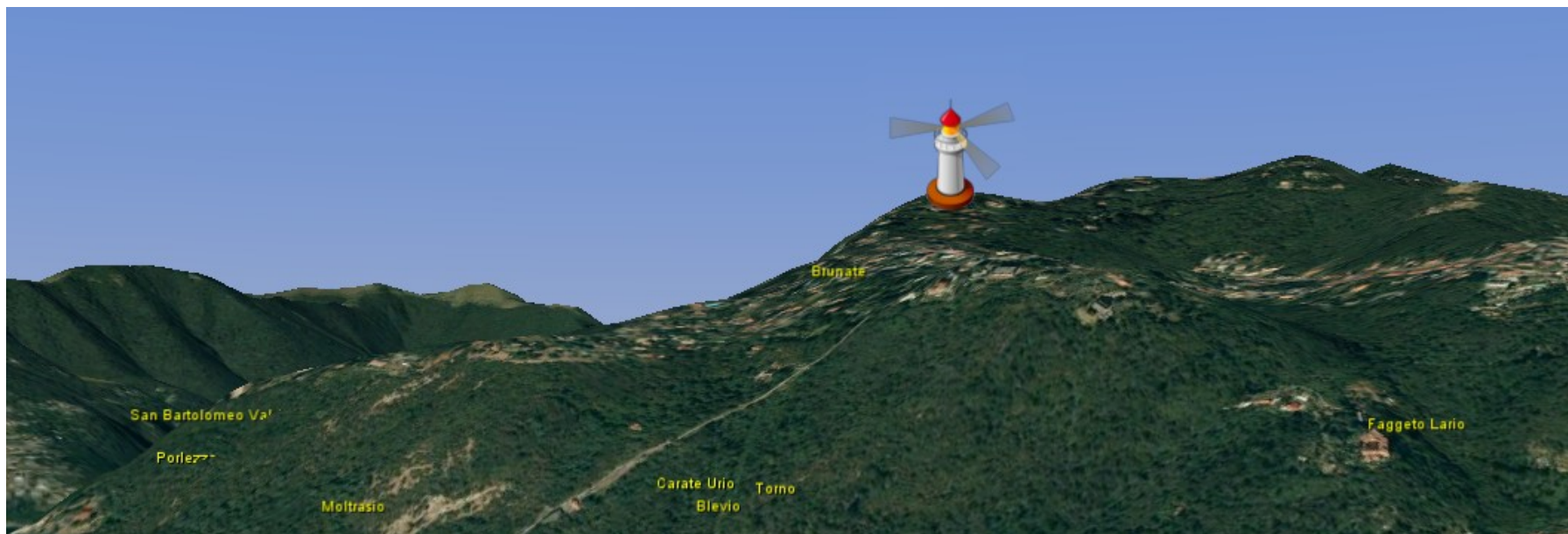
- ❖ Points Of Interest (POIs) 3D visualization on top of World Wind
 - 3 Levels Of Detail according to the altitude of the point of view over the globe
 - ✗ first LOD: representation of all the POIs with a common icon (i.e. a pin)



- ❖ Points Of Interest (POIs) 3D visualization on top of World Wind
 - 3 Levels Of Detail according to the altitude of the point of view over the globe
 - ✗ second LOD: representation of POIs with icons showing their category

