Available online at https://msubuug.edu.ph/journal

Asian Journal of Advanced Multidisciplinary Researches

ISSN: 2782-9057

Revealing the Crops Using GIS-Enabled Tool Crops Mapping System

Dennis C. Tenerife[2], Yedda Joy C. Sorio[1], Ailyn B. Torres, Sarah Jane P. Olanda

College of Information Technology, Mindanao State University-Buug, Philippines
Email: addeyoiros@gmail.com[1], dennis.tenerife@msubuug.edu.ph[2]

ABSTRACT

Research has shown that mapping plays a vital role in monitoring the soil and its irrigation in any given farmland. Geographic Information Systems (GIS) are helpful in mapping the location of a particular land with crops. This study was conducted to assess the type of soils and the best crops to be planted in a particular location. Soils are tested using soils analysis test to determine its nutrient parameters such as pH level, Organic Matters (OM), Potassium (K) and Phosphorous (P). The crops to be planted in the location will vary on the pH level of the soil, and results will be map in the crops mapping system. Crops Mapping System (CMS) is a mapping tool that helps farmers and agriculturist to search crops planted in a specific area. Based on the evaluation conducted, it shows that 62.5% of the respondent's responses are "Agree" which signifies that they agree on the overall functionalities of the system. The study recommended that the developed crop mapping system would be implemented online using web-based system. Aside from that, the developed user interface design of the prototype could also be enhanced using a multimedia software. Lastly, it will be implemented in a mobile applications.

Keywords: ICT, Crops Mapping System, GIS, Soils, Crops, Soils Analysis, Buug Zamboanga Sibugay

INTRODUCTION

Soil plays a vital role in the development of the country's economy. Agricultural and farming industries depends upon the soil, especially in the crops production. Rich in nutrient soils can produce good productions of crops. Moreover, to produce high productions, crops should be planted in an appropriate soil nutrient. Crops are essential in our daily needs. People always depend on it for their shelter. It is also the way of earning an income through selling it in the market. In the Philippines, the Department of Agriculture is trying its best to supply the country with the basic commodity. Aside from that, the department is also monitoring the agricultural land of the country using Geographic Information System (GIS) maps. GIS is very helpful in mapping current and future fluctuations in temperature, crops output, precipitation, and more, according to Borneman (2014). By mapping geographic and geological features of potential farmland, farmers and agriculturists can work together to create more efficient and effective farming techniques that could increase more food production. In the local situation, some barangays in the Municipality of Buug will be investigated because it is an agricultural land where crops are the primary sources of income. On a sad note, some crops are being planted in the area that does not suit to the soil nutrients just to gain earnings. In this regard, the researchers intend to map the different types of crop to be planted for a particular type of soil.

METHODOLOGY

Research Design

Research designs are procedures or guides that the researchers should follow when analyzing, collecting, interpreting, and reporting research output data (Creswell & Plano Clark, 2011). The study was descriptive by nature specifically in gathering the data but the approach used in analyzing the data is a mixed method. Mixed method is a combination of qualitative and quantitative approach (Creswell, 2013).

Locale of the study

Buug is a third class municipality in the Province of Zamboanga Sibugay, Philippines, which has a total population of 38,852 people. Buug within the Philippines is 7°44′N 123°04′E with a total area of 134.06 km2 (51.76 sq mi) as shown in Figure 3. It politically subdivided into 27 barangays which are Agutayan, Bagong Borbon, Basalem, Bawang, Bliss, Bulaan, Compostela, Danlugan, Datu Panas, Del Monte, Guintoloan, Guitom, Guminta, Labrador, Lantawan, Mabuhay, Maganay, Manlin, Muyo, Pamintayan, Pling, Poblacion, Pulog, San Jose, Talairan, Talamimi and Villacastor (MPDC Report, 2017).

Respondents of the Study

The respondents of this study are the farmers of the barangays who own agricultural land.

Data Gathering Procedures and Instruments

The researchers make a formal consent to ask permission to the owners in order to conduct the study. The interview was used as a data gathering tool. The researchers gather some samples of soil in the study areas and conduct an interview with the landowners about the different common commodity crops planted in the area. The soil sample will be sent in the Department of Agriculture – Regional Soil Laboratory Management in Zamboanga City to test the soils characteristics. Furthermore, the researchers also interview the Soil and Crops Research Management personnel of the Department of Agriculture in Zamboanga Sibugay Provincial Office to gather more insights on soils and crops.

