A SYSTEM SOFTWARE TO MANAGE GEOSPATIAL DATA AND MAPS OF AGRICULTURAL RESOURCES IN THE PHILIPPINES

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Abstract: The Phil-LiDAR 2 Project 1: Agricultural Resources Extraction from LiDAR Surveys (PARMap) was established to complement on-going programs of Philippine government agencies with the goal of providing an updated and detailed inventory of agricultural resources and produce maps of agricultural crops (high value crops), and vulnerability assessment in the Philippines. In line with this, a web portal is needed to streamline the process of data exchange to fourteen (14) partner State Universities and Colleges/Higher Education Institutes (SUC/HEIs), national government agencies, and more than 1,000 local government units. This paper describes the development process of PARMap's system software to handle the project's geospatial data from LiDAR surveys and other remote sensing systems, integrated application that generate results from field measurements, and a medium of data distribution using Cygwin with rsync package, a secure open source tool that downloads files using encryption from the Linux server. PARMap's system software is currently being used as a repository of the project's output layers and a tool of data exchange for vulnerability assessment of the country's agricultural resources. Its spectra calculator that computes results from spectrometer readings was distributed to partner SUC/HEIs to expedite the generation of field measurement outputs. Additional functions are still under development such as spectroscopy database and editable dataset for vulnerability assessment of agricultural resources. Development of such interoperable system software is essential to the project's collaborating agencies, data dissemination for research purposes of agricultural resources and can aid in planning of local government agencies in the Philippines.

1. INTRODUCTION

Agriculture is very important in the economy of the Philippines with almost 10 million hectares or approximately 33% of the country's total land area. That is why it is important to be able to monitor the status of the agricultural sector to help manage agricultural lands and prevent haphazard development that could lead to their diminished productivity (NSCB, 1998).

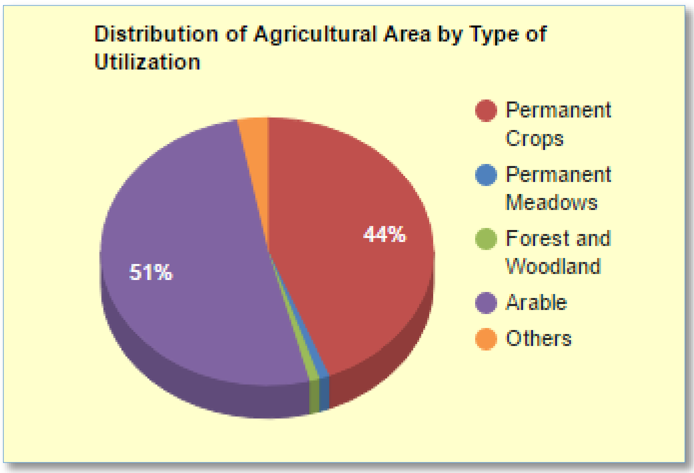

Figure 1. Distribution of Agricultural Area by Type of Utilization. Copyright 2014, PSA

The Phil-LiDAR 2.A.1 Agricultural Resources Extraction from LiDAR Surveys (PARMap) is one of the five project components of a directed research program funded by the Department of Science and Technology through the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD-DOST) entitled Detailed Resources Assessment using LiDAR (Phil-LiDAR 2). It is implemented by the University of the Philippines Training Center for Applied Geodesy and Photogrammetry (UP TCAGP) that aims to provide an updated and detailed inventory of agricultural resources in the Philippines by developing methodologies for mapping such resources using LiDAR (Light Detection and Ranging) and other geospatial technologies such as optical imagery. Since quality checking of the project's outputs are processed in UP, an efficient medium of data access and distribution system is needed to streamline data exchange to fourteen (14) partner State Universities and Colleges (SUCs) and Higher Education Institution (HEI).

Moreover, having adequate and well-presented agricultural information can help improve the efficiency of the country's policies, projects and decision making regarding land, capital, and management (LawalIro, 2014). Although there are many agricultural research institutions in the country, the products of research from these institutions are not widely disseminated and utilized. The agricultural information produced by research institutions result in costly duplication of efforts due to poor mechanisms and infrastructure for sharing and exchanging data. Scientists normally fail to find all of the most relevant information. Disseminating the needed agricultural information throughout the country have been proven to be a daunting task (Natividad, 2015). Taking advantage of the technology breakthroughs such as developing a web portal for data sharing can be done to utilize the outputs produced by PARMap.

