Using Mobile Geographical Information System for Biomass Waste Management

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***Abstract*—Land cover maps are one of the main data sources used to assess the availability of biomass residues. Mobile Geographic Information Systems can help field work providing spatial data including map browsing, query and collecting field information. However, the large amount of data undergoing processing, creates challenges for its use on mobile devices, because of the typical constraints of these devices. In this paper, it is presented a mobile solution that is able to handle efficiently large amount of spatial data, which is part of a platform for biomass waste management.**

Keywords-Mobile geographic information system; geovisualization; mobile computing; biomass waste; field work.

I. INTRODUCTION

Almost 13% of the renewable energy consumed around the world in 2006 derived from biomass [1]. The biomass resources are of different types and its availability varies geographically widely. On the other hand, the biomass resources exhibit different power generation characteristics and have to be transported to power plants. These demands have created opportunities for the use of decision support systems based on spatial information that utilize advanced mapping, mobile field-based applications and Location Based Systems (LBS). These systems can be used for the selection of places for bioenergy projects or in the assessment and mapping of biomass residues and the estimation of transport costs to existent or proposed power plants.

Land cover maps are one of the main data sources which feed those systems [2]. They are produced using mainly orthorectified imagery from satellites, aircraft, Unmanned Aerial Vehicles (UAV) and also information collected in field in a high cost process. Because of this, the land cover maps are often out of date due to natural causes or human intervention, which could represent a problem in some uses.

A geographic information system (GIS) has the ability to handle and process land cover maps, enabling users to view and analyze geospatial data with ease. A GIS is an expensive investment and data intensive system that must handle a large amount of data. The use of mobile GIS tools can provide information for real time analysis and data collection in the field. However, condensing GIS information for mobile computing, is a complex task due to typical constraints of this types of devices.

In this work, it is presented a mobile tool that is part of a platform that allow the biomass waste management which include data from Alto Alentejo (Portugal) and Extremadura (Spain) regions in a total of 3.230.323 ha registered in the platform.

In addition to this introductory section, this paper is organized as follows: Section 2 presents a summary of key technologies and projects in the field of GIS and mobile GIS. Section 3 presents some topics concerned the processing of land cover maps. Section 4 deals with the technical approach and finally in Section 5, we present the main conclusions.

II. RELATED WORK

Modern GIS architectures rely on a client/server model [3] in a distributed environment based on a GIS Server and clients that can be desktop, web or mobile applications. A GIS Server share geospatial data and functions, while client subsystems act as consumers through a set of interfaces. The Open Geospatial Consortium (OGC) provides a blueprint for implementing these interfaces in a Service Oriented Architecture (SOA) [4]. These interfaces support interoperable solutions and empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. They are categorized according to the type of data they provide and the most important are the Web Map Service (WMS), the Web Feature Service (WFS) and the Web Coverage Service (WCS). The Web Map Service provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases [5]. A WMS request produces complete maps, rendered at the server and transmitted as images to the client that can be displayed in a browser application. The Web Feature Service provides an interface allowing requests for geographical features across the web using platform-independent calls [6]. It supplies individual features, encoded as vectors, selected from the underlying spatial database, to be rendered at the client side. The Web Coverage Service offers multi-dimensional coverage data for access over the Internet [7]. Unlike WMS, WCS provides only non-interactive data access. Besides commercial products, there is a number of open source projects, such as MapServer, GeoServer or GeoNetwork, which provide OGC compliant servers for sharing geospatial data, suitable for the development of custom applications.

The data tier of a GIS Server include spatial database servers that store geo-data and retrieve data according to client or application server business logic. Products like PostGIS, SpatiaLite, Oracle Spatial and ArcSDE, are examples of spatial database servers. They supports spatial

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and non-spatial data, besides common geographic file formats such as Shapefiles, GeoTiff, Keyhole Markup Language (KML), Geography Markup Language (GML), Scalable Vector Graphics (SVG), GeoRSS or GeoJSON.

Mobile devices have a lack of resources when compared with a desktop computer that represent constraints to handle massive amount of data such in GIS. There are form factor, storage, computing, battery and network issues that need to be addressed. Projects like the ones presented in [3][8][9], attempt to introduce mobile computing as an aid for field work and data collection.

The mobile tool presented in this article implements a location-based system that provides information on the availability of biomass and its potential to produce energy, still allowing the correction of spatial data in the field. To make this possible, in an efficiently way, spatial data are preprocessed in a server and only then made available to the mobile device.

