PREPARATION OF THEMATIC MAPS ON SOIL ZONING FOR DOMINICO VARIETY BANANA CULTIVATION USING GIS TOOLS, IN THE MILAGRO GUAYAS AREA.

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KEYWORDS	ABSTRACT
edaphoclimatic, thematic maps, geographic information system, sustainable.	This article focuses on the development of thematic maps using Geographic Information Systems (GIS) tools to determine soil types suitable for banana cultivation in the province of Milagro. This process requires information from organizations dedicated to edaphoclimatic studies. Once the data is collected, thematic maps will be created to clearly identify the zones and soil levels present in the area. Additionally, the use of Geographic Information Systems (GIS) provides a valuable tool for data-driven decision-making, enabling more precise and sustainable planning, optimizing resource allocation, and minimizing risks to improve agricultural productivity.

Introduction

Plantain cultivation is of great importance to the Ecuadorian economy, both for the consumption of the producer and the inhabitants; it generates sources of employment and helps improve the occupational level of producers and their families. Plantain is an important crop for the world's food supply. In addition, it is an export item and a source of employment in many areas of the country (Ramírez, 2019).

According to Hernández, Morales and Morales (2018), they mention that the importance of thematic maps in Agriculture is due to the fact that it allows farmers to map field data by organizing and analyzing them for soil improvement, conservation and rehabilitation work. The term cartography has been used for hundreds of years with more or less broad criteria, depending on the professional profile of the people who have used it, both for their experience with maps and the type or level of use of the same (Soto, 2016).

According to Palma (2019), the first and most basic objective pursued by cartography was to represent important areas for man that would serve as a guide. This criterion has subsequently been expanded to include the representation of phenomena that man takes into account in his decisions, both visible (a forest, a river, a coast) and invisible (municipal boundary lines, for example).

The relevance of this study is based on the development of a thematic map by land use zoning by land use of Dominican green banana cultivation using GIS tools in the Guayas miracle area. The purpose is to create additional maps that use geographic information, productivity and performance.

Goals

The article entitled 'PREPARATION OF THEMATIC MAPS ON SOIL ZONING FOR DOMINICO VARIETY BANANA CULTIVATION USING GIS TOOLS, IN THE MILAGRO GUAYAS AREA' is descriptive in nature and deals with the foundations and the proposal regarding the following objectives.

General Objective

Prepare thematic maps on land use zoning for the cultivation of the Dominico variety of banana using geographic information system tools, in the Milagro area, Guayas.

Specific Objectives

- Description of soil types for crops in Ecuador.
- Determine the soil information where the banana is grown.
- Implement thematic maps on land zoning where bananas are grown.

Determine the soil information where the banana is grown.

According to Ortega, Noroña and Noroñas (2019), they mention that banana is considered one of the crops of relevant importance in Ecuadorian society because it is part of being a basic food in the food security of the population, especially in the regions of the Coast and the Amazon, some varieties are cultivated. It is present in most agricultural production systems, generates work and income for thousands of Ecuadorians and represents an important export item.

However, its cultivation is not exempt from problems that affect productivity, such as poor management of soil fertility and lack of knowledge in the use and application of efficient technologies. In the country, there are 82,341 ha as monoculture and 101,258 ha in association, with yields of 317,523t and 171,293t respectively (National Institute of Agricultural Research 2021).

Soil characteristics for banana cultivation

According to SIPSA (2017), the soil has physical and chemical characteristics that facilitate the timely and balanced supply of mineral elements (nutrients), essential for the growth and development of plants. Likewise, Gonzabay (2017) mentions that it is necessary for the soil to have good contents of organic matter and nutrients available in optimal and balanced quantities, which are not present naturally, and must be supplied to the plant from alternative chemical and organic sources.

Land used for banana cultivation must meet certain natural conditions that make it suitable for this purpose. Appropriate soils are those that vary from slightly acidic to neutral (pH 6.5 -7.0), although it also tolerates slightly alkaline soils. The soils must have a flat topography to facilitate cultural work and avoid erosion as much as possible, loose, deep, rich in organic matter, fertile and with good drainage, since puddles affect it and can even kill the plant (Producer, 2018).

Implement a thematic map on land zoning where bananas are grown.

According to Guzmán (2019), he explains that thematic maps are cartographic tools that allow us to understand the geographical area of study. Every thematic map is made up of two

fundamental elements: A geographic base (base map), and a layer of thematic content. The user of a thematic map will be able to integrate them, visually and intellectually, while reading the map (De la CRUZ, 2018).

Components of a thematic map

Base map

According to Fallas (2019), a base map provides spatial information on which to reference the content corresponding to a certain specific topic. It must be correctly designed and include only the amount of information necessary to convey the message. We can define it as a more or less synthetic image of the territory, whose objective is the geographical referencing of the thematic content of the map. Regarding the thematic content, its simplicity and legibility are important.(Andrade, Maizares, Varas, and Vargas, 2022).

According toSuárez and Rubiano (2019) describe that the theme is one of the main conditions of the content of the geographic base, because there are often relationships between the geographic characteristics of the territory and the thematic variables that are represented, so it is desirable to make them clear in order to better understand the given distribution.

Elements to include in the base map

According to Lois (2015), he describes that the information on the base map is what makes the map user orient the thematic content to a specific spatial or geographic reference. It will be the cartographer's job to select those characteristics that help the reader to a good interpretation of the total map. On the other hand, Cedec (2019) cites a series of elements that can help to choose the content to provide a readable map, this will depend on the purpose of the map. It is normal for some elements to appear in more detail than others.

- The caneva

The network of meridians and parallels is necessary as a general reference system. The importance of the canvas on the map increases as its scale decreases, being essential on small scales that represent large surfaces. The general orientation system can also be offered by means of small location maps at smaller scales, showing with them the position of the area represented on the general map (Cedec, 2019).

- The river network

There are hardly any maps that do not show a part of the river network. This network is one of the best reference systems, although as indicated above, some cases will require more detail in their representation than others (Cedec, 2019).

- The relief

Many cartographic themes are directly or indirectly related to the third dimension. The representation of the relief on the base map will be carried out considering in each case the degree of reliability required, the final scale of the map and its representation technique (Cedec, 2019).

- Topographic map as a base map

The topographic map can be used as a base map for thematic maps. This does not mean that it is useful in its original form, since in most cases the information and colors of the base itself

will interfere with the reading of the thematic information that has been superimposed. (López, 2020).

- Base map scale

According to Malagón (2015), he describes that the choice of scale has important consequences on the appearance of the map and its potential as a means of communication. In this section we are interested in emphasizing the idea of the relationship between scale and symbolization and the degree of generalization of the map. Factors that will influence the choice of scale will be, in principle, the purpose of the map and the actual surface of the area to be represented. The choice of the scale to be used will mainly be a compromise between these three factors: Purpose, area and necessary detail. On the other hand, it must be remembered that the scale varies on the map depending on the projection (Cedec, 2019).

