Forest Explorer: User-Friendly Navigation of Iberian Forestry Linked Open Data

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Abstract

The Forest Explorer is a web application that allows easy browsing of the contents of the Forest Inventories and Maps of the Iberian Peninsula. It accesses a linked open data source created from the original data in the European Cross-Forest project. The application is available at https://forestexplorer.gsic.uva.es/explorer/ and can be accessed with a simple web browser on desktops, tablets, and mobile phones. The user interface hides the complexity of the underlying technologies, providing an interactive map to navigate to the area of interest and presenting the forest data in appropriate detail. The application is suitable for professional as well as casual use by science communicators, data journalists or citizens.

Keywords

Forestry Data, Geospatial Data, Linked Open Data, Map Visualizations, User Interfaces

1. Introduction

Modern forestry science increasingly relies on the use of large datasets [1]. Among these, national forest inventories and land cover maps are of particular importance. These datasets are created and published as open data by national governments, to be used by different agents, including forest stakeholders, operational foresters, data and environmental journalists, or interested citizens. However, these datasets are difficult to use, especially if integrated access is required, as they are created following different methodologies and published in a diversity of formats. Semantic Web technologies can potentially facilitate the integration and promote the usage of these datasets, but the lack of knowledge by forestry agents in these technologies makes it necessary for tools to fill this gap.

Cross-Forest[1] was a European project working on the integration of forest inventories and land cover maps data from Spain and Portugal with Semantic Web technologies. The source datasets included: (1) The Spanish National Forest Inventory (Inventario Forestal

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[1]https://crossforest.eu/

Nacional, IFN$_{es}$) based on the use of a of a 1x1 kilometer grid, with a plot[2] at each point of the grid. (2) The Portuguese National Forest Inventory (Inventário Florestal Nacional, IFN$_{pt}$) contains generalized dendrometric data grouped by NUTS[3] levels. (3) The Spanish Forest Map (Mapa Forestal Español, MFE), a land cover map focused on forestry patches[4]. Each patch includes information about land use and the dominant tree species. And (4) the Portuguese Land Use Map (Carta de Ocupação do Solo, COS) a land cover map of general use.

In the Cross-Forest project the ontologies are developed using a bottom-up methodology. First, modeling the relevant concepts and relations in each source. Second, identifying and describing concepts and relations shared among several sources (such as species, positions, and measures). And third, generalizing related concepts within the same domain (i.e., forest inventories and land use). This leads to a modular ontology comprised by three sets of modules: (1) bottom-level ontologies corresponding to the sources, (2) top-level domain ontologies for forest inventories and land use, and (3) general cross-domain ontologies for shares concepts and relations. The data is generated using first Open-Source tools[5] to convert the original sources into csv and GeoJson files, and then SPARQL-Generate [2] to transform these files to RDF. All the results are publicly available in the GitHub repository of the project[6], as well as Spanish[7], Portuguese[8], and European[9] data portals. The data can be queried through a SPARQL endpoint[10] and all IRIs for the Spanish datasets are dereferenceable. Ontologies and data are aligned with relevant external sources, such as Wikidata [3], DBpedia [4] , and the NCBI Bioontology[11].

However, potential users lack the necessary knowledge in Semantic Web technologies to properly exploit these results. Hence, we present the Forest Explorer, a web application that allows to navigate the content of the published LOD datasets, and download their data for a selected area.

2. The Forest Explorer

The Forest Explorer makes the Iberian forest inventories and land cover maps accessible to potential users. It makes use of the LOD datasets published in the Cross-Forest project. Its logical architecture can be seen in Figure 1. The Map generator is in charge of displaying the view for the end user, employing a base map obtained from the Map server, and listening to the requests made from the different Feature[12] Managers to show markers, polygons, popups, or tooltips on top of the map. The activation of different

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[2]Sample locations where dendrometric observations (such as tree density or wood volume) are taken
[3]Nomenclature of Territorial Units for Statistics. See http://ec.europa.eu/eurostat/web/nuts/
[4]Homogeneous areas of land delimited by polygons
[5]MDB Tools (https://github.com/mdbtools/mdbtools) and Mapshaper (https://github.com/mbloch/mapshaper)
[6]https://github.com/Cross-Forest/
[7]https://datos.iepnb.es/def/sector-publico/medio-ambiente/
[8]https://snig.dgterritorio.gov.pt/
[9]http://www.europeandataportal.eu/
[10]https://forestexplorer.gsic.uva.es/sparql/
[11]https://obofoundry.org/ontology/ncbitaxon.html
[12]Features in the Forest Explorer include provinces, patches, plots, and trees

feature managers depends on the zoom level. The Data manager handles all data requests from the Feature managers. This component communicates with the SPARQL endpoints using a REST API created with CRAFTS [5], configured to use the Cross-Forest and DBpedia[13] endpoints. Data requests include geospatial queries for obtaining the features in a bounding box, as well as information requests about the details of a feature. Upon receipt of a request, the Data manager first checks if the result is already available in the Data cache. In case of a miss, the Data manager sends a call to the REST API, which in turn sends one or more SPARQL queries to the endpoints.