This paper describes the development process of PARMap's system software to handle the project's geospatial data from LiDAR surveys, and other remote sensing systems and detailed inventory of agricultural resources. Specifically, the system has modules that manage different user type accounts, manage and track data requests and provide an integrated application that generate results from field measurements.

2. REVIEW OF EXISTING SYSTEMS

2.1 CountrySTAT

CountrySTAT is an internet-based information system established by the Philippine Statistical System (PSS) through the Philippine Statistical Association (PSA) to ensure harmonization of national food and agricultural statistical data and metadata collections from National Statistics Office (NSO), Bureau of Labor and Employment Statistics (BLES) and National Statistical Coordination Board (NSCB) for analysis and policy making (Lizarondo et al., 2006). However, the statistical framework of the CountrySTAT system is not interoperable because it is based entirely on the Food and Agriculture Organization of the United Nations (FAOSTAT) system's framework.

2.2 Department of Agriculture

The Department of Agriculture is one of the Phil-LiDAR 2 PARMap's collaborating agency. The department is the government agency responsible for the promotion of agricultural development by providing the policy framework, public investments, and support services needed for domestic and export-oriented business enterprises. Its website contains agriculture and fisheries information services, news page where the accomplishments of the department are published and website links that could contribute to agricultural information. The department's website has tab which contains links to other agencies and research institution websites in the agricultural sector. PARMap's system software will later on be added to the said list.

2.3 LIPAD

LIPAD is a Geonode-derived web portal of Phil-LiDAR 1, another Phil-LiDAR program of the Philippines that handles hazard maps resource maps using LiDAR technology that could aid in monitoring and management of disasters and mitigations of damages. This web portal contains a link to PARMap's system software (Lat, 2015). The registration to Phil-LiDAR program web portals and file transfer protocols will have a centralized database for efficient data sharing and access.

3. TOOLS FOR SOFTWARE DEVELOPMENT

3.1 Geonode

Geonode is an open-source geospatial content management system (CMS) for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI) (Geonode's Documentation, 2015). It is built upon an open source platform including GeoServer, a server for sharing geospatial data and Django, a Model View Controller (MVC) web framework which has a large ecosystem of apps that makes it easy for collaboration.

3.2 Javascript

JavaScript is a programming code that can be inserted into HTML pages. It is a programming language designed for performing dynamic tasks such as making web pages interactive. It is often used to validate input

3.3 Cascading Style Sheet (CSS)

CSS is a style language that defines the layout of HTML documents including the fonts, colors, margins, lines, height, width and background images. HTML is a markup language for creating web pages.

3.4 Hypertext Markup Language (HTML)

HTML tells the web browser how to display a web page and can embed scripts written in other programming languages.

4. MATERIALS AND METHODS

PARMap's system software used the V-shaped software model in the development of the system. Its phases include requirement analysis phase, system detailed design phase, implementation and unit testing, and integration and system testing. It is an extension for waterfall model but instead of moving down in a linear way, the process steps are bent upwards after the coding phase, to form the typical V shape. The major difference between v-shaped model and waterfall model is the early test planning in v-shaped model. V-Shaped Model is simple and easy to use. Each phase has specific deliverables and has higher chance of success over the waterfall model due to the development of test plans early on during the life cycle. It works well for where requirements are easily understood (Munassar et al., 2010).

4.1 Requirement Analysis Phase

In this phase, the system developer gathered and systematized information, guidelines, data, and how to ensure the interoperability of the system. The needs in archiving the project's output and disseminating of acquired agricultural information using LiDAR and field measurements were studied by the system developer in order to create an effective data access and distribution system.

