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Development of geo-referenced agricultural map and management information system for Samar Island

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ABSTRACT

This study focuses on the developed web-based information system which allows local government unit (LGU) in Samar Island and other agricultural sectors to have access to updated farmers' information and the soil nutrient, soil fertility status, and the crop suitability of soil in the different municipalities of Samar. Geo-referenced agricultural map and management system can be an important tool for both operational and policy levels by accelerating the supply of up-to-date data, supporting the implementation of different types of projects targeting objectives such as municipal development, regional economic development, agricultural development, sustainable resource management, good governance, and many others. The management information system was developed using MySQL. The server-side language used in this study was PHP and the client-side language used was hypertext markup language (HTML). The map was created using Mapbox GL JS, then, geo-referenced map layers are saved to the local server as an array map for direct access via the front-end web application. With the use of the system, LGU in Samar Island and other agricultural sectors can implement project more efficiently because farmers' information and the nutrient capacity of the soil is readily available.

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1. INTRODUCTION

Georeferencing is a way to show the exact position of the spatial data. It assigns coordinates to a digital image that uses individual pixels. Common frames and coordinate systems are developed to define the positions within the information. One major output of the geo-referenced agricultural map is a thematic map visualizing the agricultural data necessary for decision making such as farmers' profiles or the soil properties within a specific area. Enough information about farmers and soil suitability in farming can be available anytime and inquiries that usually take a long time can be automated. A geo-referenced agricultural map and management system is a prerequisite to achieving optimum utilization of the available land resources for sustainable agricultural production [1]. Can also accelerate any kind of agricultural sector's many daily procedures and through the quick supply of up-to-date data, support the implementation of different types of projects targeting objectives such as municipal development, regional economic development, agricultural development, sustainable resource management, good governance, and many others.

Geographic information system (GIS) in the agricultural aspect as a tool is increasingly used in spatial data analysis, integrated with extracted soil data to come up with the output maps informative to the farmers and local government unit. In the province of Bukidnon, Mindanao, Philippines for example, a soil

fertility map was developed and they determined crop suitability in the province of Bukidnon, Mindanao Philippines using GIS. It entails combining and analyzing agro-environmental, soil information, and crops biological requirements for growth. The result of analyzed soil samples revealed that light clay soils dominated the province [2].

It entails combining and analyzing agro-environmental, soil information, and crops biological requirements for growth. The scope of the study of Adornado however is only contained in Bukidnon, although it contains information about crop suitability, the available data are limited only in their region and nearby municipalities. The Philippine government created the central mapping agency of the country which is the national mapping and resource information authority (NAMARIA). It is an online platform for the sharing of and access to geospatial information produced by government agencies in the Philippines. Its mandate is to provide the public with mapmaking services and to act as the central mapping agency, depository, and distribution facility for natural resources data in the form of maps, charts, texts, and statistics [3], [4]. Although the NAMRIA as the central mapping agency of the Philippines provides a rich repository of spatial data, data is not specific in Samar region or classification of the nutrient content status or the physico-chemical soil properties within the specific area in Samar needs to source-out. There are available agricultural geo-referenced maps and management information systems in the country but not specific for Samar island. This also means that local government unit (LGU) in Samar island and other agricultural sectors does not have access to updated farmers' information and the nutrient capacity of the soil in Samar to determine the suitability of growing crops.

This study mainly focuses on the development and the discussion of the features of the geo-referenced agricultural map as well as the discussion of the management information system that can be used by the LGU and other agricultural sectors in Samar. The system is capable of handling a vast amount of farmers' information as well as the soil nutrient, soil fertility status of different agricultural land areas, and the crop suitability of soil in different municipalities of Samar. This web-based information system and map can be used as a tool for decision-making and in agricultural production. While natural inputs in farming cannot be controlled, agricultural environments can be better understood and managed with the applications of this system [5].

2. RESEARCH METHOD

This paper is the third component study of the project titled "Development of geo-referenced agricultural mapping and management system for Samar island" funded by the CHED-DARE-TO. The project was participated-in by the researchers from Samar State University and partner universities-Eastern Samar State University, Eastern Visayas State University, and Northwest Samar State University.

