

# Sextant: Browsing and Mapping the Ocean of Linked Geospatial Data\*

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**Abstract.** Linked geospatial data has recently received attention as researchers and practitioners have started tapping the wealth of geospatial information available on the Web. With the rapid population of the Web of data with geospatial information, applications to manage it have also started to emerge. What the semantic geospatial web lacks, though, compared to the technological arsenal of the traditional GIS area are the tools that aid researchers and practitioners in making use of this ocean of geospatial data. In this demo paper, we present Sextant, a web-based tool that enables exploration of linked geospatial data as well as creation, sharing, and collaborative editing of thematic maps by combining linked geospatial data and other geospatial information available in standard OGC file formats.

## 1 Introduction and Motivation

Linked geospatial data has recently received attention as researchers and practitioners have started tapping the wealth of geospatial information available on the Web [4]. As a result, in the last few years, the Web of data is being rapidly populated with geospatial information. Ordnance Survey is the first national mapping agency that has made various kinds of geospatial data from Great Britain available as open linked data<sup>1</sup>. Another representative example of such efforts is LinkedGeoData (<http://linkedgeo.org/>) where OpenStreetMap (OSM) data are made available as RDF and queried using the declarative query language SPARQL [1]. A similar effort is GeoLinked Data (<http://geo.linkeddata.es/>) where geospatial data from Spain is made public using RDF [6]. Finally, the Greek Linked Open Data portal (<http://linkedopendata.gr/>) that is being developed by our group has recently published a number of open datasets for the area of Greece as linked data.

Applications for exploiting this abundance of geospatial information have also started to emerge. In project TELEIOS<sup>2</sup> we have built a service for real-time fire monitoring using semantic web and linked data technologies [3]. The core

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<sup>1</sup> <http://www.ordnancesurvey.co.uk/oswebsite/products/os-opendata.html>

<sup>2</sup> <http://earthobservatory.eu/>

component of this service is the geospatial RDF store Strabon [5] which stores hotspot products extracted from satellite images and linked geospatial data offered by the Greek Linked Open Data portal mentioned previously and queries it to deliver the service. Strabon supports two query languages: stSPARQL, an extension of SPARQL 1.1 for querying linked geospatial data that changes over time [5] and GeoSPARQL [7], a recent OGC standard for static geospatial data.

What the semantic geospatial web lacks, though, compared to the technological arsenal of the traditional GIS area are the tools that aid researchers and practitioners in making use of this ocean of geospatial data. Although tools for exploring the content of linked geospatial data have made their appearance recently, these tools focus on browsing a single dataset or the content of a single SPARQL endpoint. The LinkedGeoData browser<sup>3</sup> for example, being the most promising among these tools, offers browsing functionality for OSM data and also editing capabilities in the style of the original OSM portal. Map4RDF<sup>4</sup> is another browser for RDF data with geospatial information which also supports the visualization of statistical data modeled according to the SCOVO vocabulary. Although such tools are very useful for exploring the data offered by a single SPARQL endpoint, they present severe limitations when they are faced with the task of exploring the linked geospatial data cloud. This problem has been tried to be eliminated in its general form (not only in the geospatial domain) by the recent tool LODVisualization<sup>5</sup> which is based on the Linked Data Visualization Model [2] for visualizing RDF data. Although LODVisualization seems a very promising tool, it has very limited support regarding visualization of geospatial data and construction of meaningful thematic maps.

With the aim of filling this gap and going beyond data exploration to map creation and sharing, we designed and developed Sextant<sup>6</sup>. Similar to well-known GIS tools (e.g., ArcGIS, QGIS), Sextant can be used to produce thematic maps by layering geospatial information which exists in a number of data sources ranging from standard SPARQL endpoints, to SPARQL endpoints following OGC standards for the modeling and querying of geospatial information (i.e., GeoSPARQL), or even other standards or well-adopted geospatial file formats, such as KML and GeoJSON. The feature that distinguishes Sextant from other semantic web or GIS tools is that map creation and sharing, as well as exploration of data can be done in a declarative way using the query languages stSPARQL or GeoSPARQL. In this sense, Sextant is able to create useful thematic maps by layering information coming from the evaluation of SPARQL queries.