4.2 User Requirements

The system was designed to be accessible to LGUs and agencies, partner SUCs and UP Diliman (UPD) PARMap research staff. It can accommodate various user types categorized as Admin, SUC/HEI, and UPD RA. A UPD PARMap research staff can manage layers, agricultural maps and documents. SUC/HEI user can manage documents/narrative reports of the uploaded spatial layers and maps and navigate the system. The Administrator can perform all the functions that the system offers.

4.3 Software Requirements

The system uses PostgreSQL which provides access to manage databases and accommodate database requirements and functions of the system. It also uses the programming language Python along with JavaScript, Jquery, Cascading Style Sheets (CSS) and HyperText Markup Language (HTML).In using the spectral calculator of the system, the user must have spreadsheet (Microsoft Excel) and notepad in viewing generated results of the integrated application.

Functional Decomposition Diagram

PARMap web-based system software has five management subsystems as shown in the functional decomposition diagram in Figure 2. Each of the management systems has necessary functions for systematic interaction between subsystems.

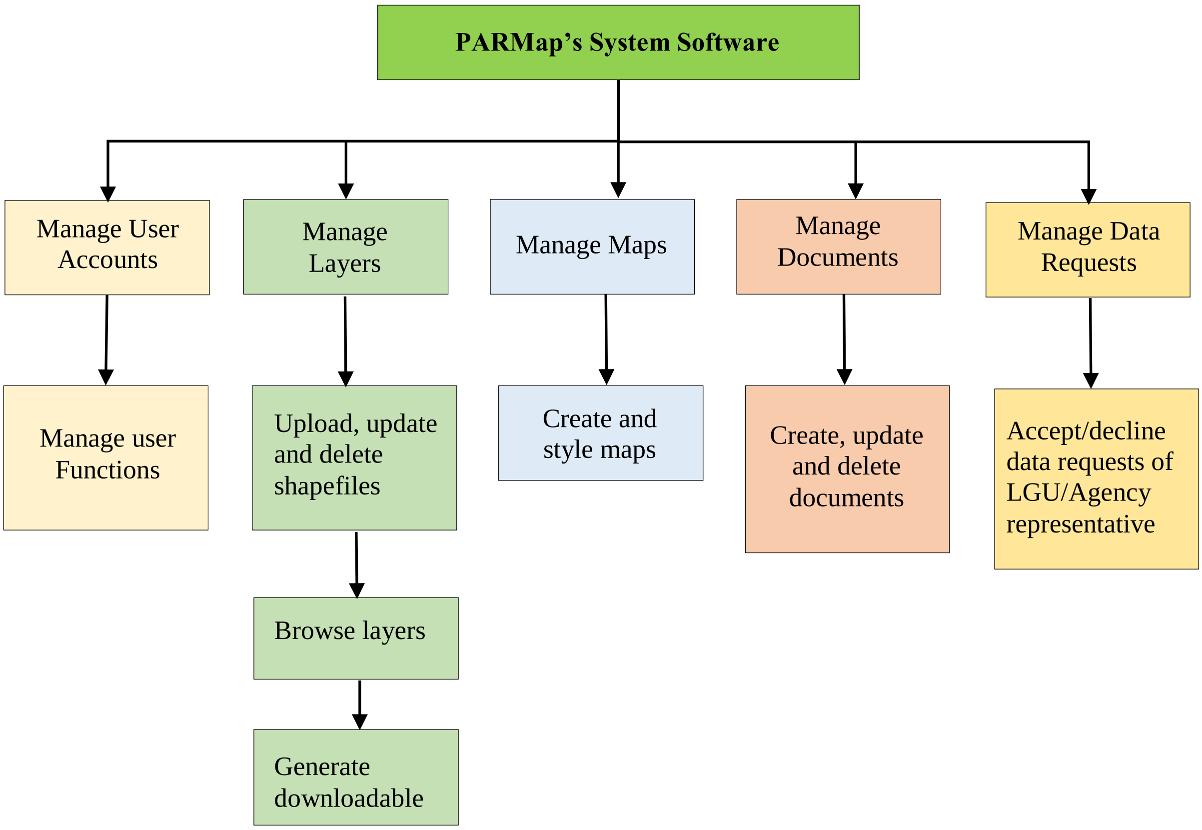

Figure 2. Functional Decomposition Diagram of PARMap's System Software

Data Flow Diagram

Data flow diagrams (DFDs) reveal relationships among and between the various components in the PARMap system software. DFD depicts how entities, processes, data stores, and data flows interact in the system. This diagram could help the system developer during initial analysis stages visualize the requirements of the system software. The hierarchical DFD typically consists of a top level diagram (Level 0) as shown in figure 3 underlain by cascading lower level diagrams that represent different parts of the system.

