THEORETICAL FOUNDATIONS OF LIVESTOCK MAPPING METHODS

Kuvondikov Rustam Abdurasul o‘g‘li
National University of Uzbekistan named after Mirzo Ulugbek

Abstract

This article examines the theoretical foundations of livestock mapping methods by analyzing the influence of natural and socio-economic factors, the spatial distribution of livestock sectors, and their developmental characteristics. It also discusses the scientific and methodological aspects of applying conventional cartographic techniques, Geographic Information Systems (GIS), and remote sensing data for the cartographic representation and spatial analysis of livestock production systems.

Keywords

livestock mapping; cartographic methods; Geographic Information Systems (GIS); remote sensing; spatial analysis; pasture resources.

Introduction. At present, the digitalization of agriculture, the rational use of natural resources, and the provision of food security are recognized as major global priorities. In this context, cartographic research has become increasingly important for assessing the spatial development of the livestock sector, analyzing the distribution of livestock resources, and supporting their scientific management. Livestock maps constitute an essential source of spatial information, providing a comprehensive representation of livestock populations, sectoral specialization, pasture and fodder resources, production infrastructure, and the spatial distribution of natural and socio-economic factors.

Although conventional cartographic methods have long served as the primary tools for the spatial analysis of livestock production, recent advances in Geographic Information Systems (GIS), remote sensing technologies, and digital cartography have

led to the emergence of new scientific and methodological approaches in livestock mapping. These technologies facilitate the integration of spatial and statistical data within a unified geospatial database, enable multi-criteria spatial analyses, and support the production of high-accuracy thematic maps for effective decision-making and sustainable livestock resource management.

In the Republic of Uzbekistan, the development of livestock maps using modern cartographic methods has become an important scientific and practical task in the context of ensuring the sustainable development of the livestock sector, improving the efficient use of pasture resources, and enhancing regional planning. In particular, the application of Geographic Information Systems (GIS) and remote sensing data plays a crucial role in identifying the spatial characteristics of livestock production, assessing available resources, and determining their future development prospects.

The principal cartographic features represented on livestock maps include livestock population, stocking density, sectoral composition, productivity, pasture resources, fodder base, and production infrastructure. From a theoretical perspective, the development of livestock maps is based on the concept of territorial systems. According to this concept, livestock production evolves as an integrated component of a territorial system that is closely associated with natural and geographical conditions, land resources, water availability, climatic conditions, demographic factors, and transportation infrastructure. Therefore, livestock maps should represent not only statistical indicators but also the spatial relationships among these influencing factors.

The scientific literature identifies several methodological approaches to livestock mapping. The first is the statistical-cartographic approach, which is based on the visualization of livestock numbers, production volume, productivity, and other indicators using choropleth maps, cartodiagrams, and dot-density mapping techniques. This approach has traditionally been widely employed in thematic cartography and

continues to be valuable for conducting comparative spatial analyses across different regions.

The second methodological approach is based on geosystem analysis. Within this framework, livestock production is examined as an integral territorial system in which natural resources, land cover, vegetation, water resources, and socio-economic infrastructure are considered as interconnected components. This approach enables a comprehensive assessment of the factors influencing livestock development and facilitates the construction of integrated cartographic models that reflect their spatial interactions.

Livestock production is one of the most important sectors of agriculture, playing a significant economic, social, and environmental role. In recent years, modern Geographic Information System (GIS) technologies have become essential tools for improving the efficiency of livestock management, promoting the sustainable use of resources, and minimizing environmental impacts. GIS enables accurate monitoring of livestock distribution, pasture conditions, climatic factors, and other key parameters. This capability supports scientifically based analysis, planning, and sustainable management of livestock production systems.

In the Republic of Uzbekistan, the application of Geographic Information Systems (GIS) and remote sensing (RS) technologies has expanded considerably in the digitalization of agriculture, land resource monitoring, and environmental assessment. These technologies provide advanced opportunities for spatial analysis and cartographic modeling not only in crop production but also in the livestock sector. Their integration facilitates the assessment of spatial patterns in livestock production, improves resource management, and enhances evidence-based decision-making for sustainable agricultural development.