## 2 Sextant Overview

Figure 1a gives a high-level overview of Sextant. The two main functionalities of Sextant can be summarized as follows:

<sup>3</sup> <http://linkedgeodata.org/LGD%20Browser>

<sup>4</sup> <http://oeg-dev.dia.fi.upm.es/map4rdf/>

<sup>5</sup> <http://lodvisualization.appspot.com/>

<sup>6</sup> <http://wikipedia.org/wiki/Sextant>

- Exploration of linked geospatial data spanning multiple SPARQL endpoints.
- Creation, sharing, and collaborative editing of thematic maps by combining linked geospatial data and other geospatial information available in vector or raster formats, such as KML, GeoJSON, and GeoTIFF.

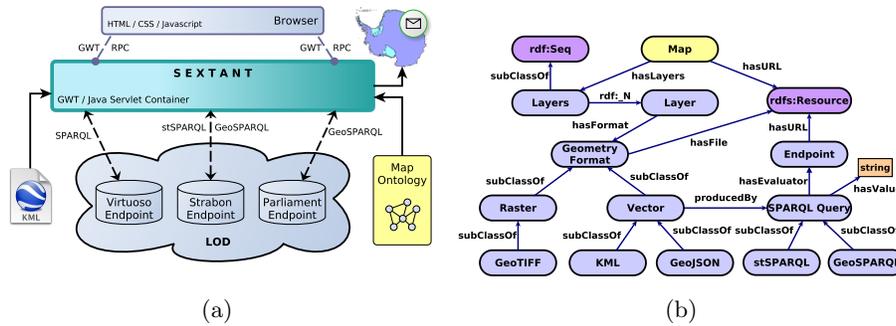


Fig. 1: (a) Sextant overview and (b) Map ontology

Sextant delivers the above functionality by modeling the content of a map according to the Map ontology of Figure 1b. In terms of exploration, Sextant harvests the content of a SPARQL endpoint to build a class hierarchy and discover the spatial extent of available information (assuming that the endpoint supports either stSPARQL or GeoSPARQL). According to the Map ontology, a map comprises an ordered set of layers the content of which may derive either from the evaluation of an stSPARQL/GeoSPARQL query on a SPARQL endpoint or directly from a standard file format for representing geospatial information, such as KML. A layer may also derive from the evaluation of standard SPARQL queries using other vocabularies such as the W3C GeoXG<sup>78</sup> and Neo-Geo (<http://geovocab.org/>). In such cases, however, one has to provide an adapter for transforming the representation of a geometry to a standard OGC representation format, such as Well-Known Text or GML, the two OGC geospatial data formats supported by stSPARQL and GeoSPARQL. Population of the Map ontology results in the production of a map as a web resource which can be shared with others for collaborative editing and viewing in Sextant. Collaboration can be achieved also using well-known desktop or web-based tools (QGIS, ArcGIS, Google Maps, OpenLayers) by leveraging the export facility of Sextant.

The main design goals in the development of Sextant have been flexibility, portability, and interoperability. Sextant achieves these goals based on the following technologies. It has been developed in the Google Web Toolkit frame-

<sup>7</sup> <http://www.w3.org/2005/Incubator/geo/XGR-geo/>

<sup>8</sup> The W3C GeoXG incubator group has also developed a geospatial ontology available at <http://www.w3.org/2005/Incubator/geo/XGR-geo-ont/>.