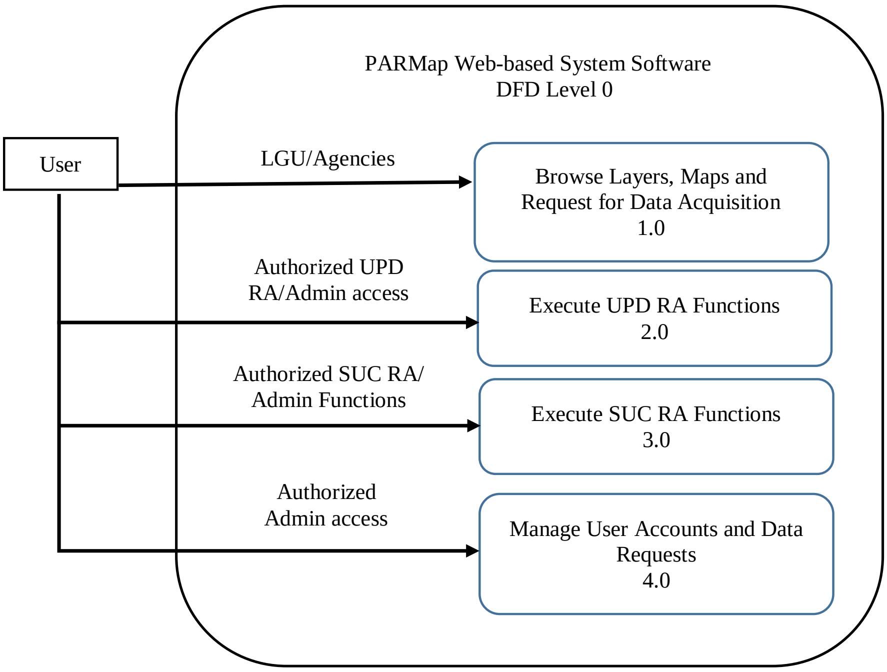

Figure 3. DFD of PARMap GIS Web Application System Level 0

5. RESULTS AND DISCUSSIONS

The Database Management System used in implementing the system is PostgreSQL, an open source object-relational database system which has a strong reputation for reliability, data integrity, and correctness (PostgreSQL Global Development Group, 2016). The system also relies on GeoServer, a Java-based software server that allows flexibility in map creation and data sharing.

5.1 Manage User Accounts

As discussed in user requirements, the system was designed with four user types and among these user types, only the admin can manage user accounts. The admin can dynamically add user accounts in the GeoServer using the *Add* button inside the *People* box. Upon clicking the *Add* button, the user will be directed to add user page for user information input. Admin can also add more information in user's profile by clicking the name on the table and delete user account.

After the admin creates a user account with the assigned user type, the user can now access the system using the username provided by the admin and default password. Upon login, system features/functions are available according to user type. Restriction in data manipulation and information sharing according to user types is essential to ensure security and data integrity. Only the viewing of home page (Figure 4) and browse layers (Figure 5) and maps functions are allowed for general users.

5.2 Manage Layers and Maps

The manage layers module allows authorized users to browse, upload and download layers function. Figures 6 and 7 shows the interface for these functions. Update and delete layer function can be done by UPD RA user types only. The managing maps module of the system allows users to create maps based on the layers uploaded and combine them with some existing layers, style then publish for sharing or public viewing.