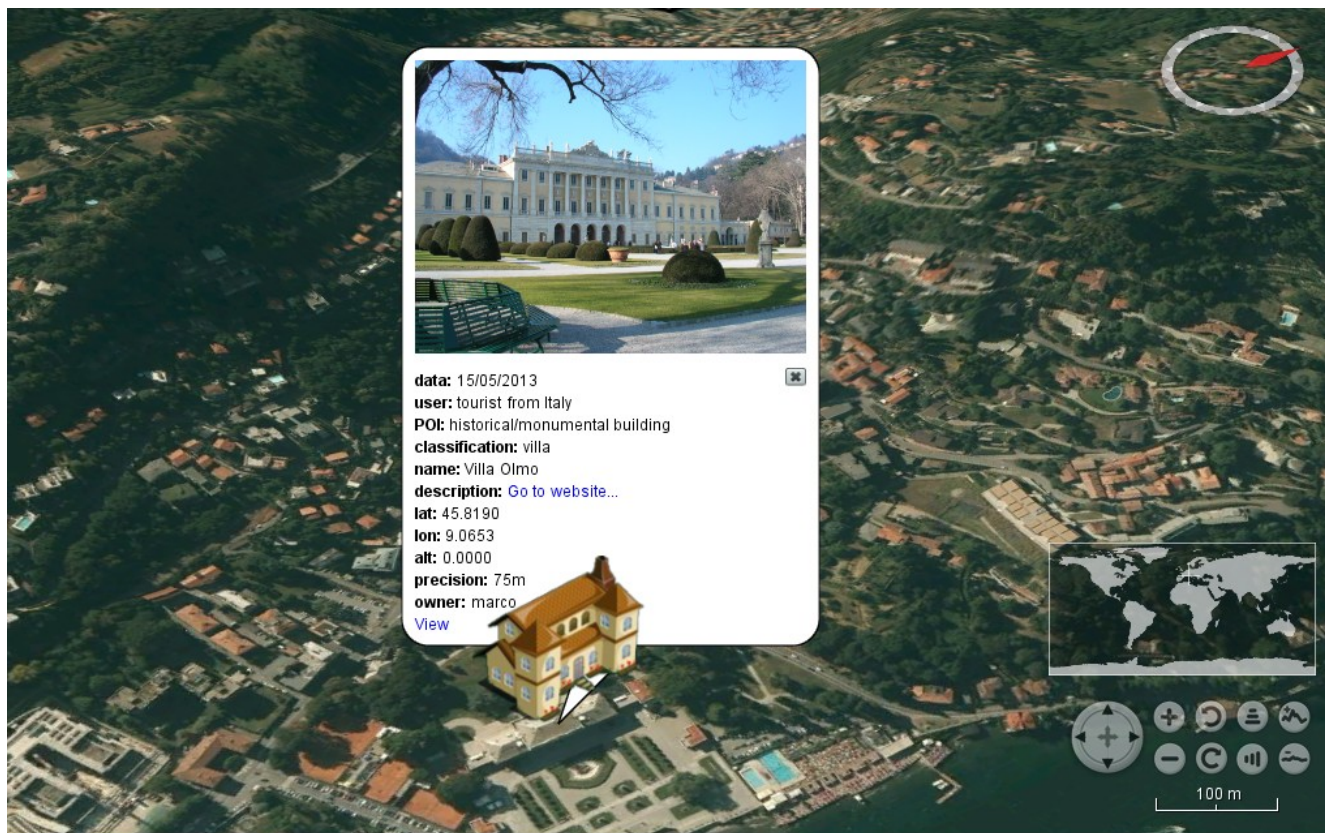


- ❖ Points Of Interest (POIs) 3D visualization on top of World Wind
 - 3 Levels Of Detail according to the altitude of the point of view over the globe
 - ✗ third LOD: representation of POIs with icons showing their classification




❖ Querying Points Of Interest

- **clickable** POIs placemarks
- visualization of Android ODK Collect-reported information in a **balloon**