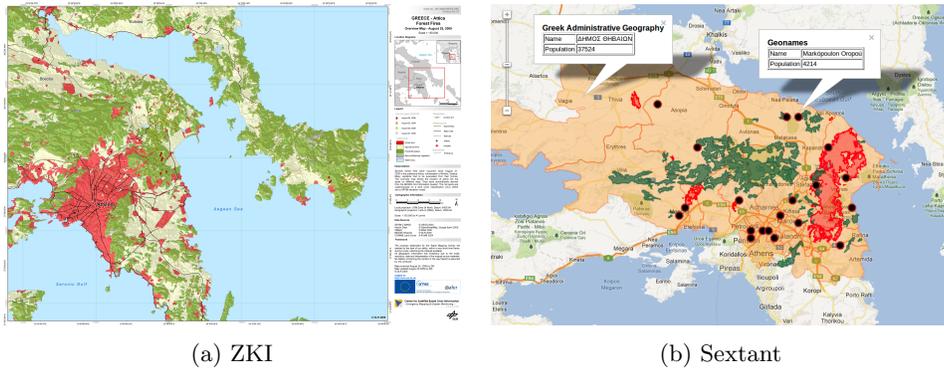


Fig. 2: Fire products of 2009 in the prefecture Attica, Athens, Greece

work<sup>9</sup> which is a mature framework that provides rapid cross-platform and cross-browser implementations of web applications. It is also based on OGC standards for the representation and querying of geospatial information (GeoSPARQL, KML, WKT), thus making it easily interoperable with well-established and mature GIS applications.

### 3 Demonstration Overview

To demonstrate Sextant, we will present how one could explore and then create a map using linked geospatial data spanning multiple SPARQL endpoints and KML files. The demonstration will be based on a real user scenario in which an expert of an emergency response agency like the Center of Satellite Based Crisis Information<sup>10</sup> (ZKI) or the National Observatory of Athens<sup>11</sup> (NOA) would like to quickly compile a map in response to an emergency event, for example a flood, a tsunami, an earthquake, a forest fire. A typical map product that ZKI produced on August 25, 2009 for assessing the area burnt as a result of the fires of the period from August 21 to August 24, 2009 in Attica, Greece is presented in Figure 2a and may be found at <http://www.zki.dlr.de/map/1034/>. Such a map, apart from depicting burnt areas, it is annotated with other kinds of information to aid experts in assessing the severity of the fire event. Typical information includes the road network, land use/cover, toponyms, population, and other more detailed information concerning map production and the data sources that were used.

We will use Sextant to produce the map presented in Figure 2b that is similar to the one produced by ZKI above. The major difference between the two maps is that the one produced by Sextant is based solely on Linked Open Geospatial

<sup>9</sup> <https://developers.google.com/web-toolkit/>

<sup>10</sup> <http://www.zki.dlr.de/>

<sup>11</sup> <http://www.noa.gr/indexen.html>

Data that are publicly available on the web. This will allow an emergency response manager to quickly compile a map based on “open source intelligence” until more precise, detailed data becomes available, i.e., after contacting local authorities. Sextant will communicate with three endpoints on top of well-known spatially-enabled RDF stores (Strabon, Parliament, and Virtuoso) and also KML files that are publicly available on the web to get most of the information mentioned above. To demonstrate the collaborative editing capabilities of Sextant, we will share the URI corresponding to the produced map with another user who will be able to edit the map. The changes will be reflected back to the creator of the map.

## 4 Conclusions and Future Work

In this work, we presented Sextant, a web-based tool that offers functionalities which are of fundamental importance to leveraging linked geospatial data: a) exploration of linked geospatial data that span across multiple SPARQL endpoints, b) creation, sharing, and collaborative editing of thematic maps produced by querying the linked geospatial data cloud and other geospatial data sources available in OGC standard file formats, c) export of maps in OGC standard formats for viewing and editing using other GIS applications.

In the future, we plan to extend Sextant in two directions. First, we will enable the creation of a single layer of a map by combining geospatial information present in different SPARQL endpoints. Such a feature would turn Sextant into a very powerful and desirable tool for leveraging the linked geospatial data cloud. In principle, such functionality could have been easily realized by the existence of both a *spatially-enabled* and *federated* RDF store. Second, we will extend map rendering, which currently uses Google Maps, to use the more versatile OpenLayers project.

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