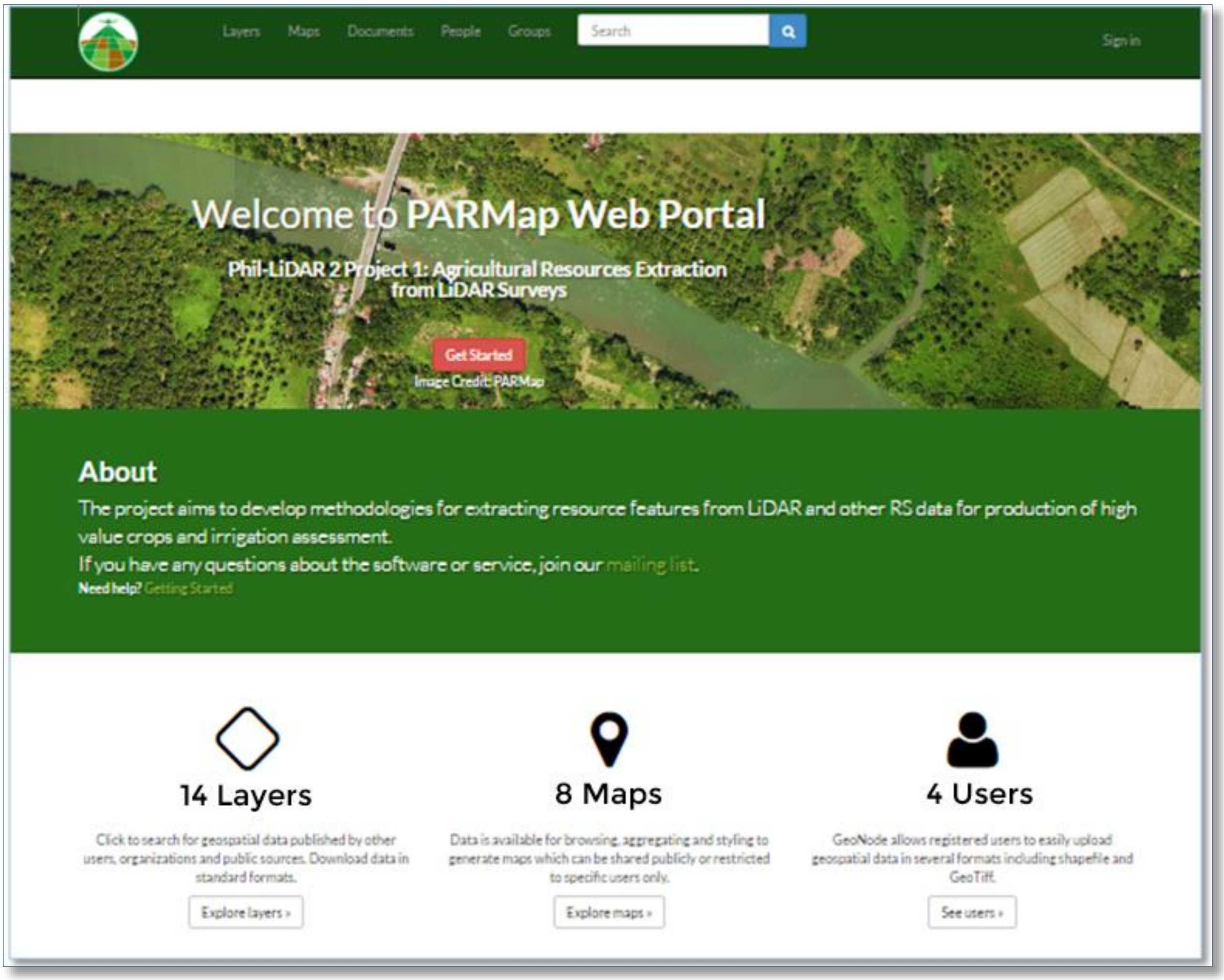

Figure 4. Web application Home Page

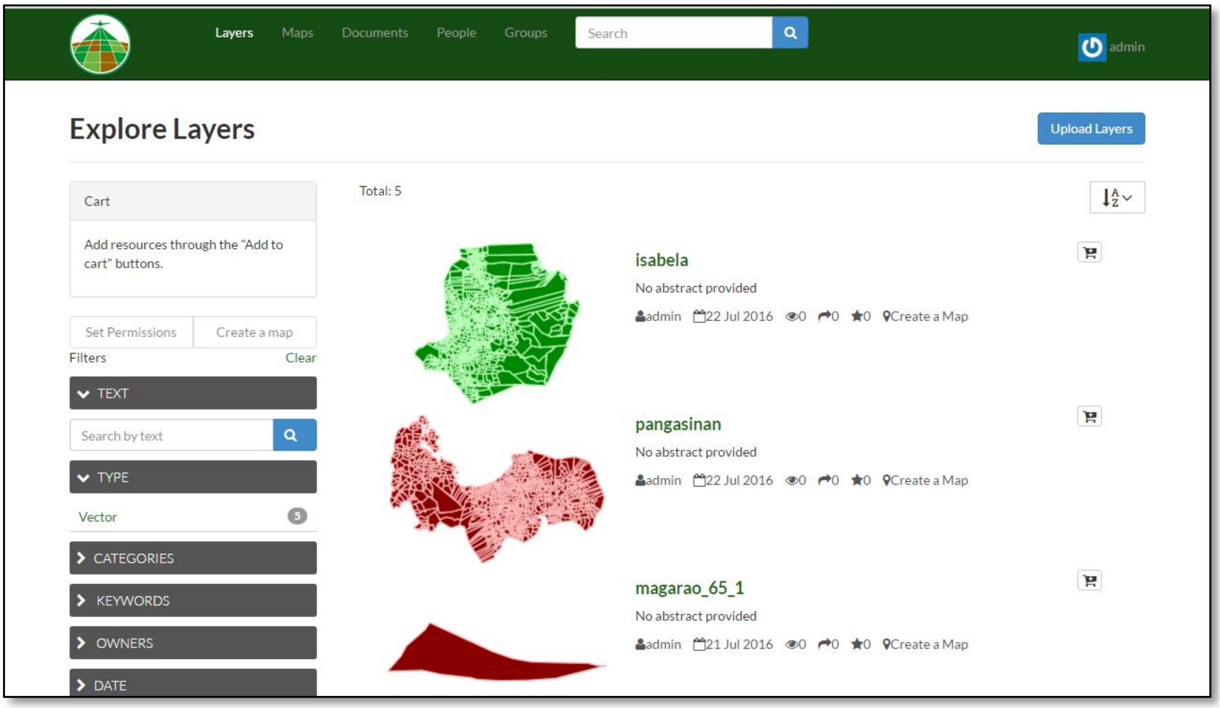

Figure 5. Browse layers

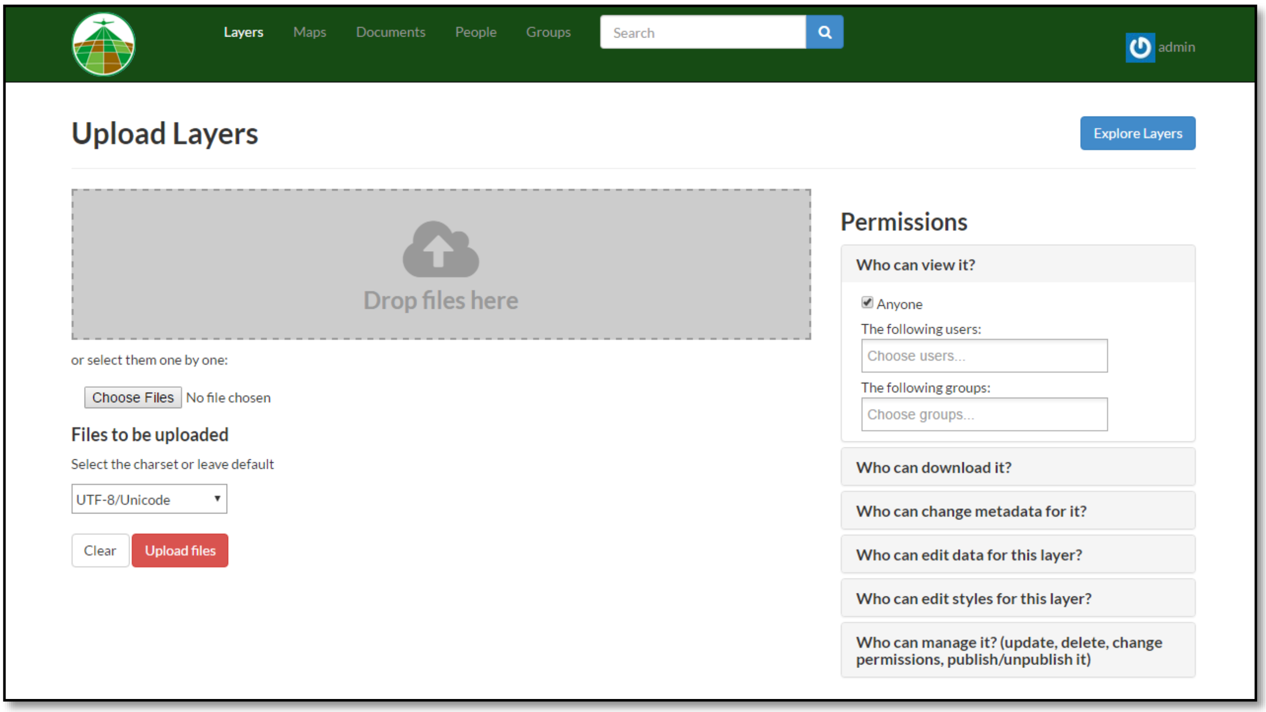

Figure 6. Upload Layers page.

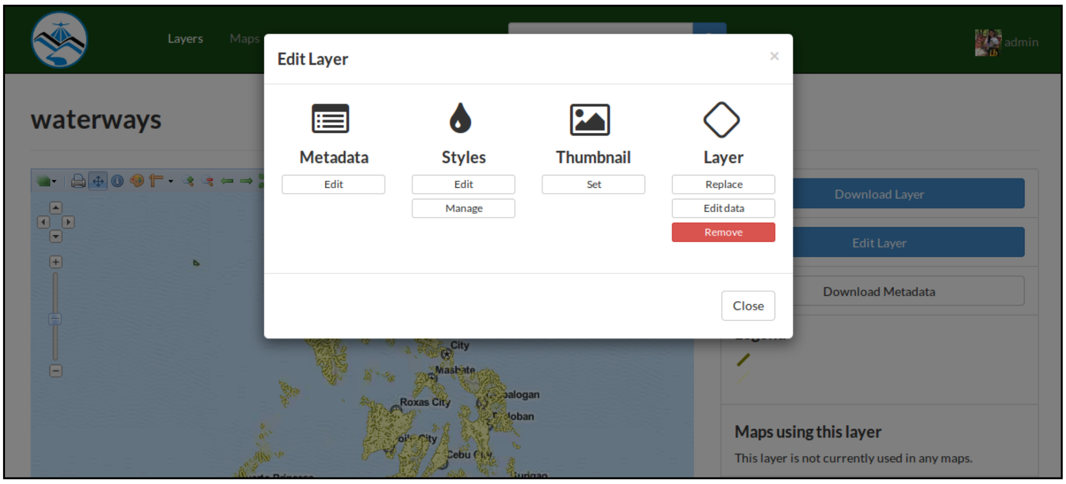

Figure 7. Update layer options page.

6. SUMMARY AND CONCLUSION

In our fast paced developing society, PARMap system software is being developed to take advantage of the technology breakthroughs to help improve the efficiency of the country's policies and decision making regarding land management in the agricultural sector. The development of the system software, using Geonode as its suitable web-based system framework, will be used as an effective medium to archive, share and deploy the project's geospatial layers and agricultural maps. Since the tools used for system development of the system are open source, the system is easier to install and replicate by other research project in developing geospatial information systems (GIS) and deploying spatial data infrastructures (SDI). PARMap's system software will serve as the project's repository of output layers and a tool of data exchange for vulnerability assessment of the country's agricultural resources.

The PARMap web-based system software is still under development. A spectra calculator, database for gathered spectroscopy data of agricultural crops, and editable metadata for vulnerability assessment of agricultural resources will be added to the system's feature. It will undergo security and function testing and will be officially deployed by December 2016.

Acknowledgements

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