- Choosing the projection

Finding the appropriate projection will depend on several factors such as the scale and purpose of the map, and the location, shape and size of the area to be represented (Cedec, 2019).

The purpose of the map

When creating a thematic map, the cartographer has hundreds of projections to choose from, but their number will be reduced depending on the purpose of the map. The equivalence property is an important factor in the representation of many thematic features (Cedec, 2019).

The area

The specific area to be mapped, depending on its size, location and shape, also determines the selection of the projection. The cartographer must select the most appropriate projection for each case. Nowadays, the choice of one projection or another is a task that is facilitated by the use of computer programs, so that more time can be invested in the selection of the projection itself, in which different aspects must be carefully considered: The properties of the projection (Cedec, 2019).

Symbolism

The way of representing thematic details on a map is very varied and depends largely on the type of elements to be displayed. The main ones are listed below:
- Data point symbols: identify a feature and its location
- Linear data symbols: represent details that have a defined line, such as subway lines, road networks, rivers.
- Surface data symbols: provide information about a certain surface, such as geological maps, forest maps.

Methodology

Type of research

This work is descriptive in nature, because a thematic map of zoning by land use of the Dominican banana crop will be prepared using GIS tools, in order to obtain cartographic information that contributes to the planning and detection of patterns and trends, as well as to quickly address the crop problems that arise:

- **Descriptive Research:**involves observing and describing the behavior of a demographic segment of the study.
- **Documentary Research:**A documentary-type research will be carried out and information will be collected using published scientific articles, website documents, theses and/or information from pages related to agriculture.

Methods

In this project, the analytical method will be applied, which is broken down into sections that make up the entire case to be studied. In addition, a thematic map will be used to understand a specific geographic phenomenon, and the use of tools such as GIS will allow mapping field data, as well as organizing and analyzing it.

Techniques

This research project develops a thematic map of land use zoning using GIS tools. The use of geographic information systems has allowed the generation of thematic, interactive and layered maps that collect more detailed information on soil types, nutrients, among others, which allow the management of agricultural operations. Among the GIS tools is the ArcGIS system, which is a software tool that allows the use, creation and distribution of geographic information and mapping analysis. Any user can access the maps and data resulting from the project.

Variables

Thematic map of soil types.

Independent variable

Cultivation of Dominico – Hartón variety banana.

Dependent variable

- **Spatial distribution:**Establish the location of the study area that will allow obtaining the land; that is, the type of soil.
- **Soil analysis:**Integrate cartographic information on the type of soil and the components present.

Research Management

Base map data acquisition

Use of equipment and technologies for data collection

Processing of cartographic data

Digital models were generated with soil data from the crop under study.

Data integration

Using other data related to the crops under study, the thematic zoning map is created.

Developing an interface

Develop visualization and analysis tools so that farmers can use the generated cartographic information.

Analysis of Results

Description of soil types for crops in Ecuador

Ecuador has considerable variability in its geography, from the coast to the mountains and the Amazon rainforest. Describing soils is essential to adapt agricultural practices to the specific conditions of each region, as it helps to understand water retention capacity, texture, and other aspects related to fertility. This allows irrigation and fertilizer applications to be managed more efficiently, making better use of resources and reducing costs. In addition, different types of soil are better for certain types of crops. By knowing soil conditions, farmers can select the best crops to increase crop yield and quality.

Soil description helps to identify environmental problems such as soil erosion or salinization. This allows preventive measures to be implemented to maintain soil health and ensure long-term stability. Due to climate variability, this will help farmers adapt to changes in rainfall, temperature, and other weather conditions. This is important to maintain agricultural production under climate change. Knowing the texture and type of soil will facilitate land use planning, helping to avoid practices that may result in soil degradation or loss of quality. Taking into account that soil characteristics promote the implementation of sustainable and environmentally friendly agricultural practices, contributing to the conservation of natural resources.

Determine the soil information where bananas are grown

Land zoning allows land to be divided into different areas based on topography. In this way, it promotes agricultural planning by optimizing the use of land and resources by distributing banana crops in the most suitable areas. Because bananas have very high nutritional requirements, knowing soil characteristics, such as nutrient content, allows fertilizers to be adjusted to meet the plant's needs and increase results. As a result, studying soil types, including properties such as texture and water holding capacity, affects irrigation management. Knowing these factors will help you plan irrigation schedules, avoid flooding or drought problems that could affect your crops, and implement appropriate management practices to reduce risk and maintain soil health.

Implement a thematic map on land zoning where bananas are grown

The project began with the development of a thematic map, since these are based on topographic maps, which are made to reflect a particular aspect of the geographic area in which they are defined. In this way, a better spectrum of the study was achieved (See Figure 1 and 2).
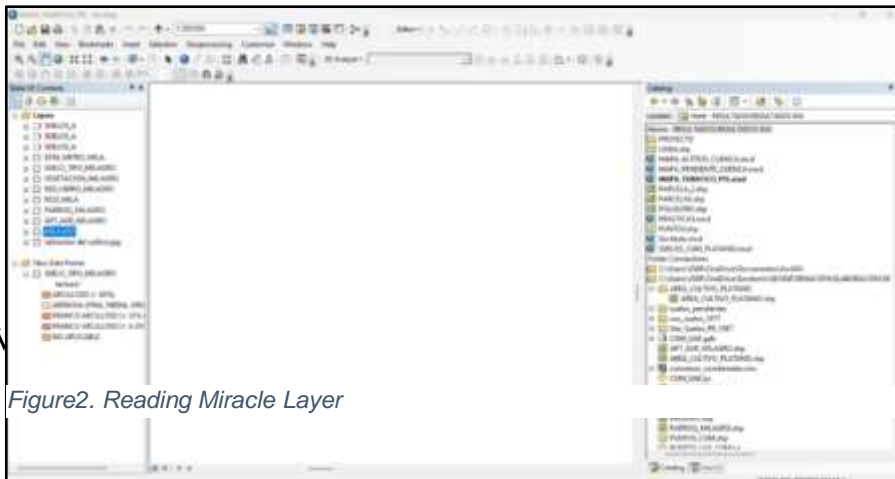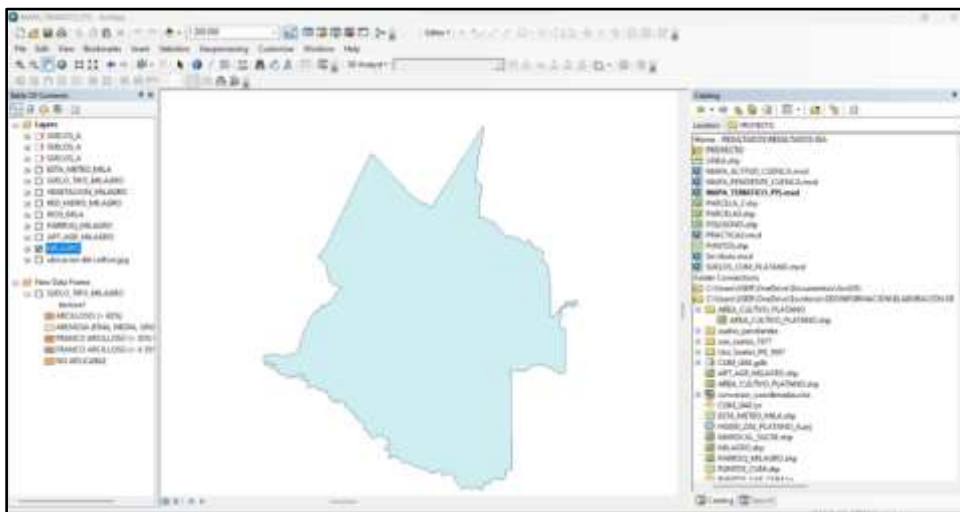
Figure1.Using the application