- ❖ View/upload additional contents about POIs

View Related Media and Comments



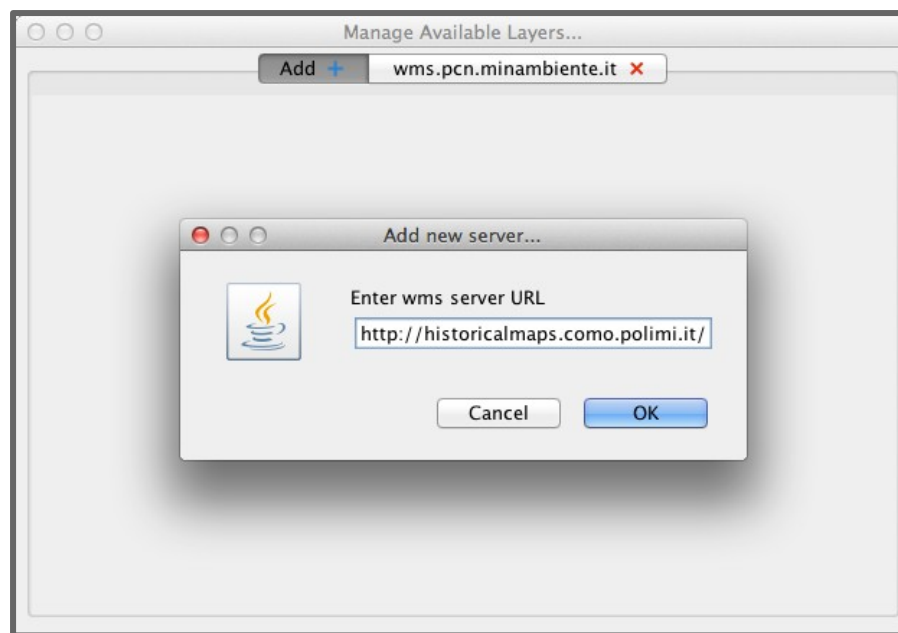
Data: 25/05/2013
User: Italian citizen
POI: place of worship
Classification: church/basilica
Name: Basilica di San Fedele
Description: [http://en.wikipedia.org/wiki/Basilica_di_San_Fedele_\(Como\)](http://en.wikipedia.org/wiki/Basilica_di_San_Fedele_(Como))
Lat: 45.8097
Lon: 9.0846
Alt: 0.0000
Precision: 75m
Owner: marco



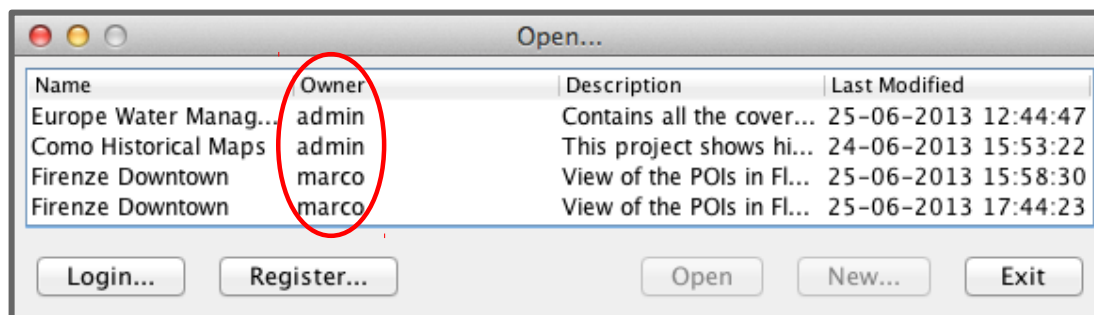


PoliCrowd
A Social World Wide Platform

- ❖ Adding layers from available **WMS servers**
 - users have to enter a valid WMS **server URL** and then select from the list the desired layer(s)
 - all the WMS layers added to a PoliCrowd projec feed a **catalogue** available for the whole community