2.1. Data

The socio-demographic and economic profiles of farmers from the gathered data in the first component study are stored in MySQL databases such as educational qualification, land tenure status, income, and preferred farming method [6]-[10]. Also included in the database are data about the nutrient and soil fertility status of different agricultural land areas and the crop suitability of soil in different municipalities of Samar.

2.2. Client-server infrastructure

The use of a web-based graphical user interface (GUI), enables the user to interact with the system by initiating data requests to the XAMPP local server [11]-[13]. The server-side language used in this study was PHP and the client-side language used was hypertext markup language (HTML). Figure 1 illustrates the interconnection of the web client and the computing back-ends.

As shown in Figure 1, a web client serves as the front-end and PHP and MySQL as computing back-ends. The front-end is the GUI web client where users can choose the information they want to view. The backend uses PHP for accessing data from XAMPP local server [14], [15]. MySQL is used to store farmers' information, the nutrient and soil fertility status of different agricultural land areas, and the crop suitability of soil in the municipalities of Samar namely: Basey, Calbayog, Calbiga, Catbalogan, Gandara, Jiabong, Matuguinao, Paranas, San Jorge, San Jose de Buan, San Sebastian, and Sta. Margarita. Crop suitability in a specific location is connected with a simple JavaScript code for loading maps to the web. The map was created using Mapbox GL JS, then, geo-referenced map layers are saved to the local server as an array map for direct access via the front-end web application.

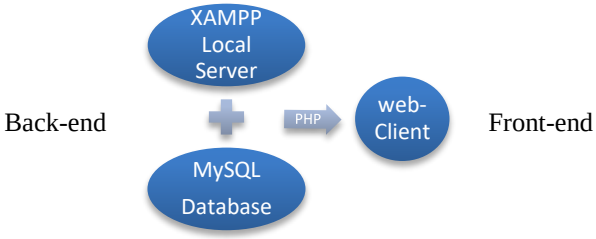


Figure 1. Front-end and back-end interconnectivity

3. RESULTS AND DISCUSSION

The geo-referenced agricultural map and management information system can be an important tool both at operational as well as policy level overviews of land suitability assessment [16]-[20]. At the operational level of this demonstration application, for instance, local farming extension workers in Samar can find it an important spatial decision support tool as their task involves advisory service and recommendation to farmers of agricultural land suitability for various purposes. At the policy level, regional land and municipal agricultural decision-makers can be better informed using this spatial decision support framework for a spatially explicit overview of locations and extents of various categories of general agricultural land suitability [21]-[25].

3.1. Management information system

3.1.1. Log-in page

The log-in page is the first page that will be loaded when a client first accesses the web-based management information system. The system will not allow access if the client is not a registered user of the system. As shown in Figure 2, a client needs to provide the log-in information and the system will validate if the client is a registered user. The log-in page allows the user to gain access to the system by entering the username and the password. User registration is necessary to ensure that client may not be able to change or alter the content of the database. The system allows administrative and client access. When someone logs in to the ordinary user account or client account, that person receives access to only a limited set of files and programs on the system. When someone logs into an administrative account, that person acquires access to all files and programs on the system. The data by log-in procedures is handled in PHP which serves as the tunnel between the server and the client. In addition to restricting access, login also the server from hacking or unauthorized alteration of information in the database.