Figure2. Reading Miracle Layer

The first step was to create a map of the Milagro canton and proceed to take all the pre-existing shapes such as the parish shape, rivers, vegetation. (See figures 3, 4 and 5).

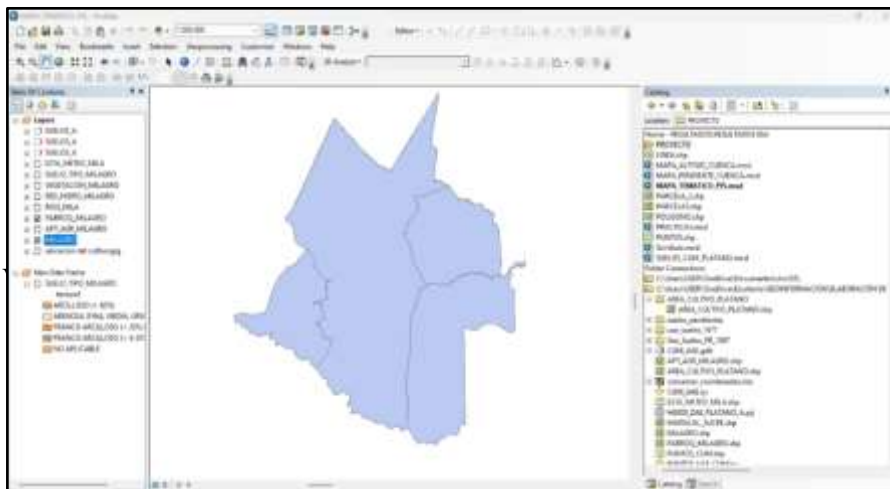*Figure3Reading of the cape of the Parishes of Milagro*

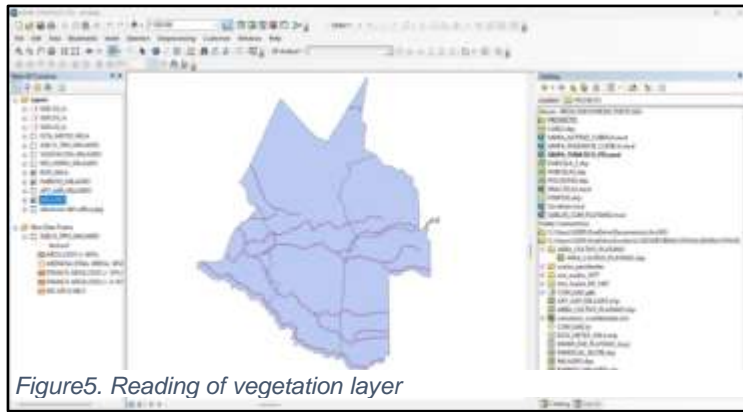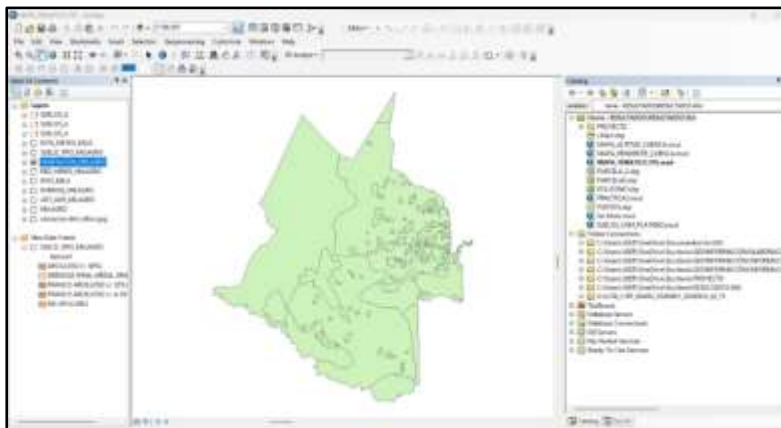*Figure4. Reading of watersheds of the Milagro canton*

Figure5. Reading of vegetation layer

Then an Excel file is created where all the data obtained on the types of soil used in the banana plantations of the Milagro canton is placed, all this in order to be able to enter this data in the ArcMap table and then save it in the Excel 97-2003 format.

This file was saved in XLS format so that it could be inserted into the data table under the name thematic map.

The Milagro shape was dragged to the table of contents and then the AddData option was selected and the table called APT was added to the table of contents. Next, we opened the attribute table, right-clicked on the soil-type option and chose the open attribute table option. (See figures 6, 7 and 8).
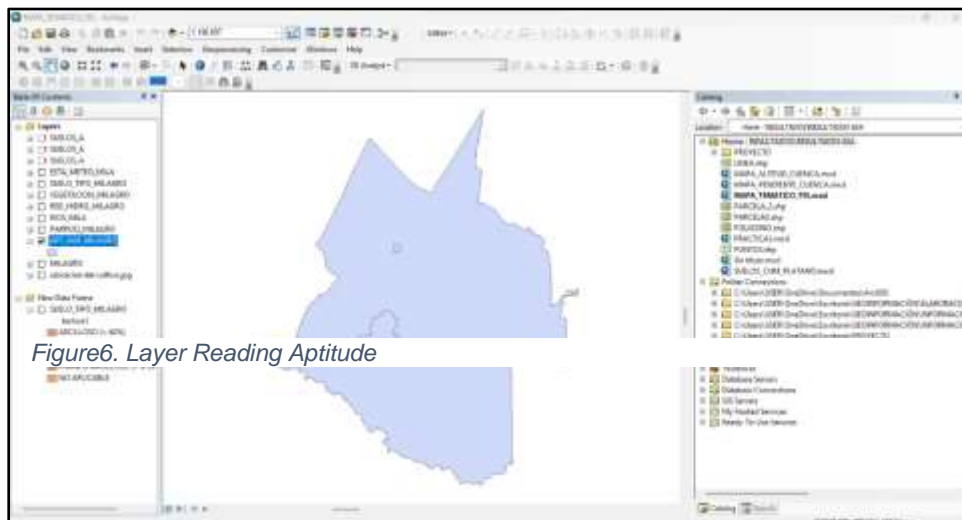
Figure6. Layer Reading Aptitude

