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THEORETICAL AND PRACTICAL ISSUES OF CREATING A MAP OF THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

Annotation: GIS technologies are convenient for collecting spatial data, providing in detail a way to control, analyze and demonstrate them. GIS maps have become an important tool for making optimal decisions in a variety of areas, including urban planning, environmental management, and disaster response. This article presents important methodologies in the creation of the GIS map. The article will also discuss the various GIS programs and their features that are currently available when creating maps.

Keywords: GIS, map, spatial analysis, GPS, spatial data.

Introduction: GIS technology enables meaningful analysis and visualization of complex spatial data. This article provides a comprehensive overview of GIS mapping, an important tool for spatial analysis and optimal decision-making. Also, during the research, scientific works of a number of scientists on creating GIS maps were analyzed. According to him, in the scientific article "Cartography of Geographic Information System (GIS) for Environmental Assessment in Pekalongan Regency, Indonesia" the issues of environmental mapping in the Pekalongang region of Indonesia using GIS technologies were studied. The authors of this article emphasize the advantage of GIS technologies in creating thematic maps, which allow the authors to identify and study the changes occurring in the environment, as well as to identify its weak and needing special attention. The article discusses various GIS technologies used in research, including data collection and processing, spatial

analysis, and mapping. The authors also emphasize the importance of considering social and economic factors when developing environmental assessment strategies using GIS [1].

Methodology. Based on GIS technologies, the correct interpretation of data and the creation of a visual map for users is carried out in several stages. There are various sources of data collection, including satellite imagery, aerial photography, GPS data, and government statistical databases. The choice of data source depends on the purpose of the map and the availability of data. After receiving the data, it is necessary to carry out pre-processing steps such as geocoding, cartographic projection and data sorting. Satellite images are important for real-time data analysis, identifying changes and proposing specific solutions [2]. Accurately reading spatial imagery and understanding data from geospatial images requires considerable knowledge and skills. To understand the environment, to collect data, several countries now have their own satellites. Of course, data analysis depends on the level of accuracy of spatial images. Below, we can get more detailed information about the Landsat spacecraft and its images of the Landsat mission, which transmits open satellite images (Figure 1).

Figure 1. Landsat 1 satellite

The Landsat satellite was first launched for the USGS (United States Geological Survey) in 1972 by NASA at Vandenberg Air Force Base in California. Data collection can be done through aerial photographs taken from unmanned aerial vehicles (UUVs or drones) to obtain high-resolution data for a smaller area. Through this, it is convenient for us to create orthophotoplan, relief maps, 3D model and operational maps [4] (Fig. 2). Data collection via GPS is carried out directly in the field. Data acquisition Various geodetic instruments are collected by receivers of waves from satellites based on location (Figure

3).

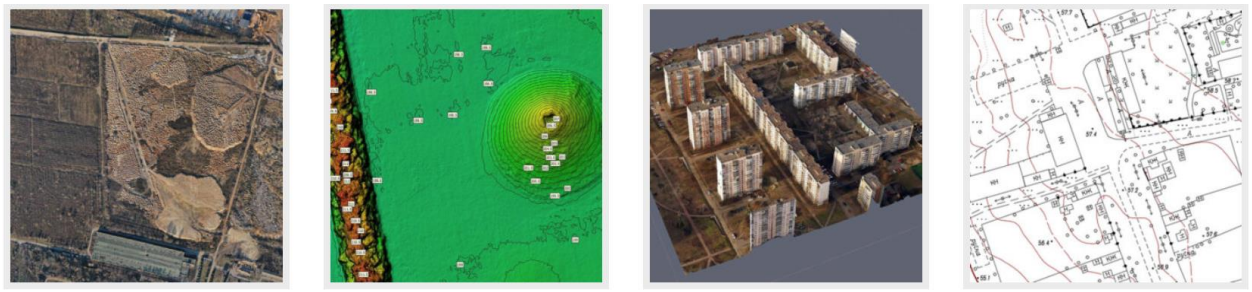

Figure 2. Aerial images taken by drones. Source: https://aerophoto.com.ua/uslugi-s-pomoshhyu-dronov/aerogeodeziya-i-kartografiya-s-pomoshhyu-dronov/#ortho

Before using the satellite images, it is necessary to perform some pre-processing steps. The items used in the study were placed in layers and included the study area. Then, the digital numbers (DN) of the 10 bands were converted to top of atmosphere reflectance (ToA) using Equation (1), and the DNs of the OLI bands needed for the indices were converted to ToA reflectance using Equation (2,3). These conversion formulas can be obtained from the Landsat 8 manual [2].

