Methodology development for creating agricultural interactive maps

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Abstract. The mapping of agricultural land worldwide is exceptionally important since these maps provide a robust foundation in regards to the open spatial database of agriculture. Mapping processes usually and initially take part in interactive creation maps of agricultural sectors. As a result, this enables agricultural experts and specialists to undertake interactive management and monitoring of all agricultural sectors. This study was carried out in the Bukhara region of Uzbekistan. The potential and most appropriate technology of creating an interactive map of agricultural sectors of the study area was developed using ArcGIS, MapInfo, and Global Mapper software, appertain to the family of up-to-the-date GIS technologies. This software was used in the creation of agricultural spatial data and thematic layers. The created thematic layer and database were integrated into the Java applet, thus a user working window was developed and an interactive agricultural map of Bukhara province of Uzbekistan was created. The interactive map can visualize and illustrate all branches of agricultural sections as separate thematic layers and statistic diagrams.

1. Introduction

The interaction from a cartographic perspective is defined as a dialogue between computer and moveable maps and this critical issue for researching geo-visualization and geo-visual analytics [1]. An interactive map is an electronic map that operates in a two-way dialogue mode between the user and the computer and depicts a visual data system. It should be noted that today the level of awareness on interactive maps is expanding [2, 3]. Interactive maps store information in a hidden state, and when the user performs certain actions on the map, information about the object or area appears [4].

The current high level of open data and online mapping software are opening up new possibilities for interactive mapping in agricultural applications. Simultaneously there are facilities to develop highly interactive platforms with exploratory and analytical tools [5]. The advanced level of interactivity of maps means a requirement of the ability to design maps under the support of spatial thinking, data analysis and decision making [6]. Interactive map creating have been classified as dynamic via link-based [7], changing cartographic methods another one based on phenomena [8], using different interactive functionality [9].

Based on architecture, interactive maps are divided into the following types [10]:

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- non-interactive software-related;
- software-interactive;
- software-independent interactive.

Software-related non-interactive electronic cards include maps created with graphics elements, including those created in CorelDRAW, Adobe Illustrator, and Macromedia Freehand software [11]. To use these maps, the user must have a computer running the operating system and software that can be used to create this map or read its format [12].

Software-dependent interactive electronic maps are created using ArcGIS, MapInfo, GlobalMapper, and other cartographic software, which mainly belong to the GIS family. As a result, the map itself describes the files (or multiple files). To work with these maps, the user's computer must be equipped with the operating system and the software used to create the maps [13].

Software-independent interactive electronic maps are made using special software, i.e. Curious, MapGPS, Gisware, World Maps, Java and others. To work with these maps, it is enough to have only the operating system on the user's computer [14].

Nowadays, to create interactive maps different types of coding applets and tools have been used. With an increasing number of simple and complicated mapping applets and the possibility of digital maps, thematic cartography can entirely utilize the potential of the web to communicate spatial information to a large audience. The use of the Java applet model ensures usability and accessibility for a broad audience [15]. Different Java applets have been developed for the support of analysis of different types of spatially linked information (Figure 1).

![Figure 1. An overview of the functionality of the Java applet](image)

Most Java-based interactive maps are created in different applications. However, according to literature reviews and surveying's it was rarely used in the case of mapping agriculture.

2. Materials and methods

2.1 Study area

The object of this research is the objects of the agricultural system, industries and infrastructure of Bukhara province of the Republic of Uzbekistan. The province is located in the lower reaches of the Zarafshan River, in an oasis 39°43’ north latitude and 64°38” east longitude, which has long been suitable for agriculture. In terms of area, it ranks second with the area of other provinces of the country, with 40,220 km². Agriculture plays an important role in the social, employment and economy of Bukhara province. The province's agriculture is divided into two main sectors: agriculture and animal husbandry. Considering that the majority of the population is engaged in agriculture, it can be seen that this sector is widely developed in the province. The climate is sharply continental: summers are hot, long, and dry, the average temperature in July is 28-32°C, and in the sands, it rises to 60-70 °C. The average January temperature drops from 0° to -2°C with 90-150 mm of precipitation per year. It rains mainly in spring and winter. The vegetation period is about 220 days.

2.2. Research methodology

Based on the analysis of the features of the existing interactive maps and the analytical research on their creation, the goal is to create an interactive map of Bukhara province named "Bukhara_AGRO". In creating these maps, the aim was to develop the technology, capabilities and technological scheme
of the elements of equipment to create an interactive map of agriculture "Bukhara_AGRO" by studying the capabilities of GIS and programming platforms.

To create an interactive map JavaFX platform was used for the Java programming language. This programming platform differs from other software platforms by its ability to perform direct integration with web pages, mobile devices and internet applications (Figure 2).

Figure 2. Creating a user interface in the Java programming language (a - user view. b - interface program code)

The program was created in the language of the Java platform for creating computer software. The main stages of program creation are as follows:

• create a user interface section
• programming an interactive map component
• the process of preparation and preparation for testing
• software product testing and delivery.

The technological stages of creating an interactive map of agricultural sectors of Bukhara province by Java platform were developed (Figure 3).

The general features and equipment of the creating interactive map are divided into four parts. The first part involves the process of entering data on the map. In this case, the web map data with the extension. "kml" is loaded as the input data to the program, the java library is used to display in the program. Additional libraries are called in to create data upload and storage capabilities from Excel. Once the data is loaded, using .kml files, the area coordinates are obtained, polygons are created, and the area is displayed in a window.

The data was also displayed in "circular", "linear", "columnar" and "spherical" views. When entering data, it is possible to download a file (.xlsx) created using Microsoft Office Excel software, which belongs to the Microsoft Office Suite, and visualizes the data belonging to the GIS family or available on web cards (.xlsx). The second part selects the administrative units of the existing district territories on the map in terms of the administrative division of the territory. Agricultural quality and quantity indicators for selected provinces will be included. The next part, i.e. the third part, covers the equipping processes (animation process, drawing, editing data, linking to other types of maps, printing, etc.) related to the information to be included in the interactive map.
Figure 3. Workflow of methodology for creating "Bukhara_AGRO" interactive agricultural map

In the fourth section, the edited data are linked by geographic location, and the quality and quantity indicators are described by five different visual means (Fig. 4).

Figure 4. General features of interactive maps "Bukhara_AGRO" and technological scheme
3. Results
Based on research methodology the interactive agricultural map of Bukhara region Bukhara_AGRO" was developed (Figures 5-7).

Figure 5. Data content of the interactive map

Figure 6. Visualizing distribution of each district on an agricultural section of Bukhara province by Choropleth mapping method.

Figure 7. The appearance of agricultural statistical data on Bukhara_AGRO interactive map.
4. Conclusion

The main advantages of the created interactive maps over other types of maps are as follows:

• there is no need for a system of symbols on the map due to the ability to effectively visualize large amounts of data belonging to the map area;
• ability to interact with electronic maps created by software belonging to the GIS family and web maps in the internet system;
• there is no need for special GIS family software and internet system due to the ability to work on other types of modern computer devices.

The methods and technologies developed for the creation of these types of interactive agricultural maps will be the basis for the creation of thematic maps for other provinces.

Interactive agricultural maps were created based on field surveys, geodetic measurements, data obtained by the state organization in the field, statistics and other additional, auxiliary sources, in the assessment and forecasting of the economic performance of agricultural sectors, as well as foreign investment in the province.

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