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Figure7. Selection of color scale of zones in the canton

Figure8. Layer Reading Aptitude
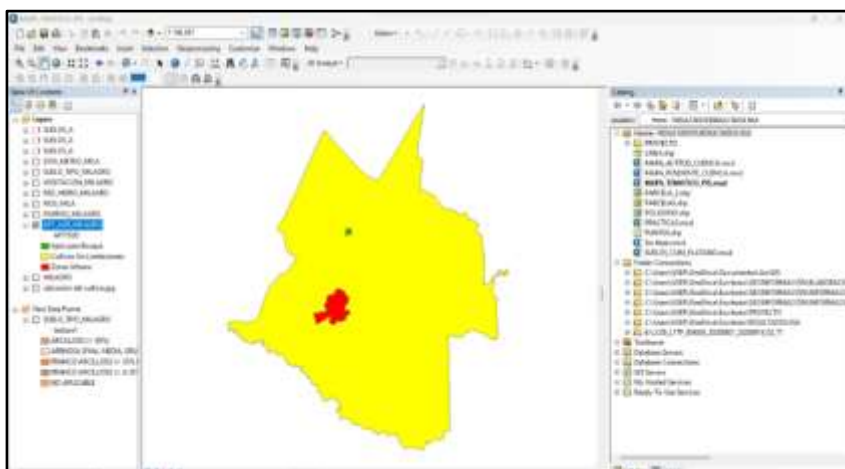
Similarly, the miracle table opens for them by right-clicking on the soil-type layer and choosing the open option.

Then we right click on table options, select arrange tables and choose new vertical table, the tables will be displayed together at the same time and we can verify that the names of the soil types to be worked on are correctly written and match in order to join the tables. (See figures 9, 10 and 11).

Figure9. Soil layer reading - types
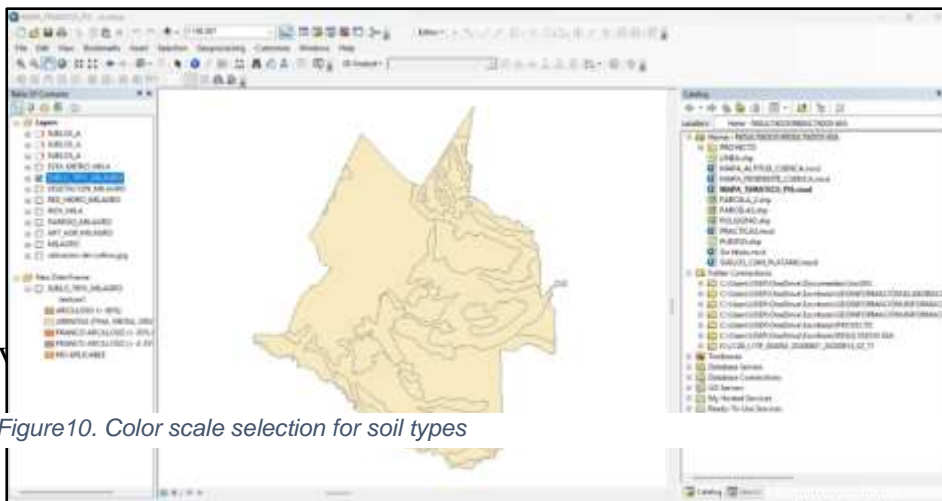
Figure10. Color scale selection for soil types
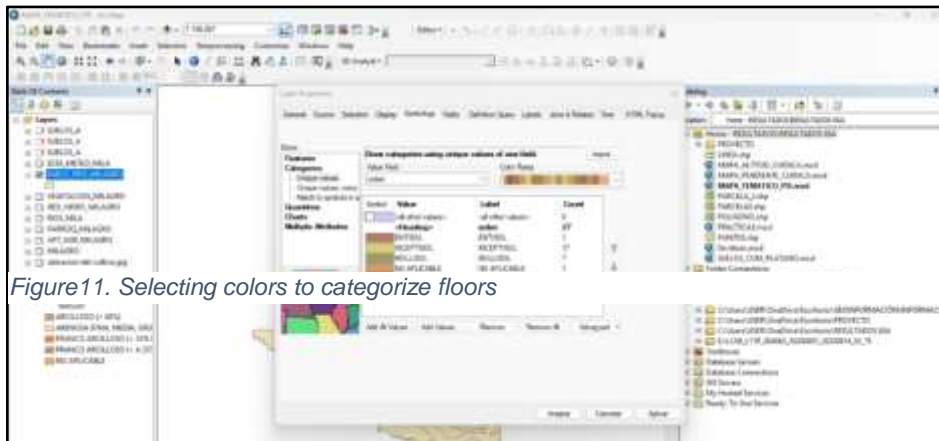
Figure11. Selecting colors to categorize floors
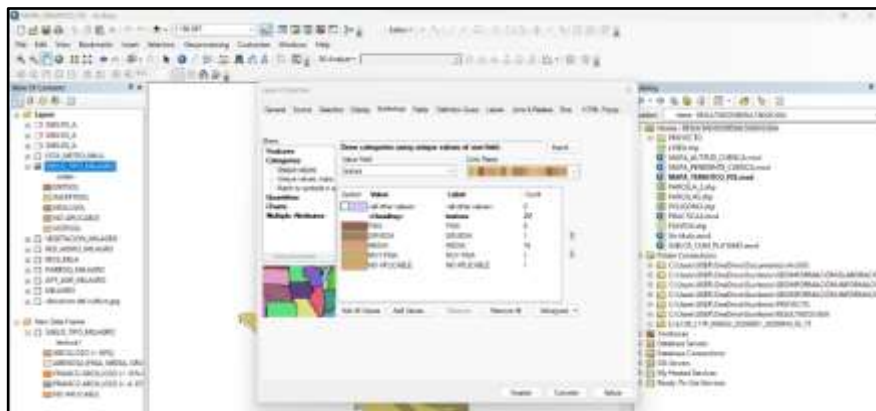
Then, when joining the tables, you must right-click on the soil-types layer and choose the Joins and relates option followed by the Join option.

In the new window, the disease table will automatically appear in parameter two; therefore, in parameter one, choose the Nomdep field; and in parameter three, the provinces field, then click on validate join and once it has been verified, click on ok.

We can open the miracle table and we can see that it is linked to the soil-type table. To keep this data, we must export the data. To do this, right-click on the miracle layer and choose the data option, then export data. A window will appear to save the new shape. We click on save and then OK. (See figures 12 and 13).