Figure 3. GPS receivers. Source: https://geo-teo.ru/stati/gps-priyomnik-geodezicheskij/ va https://www.trimble.com/en/solutions/technologies/positioning

$$L_\lambda = M_L\, Q_{cal} + A_L \quad (1)$$

here:

L_λ= Spectral radiation. Watts/(m2*srad*μm)

M_L = The multiplicative scaling factor of the radiation for the network (from metadata RADIANCE_MULT_BAND_n).

A_L = The radiation additive scaling factor for the network (from metadata RADIANCE_ADD_BAND_n).

Q_{cal} = Level 1 pixel value in DN.

$$p'_\lambda = \frac{M_p Q_{cal} + A_p}{\sin(\theta_{SE})} \quad (2)$$

here:

p'_λ = TOA planetary spectral reflectance, without corrections for sun angle. (Without unity).

M_p = Reflectance multiplicative scaling factor for the network (from metadata REFLECTANCEW_MULT_BAND_n).

A_p = Additional scaling factor that reflects for the ribbon (from metadata REFLECTANCE_ADD_BAND_N).

Q_{cal} = Level 1 pixel value in DN.

Note that TOA Reflectance is invalid because it does not include a correction for solar elevation angle. This correction factor was left out of scale 1 at the request of users. Once the solar elevation angle is selected, the transition to the actual TOA Reflectance is [2]:

$$p_\lambda = \frac{p'_\lambda}{\cos(\theta_{SZ})} = \frac{p'_\lambda}{\sin(\theta_{SE})} \quad (3)$$

here:

p_λ = TOA planetary reflectivity.

θ_{SE} = Local solar elevation angle; the solar elevation angle of the scene center in degrees is given in the metadata.

θ_{SZ} = Local solar zenith angle; θSZ=90° - θ SE

The formulas of Landsat 8 data indices are given in Table 2 [7].

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Normalized Difference Vegetation Index	$NDVI = \frac{NIR - RED}{NIR + RED}$
Relative Vegetation Index	$RVI = \frac{NIR}{RED}$
Infrared Percentage Vegetation Index	$IPVI = \frac{NIR}{NIR + RED} = \frac{NDVI + 1}{2}$
Difference Vegetation Index	$DVI = NIR - RED$

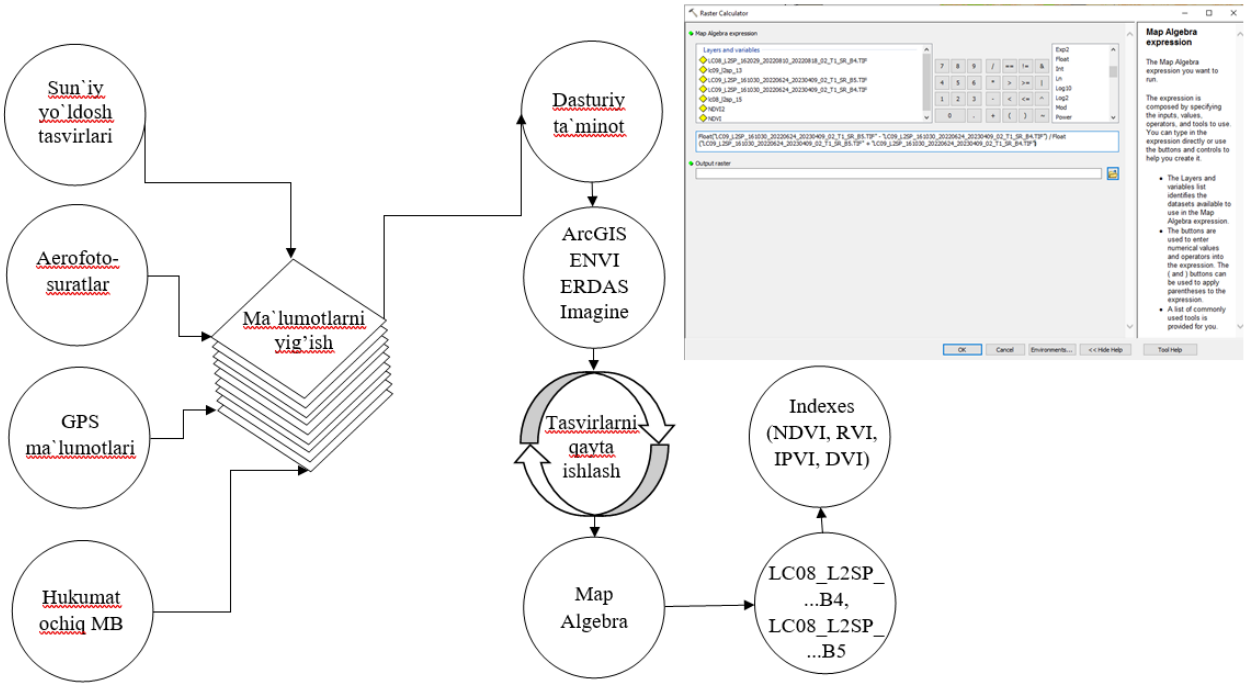

Figure 6. Scheme of map development

Results and discussion. This paper examines some of the main problems encountered in the creation of GIS maps and proposes solutions to solve these problems [7].

