International Cartographic Association
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GIS Applications for Military Logistics Planning: Study from Czechia

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Keywords: geospatial analysis, multi-criteria decision-making, military logistics, web cartography

Abstract:

Geographic Information Systems (GIS) have become an essential component of modern military operations due to their ability to integrate, analyse, and visualise spatial data across a broad spectrum of defence activities, e.g. Chipatiso (2025). Contemporary armed forces employ GIS for battlefield terrain analysis, intelligence collection and dissemination, operational planning, infrastructure protection, and command-and-control decision support, e.g. Marit (2023). Within operational planning, GIS enables commanders to evaluate terrain constraints, identify optimal manoeuvre corridors, and model potential mission scenarios.

Every branch of the armed forces has a mission, and GIS is increasingly the force multiplier behind it. As GIS capabilities expand, logistics has become one of its most powerful areas, e.g. Antai et al. (2023). In military logistics and national defence, spatial intelligence drives how ammunition, supplies, and critical resources are positioned and moved. By systematically harnessing spatial data and GIS models, commanders can track flows of people, goods, and materiel, pinpoint optimal hubs, sharpen decisions, and build resilience against both everyday demands and full-scale crises. GIS doesn't just map the battlefield; it analyses and visualises location-based data to turn geography into a strategic advantage, e.g. Henrico (2025).

Among the tasks of military logistics, the establishment of an ammunition depot must always be guided by the overriding goal of maintaining and improving military capabilities and operational effectiveness, e.g. Gigović et al. (2016). The interplay of political and legal conditions, the military-operational setting, and relevant time and budget constraints provides the key framework to determine the most suitable type of storage installation. Selecting optimal sites for ammunition depots requires balancing frequently competing economic and technical considerations with environmental and safety standards. To do this, it is crucial to define clear rules that allow decision-makers to evaluate potential locations based on spatial, safety, environmental, and economic constraints and criteria. The graphically illustrated approach shown in Figure 1 was applied in the ammunition depot site-selection study conducted in the Czech Republic.

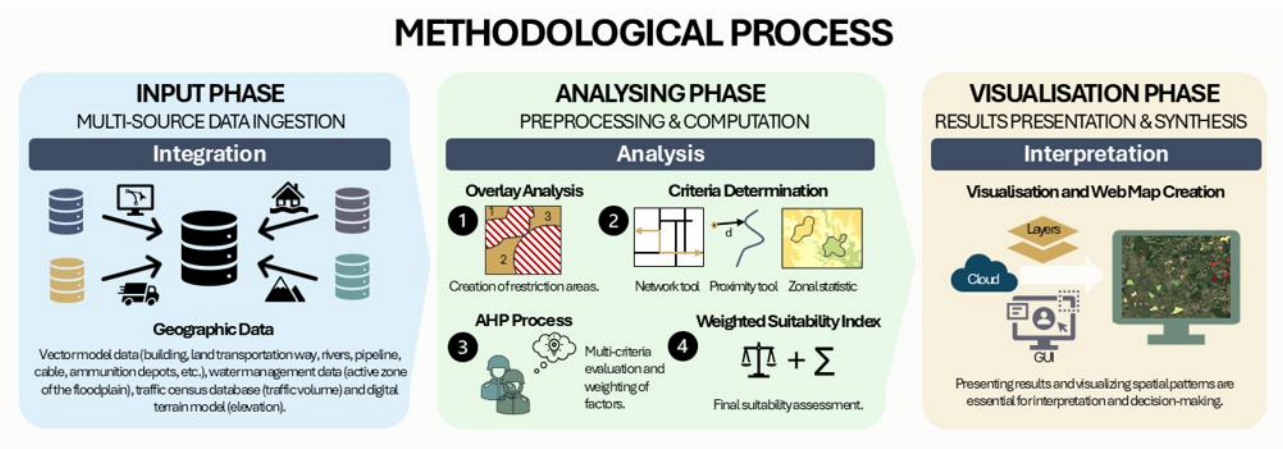

Figure 1. Flow chart of the methodological process.