Figure12. Layer reading Crop location
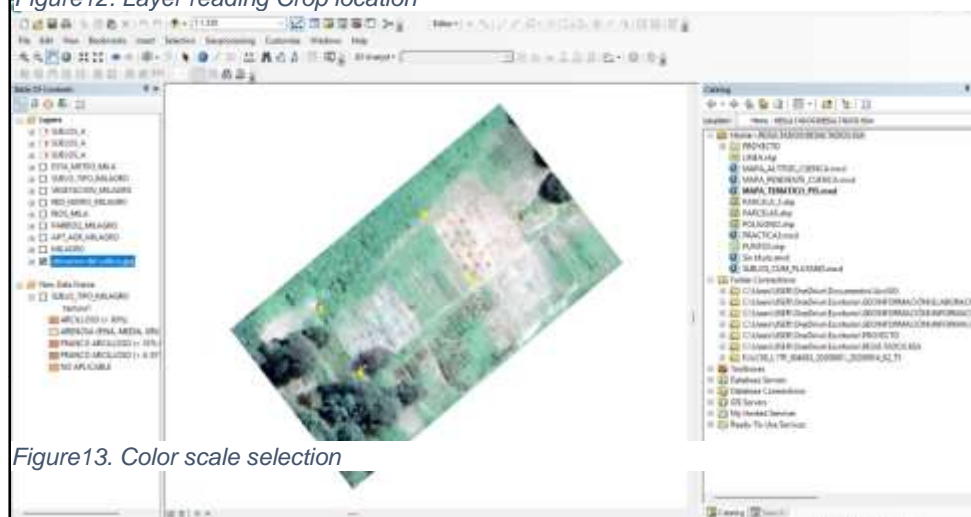
Figure13. Color scale selection
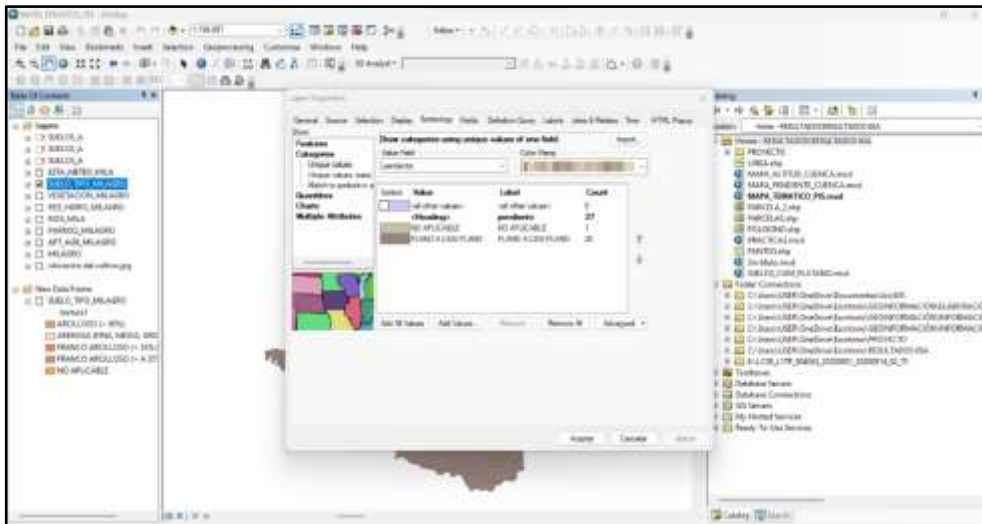
Then you must choose the new extracted layer, right click on the properties option, to go to the symbology address followed by quant times, graduate colors, select the range of colors you want to use to identify the incidence levels on the map (See figures 14, 15 and 16).

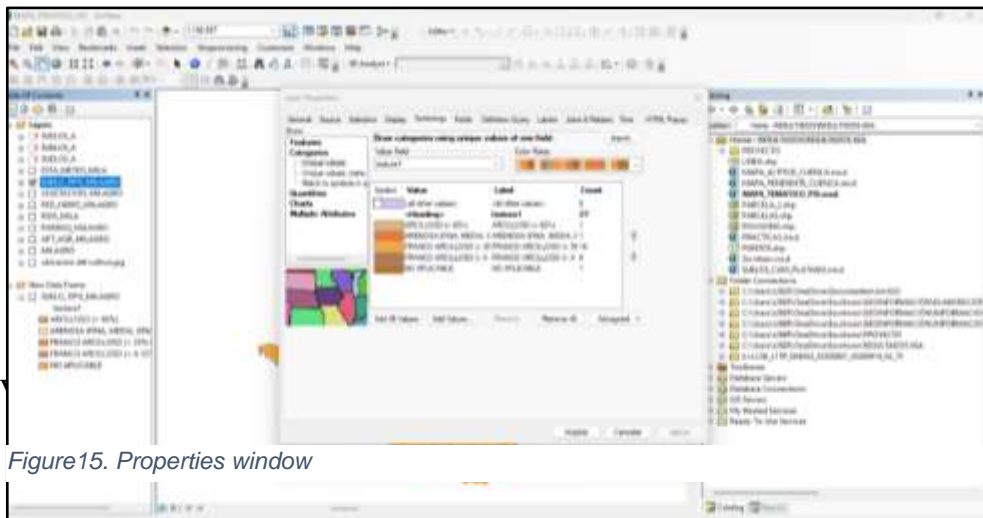*Figure14. Selection of color scale with soil types*
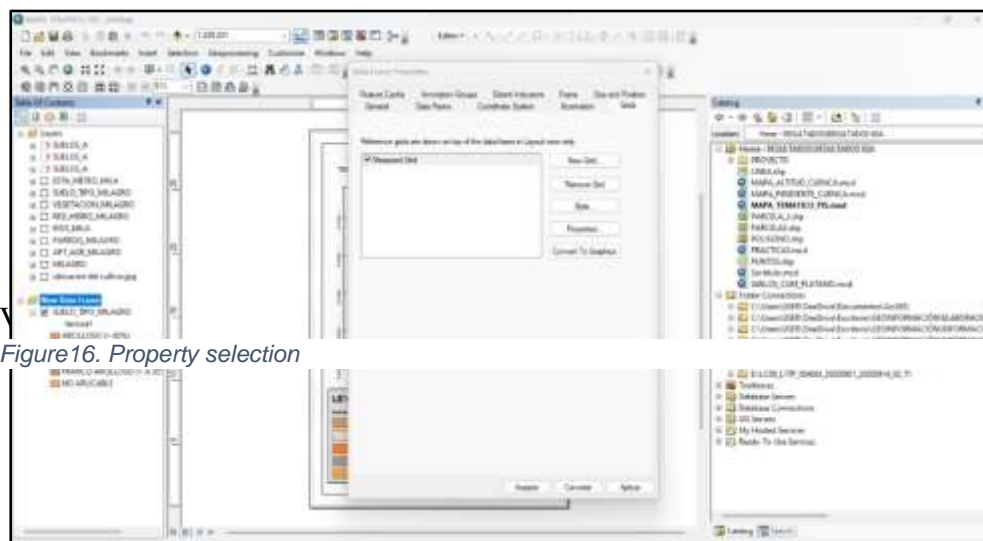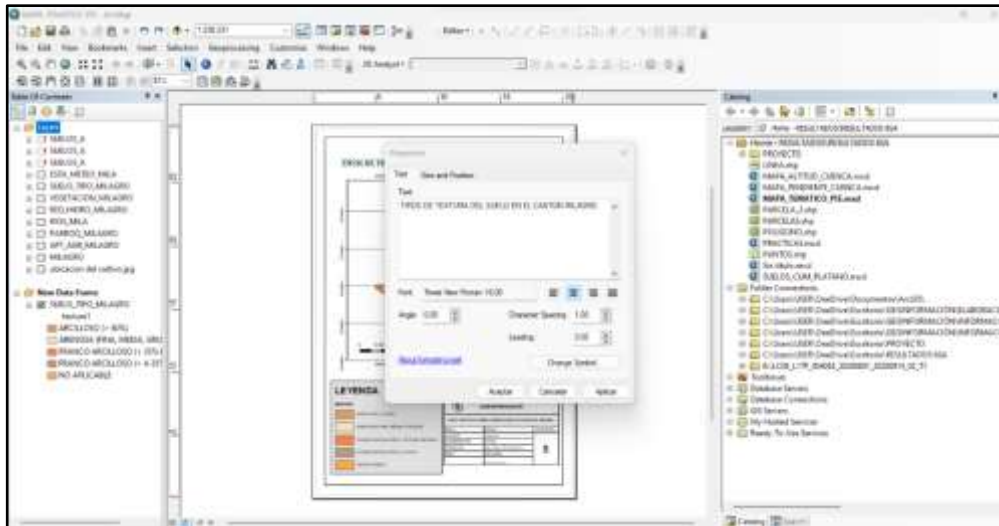