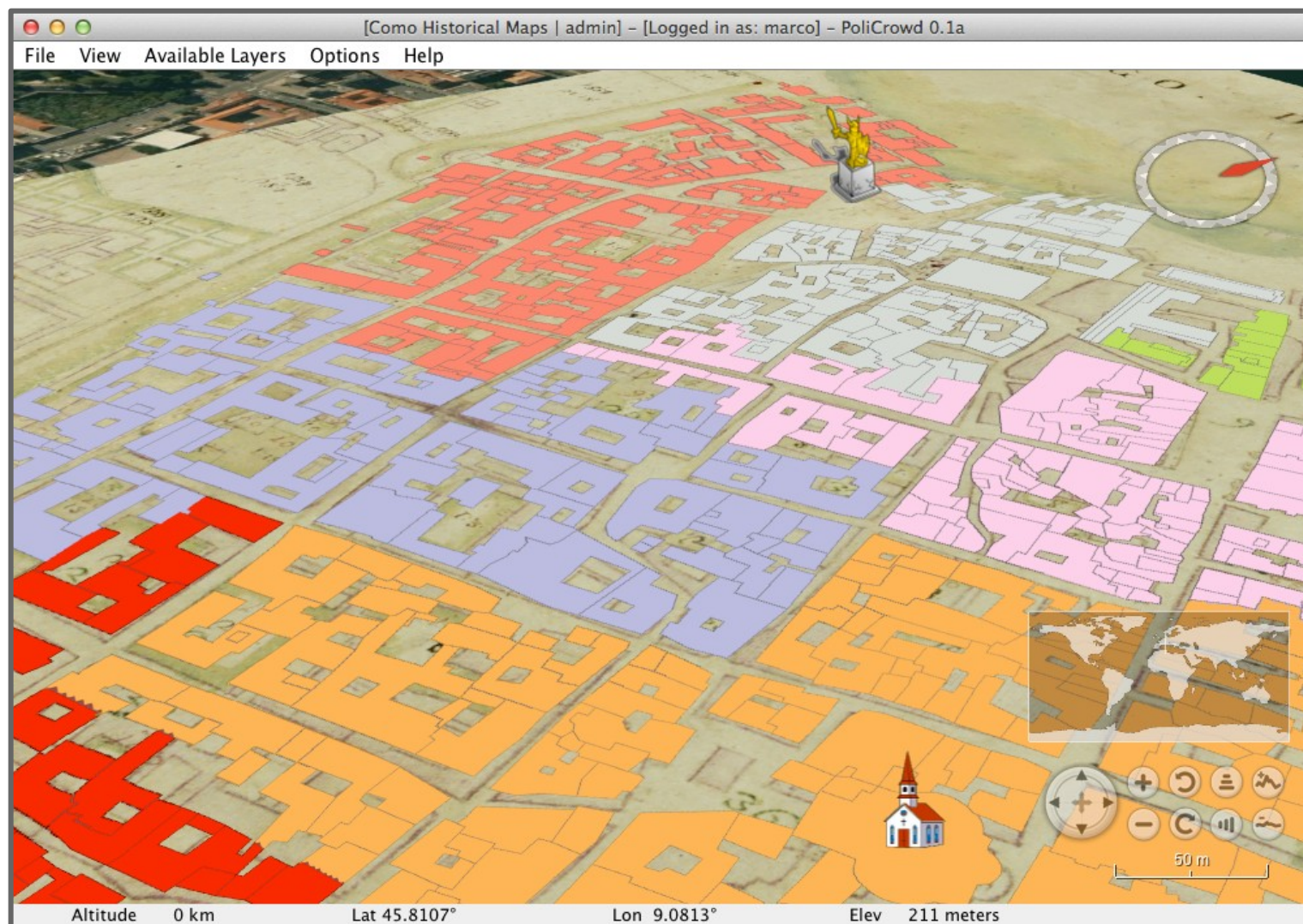
- ❖ Creation of a new PoliCrowd project
 - authenticated users can create a new project, entering a name and a description
- ❖ Saving a PoliCrowd project
 - storage of the **current layers**, the **position** (i.e. latitude, longitude and altitude) and the **camera orientation** of the point of view over the globe
- ❖ Visualization of user-created projects
 - all the created project feed a **catalogue** available for the whole community
 - the catalogue keeps trace of the project owner



| Name | Owner | Description | Last Modified |
|-----------------------|-------|---------------------------|---------------------|
| Europe Water Manag... | admin | Contains all the cover... | 25-06-2013 12:44:47 |
| Como Historical Maps | admin | This project shows hi... | 24-06-2013 15:53:22 |
| Firenze Downtown | marco | View of the POIs in Fl... | 25-06-2013 15:58:30 |
| Firenze Downtown | marco | View of the POIs in Fl... | 25-06-2013 17:44:23 |