RESULTS

3.1 Types of Soil and its Characteristics

Four types of soil were being tested at the Regional Soils Laboratory in Zamboanga City as shown in Table 3. The results also recommend what crops will be planted in that particular soil and lime or nutrient required for the crops as shown in Table 4. Furthermore, Table 5 also presents the recommended fertilizer on the particular crops being planted in the soil.

Table 3 Soil Analysis Results

Type of Soil	pH	OM (%)	P (ppm)	K (ppm)
Loam and Clay Soil	5.42	1.3	98.6	400.0
Loam and Clay	5.98	1.1	15.8	90.0
Black, Sandy and Loam Soil	5.50	1.2 0.1	101.2 0.3	195.0 40.0
Red and Loam Soil	6.17			

Table 4 Lime or Nutrient Requirements for the Crops

Type of Soil	Nutrient Requirements	Crops
Loam and Clay Soil	120 – 0 – 0	Rice (Inbred)
Loam and Clay	80 – 0 – 7	Corn (OPV)
Black, Sandy and Loam Soil	0.14 – 0 – 0	Banana (TBP)
Red and Loam Soil	0.040 – 0.080 – 0.090	Rubber (TBP)

Table 5 Fertilizer Recommendation on the following Crops

Type of Crops	Recommendation
Rice	Option 1 After 2nd harrowing - Incorporate 10-20 bags Organic fertilizer (BASAL) 1st Application - Apply 2.5 bags Urea (46-0-0) after the last harrowing. 2nd Application –Top dress with 1.5 bags Urea (46-0-0) 10-14 days after transplanting. 3rd Application - Top dress with 1.25 bags Urea (46-0-0) 20-25 days after transplanting.
Corn	Option 1 @ Land Preparation - incorporate 10-20 bags Organic fertilizer. 1st Application - Apply 1.75 bags Urea (46-0-0) and 0.25 bag Muriate of potash (0-0-60) 1n a banc about 2" to the sides of and about 2" below the seed during planting. 2nd Application – Side dress 1.75 bags Urea (46-0-0) when plants are about four (4) weeks old or when plants are knee high (12-18“ high).
Banana	Apply the fertilizer around the planting hole at 3-4 inches below and to the side of the sucker. Option 1 - Mix and app|y 1 kilo of Urea (46-0-0) with one-kilogram Organic fertilizer.

Rubber	Apply the fertilizer 3 inches below the roots and 5 inches to the side of the plants at planting time. Option 1 - Mix 300 grams 14-14-14; 225 grams Solophos (0-18-0) and 90 grams Muriate of potash (0-0-60) Incorporate one kilogram Organic Fertilizer Option 2 - Mix 90 grams Urea (46-0-0); 450 grams Solophos (0-18-0) and 150 grams Muriate of potash (0-0-60) with one kilogram Organic Fertilizer.

3.2 Common Commodity Crops Grown in the Barangay and Their pH Level

The researchers conducted an interview on the landowners of the three (3) Barangays on the types of crops grown in their areas. Summary of the crops is listed in Table 6.

Table 6 Types of Crops and Their Corresponding pH Level

Types of Crops	pH Level
Rice	6.00 – 6.70
Corn	5.80 – 6.80
Rubber	6.00 – 7.00
Coconut	6.10 – 7.00
Banana	4.50 – 5.20
Squash	5.50 – 7.00
Sweet potato	5.30 – 5.60
Cassava	5.78 – 6.00
Eggplant	5.50 – 6.50
Calamansi	2.00 – 2.50
Okra	6.50 – 7.50
Tomato	5.50 – 7.50

Table 6 presents the different types of crops in the study area. It also presents that Tomato crops have the highest range of pH level that is suitable be planted to the four soils sample's pH.

3.3 Crops Mapping System (CMS)

The researchers used PHP Hypertext Preprocessor (PHP) as the front-end and MySQL database as the back-end. Notepad++ was the integrated development environment (IDE) used in the system. Javascript (JS) and Cascading style sheet (CSS) programs was also utilized by the researcher to make the prototype more interactive and responsive. Wamp server was also used as Database Management Systems (DBMS) to serve as a local server of the system.

