Development of the technological system of creating an electronic map of agriculture using GIS technology

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Abstract. This article discusses the scientific and practical issues of developing a technological system for creating electronic agricultural maps as a result of field research and the design of thematic maps, as well as the analysis of creation methods. One of the critical issues is the widespread use of cartographic support methods in agricultural sector research and analysis. In this regard, including the study of agricultural, natural, and socioeconomic problems related to the development of the economy in the world's developed countries, agricultural electronic maps provide reliable information about the territory. The current cartographic tasks are given special consideration.

1 Introduction

Developing effective methods of data visualization and electronic mapping based on data collection, storage, analysis, processing, evaluation, and the creation of a geodatabase using modern geo-information systems and technologies. [1]. A great deal of emphasis is being placed on conducting targeted scientific research [2]. One of the most important tasks in this regard is the development of modern geo-information system technologies and cartographic provisioning methods for improving the method of creating electronic maps describing the agricultural sector while taking socioeconomic conditions into account [3,21-25].

The creation of thematic maps, as well as the creation of all types of topographic and general geographic maps, is carried out in two different ways: [4]

-creating a map by taking a large-scale topographic plan (photograph) directly in the field with the help of geodetic instruments;

-creating medium- and small-scale maps based on the processing and generalization of statistical data and cartographic sources in camera (laboratory conditions).

Digital maps in general, this is in the computer's memory a digital record of images (for example, cartographic, navigational, etc.) that are stored, automatically generated, and

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automatically solve various visual problems [5]. The standard of digital cartography is the coordinates and elevations in the projection adopted on the basis of the laws of cartographic generalization of the digital map describes the digital model of the earth's surface created in the systems [6]. Maps are also divided into different types according to their purpose. Sometimes maps are used for only one purpose [7]. Study maps are used only for educational purposes, and adapted to the curriculum of geography and history is made. There are many maps being created for different purposes. They may be intended for a wide [8]. Such maps can be more general geographic maps, and special agricultural maps [9].

The main structure for creating a vector map for Geographic information technologies (GIS) includes preparing the map, vectorizing it, identifying spatial objects, and connecting them to the attributive database, as well as necessary verification and editing [10]. The steps that are often distinguished in the complete technological cycle of vector map preparation are the identification of objects with vectorization and attributive database linking – in practice each can occupy from 20 to 50 percent (usually together occupying at most 80 percent of the entire technological cycle). Proportionately it is saving time at the expense of speeding up work in stages is extremely important [11–16]. In addition, for most traditional cards, the process of digitizing them often involves interpretation of the original card material, since traditional cards were not designed to be digitized and are generally used in GIS [2]. Interpretation occurs in cases where objects marked with conventional symbols, objects with conventional symbols, or inscriptions are numbered. Also, interpretation is necessary in cases where the boundaries of polygonal objects are not clearly indicated on the initial map, and the objects are incorrectly located on the initial map from the point of view of common sense (quarters that fall into the river, the road that passes by the edge of the lake, etc.) [14]. As the scale of the starting card increases, the number of situations requiring such an interpretation tends to decrease, but the cost of understanding such situations tends to be time-consuming. Sometimes such an interpretation of numbering is not possible at all technologies are used – everything is numbered as it is on the initial card, or when certain decisions are entirely within the authority of the operator.

2 Materials and methods

At the final stage of the above processes, the content and description methods of the thematic layers of our electronic map are determined. In this, tabular, attributive data pertaining to the depicted object and in what layers this data is to be depicted, i.e., field, dot, or linear, are defined. ArcGIS software was used to create thematic layers for the agro-geodatabase and agricultural electronic map, which includes information about natural conditions, agricultural networks, infrastructure facilities, and agricultural land resources in the research area. ArcCatalog application was used. The data collected during the field research was prepared in the form of a spreadsheet in Microsoft Excel. The main reason for this is to allow you to save the spreadsheet you created in the program in CSV (comma-separated values) format. Downloading a file in this format using Global Mapper 18 and exporting a shp (.shp) file that can be imported into most GIS family software, including ArcGIS, is possible. It is critical that this software (Global Mapper 18.2) can import and export files in over 100 different formats. Furthermore, the software allows the data collected in GPS receivers (coordinates, name, and all object properties) to be downloaded directly to the ArcGIS program.

3 Results and discussion

When developing a map program, the territorial characteristics of the events depicted on the map and the sources of mapping should be known in advance, that is, the geographical study of the objects to be mapped and the process of collecting resources should be organized before creating the program. The map program allows you to define the tasks and details of the geographical study and to have an idea about the necessary resources. As a result of determining the purpose of the map, getting to know the selected sources and geographical features of the area being mapped, as well as the experience of creating maps created on this topic, allows creating a program of the initial map as its main laws.

The introductory part of the program begins with defining tasks for creating a thematic map. In addition to clearly formulating the name of the map and its purpose in the tasks, it is important to explain the scope of the map users, the function of the map, the nature of the tasks intended for the development of the map, and the conditions of its use. In addition, during the process of creating a map, the results of previous work on collecting resources serve as a basis for developing the mathematical elements of the map and its content. In the next stages, the selected scale and projection for the map are based, the boundaries of the area to be mapped are determined. At the next stage of the program created for the content of the map, content elements, their classifications, methods of representation and graphic symbols, organic connections, and principles of generalization, and accuracy standards are defined.

These sections form the map program, including the general concept of the map, its methodological guidelines, content, and form. The program should include clear instructions on how to follow the rules and guidelines for creating a map, in simple terms, how to create a map and what technology to use. This part of the program is important for teamwork in the design and implementation of mapping by various specialists in cartographic production. The program of the map is completed with the following technological section: methods and procedures for creating original copies of maps, preparation, and manual for map printing, editing, correction, and publication processes (Figure 1).

