Metadata GeoPortal: Advancing Map Data Management and Collaboration Across Sectors

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Abstract

In Turkiye, a diverse range of organizations, including public institutions and private sector entities, are actively engaged in the" production and management of geospatial information. To enhance coordination, minimize duplication of efforts, and optimize resource use, the Metadata GeoPortal (Map Information Bank) was developed. This web-based platform acts as a central hub for both public and private users to enter, update, and share metadata connected to their mapping activities. It offers quick access to essential map data, supports decision-making processes, and underpins various e-government initiatives. Operating in accordance with the Large-Scale Map and Map Information Production Regulation, the Metadata GeoPortal aims to prevent redundant map production and ensure efficient utilization of national resources. Designed to comply with the ISO 19115 Metadata Standard, the platform allows users to register mapping projects, assign unique project numbers, and generate endpoint numbers (SNN) for coordinate data. The GeoPortal improves data sharing and coordination across different sectors. For instance, data entered by entities such as the General Directorate of Land Registry and Cadastre (TKGM) and the General Directorate of Mapping (HGM) can be shared with other stakeholders through web services following established protocols. This facilitates seamless access to critical geospatial data, including control points, aerial photographs, orthophotos, elevation models, and topographic maps. Since its launch in July 2008, the Metadata GeoPortal has undergone continuous improvements. It is now widely used by ministries, public institutions, municipalities, and private entities, extending its impact in mapping, cadastral work, and geographic information systems. The February 2022 update introduced a new user interface, allowing TKGM units to download map data directly without formal correspondence. Additional features, such as direct access through the Parcel Inquiry System, have further increased the platform's usability. Looking ahead, the upcoming "Phase 4" updates will expand the platform's functionalities, enhancing geospatial data management and collaboration across sectors. The Metadata GeoPortal is a pivotal tool in Turkiye's efforts to modernize and centralize geospatial" data management, reduce redundancy, and maximize resource efficiency.

1. Introduction

Geospatial information has become fundamental to a broad range of applications, from urban planning and environmental management to disaster response and infrastructure development (Goodchild, 2020). In Turkiye, both public institutions and" private entities have long recognized the need for robust geospatial data. However, without an efficient central mechanism to collect and share this data, organizations end up producing duplicate data sets, inadvertently wasting resources and complicating data harmonization (INSPIRE, 2008).

Against this backdrop, the Metadata GeoPortal (also referred to as the Map Information Bank) has emerged as a strategic solution aimed at modernizing the way geospatial data is cataloged, managed, and shared at the national level. Developed under the guidelines of the Large-Scale Map and Map Information Production Regulation, the Metadata GeoPortal aspires to streamline mapping workflows, reduce production redundancies, and ultimately promote a centralized and integrated geospatial data infrastructure across the country. It doesn't just focus on organizational efficiencies, either—its far-reaching impacts bolster e-government services, decision-making processes, and datadriven projects across multiple sectors.

This paper delves into the motivations, design, functionalities, and future potential of Turkiye's Metadata GeoPortal. We provide" an overview of the platform's compliance with relevant standards like ISO 19115 (ISO, 2014), highlight the roles of various stakeholders, and discuss the challenges encountered during the platform's development and expansion.

2. Literature Review

The advancement of metadata geoportals represents a significant evolution in the management and collaboration of geospatial data across various sectors. These platforms serve as critical infrastructures that facilitate the discovery, access, and utilization of geospatial information, thereby enhancing data sharing initiatives at both national and global levels. The integration of various technologies and standards, such as those established by the Open Geospatial Consortium (OGC), plays a pivotal role in the effectiveness of these geoportals.

One of the primary challenges faced by contemporary geoportals is the optimization of metadata for search engines. Traditional geoportals, which often rely on the Catalogue Service for the Web (CSW), are not inherently designed for web crawling, leading to limited visibility of geospatial resources online (Katumba & Coetzee, 2017). This limitation can be addressed through the application of Search Engine Optimization (SEO) techniques, which can significantly improve the discoverability of geospatial metadata by publishing it in HTML formats. Such practices not only increase web traffic to geoportals but also enhance user engagement by allowing users to explore and download relevant geospatial data more efficiently (Katumba & Coetzee, 2017).