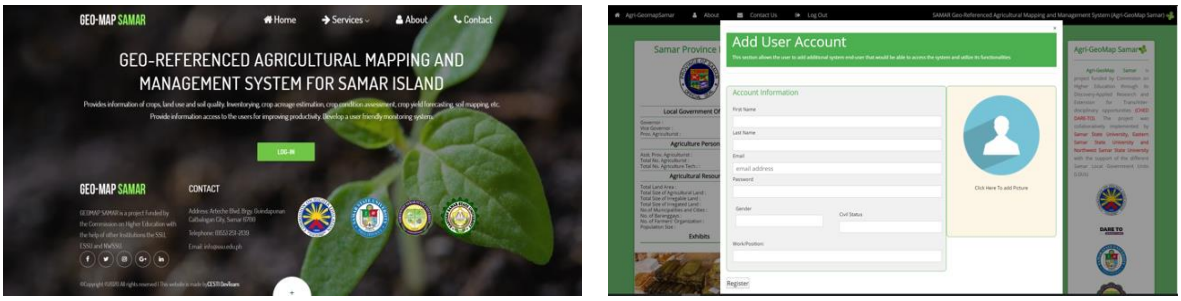


Figure 2. Log-in page and add user account page of the geo-referenced agricultural map and management information system

3.1.2. Main page

Once an authorized client logs-in to the system, the client is directed to the main page where Samar province profile is shown. This is the default page after successful log-in to the system. The main page is illustrated in Figure 3. As can be seen in Figure 3, the client can select the menu options that provide links to the different section of the system such as the municipality, farmers' profile, crops profile, soil profile, publication, and add user. Samar province profile and the Samar agriculture map to view agricultural commodities and its location in Samar Island are also provided in the main page.

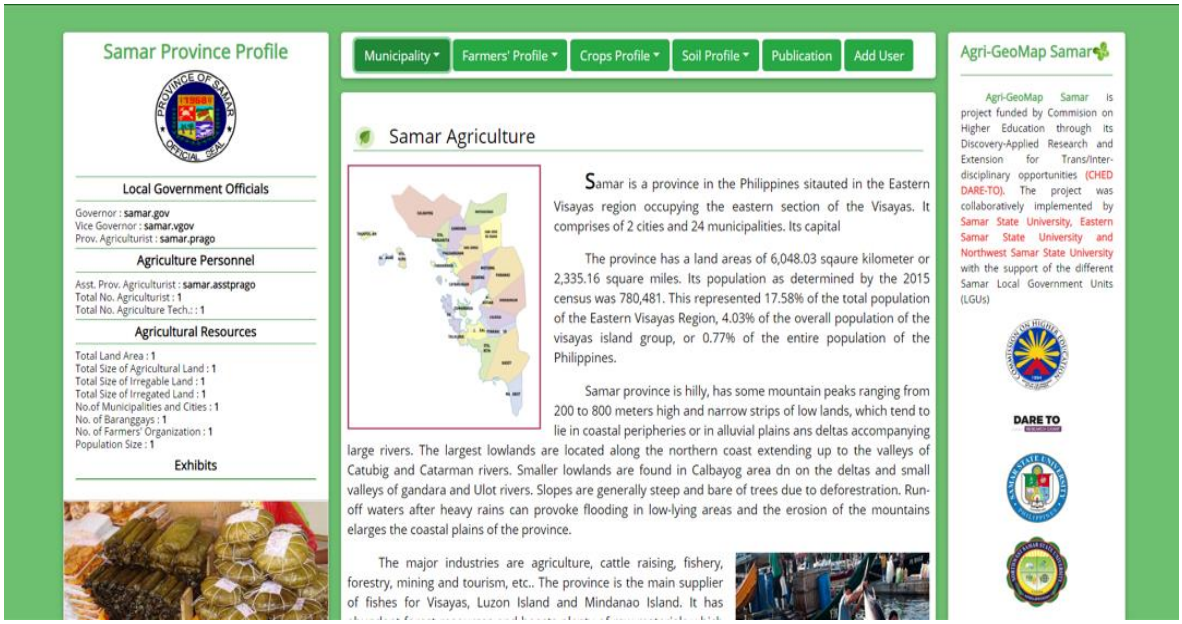


Figure 3. The main page of the geo-referenced agricultural map and management information system

3.1.3. Samar farmer's information page

Samar Farmer's Information is essential for LGU in Samar Island and other agricultural sectors in the farmer context. It allows them to provide farmers with the right instruments and/or the right actionable information at each stage of the crop cycle to increase yields. The more information they have, the more they can make decisions that are tailored to their farm's specific needs.