Figure15. Properties window

Figure16. Property selection

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Once you have reached this step, you can say that the map is finished. The next step is to add the cells to the map, place the legend, the title, the compass and the scale. (See figures 17 and 18).
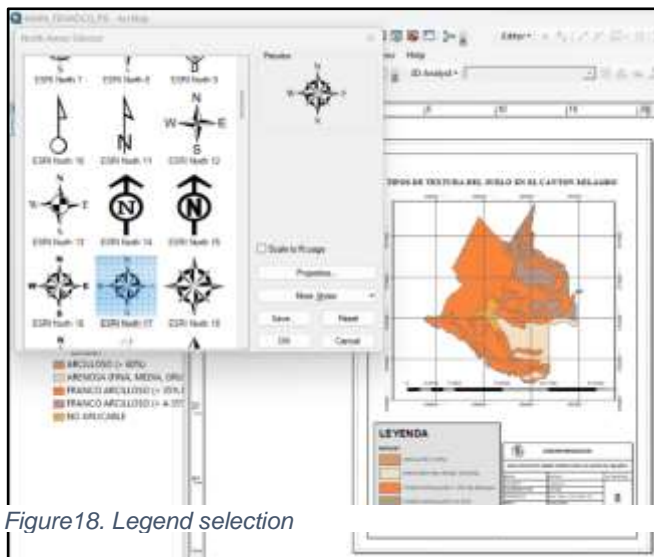
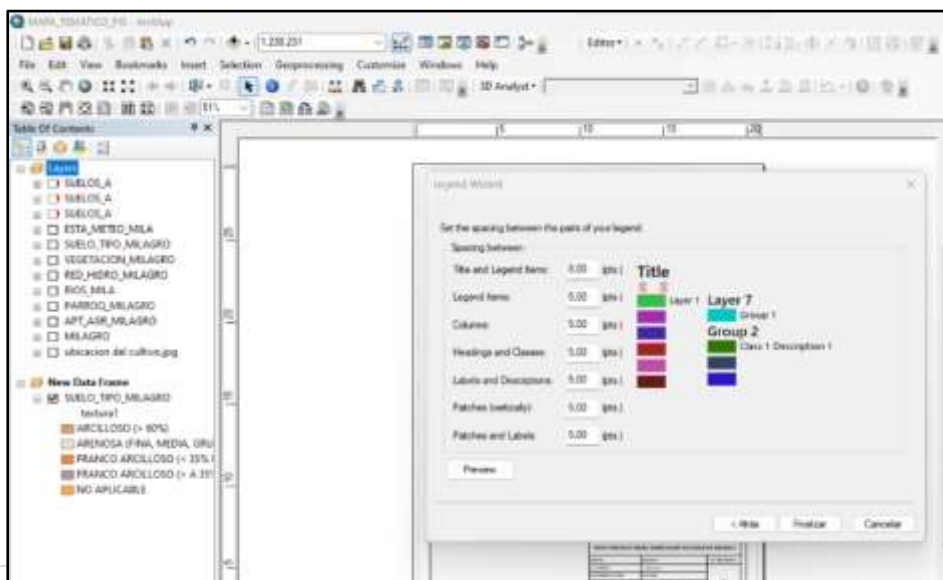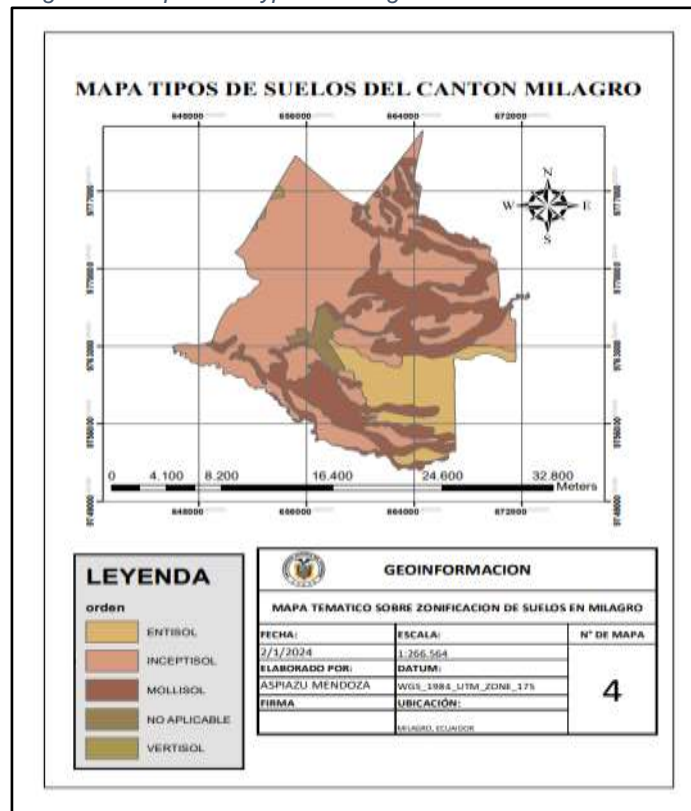*Figure17. Placement of cartographic element*