The map program's technological component demonstrates the use of new technological tools that can be used to create maps and atlases, such as a computer, various software, and other new equipment. The following stages were completed during the course of this research: preparation for creating an electronic agricultural map, field research, and mapping.

When creating an electronic map of agriculture, the initial data collected and analyzed will be the study of the quality and quantity indicators of the existing general agriculture in the area being mapped, as well as the analysis of previously created cartographic works. As a result, agricultural electronic map thematic (content element) layers will be created. In this process, new content elements (layers) are added to the existing thematic layers for the purpose of analyzing the qualitative and quantitative indicators of agricultural objects, statistical data, and their geographical distribution, evaluating, and forecasting for the future.

There are several methods for selecting the mathematical basis of the map. The selection of cartographic projection and other mathematical basis elements begins with an examination of previously created analytical maps and their mathematical basis. The projection recommended in atlases is then examined in order to select a cartographic projection in the following stages [1].
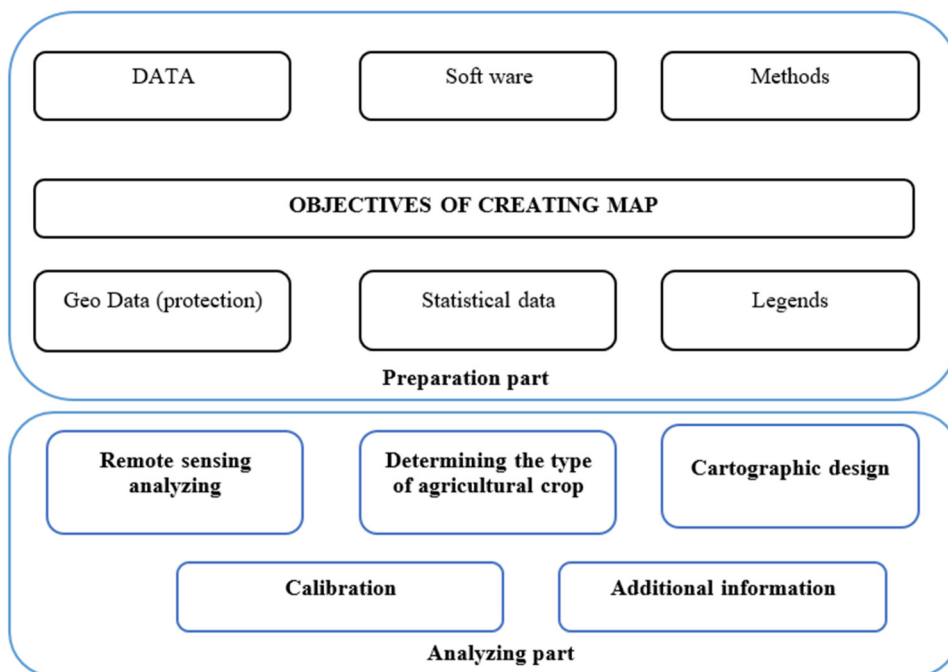
Fig 1. Process of creating agricultural maps (Suggested by the author).

It is recommended that educational manuals, recommendations, and manuals related to mathematical cartography be used during this process. During the research, electronic maps, "SAS. Orthophoto planes and remote sensing data were used on a scale of 1:25000 in the nomenclature section using the "Planeta" program. There are numerous types of GIS software available for creating digital and electronic maps. (Global Mapper, ArcGIS, Panorama, MapInfo, Surfer, etc.). The agricultural electronic map was created using ESRI's ArcGIS software. Following the completion of the data entry process, field research observations are conducted in terms of the regional distribution of qualitative and quantitative indicators of the development of all types of agricultural industries, as well as the determination of the geographical location of their objects. This process primarily entails locating agricultural infrastructure facilities in the area using GPS (global positioning system) receivers and uploading them to an electronic map. During the field research, the geographic location of agricultural infrastructure facilities, such as maintenance and gas stations, was determined and mapped using a Trimble Juno 3 GPS device. An additional database was created during this process based on the characteristics of each object. These data are generated using a previously prepared record and additional information gathered at the research site. (Table 1).

Table 1. Attributive information in agricultural maps (Suggested by the author).

Object	Name	GeoDATA (coordination)	Address	Service	Info
Agricultural infrastructure	Gulistan gas station	69°43' 42°35'	Bukhara region Olot district	Oil and gas station	Tel: 8-365-34-2100

4 Conclusions

During the research, data collection and sorting were carried out on the basis of geo-information systems and technologies, and a geodatabase was designed. The process of designing the GIS geodatabase includes the process of organizing geographic information in the thematic data group, thematic layers that contain information on location. In general, the design of a geodatabase begins with the determination of the data on which topic to use. The system of conventional symbols of the agricultural electronic map will be developed in the fifth stage. The conditional sign system's composition is divided into two types. The natural and geographical objects of the area being mapped were developed in the first round using the ArcGIS program's library of conditional symbols, as well as standard symbols and thematic elements on 1:10 000 scale maps, including the process of creating an electronic agricultural map, uploading all thematic layers of the map to the ArcGIS program, and equipping common design elements.

As previously stated, a map of measurement of all types of agricultural crops for the harvest of irrigated croplands in the massif was taken as a basis for the electronic map of agriculture. When working on map design, we must pay attention to two major processes: combining design elements and map design processes. Before a single line is drawn, decisions about how to include information on the map, exposure, scale, and callout type are made. It is central to the map-making process. The technology for creating an electronic map of agriculture will be formed if the preceding stages are summarized and systematized. A technological system for creating an electronic agricultural map of the area being mapped is created based on the sequence of steps presented in this technology.

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