Figure 4 shows the Samar farmer's information page. Users can select the municipality from the drop-down menu and the farmer's information such as name, age, gender, address, education, farming experience, financial status, land area and land tenure will appear. The local government officials and the provincial agriculture personnel information are also provided in the Samar farmer's information page.

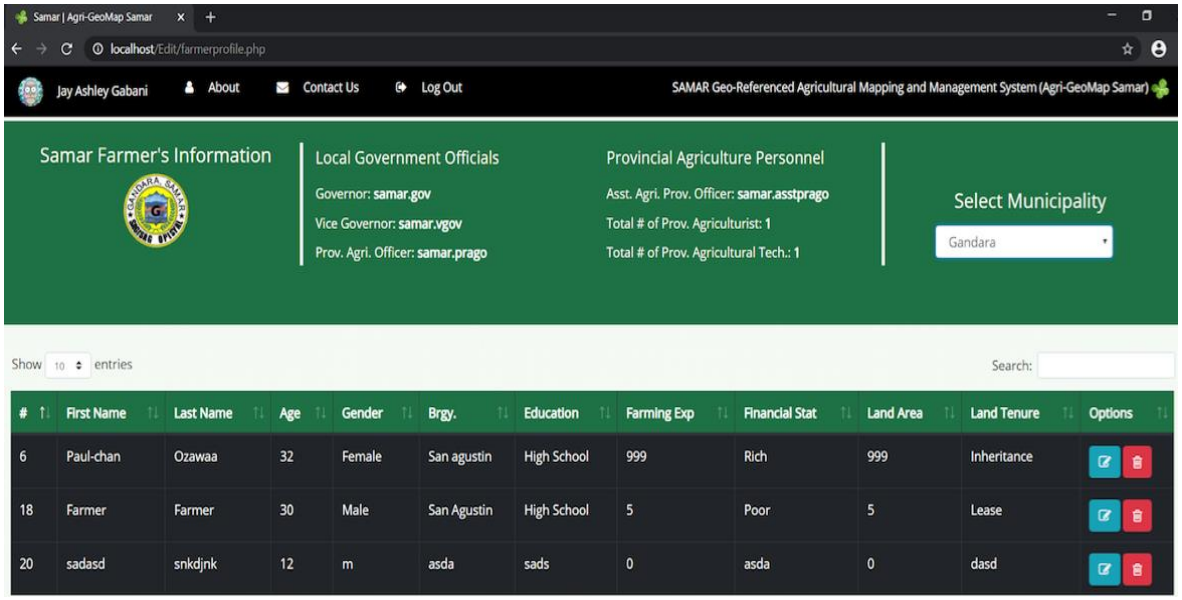
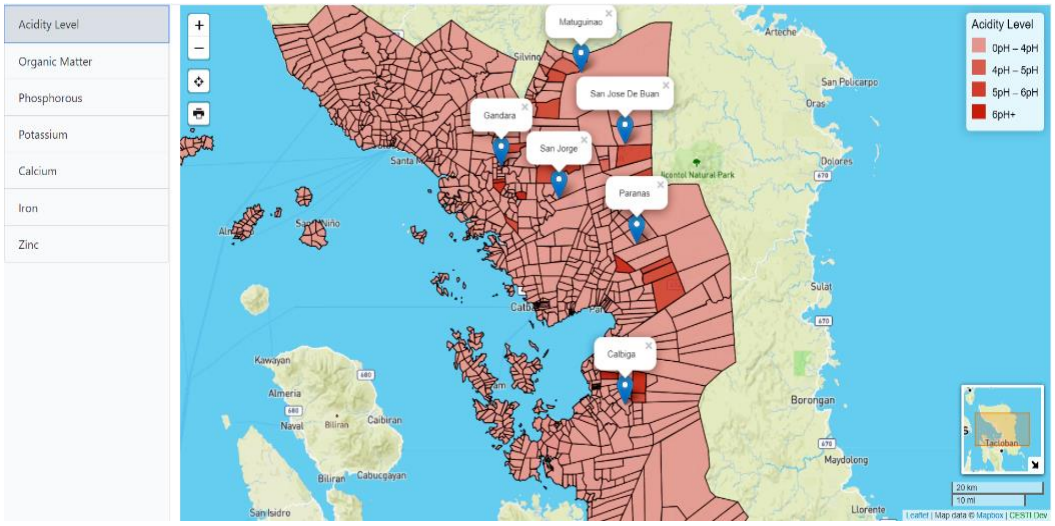


