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A Methodological Approach to Standardizing Basic Layers in Armenia's NSDI

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Abstract:

The development of a National Spatial Data Infrastructure (NSDI) represents a critical advancement in the management and accessibility of geospatial data, facilitating informed decision-making across sectors such as government administration, environmental monitoring, and urban planning {(Rajabifard and Williamson 2003), (Rajabifard and Williamson 2002), (Nebert 2001)}. In the context of Armenia, establishing a robust NSDI is particularly important, given the country's need to modernize its spatial data infrastructure and align with international standards, such as the European INSPIRE Directive (European Commission, 2007). One of the key components of this effort is the standardization of spatial data layers, which is essential for ensuring the effective use of data in various applications ranging from urban planning to environmental protection and resource management.

This research focuses on developing a methodology for the standardization of basic layers in Armenia's NSDI, which are critical for the country's geospatial data infrastructure. These basic layers include administrative boundaries, real estate data (cadastral data), land valuation, property rights, land use (land cover), addresses, geographical names, surface water data, elevation models, relief, and transport infrastructure. Standardizing these layers involves creating consistent and interoperable datasets that can be utilized across various sectors, including land administration, environmental monitoring, disaster management, and infrastructure planning. The proposed methodology follows best practices outlined in international frameworks such as the INSPIRE Directive (European Parliament and Council, 2007), the ISO 19100 series of geographic information standards (ISO, 2002), and the Open Geospatial Consortium (OGC) standards (OGC, 2020), ensuring that the basic spatial data layers adhere to both national and international interoperability requirements.

The methodology developed in this study consists of four key stages: (1) Data Collection and Preparation—gathering raw spatial data from a variety of sources, including orthophotos and existing topographic maps, to ensure comprehensive and up-to-date information; (2) Attribute Definition—establishing the mandatory attributes for basic spatial data layers based on NSDI standards for Armenia, ensuring completeness, consistency, and interoperability with other datasets {(Nogueras-Iso, Zarazaga, and Muro-Medrano 2005), (Tóth et al. 2012), (Hadzilakos et al. 2000)}; (3) Data Structuring and Conversion—transforming raw data into standardized formats such as vector and raster formats, ensuring compatibility with NSDI requirements, and using standardized coordinate systems and metadata formats {(Hećimović, Marasovic, and Tavra 2014), (Rao et al. 2002)}; (4) Data Integration—combining basic spatial data layers with each other, such as administrative boundaries, land use, surface water, elevation models, and other relevant data, to create a cohesive and interoperable spatial database that can be used for multi-disciplinary applications. By following these stages, the research aims to contribute to the successful implementation of standardized and accessible basic spatial data layers within Armenia's NSDI framework.

This approach not only aims to meet Armenia's national standards but also aligns with international initiatives for spatial data infrastructure development, ultimately enhancing the quality and availability of basic spatial data layers for a wide range of applications {(Craglia and Annoni 2006), (Kotsev et al. 2020), (Merodio Gómez et al. 2019), (Al-Yadumi et al. 2021)}.

To facilitate the standardization process and ensure compliance with established guidelines, a Python-based tool was developed to automate the transformation and validation of basic data layers. Additionally, the Hale studio toolkit, an

open-source software suite, was installed to further enhance the validation and quality control processes, ensuring that the spatial data conforms to the requirements of the INSPIRE directive.

The validation process focused on two main aspects: (1) Data Quality Assurance—ensuring the accuracy, completeness, and consistency of the basic spatial data layers by running automated checks using the Python tool and Hale studio toolkit, and (2) Compliance Testing—verifying that the data conforms to the predefined standards for metadata, attributes, and geometry as specified by the NSDI guidelines and the INSPIRE directive. The Python tool provided automated feedback on data quality issues, which allowed for iterative corrections and improvements.

Although this research represents an initial pilot for standardizing the basic spatial data layers, the methodology and tools developed are intended to serve as a model for updating the entire spatial data infrastructure in Armenia. The findings from this study demonstrate that the proposed approach can successfully standardize key geospatial layers, providing a solid foundation for improving the overall quality, consistency, and interoperability of Armenia's NSDI. This work lays the groundwork for scaling the standardization efforts to thematic data layers, ultimately supporting informed decision-making and sustainable development in Armenia.

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