Moreover, the concept of interoperability is crucial for the effective functioning of geoportals. By enabling seamless access to geospatial data across different platforms and services, interoperability fosters collaboration among various stakeholders, including government agencies, researchers, and the public.

For instance, initiatives like the SwissEnvEO project exemplify how national environmental data repositories can facilitate data

sharing through interoperable systems, contributing to broader data-sharing frameworks such as the Global Earth Observation System of Systems (GEOSS) (Giuliani et al., 2021). This interoperability is often achieved through the implementation of the Resource Description Framework (RDF), which organizes metadata as nodes and links within a globally interconnected data graph, thus enhancing the semantic search capabilities of geoportals (Hu et al., 2015).

The role of institutional frameworks in the development of National Spatial Data Infrastructures (NSDI) cannot be overstated. Effective governance and policy-making are essential for the successful implementation of geoportals, which serve as the technical backbone for geospatial data sharing (Budi, 2023). The establishment of a robust NSDI enables the integration of various data sources, promoting the efficient use of geospatial information for decision-making processes. This is particularly evident in the evolution of NSDI in countries like Indonesia, where the transition from traditional mapping agencies to more collaborative, geoportal-based approaches has facilitated greater data sharing and utilization (Putra et al., 2019).

In addition to governance, the technical architecture of geoportals is fundamental to their functionality. The design of a geoportal must consider user needs and the types of data being managed. For example, the development of a regional geoportal for agricultural monitoring demonstrates how tailored architectures can provide access to specific data products and thematic maps, thereby supporting targeted decision-making in the agricultural sector (Granell et al., 2017). Furthermore, the integration of crowdsourcing models into geoportals can enhance data collection and validation processes, as seen in the Open Community-Based Crowdsourcing Geoportal for Earth Observation Products (Vahidnia & Vahidi, 2021).

The evolution of geoportals also reflects a growing recognition of the importance of user engagement and participation in the datasharing process. By empowering citizens to contribute geospatial data, geoportals can enhance the richness and diversity of the information available. This participatory approach is particularly relevant in urban disaster management contexts, where citizengenerated data can provide critical insights into vulnerabilities and risks (Lee, 2016). The implementation of Volunteered Geographic Information (VGI) systems within geoportals exemplifies this trend, as they leverage community input to enhance the quality and relevance of geospatial datasets (Kocaman et al., 2021).

Furthermore, the implementation of standardized protocols and frameworks is essential for ensuring the interoperability and usability of geoportals. The adherence to international standards, such as those set by the OGC and INSPIRE, facilitates the integration of diverse geospatial datasets, enabling users to access and utilize information from multiple sources seamlessly (Sari, 2018). This standardization not only enhances the technical capabilities of geoportals but also promotes trust and reliability among users, as they can be assured of the quality and consistency of the data provided.

The integration of advanced technologies, such as cloud computing and machine learning, into geoportal development is also transforming the landscape of geospatial data management. Cloudbased geoportals can offer scalable solutions for data storage and processing, while machine learning algorithms can enhance data analysis and visualization capabilities (Sanchez-Gallegos et al., 2018). These technological advancements enable geoportals to handle large volumes of data more efficiently,

thereby improving the overall user experience and facilitating more informed decision-making processes.

In conclusion, the advancement of metadata geoportals is a multifaceted endeavor that encompasses technical, institutional, and participatory dimensions. By leveraging SEO techniques, ensuring interoperability, and fostering user engagement, geoportals can significantly enhance the management and collaboration of geospatial data across sectors. The ongoing evolution of these platforms will undoubtedly play a crucial role in addressing contemporary challenges related to data sharing, accessibility, and utilization in an increasingly data-driven world.

3. Methodology

3.1 Platform Architecture

The Metadata GeoPortal's architecture relies on a modular design that accommodates both central and distributed components. The central module oversees metadata registration, validation, and storage, while distributed modules (implemented by stakeholder agencies like TKGM or HGM) handle tasks specific to their organizational needs. This setup ensures flexibility—entities can manage and update their own data while still adhering to the overarching guidelines of the central platform.