Google API were also utilized in displaying the marker in the location of the map. The system was tested and debugged using a web browser such as Google Chrome and Mozilla Firefox.

3.3.1 System Features

The features of the best crops mapping system are the following: (1) Home User Interface; (2) Search Crops/Location; (3) Soils User Interface; and (4) Crops User Interface. Each of these features is discussed in the subsequent section.

Home User Interface

Figure 5 shows the homepage of the system. The homepage is an essential part of the system where it is the main screen that users interact most.

Figure 5 Home User Interface

Crops User Interface

Figure 6 shows the Crops User Interface. It will automatically display the information of particular types of crop specifically the PH Level.

Figure 6 Crops User Interface

Soils User Interface

Figure 7 shows the Soils User Interface. It will display the types of particular soil and the information.

Figure 7 Soils User Interface

Search Crops/Location User Interface

Figure 8 shows the Search Crops/Location User Interface. It is a search button where the user can search the name of the crops as well as the location which will automatically display the result of different crops to be planted in a particular area.

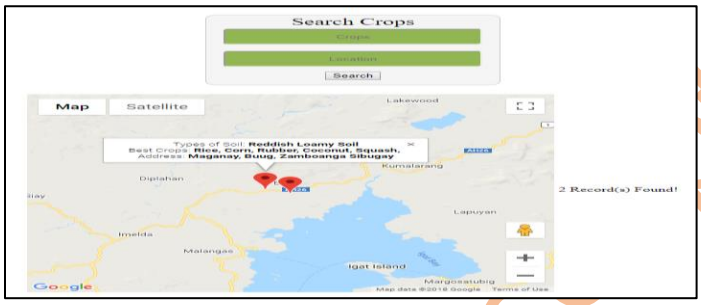

Figure 8 Search Crops/Location User Interface

3.4 System Evaluation

Figure 9 shows the system evaluation. There were 30 respondents in the system evaluation who were given a chance to navigate the functionality of the system. Based on the evaluation results, it shows that 62.5% of the respondent's responses are "Agree". This signifies that the overall functionality of the system is acceptable and useful.

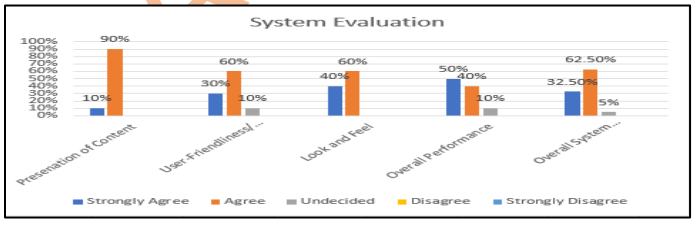

Figure 9 System Evaluation

3.5 System Architecture

Figure 10 shows the system architecture used in the system deployment. The system architecture was composed of the database server, google server, web server and the client. The system used an Apache web server that handles the request of the client when they open a web page using hypertext transfer protocol (HTTP). This server also supports the use of MYSQL databases that manage the retrieving and storing of data every time the client has a transaction.

The main server utilized an open source operating system such as Linux platform because most of the offered services of the system are also open source such as Google server. The client can only connect to the server through web browsers.

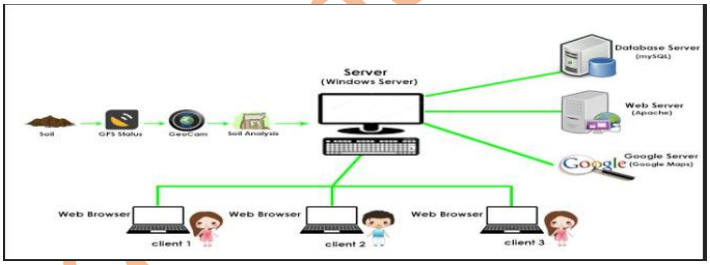

Figure 10 System Architecture

4.1 Conclusions

The study was conducted at Barangay Maganay, Barangay Pling and Barangay Datu Panas of Buug Zamboanga Sibugay with a total of ten farmers who participated in the conduct of the study. The farmers were given the chance to navigate the developed crop mapping system. The crop mapping system has been used to analyze farmland's suitability for the growth and production of some of the selected crops in the study area.

However, the information gathered were used as indicators in the development of the crops mapping system using GIS model.

Moreover, mapping plays a vital role in monitoring the soil and its irrigation of any given farm land. The developed system helps the farmer in increasing production, reducing cost, and managing their land resources more efficiently.