Buttons: Login... Register... Open New... Exit

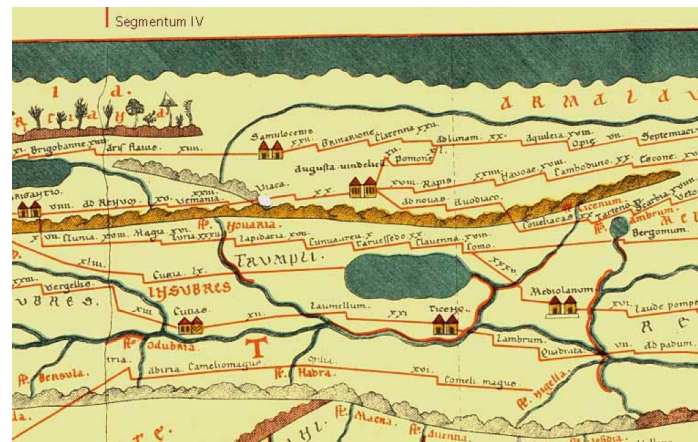
- all users can visualize PoliCrowd projects
- project owners have also **editing options** available



The Paths of Via Regina



- ❖ Via Regina defines a **cross-border area** between Italy and Switzerland
 - trade, pilgrim and cultural route since Roman times
 - transalpine system of soft mobility links



- ❖ “The Paths of Via Regina” INTERREG project
 - **purpose**: to valorise the cultural heritage of the area and foster tourism
 - **beneficiaries**: local communities, administrations, pilgrims, tourists
 - **expertise involved**: cultural heritage, land planning and management, geomatics

<http://www.viaregina.eu>

The Paths of Via Regina



- ❖ Exploitation of the available **Web Mapping** technologies
 - **crowdsourcing**: upload of field-collected data (e.g. photos, notes, travel routes)
 - **augmented reality**: real-time access to local cultural and historical information
 - **3D visualization**: realistic user experience
- ❖ NASA World Wind is a **suitable tool** for 3D visualization
 - **available functions**: upload and use of custom base layers (e.g. the LiDAR DTM) and overlay layers (e.g. historical/thematic maps, tourism info, GPS tracks)
 - **functions to be customized**: default WMS layer connection to the institutional geoportals of interest (i.e. INSPIRE, Italian Environmental Ministry, Lombardy Region and Ticino)
 - **functions to be added**: computation of terrain profile and statistics about paths (e.g. length, slope, level of difficulty), creation of virtual tours

Conclusions



- ❖ Virtual globes have been changing the way we experience the world
 - powerful, **intuitive**, easy to use
 - used in **many disciplines** and for **many purposes**
 - many virtual globes available → choose the best one according to **your needs**!
- ❖ NASA World Wind virtual globe
 - free and open source, allows rich **customization**
 - multi-platform
 - based on open standards, ensures **interoperability**
- ❖ NASA World Wind projects supporting tourism and cultural heritage
 - **3D** visualization & interaction
 - **synchronization** with 2D viewers
 - **4D** extension
 - management of **crowdsourced data**
 - complex **GIS computation**

Acknowledgments



- ❖ This research has been funded by the INTERREG “I cammini della Regina - Percorsi transfrontalieri legati alla Via Regina (The paths of Via Regina - Crossborder paths departing from Via Regina)” 2007-2013 project.

Thanks for your attention!

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NASA WW Challenge

- ❖ Second NASA World Wind Europa Challenge in 2014 (first edition in 2013, (<http://eurochallenge.como.polimi.it>))