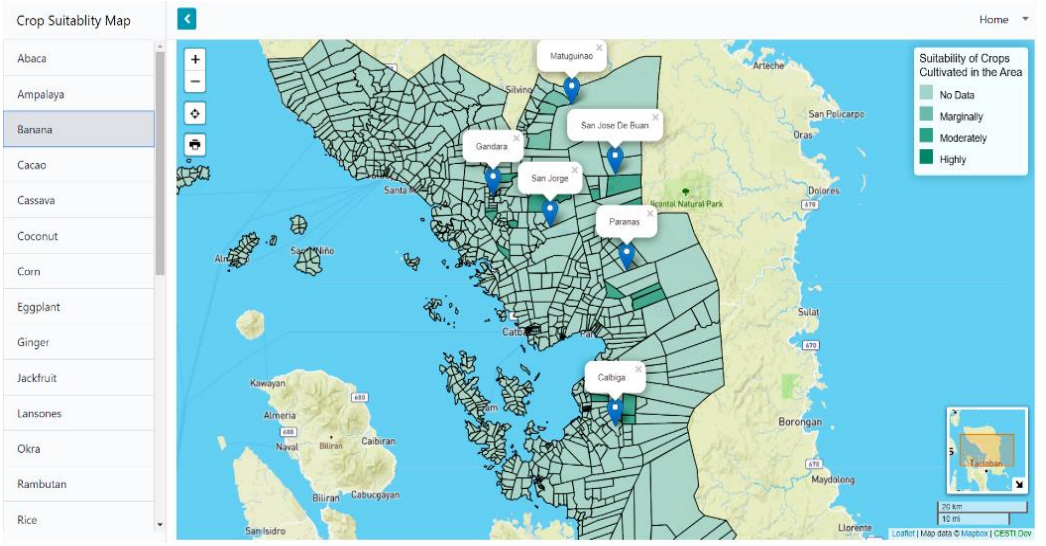
Figure 4. Samar farmer's information page

3.2. Geo-referenced map for crop suitability

A reference map shows the location of the geographic areas in Samar Island for which crop is suitable in specific area. The maps display the boundaries, soil nutrients availability, textural classification of the soil, the acidity level and the level of suitability of crops in each location. To eliminate inappropriate human influence on natural resources and develop a strategy for appropriate farming, soil evaluation is crucial to be properly carried out. In this context, crop suitability assessment was performed in Samar Island. Soil evaluation was matched based on the requirements of the selected crops, then it was associated with physiographic map units using a Geo-referenced map in Figure 5 for crop suitability. Figure 5(a) and (b) shows the geo-referenced map for crop suitability. The soil properties such as acidity level, organic matter, phosphorous, potassium, calcium, iron and zinc are shown in Figure 5(a). Hovering the mouse to a specific location will show the level of the soil properties in the upper right panel of the map. Figure 5(b) shows the type and level of suitability of each crop to specific location.



(a)



(b)

Figure 5. Geo-referenced map in Samar island, (a) soil properties and (b) crop suitability

4. CONCLUSION

This study provided information that can be used to accelerate agricultural development by providing a quick and up-to-date data. The geo-referenced map and the management information system can

support the implementation of different types of projects targeting objectives such as municipal development, regional economic development, agricultural development, sustainable resource management, good governance, and many others. LGU in Samar Island and other agricultural sectors can implement project more efficienty if Samar Farmer's Information is readily available. Therefore, determination of overall land crop suitability must be expanded not only in Samar Island but also to other nearby provinces like Eastern Samar, Northern and Western Samar. Thus, we recommend similar studies.

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