III. PROCESSING LAND COVER MAPS

The land cover maps we used (Alto Alentejo-Portugal and Extremadura-Spain), totalize an area of 3.230.323 ha. This area is represented as over 78.000 polygons and multi-polygons, which describe a particular agricultural or forest residues within the boundaries of the municipality. This create a geospatial dataset of over 8 million data points, and represents a challenge especially for use in field work through mobile devices.

The analysis of the land cover maps, revels a huge number of polygons and multi-polygons that can be optimized through the use of dissolve operations. Dissolve is an aggregation process in which a new map feature is created by merging adjacent polygons that have a common value for a specified attribute, in this case the same biomass family and the same parish or municipality. Fig. 1 illustrates how a dissolve operation work.

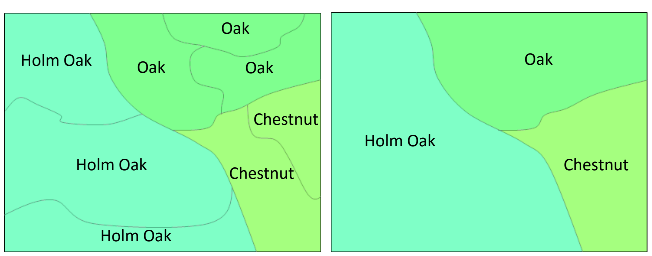


Figure 1. Dissolve operation.

With this, we reduced the number of polygons in 97% (from 78.854 to 2.339), and the number of data points in 35% (from 8.031.020 to over 5.216.195). The resulting geospatial dataset was then loaded into the server with metadata, which include, among others, the estimation of existent biomass residues and the determination of electrical generation potential according with the model defined in [2].

IV. TECHNICAL APPROACH

The system architecture is illustrated in Fig. 2. This architecture consists of a server that responds to the project domain [10]. We use GeoServer with PostGIS which share its data through WMS and WFS standards.

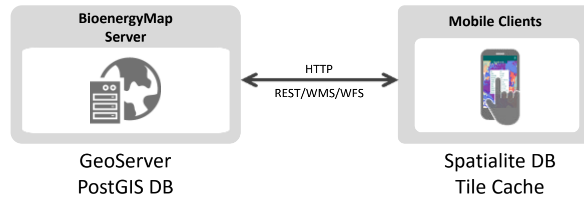
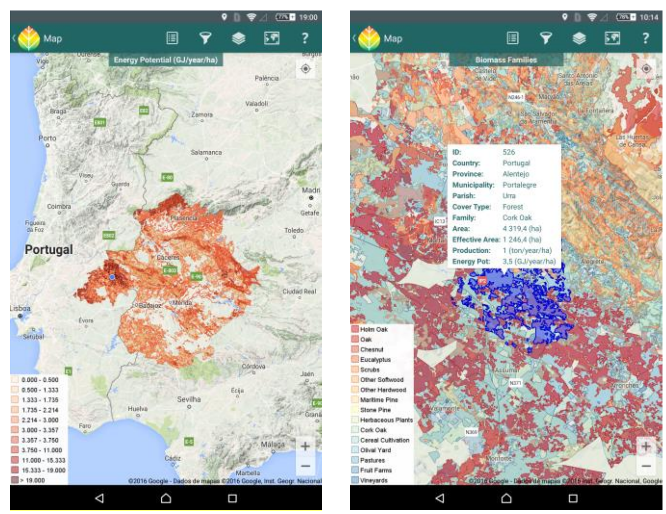


Figure 2. System architecture.

The mobile clients (Android smartphones or tablets) show spatial data using Google Maps overlaid with tiles received from GeoServer which represent the layers concerning a particular feature like biomass families, production, energy potential or cover type among others (Fig. 3a and Fig. 3b). A tile overlay (or tile layer) is a collection of images that are displayed on top of the base map.



a) b)

Figure 3. The layer of energy potential (a) and the layer of biomass families with a multi-polygon selected represented Cork Oak of Urra parish (b).

In a field work environment, the mobile client works in a setting where the connection to the server is unstable or slow. For this reason, mobile clients has an implemented mechanism for caching map tiles received from the server.

We use Spatialite (a spatial extension to SQLite) in the mobile clients. The database is synchronized with the server and maintain the same information for offline use.

Besides the map, the mobile client also allows the visualization of spatial data in a table fashion.

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V. CONCLUSIONS

In this paper, we present a solution for the use of a mobile GIS which is part of a platform for biomass waste management. This solution can help field work providing spatial data including map browsing, query and collecting field information.

Currently we have registered information from Alto Alentejo (Portugal) and Extremadura (Spain) regions in a total of more than 3,2 millions hectares registered in the platform. The evaluation performed proved that the solution is able to handle efficiently this large amount of data.

The mobile application is free available in Google Play and all the platform in [10].

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