Table 1

Methods for Mapping Livestock Resources in Uzbekistan

№	Mapping Method	Mapping Method	Mapping Method	Mapping Method
1	Remote Sensing (Satellite Imagery)	Wide spatial coverage, continuous monitoring, and cost-effective for large-scale assessments.	Reduced accuracy under cloudy weather conditions; difficulties in distinguishing certain land-cover and livestock-related features.	Remote sensing-based monitoring of pasture lands in Tashkent City and Tashkent Region (2022). Assessment of pasture biomass and grazing intensity in mountainous areas using the Normalized Difference Vegetation Index (NDVI).
2	GIS-Based Multi-Criteria Decision Analysis (MCDA/AHP)	Integrated spatial analysis, predictive modeling, and optimization of resource allocation.	Requires complex datasets, specialized software, and expert knowledge.	Development of electronic agricultural maps and agro-geospatial databases using GIS technologies in Tashkent Region. Hydrological analysis and mapping for livestock water reservoirs in the Chirchiq Valley using **ArcMap**.
3	Unmanned Aerial Vehicles (UAVs) and	Very high spatial resolution (centimeter	Limited spatial coverage, weather dependency, and	UAV-based monitoring of agricultural land in Tashkent Region, with applications adapted for pasture

	High-Resolution Aerial Photography	level), rapid data acquisition, and operational flexibility.	relatively high operational costs.	assessment and livestock grazing management.
4	GPS Tracking and Mobile Monitoring	Real-time monitoring, accurate positioning, and individual livestock tracking.	Primarily records animal movement; requires communication infrastructure and raises data security concerns.	GPS-based livestock monitoring systems (e.g., **e-Stado**) implemented on farms near Tashkent for monitoring animal health and location. Integration of GPS and GIS technologies within regional livestock monitoring projects in Tashkent Region.

The application of Geographic Information System (GIS) technologies in the territorial organization of livestock production, the assessment of pasture-use efficiency, and environmental monitoring requires the establishment of a scientifically grounded geospatial database. The effective implementation of these processes necessitates the development of appropriate scientific and methodological frameworks.

Methods for livestock mapping are based on the fundamental principles of thematic cartography and are designed to represent the spatial distribution, sectoral specialization, and level of development of livestock production systems. The data used for map compilation are obtained from official statistical agencies, agricultural institutions, remote sensing datasets, and Geographic Information System (GIS)

databases. Integrating data from multiple sources into a unified geospatial database significantly enhances the accuracy, reliability, and analytical value of livestock maps.

Table 2

Scientific and Methodological Framework for Livestock Mapping Based on GIS

Component	Content
Scientific Foundations	• Systems Approach • Remote Sensing Theory • Geoinformation Modeling Concept
Methodological Framework	• Research Methods • Remote Sensing Techniques • Statistical Analysis • Cartographic Modeling Methods • Field Observations
Data Sources	• Satellite Imagery • Aerial Photographs • GIS Databases • Field Survey Data
Scientific and Methodological Principles	• Systematic Approach • Comprehensiveness • Accuracy and Objectivity • Visualization

The methodological framework of this study is based on geospatial analysis, assessment of the fodder resource base using remote sensing data, and spatial modeling of livestock resources. During the research process, a GIS database is developed using Sentinel-2 and Landsat 8 satellite imagery, as well as statistical data obtained from the

State Committee of the Republic of Uzbekistan on Statistics. Indicators such as cattle and sheep density, pasture utilization intensity, and proximity to water resources are determined through spatial analysis, while their interrelationships are represented using cartographic modeling techniques. ArcGIS Pro, QGIS, and Google Earth are employed as the primary analytical and mapping tools. The study provides a foundation for developing practical recommendations aimed at the territorial assessment and environmentally sustainable development of the livestock sector.

Conclusion. The results of the study indicate that the theoretical foundations of livestock mapping methods rely not only on traditional cartographic approaches but also on the application of Geographic Information Systems (GIS) and remote sensing technologies. This integrated approach enables the accurate assessment of the spatial distribution and specialization of livestock production, livestock density patterns, and the condition of pasture resources.

Analyses conducted in the case of Tashkent Region revealed that the territorial development of livestock production is closely associated with natural-geographical conditions, fodder resources, water availability, and existing infrastructure. The integration of statistical data, remote sensing imagery, and cartographic information within a GIS environment made it possible to comprehensively evaluate the spatial characteristics of livestock production and to develop thematic maps reflecting its territorial patterns and development dynamics.

References.

1. Safarov E.Y., Egamberdiyev A., Musayev M.I. Kartashunoslik. – Toshkent: 2024y. 101-b.

2. Mirzaliev T., Musayev I., Safarov E. Ijtimoiy-iqtisodiy kartografiya. – Toshkent, 2010.

3. Safarov E., Prenov Sh., Mo‘minov A. Topografiya va kartografiya. GAT texnologiyalari. – Toshkent: Sano-Standart, 2018.

4. Avchiyev Sh. K. Topografiya va kartografiya asoslari. – Toshkent: Voris-Nashriyot, 2010.

5. Асамов М., Мирзалиев Т. Основы топографии и картографии. – Ташкент: Ўқитувчи, 1987.

6. Берлянт А. М. Картоведение. – Москва: Аспект Пресс, 2003.

7. Берлянт А. М. Геоинформационное картографирование. – Москва: Астрея, 1997.