Within the platform, authorized users can generate unique project identifiers and create endpoint numbers (SNN) that link coordinate datasets to their corresponding projects, as shown in Figure 2. This end-to-end workflow, from project registration to data publishing, fosters data integrity by preventing conflicts or duplication among multiple data producers. In addition to ensuring provenance, the systematic assignment of SNNs streamlines data retrieval and sharing across various stakeholder agencies.

To implement this architecture, the system adopts a three-tier design, comprising the frontend, the backend, and the database layer. The frontend is built using AngularJS, enabling the creation of dynamic, single-page applications that offer an intuitive user interface (UI) for project registration, metadata input, and dataset visualization. AngularJS's modular structure further simplifies the development of reusable components, improving maintainability. The backend is written in Node.js with the Express framework, which serves as the central point for handling requests from the AngularJS frontend. Using a REST API design, the backend facilitates a clear separation of concerns: user requests for creating or accessing projects, querying metadata, or generating SNNs are routed through defined endpoints. This approach not only enhances scalability-additional services or microservices may be integrated later without disrupting existing functionality-but also ensures consistent validation rules and business logic across the platform. For instance, validation scripts that check the correctness of coordinate systems or metadata completeness are triggered on the backend, preventing erroneous or incomplete records from being registered.

In the database layer, PostgreSQL with PostGIS integration underpins the storage of metadata and geospatial datasets. PostGIS, as an extension of PostgreSQL, offers a robust suite of geospatial functions and data types for advanced query operations. This setup is critical for applications that rely on spatial data analysis, such as identifying overlapping project areas or detecting coordinate discrepancies. The database schema is designed to store essential metadata elements—such as project identifiers, geometry objects, and contributor details—in a structured manner. This not only supports efficient retrieval but also preserves data

integrity through referential constraints and transactional consistency.



Figure 1. Metadata Geoportal's Architecture.

Overall, this architecture promotes both modularity and collaboration: the central node upholds uniform standards for metadata documentation, while distributed modules, each potentially involving unique data formats or specialized spatial analyses, seamlessly integrate through the RESTful services. As organizational requirements evolve, new services or data layers can be incorporated without requiring a fundamental overhaul of the existing infrastructure. This extensible design, driven by AngularJS on the frontend, Node.js/Express in the middle tier, and a PostgreSQL/PostGIS database, ensures that the platform can scale to accommodate the growing demands of diverse stakeholders in geospatial data management.

3.2 Data Input and Quality Control

Users (i.e., institutions or private firms) log into the GeoPortal and input metadata for their mapping projects, including the thematic scope, geographic extent, coordinate system, and additional descriptors mandated by the ISO 19115 Metadata Standard. A built-in validation feature checks for missing fields or format inconsistencies, and it flags any duplication of metadata records. If certain metadata attributes are incomplete, the system sends an automated prompt, urging data providers to rectify the issues before final submission.

3.3 Data Sharing Protocols

To align with the Large-Scale Map and Map Information Production Regulation, the GeoPortal enforces a set of compliance rules. For instance, certain map scales might be restricted to specific agencies, or coordinate reference systems might require official certification. By embedding these rules into the platform, the Metadata GeoPortal helps all stakeholders conform to national policies without having to navigate complicated legal texts individually.

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Figure 2. Creating Endpoint Numbers.

A key element of the Metadata GeoPortal is its robust data sharing capability. The platform leverages standardized APIs and web services—often conforming to OGC (Open Geospatial Consortium) protocols—for distributing data across organizations (Kubik, 2017). TKGM, HGM, and other major data providers can use these APIs to automatically sync updated datasets, ensuring real-time availability. The platform also supports role-based access, allowing data owners to grant or restrict usage permissions based on user profiles.

4. Results and Discussions

Since its debut in July 2008, the Metadata GeoPortal has steadily gained traction among both public and private users. Ministries handling transport, agriculture, and environmental management have integrated the platform into their workflows. Municipalities dealing with zoning and infrastructure projects have likewise come aboard. Even private firms—mainly engineering consultancies and mapping vendors—have found that registering their data on the platform enhances their visibility and fosters collaboration opportunities with government agencies.