The user interface allows zooming and panning intuitively with the mouse or a touch screen, as well as through explicit zoom and positioning buttons. The data displayed depends on the zoom level. Figure 2 illustrates these levels, starting with the northwestern-most region of the Iberian peninsula and zooming in into the Geres-Xures Transboundary Biosphere Reserve[14], on the border between the north of Portugal and Spain. The furthest level, shown in Subfigure 2(a), presents aggregated data by NUTS3 regions of Portugal and Spain. Zooming in shows three different layers with the data of the land cover maps (MFE and COS), each one with increasing detail, in order to facilitate visibility and reduce data transfer. Information about land use, area, density of species, and (in the case of Spain) canopy cover[15] of a patch can be displayed by hovering over it. Subfigure 2(b) shows one of such levels. When the zoom level is close enough, the plots of the IFN_{es} are displayed, as seen in Subfigure 2(c). Hovering over a plot shows its associated dendrometric measures. Finally, maximum zoom level on a plot reveals the surveyed trees, their position, and the dendrometric measures taken for each one of them. Subfigure 2(d) shows the content of a plot.

A form in the upper left corner provides several functionalities: (1) navigate to a municipality (obtained via GeoNames[16]); (2) disable or enable the layer for administrative regions (when the zoom is far enough); (3) show or hide the plots from the IFN_{es} (when the zoom is close enough); (4) download the data shown in the screen in JSON format; and (5) highlight a number of taxa (species, genus, or family) using different colors, using either common or scientific names. Images and descriptions for each taxon can be displayed when selecting them—see Subfigure 2(b). In all subfigures, the oaks are highlighted in cyan, and pines are highlighted in brown, creating different shades of color when the two genera coexist in different proportions. This form is available in all zoom levels, but can be collapsed using the "-" button. Subfigures 2(a,b) show the menu displayed, while Subfigures 2(c,d) show the menu collapsed.

The Forest Explorer makes visually accessible the map of species composition of an area and make easy the access to its data. This facilitates operational foresters and forest stakeholders make silvicultural simulations for selecting managing alternatives needed for precision forestry, and helps environmental journalists or interested citizens visualize forest composition or discover areas with the presence of an species.

The Forest Explorer is developed in JavaScript, to facilitate its deployment as a Web

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[13]To provide images and multilingual descriptions of tree species