On the other hand, respondents yielded the overall functionality of the system.

4.2 Recommendations

Based on the findings and conclusion of this study, the following recommendations were formulated:

1. Replicate this study but may expand research locale to include more farm lands.
2. The developed crop mapping system using GIS is implemented online. Aside from that, the developed user interface design of the prototype could be enhanced using a multimedia software. Lastly, it will be implemented in a mobile application.

REFERENCES

Adu, S.V (1992). Soils of the Kumasi Region, Ashanti Region, Ghana, Soils Research Institute, Kwadaso-Kumasi, Memoir, No. 8, pp 22-24.

Ande, O. T (2011). Soil Suitability Evaluation and Management for Cassava Production in the Derived Savanna Area of Southwestern Nigeria. International Journal of Soil Science, 6, pp 142-149.

Andrienko, G., Andrienko, N., and Savinov, A (2001), Choropleth Maps: Classification revisited, In Proceedings ICA 2001, Beijing,China, 2, pp 1109-1219.

Anselin, L (1998), exploratory Spatial Data Analysis in a Geo-computational Environment. In P. Longley, S. Brooks, B. Macmillan and R. McDonnell (Eds.),

Behrens, T., and Scholten, T (2006), digital Soil Mapping in Germany – a review, Journal of Plant Nutrition and Soil Science, 169(3), pp 434 – 443.

Behrens, T., Förster, H., Scholten, T., Steinrücken, U., Ernst-Dieter., S., and Goldschmitt., M (2005), digital Soil Mapping using Artificial Neural Networks, Journal of Plant Nutrition and Soil Science, 168(1), pp 21 – 33.

Bishop, T. F. A., McBratney, A. B., and Whelan, B. M (2001), measuring the Quality of Digital Soil Maps using Information Criteria, Geoderma, 103(1-2,31), pp 95-111.

Boateng, E (2005), GIS as a Decision Support Tool for Land Suitability Assessment for Rice Production in Ghana, West Africa Journal of Applied Ecology, 7, pp 69-81.

Burgess, T. M., and Webster, R (1984), optimal Sampling Strategies for Mapping Soil Types: Distribution of boundary spacings, Journal of Soil Science, 35(4), pp 641 654,.

Burrough, P. A (1991), soil Information Systems. In: Maguire, D. J. M. F. Goodchild and D. W. Rhind, Editor. Geographical Information Systems. Principles and Applications. New York: John Wiley & Sons; pp153-169.

Debella-Gilo, M., Etzelmuller, B., Klakegg, O (2007), digital Soil Mapping Using Digital Terrain Analysis and Statistical Modelling Integrated into GIS: Examples from Vestfold County of Norway, Proceedings, ScanGIS'2007, pp 237- 253.

Effland, W. R., Asiamah, R. D., Adjei-Gyapong,T., DeIa-Dedzoe, C., and Boateng, E (2009), discovering Soils in the Tropics: Soil Classification in Ghana, Soil Survey Horizon, 50, pp 39-46. Food and Agriculture Organization (FAO) (1976), a Framework for Land Evaluation. FAO Soil Bulletin No. 32, FAO, Rome, pp 17-21.

Feizizadeh, B & Blaschke, T 2012, 'Land suitability analysis for Tabriz County, Iran: a multi-criteria evaluation approach using GIS', Journal of Environmental Planning and Management, vol. 1, pp. 1-23.

Forkuo, E. K (2008), digital Terrain Modelling in a GIS Environment. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences". Vol. XXXVII, Part B2, pp 1023-1028.

Forkuo, E. K., and Asiedu, S. B (2009), developing a One Stop Shop Model for Integrated Land Information Management. Journal of Science and Technology, 29(3), pp 114-125.

Forkuo, E. K., and Dorda, A. G (2011), the Effects of Production Steps on Accuracy of Digital Orthoimages. The Journal of Geomatics, 5(1), pp 1-9.

GeoComputation, A Primer, pp. 77-94. New York: Wiley.

Getis, A., and Ord, J. K (1992), the Analysis of Spatial Association by use of Distance Statistics. Geographic Anals, 24, pp 189-206.

Halder, J, C 2013, 'Land suitability assessment for crop cultivation by using remote sensing and GIS', Journal of Geography and Geology, vol. 5, no. 30, pp. 65-74.