https://doi.org/10.5194/ica-abs-12-30-2026

The methodology for determining the optimal location and construction of an ammunition depot under the conditions of the Czech Republic was based on a systematic delineation of restrictions, i.e., areas in which a munitions depot cannot be established. These restrictions are derived primarily from NATO standards and related safety and technical regulations, which define minimum distances, conditions for protective zones, and limits for the handling of explosives. Building on this framework, evaluation criteria necessary for applying the Analytic Hierarchy Process (AHP) method are defined, enabling a multi-level, weighted assessment of the suitability of individual sites. The combination of a restrictive approach to eliminating unsuitable areas and multi-criteria evaluation using AHP provides a transparent, reproducible, and professionally substantiated basis for decision-making on the location of an ammunition depot.

Restrictive areas are represented by polygons defining the area of the feature or its surroundings. In total, 17 conditioning restrictive areas were identified in this way (e.g. active zone of the floodplain, conservation areas, cable and pipeline buffer, wetland, landslide, etc.). Using the overlay tool with the erase method, the individual restrictive areas were compared with the area of the Czech Republic. The resulting polygons represent areas of potential sites for the construction of ammunition depots (≈4.1% of the area of the Czech Republic).

The suitability assessment was conducted within an ArcGIS Pro environment through the delineation and evaluation of 1,451 spatial units (centroids of the polygon of potential areas), for which individual criterion values were systematically derived using spatial analysis methods. Proximity analysis was applied to quantify the distance from state borders, where the shortest Euclidean distance was calculated between the centroid of each spatial unit and the nearest segment of the national boundary. The characteristics of the terrain were incorporated using a digital terrain model (DTM), from which a raster-based slope model with a spatial resolution of 5×5 m was generated. Subsequently, zonal statistics were used to assign mean slope values to each spatial unit based on their spatial extent. For accessibility-related criteria, a network analysis approach was implemented using a comprehensive dataset of the transport network, consisting of motorways complemented by primary, secondary, and tertiary road classes. This network data set allowed for the calculation of the shortest path distances to selected facilities (Military Training Areas, Operational Ammunition Depots, and Host Nation Support), thereby integrating realistic transport conditions into spatial evaluation. Based on the evaluation criteria, the weighted suitability index was determined for each potential area.

The presentation of results and the visualization of the resulting spatial patterns represent a critical component for their proper interpretation and subsequent decision-making processes. Due to the extensive spatial coverage of the study area and the necessity to represent detailed polygonal features, the production of large-scale static maps is not feasible without significant loss of clarity. A web-based mapping application was developed to facilitate an intuitive presentation of the analytical results, while also integrating supplementary location-specific information not included in the initial evaluation process. These additional data layers provide an extended contextual framework that can support subsequent decision-making activities. This approach enhances the overall understanding of the spatial context and supports more informed decision-making by integrating analytical outputs with user-driven visualization capabilities.

Acknowledgements

This work was conducted within the framework of the defence research intention DZRO VAROPS and the SV24-FVL-K109-LOP specific research project both managed by the University of Defence, Brno. During the preparation of this abstract the authors used Open Writefull in order to enhance readability of the text.

References

Antai, I., Hellberg, R. and Skoglund, P., 2023. Logistics growth in the armed forces: development of a theoretical framework and research propositions. *Defence Studies*, 24(1), pp. 84–106.

Chipatiso, E., 2025. Application of GIS and Artificial Intelligence in Military Operations: Prospects and Challenges. *Southern African Journal of Security*, Vol 3, p. 17.

Gigović, L. et al., 2016. The Combination of Expert Judgment and GIS-MAIRCA Analysis for the Selection of Sites for Ammunition Depots. *Sustainability*, 8(4), pp. 372–372.

Henrico, I., 2025. Modern approaches in military geoscience: leveraging advanced geospatial technologies for strategic advantage. *Geology Today*, 41(4), pp. 166–175.

Marit, E., 2023. GIS applications for modern-style military operations planning. *Scientific Bulletin of Naval Academy*, XXVI(1), pp. 40–48.

https://doi.org/10.5194/ica-abs-12-30-2026