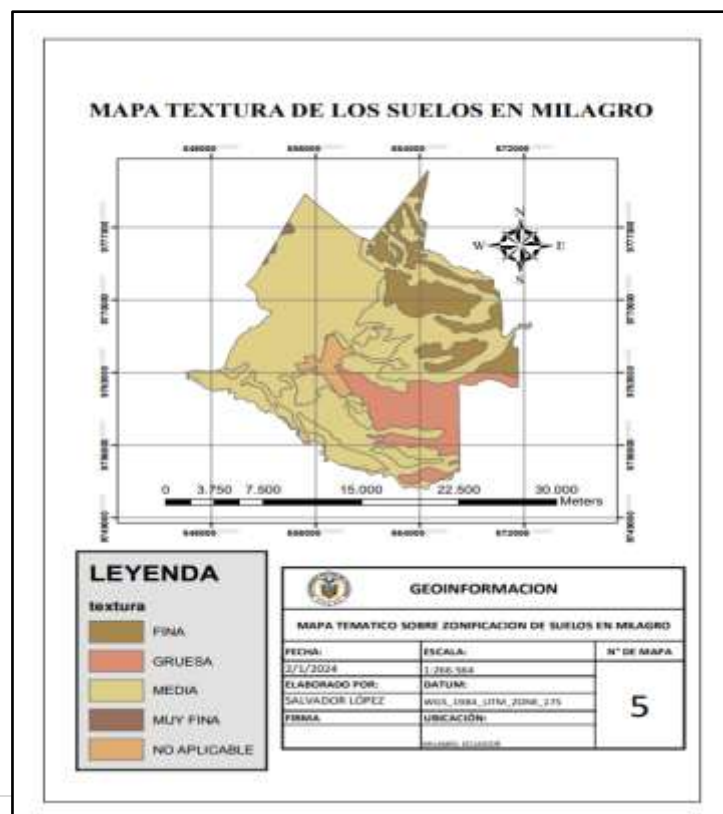*Figure18. Legend selection*

However, at this point the map can be designed to the person's taste and whatever each person needs for the presentation of said map can be placed. (See figures 19, 20, 21 and 22).
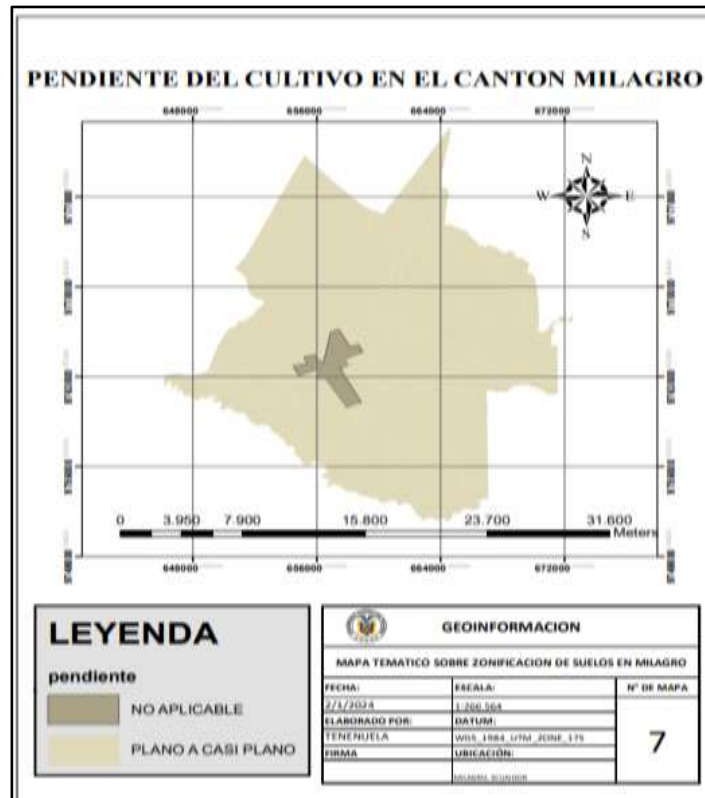
Figure19. Map of soil types in Milagro

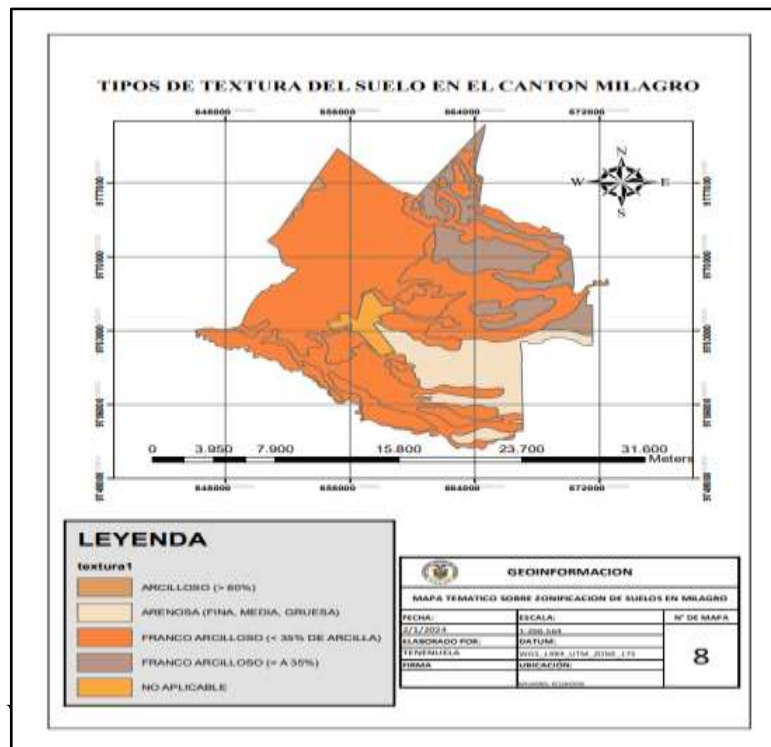

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Figure20. Soil texture map in Milagro

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Figure211. Crop slope map in Milagro

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Figure222Thematic map of soil texture types in Milagro canton

Conclusions and Recommendations

Conclusions

The wide range of GIS applications demonstrates its value as a tool for strategic planning and development planning. As shown, geographic information systems can improve the quality and efficiency of soil type analysis for the crops under study, that is, by creating thematic maps we can get a clearer picture of the main soils present in the Milagro area for banana cultivation, among which are clayey, sandy, and sandy loam with different percentages.

The main advantage of these automated systems is the ability to perform repetitive spatial calculations. Therefore, before deciding to purchase a GIS, planners should determine which planning activities can be supported by this system and carefully assess whether the amount of spatial calculations and analysis to be performed is adequate in automatic mode.