One remarkable outcome is the reduction in repetitive data creation. Before the GeoPortal, organizations often executed separate aerial surveys or topographic data acquisitions, duplicating efforts. Nowadays, they can easily discover if relevant, existing data is already accessible. This has streamlined project budgets and sped up planning cycles.

The GeoPortal's data sharing functionality has helped break down silos between agencies. When the General Directorate of Mapping (HGM) conducts aerial photography campaigns, for instance, the images are quickly made available via the platform to other authorized institutions. Likewise, the General Directorate of Land Registry and Cadastre (TKGM) shares up-to-date cadastral data that supports land administration and property tax assessment in real time. This synergy significantly enhances national projects that intersect land administration, infrastructure development, and disaster preparedness.

In February 2022, a major user interface (UI) overhaul took place, focusing on intuitive navigation, real-time data previews, and simpler metadata submission. The UI now integrates seamlessly with the Parcel Inquiry System, so users—especially municipal planners and cadastral personnel—can retrieve relevant map layers without switching between multiple software tools or websites. Additionally, TKGM units can access and download map datasets directly from the platform, eliminating the bureaucratic need for formal requests.



Figure 3. Metadata Geoportal.

The reaction to this UI redesign has been positive, although there were early complaints about certain menu items being buried under subcategories. Some users also indicated they missed the old color scheme, which they felt was more "officiallooking." However, usage metrics suggest the platform is more actively utilized now, with a noticeable drop in incomplete metadata submissions.

4.1 Challenges and Limitations

Despite its growing adoption, the Metadata GeoPortal faces a few hurdles: In some cases, metadata records lack sufficient detail, diminishing the discoverability of the associated datasets. Rural municipalities sometimes struggle with slow internet connections, affecting their ability to quickly upload or retrieve large spatial files. While major agencies typically have well-trained staff, smaller organizations might not fully grasp metadata standards or how to leverage the platform's advanced features. Addressing these challenges calls for a blend of technical and institutional measures, such as targeted training sessions, user-friendly data entry forms, and possible partnerships with local internet providers to ensure stable connectivity.

5. Future Work

Looking ahead, the planned "Phase 4" enhancements aim to broaden the platform's capabilities and strengthen the collaborative environment for geospatial stakeholders. Proposed additions include: Introducing automated data validation using machine learning modules that can detect anomalies-like unexpected coordinate reference systems-to ensure data consistency. Real-Time Sensor Integration: Allowing sensorbased data streams (e.g., from environmental monitoring stations) to be registered automatically, thereby updating the GeoPortal in near-real time. Enhanced 3D Visualization: Incorporating advanced visualization options (possibly via web-based GIS tools) to support 3D city modeling and other complex geospatial analyses. Collaboration Tools: Embedding messaging and project management functionalities within the portal, so cross-agency teams can coordinate directly. The overarching goal of these updates is not just to modernize the platform technically but to encourage deeper collaboration among stakeholders. By fostering an ecosystem where geospatial data is openly shared and continually updated, Turkiye can realize significant improvements in public services," economic development, and environmental sustainability.

6. Conclusion

The Metadata GeoPortal represents a major milestone in Turkiye's" journey toward an integrated and efficient national geospatial data infrastructure. By providing a centralized platform aligned with global metadata standards like ISO 19115, it has

curbed the duplication of mapping efforts and drastically streamlined inter-agency collaboration. Users from public agencies, municipalities, and the private sector are enjoying more direct access to critical datasets, facilitating everything from land management to transportation planning.

Ongoing enhancements, especially the forthcoming "Phase 4" updates, promise to take data sharing and usability to a new level. Nevertheless, the GeoPortal's success hinges on sustained governmental support, continued training initiatives, and robust technological infrastructure. The lessons learned—from effectively managing metadata quality to addressing connectivity challenges—can serve as a blueprint for other nations pursuing similar digital transformation strategies in the geospatial domain. As Turkiye continues on this path, the Metadata Geo-" Portal stands as a testament to the power of strategic coordination in propelling data-driven innovation.

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