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Geomatic Tools in Agricultural Management †

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Abstract: Agricultural management guarantees food security and economic development in various countries by applying new technologies to improve management practices. This study aims to identify the geomatic tools and their relationship with the agricultural activities used in cartography by reviewing scientific publications that contribute to improving agricultural management practices. The methodology consists of (i) a data source search strategy related to geomatics and agricultural management; (ii) data analysis; and (iii) a literary review of the contribution of geomatics in agricultural management. The results show that a large part of the studies orients to agricultural cartography and a smaller number to the use and cover of land (LULC) by agricultural activity, cadastre and precision agriculture. The studies focus on improving agricultural management practices to contribute to food security and combat the impacts of climate change (Sustainable Development Goals (SDGs) 2, 12 and 13).

Keywords: cadastre; cartography; geomatics; review; sustainability

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1. Introduction

Agriculture plays a strategic role in the availability and contribution of food needs in the face of the growing demand of the world population [1]. This demand requires substantial improvements in the agricultural system and farmers' activities for efficient farming management [2]. Agricultural management allows the control of processes, agricultural practices, and food security and involves the optimization of crops and resource allocation [3]. In addition, it uses strategies such as sustainable soil management, irrigation, fertilizers, pests and geospatial information tools such as remote sensing (RS) for sustainable agriculture and environmental protection [4].

Different geomatic tools, such as geographic information systems (GIS), are used in agricultural management, which analyze large amounts of spatial data on various topics [5,6]. For example, with other technological tools, GIS analyses the space–time of land use and land cover by agricultural activity [7]. In addition, it produces agricultural cadastral maps for decision-making related to land management [8]. Furthermore, the technology offers geomatic tools through RS and global positioning systems (GPS) for geopositioning, mapping and spatial data management applications [9,10].

Agricultural cartography contributes to the mapping of crops based on classification methods considering the distribution of plots, numbers of crops and cadastre applications [11]. An agricultural cadastre is a tool that responds to agrarian management needs (e.g., plot boundaries analysis) [12]. It needs information regarding the farmer, area, type of crop and number of plots, providing cadastral maps of crops and cadastral limits [13].

In addition, it uses records and property rights, land use, cultivation, restrictions and responsibilities of farmers that depend on the administration and legal system of the countries [14].

The study raises the research question: how do geomatic tools contribute to agricultural management activities?

This study identifies the geomatic tools and their relationship with the agricultural activities used in cartography through a review of scientific publications that contribute to improving agricultural management practices.

2. Methodology

Figure 1 shows the phases of the study: (i) data source search strategy related to geomatics and agricultural management; (ii) data analysis; and (iii) literature review of the contribution of geomatics in agricultural management.

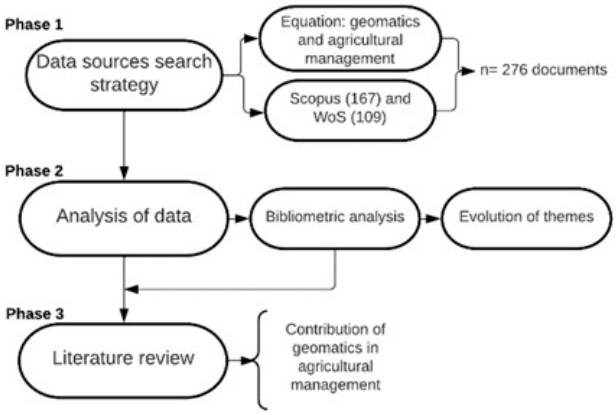

Figure 1. The methodological approach of the study.

2.1. Data Source Search Strategy Related to Geomatics and Agricultural Management

This phase carried out a bibliographic search in Scopus and Web of Science (WoS), indexed and completed scientific databases with impact indicators [15]. The search equation is TITLE-ABS-KEY (geomatic* AND (agricultural OR agriculture)). It was carried out in December 2022 and obtained 276 documents.