Recommendations

1.- Be at the forefront of all the different forms of applications that GIS has.

2.- Learn to use ArcGIS to facilitate the creation of thematic maps.

3.- Concatenate the ease that thematic maps provide to identify the types of soil, planimetry, and edaphoclimatic conditions that are needed to have information on the crop to be implemented.

4.- Always collect data correctly so that it can be captured on maps.

Literature

1. Alarcón, F. (2021). GIS model for agroecological zoning of crops: case study of the Las Ceibas River basin (Undergraduate thesis). Manizales University. Huila, Colombia. Retrieved from https://ridum.umanizales.edu.co/handle/20.500.12746/5746

2. Andrade, F., Maizares, P., Varas, A., & Vargas, M. (2022). Thematic map preparation. Obtained fromhttps://es.scribd.com/document/648288089/Informe-Mapa-tematico

3. Calderón, A., Lara, D., and Cabrera, A. (2012). Preparation of thematic maps to evaluate soil fertility in agricultural areas of the National Institute of Agricultural Sciences. Tropical Crops, 33(1), 11-18.

4. Campaign, S. (2019). Types of soils in Ecuador. Obtained from https://es.scribd.com/document/311163645/Tipos-de-Suelos-en-El-Ecuador

5. Carvalho, C., Amorim, S., and Albuquerque, F., de Pádua, P., and de Barros França-Neto, J. (2019). Agro climatic zoning of the Brazilian state of Mato Grosso for the production of soybean seeds of early cultivars1. Journal of Seed Science, 41(2),205-2012. Retrieved from https://ainfo.cnptia.embrapa.br/digital/bitstream/item/199661/1/aNeres.pdf

6. CEDEC, (2019). Thematic maps. Obtained fromfile:///C:/Users/User/Downloads/cedec-documento-mapas-tematicos-cuentame.pdf

7. De la Cruz, A. (2018). Thematic map to evaluate soil fertility in the cultivation of eet-95 cocoa on the farm "San Ramón" (Undergraduate thesis). Equinoccial Technological University. Quito, Ecuador.http://192.188.51.77/bitstream/123456789/20050/1/9839_1.Xavier%20de%20la%20Cruz.pdf

8. Fallas, J. (2019). Basic concepts of cartography. Retrieved from:https://pim.udelar.edu.uy/portal/wp-content/uploads/sites/14/2019/07/CONCEPTOS-B%C3%81SICOS-DE-CARTOGRAF%C3%8DA.pdf

9. Gonzabay, R. (2017). Banana cultivation in Ecuador. Afese Magazine, 58(58), 12-13.

10. Hernández, z., Morales, Y., and Morales, H. (2018). Using thematic maps to boost agricultural marketing. Journal of innovative engineering; 2(5), 35-40.

11. Humacata, L. (2017). Development of thematic cartography of land uses with Geographic Information Technologies. Northern Winds

12. Lois, C. (2015). The map, the maps. Methodological proposals to address the plurality and instability of the cartographic image. Geograficando, 11(1).

13. López, C. (2020). Introduction to thematic cartography. Retrieved from:http://redgeomatica.rediris.es/carto2/pdf/pdfT/tema1t.pdf

14. MAG, (2016). Soil order map report. Obtained from MINISTRY OF AGRICULTURE AND LIVESTOCK:http://metadatos.sigtierras.gob.ec/pdf/MEMORIA_MAPA_DE_ORDENES_DE_SUELOS_MAG_SIGTIERRAS.pdf

15. Malagón, E. (2015). Cartography as a text and tool for modelling the world. Astrolabio, (15), 151-173.

16. *Medina, L. (2018). Implementation of a plantain (Musa paradisiaca) crop*

17. *Based on the development of a technical agronomic management plan in the municipality of Puerto Asís Putumayo*(Undergraduate thesis). Lasalle University. Putamayo, Colombia. Retrieved from https://ciencia.lasalle.edu.co/ingenieria_agronomica/91/

18. Ortega, M., Noroña, J., and Noroña C. (2019). Situational diagnosis of small organic banana producers in the Oro province towards the European market. Espirales Multidisciplinary Research Journal, 3(25), 59-71.https://doi.org/10.31876/re.v3i25.440

19. *Palma, J. (2019).* Geographic information system (GIS) and multicriteria evaluation methodologies (MCE) as a search for alternative scenarios for the socio-spatial improvement of the popular urban areas of the city of Comayagu. Obtained from: https://datospdf.com/download/sistemas-de-informaciongeografica-sig-y-metodologias-de-evaluacion-multicriterio-mce-en-la-busquedade-es-cenarios-alternativo-s-para-el-mejoramiento-socioespacial-de-las-areasurbanas-populares-de-la-ciudad-de-comayagua-honduras-_5a4b89c7b7d7bcb74fb86784_pdf>.

20. Producer, (2018). Banana crop management. Obtained from https://elproductor.com/2018/04/manejo-del-cultivo-de-platano/

21. Ramírez, K. (2019). Generation of banana waste and its possible use to support food security (undergraduate thesis), Autonomous University of the State of Morelos. Morelos, Mexico. Retrieved from: http://www.riaa.uaem.mx/xmlui/bitstream/handle/20.500.12055/2194/KARASE01T.pdf?sequence=1&isAllowed=y

22. Rivera, R. (2019). Physical characteristics, geographical location and quality of agricultural soil in the provinces of the Ecuadorian coast (undergraduate thesis). Technical University of Machala. Machala, Ecuador. Retrieved from http://repositorio.utmachala.edu.ec/bitstream/48000/13939/1/ECUACS-2019-ESS-DE00001.pdf

23. Suárez E., and Rubiano, A. (2019). Generation of thematic and geographic cartography for the study of environmental impact in the road construction of the Villagarzón-Putumayo perimeter road (undergraduate thesis).Francisco Osé District University of Caldas. Bogota, Colombia. Obtained fromhttps://repository.udistrital.edu.co/bitstream/handle/11349/13091/Su%E1rezOt%E1lvaroFabi;jsessionid=186A638B5130F7AEEB05461C3622D44C?sequence=1

24. SIPSA, (2017). Banana cultivation, an important food for the world. Obtained from file:///C:/Users/User/Downloads/insumos_factores_de_produccion_abr_2014.pdf

25. Soto, S. (2016). Design of a methodology for the identification and mapping of landscape units at different scales. Application to the case of Puerto Rico (Undergraduate thesis). Girona University. Puerto Rico, Puerto Rico. Retrieved fromhttps://www.tdx.cat/bitstream/handle/10803/392165/tssb1de1.pdf?sequence=5

26. Zambrano C. (2021). Introduction to thematic cartography. Retrieved from file:///C:/Users/User/Downloads/tema1t%20(2).pdf