One of the most important factors in creating accurate GIS maps is data quality. The quality of the data used to create GIS maps can significantly affect the accuracy and reliability of the resulting maps. Data used to create GIS maps should be checked to ensure data quality. This can be done by checking the quality of the data, cross-referencing the data with other sources, and verifying the data with fieldwork (Figure 4). In the article, to ensure accuracy, it is necessary to use high-quality data, ensure data compatibility, and select an appropriate scale. It is also important to confirm the accuracy of the obtained

maps by comparing them with real data on the ground [9,10]. Overall, the article provides valuable insights into the challenges that arise in creating GIS maps and suggests solutions to overcome these challenges.

The solutions proposed in the paper help provide accurate and reliable GIS maps that can be used for effective spatial data analysis and decision making. At the same time, it was possible to provide more specific examples of the practical application of the solutions proposed to solve the issues discussed in the article. Future research could investigate the effectiveness of these solutions in real-world scenarios.

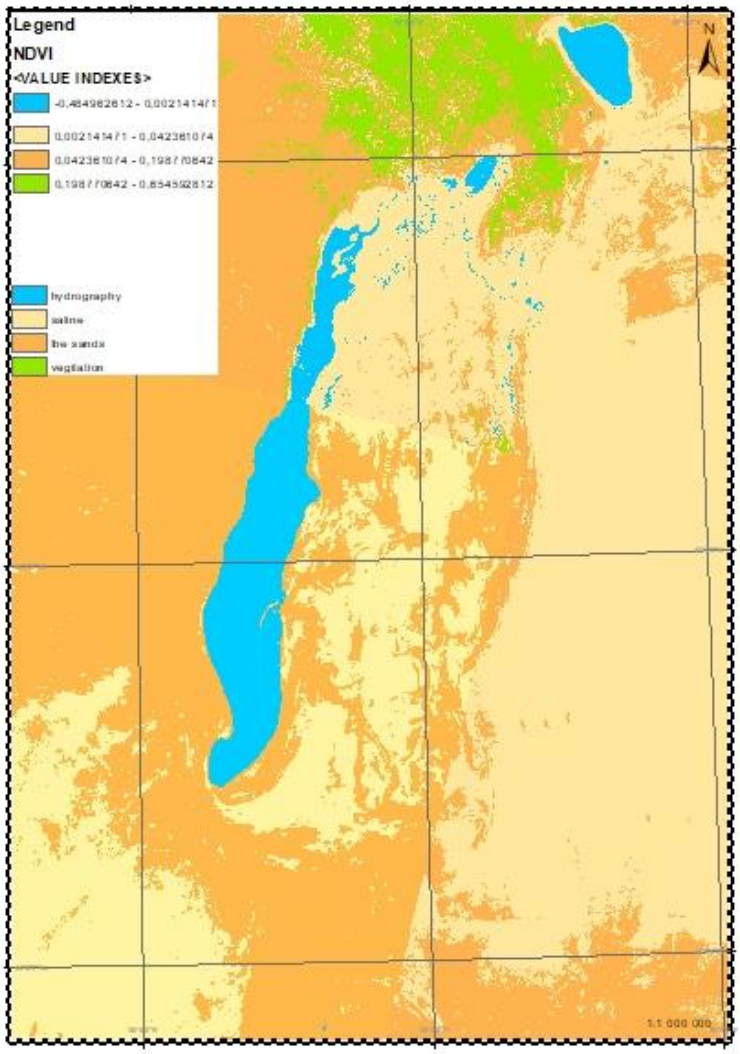

Figure 4. GIS map by the authors

Conclusion: In conclusion, the creation of accurate GIS maps is essential for effective spatial data analysis and decision making. This article has discussed

some of the main issues that arise when creating GIS maps and suggested solutions to address these issues.

Ensuring accuracy and reliability in GIS maps requires the use of high-quality data, data validation, and data consistency. By implementing the proposed solutions, accurate and reliable GIS maps can be created that can be used for effective spatial data analysis and decision making.

In addition, the use of emerging technologies such as artificial intelligence to further improve GIS mapping can be explored. In general, GIS mapping is an ongoing process that requires continuous improvement and adaptation to meet the evolving needs of different industries and sectors.

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