Jayasinghe, P. K. S. C. T., and Machida, T (2008), web-based Online Consulting System with Crop-Land Suiability Identification, Agricultural Information Research, 17(1), pp 13-19.

Kahenda, M 2013, Governor Daniel Waithaka's big plan for Nyandarua County, viewed 20 May 2014, <http://www.standardmedia.co.ke/?articleID=2000092103&story_title=governor-s-big plan-for-nyandaruacounty>.

Kalogirou, S (2002), expert Systems and GIS: An Application of Land Suitability Evaluation. Computers, Environment and Urban Systems, 26(2-3), pp 89-112.

Khoi, D, D & Murayama, Y 2010, 'Delineation of suitable cropland areas using a GIS based multi-criteria evaluation approach in the Tam Dao National Park Region, Vietnam', Sustainability, vol. 2, pp. 2024-2043.

Kihoro, J, Njoroge J, B & Murage, H 2013, 'Suitability analysis for rice growing sites using a multi-criteria evaluation and GIS approach in great Mwea region, Kenya', SpringerPlus, vol. 2, 265-274.

Kumar, N (2003), mapping Spatial and Statistical Distributions in a Choropleth Map. ArcUser, Online Magazine for ESRI Software Users. Available at http://www.esri.com/news/arcuser/1003/files/choropleth.pdf, Accessed on August

Kuria, D, Ngari, D & Waithaka, E 2011, 'Using geographic information systems (GIS) to determine land suitability for rice crop growing in the Tana delta', Journal of Geography and Regional Planning, vol. 4, no. 9, pp. 525-532.

McBratney, A. B., Mendonc Santos, M. L., and Minasnya, B (2003), on Digital Soil Mapping. Geoderma, 117, pp 3–52.

Monmonier, M (1993), maps in humanities and Social Science. In: Monmonier M, ed. mapping it Out-Expository Cartography for The Humanities And Sciences. Chicago, University of University Press, pp 3-18.

Moore, I. D., Gessler, G. A., Nielsen, G. A., Peterson (1993), soil Attribute Predictionusing Analysis, Soil Science Society of American Journal, 57, pp 443-452.

Mustafa, A, A, Singh, M, Sahoo, R N, Ahmed, N, Khanna, M, Sarangi, A & Mishra, A, K 2011, 'Land suitability analysis for different crops: a multi criteria decision making approach using remote sensing and GIS. Researcher, vol. 3, no. 12, pp. 61-84.

Ramakrishnan, S. S., and Guruswamy, V (2009), GIS Applications in Soil Data Analysis, Center for GIS Applications, Anna University, India. Available at: http://www.gisdevelopment.net, Accessed on March 2011.

Saaty, T, L 2008, 'Decision making with the analytic hierarchy process', Int. J. Services Sciences, vol. 1, no. 1, pp. 83–98.

Scull, P., Franklin, J., Chadwick, O. A., and McArthur, D (2003), predictive Soil Mapping: A Review. Progress in Physical Geography, 27(2), pp 171–197.

Senayah, J. K., Adjei, S., Dwomo, O., and Asiamah, R. O (2003), land Suitability Assessment for the Production of Selected Crops in the Adansi West District: SRI Technical Report No. 23. Kwadaso-Kumasi.

Shi, X, Z., Yu, D. S., Warner, E. D., Pan, X. Z., Petersen, G. W., Gong, Z. G., Weindorf, D. C (2001), soil Database of 1:1,000,000 Digital Soil Survey and Reference System of the Chinese Genetic Soil Classification System, Soil Survey Horizons, 45(4), pp 129-136.

Smith, M. P., Zhu, A. X., Burta, J. E., and Cynthia Stiles (2006), the Effects of DEM Resolution and Neighborhood Size on Digital Soil Survey. Geoderma,137(1-2), 31, pp 58-69.

Teka, K & Haftu, M 2012, 'Land suitability characterization for crop and fruit production in midlands of Tigray, Ethiopia', CNCS, Mekelle University, vol. 4, no. 1, pp. 64 76.

Triantaphyllou, E & Mann, S, H 1995, 'Using the analytic hierarchy process for decision making in engineering applications: some challenges', Inter'l Journal of Industrial Engineering: Applications and Practice, vol. 2, no. 1, pp. 35-44.