2.2. Analysis of Data

Data processing merged the databases (Scopus and WoS), cleaned the database through filters and conditional formatting, and used the Bibliometrix tool [16,17]. Data cleaning removed 86 duplicate and eight incomplete documents, leaving 182 papers for review. Subsequently, a bibliometric analysis was carried out that allowed the exploration of the evolution of themes with their respective periods in the field of study [18].

2.3. Literature Review of the Contribution of Geomatics in Agricultural Management

This phase analyzed the title and abstract of the 182 documents to determine a synthesis of the contribution of geomatics in agricultural management activities. Then, a narrative synthesis approach was applied to explain the results [19].

3. Results

3.1. Evolution of the Themes

This study highlights the time intervals: 1990–2017 and 2018–2022. Figure 2 shows the change in the terminology of some topics in time intervals: GIS is incorporated into the term geomatics, agriculture to land use and photogrammetry in precision agriculture.

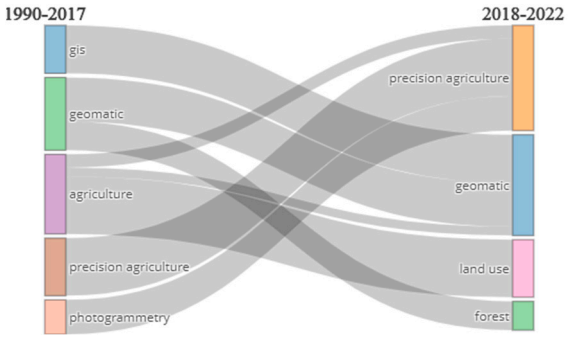

Figure 2. Evolution of themes (1990–2022).

3.2. Contribution of Geomatics in Agricultural Management Activities

Geomatics identifies and analyzes the geosystems involved in the agricultural cadastre, contributes to food production through arable land, land tenure security, increased livelihoods and efficient and sustainable management strategies for agricultural land for food security.

The relationship between geomatics and agricultural management activities improves yield, agricultural quality and production estimation. In addition, much agricultural management relates to mapping due to crop monitoring, the development of smart farming systems, pest management, fertilization and irrigation implementation (Figure 3).

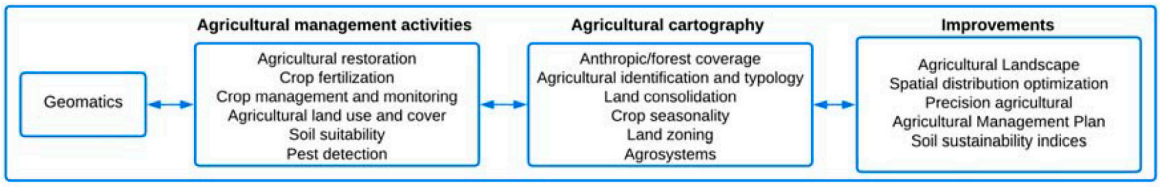

Figure 3. Geomatics–agriculture relationship.

Regarding sustainable agriculture, the application of geomatics in agriculture promotes sustainability improvements in agricultural management, such as the identification of areas of water scarcity to establish action plans with sustainable crop patterns, agricultural restoration, detection of pastures for livestock and agricultural projects that offer job opportunities and improve environmental conditions.

This study identified 60% of the scientific contribution on issues of agricultural cartography and 40% distributed on topics such as precision agriculture, agricultural LULC and agricultural cadastre.

4. Conclusions

The study found that geomatic tools are applied in agricultural management, such as identification, suitability, seasonality, edaphology, and monitoring of agricultural areas; registration and management of farming properties; and security of land tenure and land value and taxes, for innovative administration and crop management approaches. In addition, this review highlights the contribution of geomatics in the identification, mapping, monitoring, and agricultural management, contributing to decision-making associated with food security in the sectors. The most used geomatic tools in agricultural management activities are GIS, RS, and GPS, and they contribute to accurate thematic maps at plot scales.

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