[14]https://www.reservabiosferageresxures.eu

[15]The proportion of the forest covered by the vertical projection of the tree crowns [6]
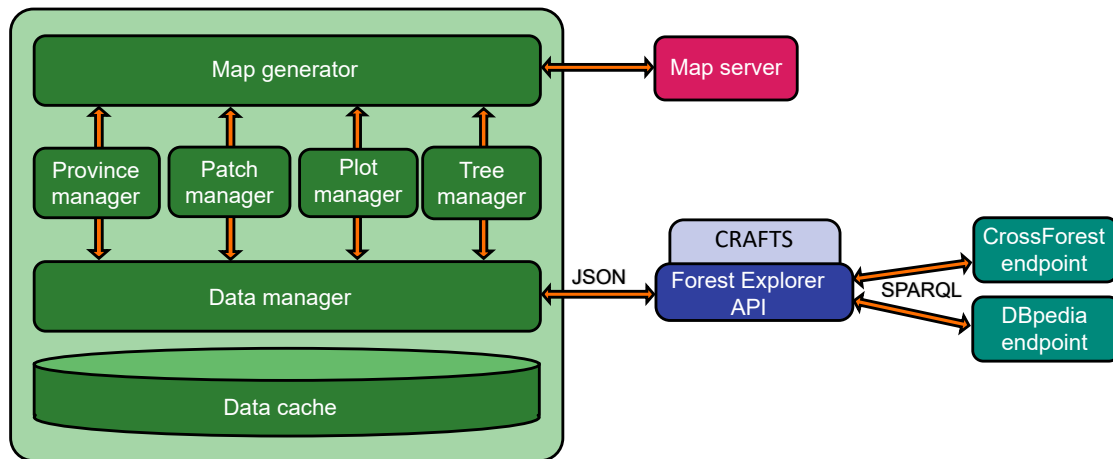
[16]https://www.geonames.org/
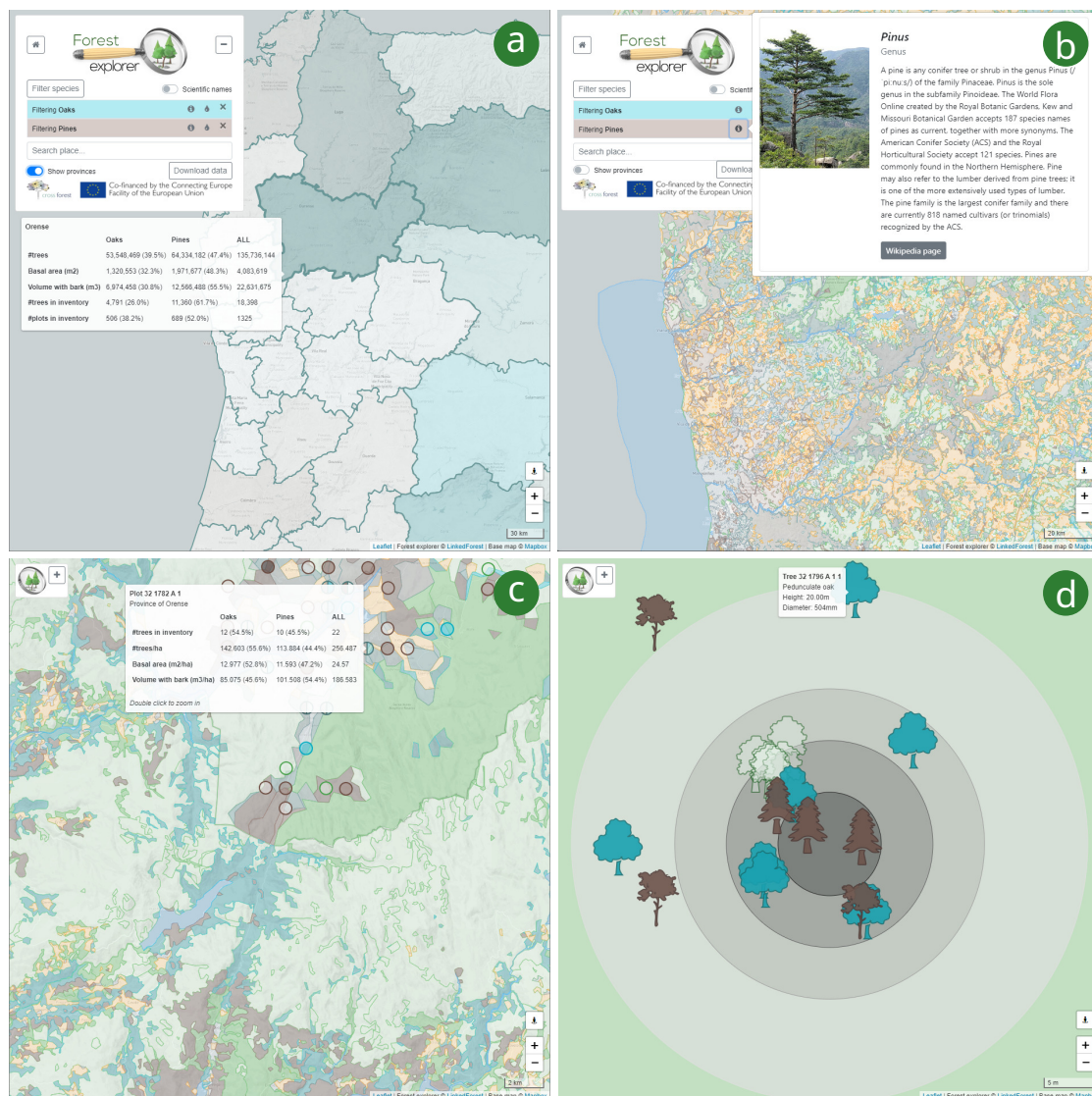
Figure 1: The Forest Explorer Architecture

Figure 2: Snapshots of the Forest Explorer user interface. (a) Northwest Spanish and Portuguese NUTS3 regions. (b) Northwest Spanish and Portuguese land cover maps. (c) Land cover maps in the Geres-Xures transboundary biosphere, with plots displayed for the Spanish area as circles on top of the patches. (d) Plot on the Spanish side of the Geres-Xures transboundary biosphere.

application. It is portable and can be used on any device with a modern browser (it has been successfully tested with the latest versions of Google Chrome and Mozilla Firefox on various smartphones, tablets, and personal computers). It is publicly available at https://forestexplorer.gsic.uva.es/explorer/. A video recording showcasing the functionalities of the Forest Explorer interface can be found at: https://doi.org/10.6084/m9.figshare.24131916

3. Conclusions and Future Work

The Forest Explorer is a Web application to navigate, visualize, and selectively download the contents of the Spanish and Portuguese national forest inventories and land cover maps without needing to understand the underlying Semantic Web technologies of which it makes use. This makes this important data available to different forestry agents and lay users without requiring from them any knowledge of Semantic Web technologies.

The Cross-Forest dataset and the Forest Explorer are living projects. Our current and future work includes adding the temporal dimension (by combining previous and upcoming new versions of inventories and land cover maps) and incorporating spatial planning data. We also envision extending the approach to other territories beyond the Iberian peninsula.

Acknowledgments

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