

ADVANCING GEOSPATIAL DATA INTEGRATION: CHALLENGES AND ACHIEVEMENTS UNDER INSPIRE DIRECTIVE

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Abstract- This research paper explores the progress and challenges Albania has faced in implementing the INSPIRE Directive, focusing on the development of its National Spatial Data Infrastructure (NSDI) between 2014 and 2023. By aligning with European standards, Albania has made significant strides in improving the standardization, publication, and accessibility of geospatial data, with the ultimate goal of enhancing decision-making. The paper highlights the critical role of geospatial metadata, legal frameworks, and data specifications in enabling effective data sharing and governance. Through an analysis of the approval process for thematic standards by the Albanian Council of Ministers, it underscores the importance of technical specifications and interoperability in integrating national and European data. The establishment of a National Geographic Information System (GIS) is identified as a key achievement in ensuring better sharing and use of geospatial data. From the evaluation of actual situation, there are published 308 layers in national geoportal from which only 142 are standardized during the period 2014-2023. Finally, the paper outlines the challenges and future steps for improving data quality, strengthening training programs, and fostering collaboration across sectors to further align Albania with the EU's geospatial framework.

Keywords: INSPIRE Directive, National Spatial Data Infrastructure (NSDI), Geospatial Data Standards, Data Interoperability, Geospatial Governance.

1. INTRODUCTION

The development of information leads to improved decision-making in various fields. Albania is currently undergoing development and making a lot of significant decisions that influence decision-making, governance, and management in a variety of fields.

During the last years, there has been an increase in cases of natural disasters, such as: floods, fires, landslides, etc. The development and integration of the NSDI leads to the integration of the conditions and standards of the

European Union as well as to the prevention of the effects of natural disasters.

The collection of inherited information, such as historical data, and addressing the numerous issues that geoinformation has faced in Albania, has required significant effort to improve and further develop geoinformation based on the specifications of the INSPIRE Directive. This directive leads to the unification of this information according to the standards of European Union countries. This ensures that decision-making, management, and development are achieved in line with the pace and steps of different European countries.

These days, geoinformation plays a crucial part in data interchange. As global changes on the earth that impacts on population urbanization and environments disasters, smart cities concept implementation [1], technology advancements, the need for a sustainable governance, have also contributed to and made it necessary to have accurate, unique, and interoperable geodata with all other data.

Based on the needs, analyses and the importance of establishing a geoinformation infrastructure, it was deemed necessary to establish the National Infrastructure of Geospatial Data for Albania, which represents an integrated system of geospatial data, creating the possibility of the use of information deposited from different sources. The responsible authority that creates NSDI in accordance with European initiatives and trends is the State Authority for Geospatial Information - ASIG, providing and meeting the needs and requirements for geospatial data for the public, private sector and all users of geoinformation. Through detailed strategies and policies NSDI was realized through the fulfilment of objectives such as:

Infrastructure, standardization, geoinformation data and services, coordinate reference system, financing, scientific research, etc. To establish this infrastructure, Albania first needed to adjust its legal framework by adopting Law No. 72/2012, "On the Organization and Functioning of the National Infrastructure for Geospatial Information." This law was aligned with Directive

2007/2/EC of the European Parliament and Council, dated March 14, 2007, "On the establishment of an infrastructure for spatial information in the European Community (INSPIRE)." The goal of the INSPIRE Directive is to create a unified spatial database for all European countries, both legally and technically.

2. BACKGROUND

2.1. Fundamentals of Geospatial Data Theory

Geoinformation plays an important role today, providing users with conveniences in daily life through the availability of standardized information.

Geoinformation in Europe underwent significant development in 2007 when the INSPIRE Directive came into effect. This directive established an infrastructure for geoinformation and supported many important environmental fields and areas related to the environment, achieving efficiency in decision-making through harmonized and high-quality information. Based on this, Albania created a law adapted to the INSPIRE Directive in 2012, taking into account the difficulties encountered due to the lack of collected and accurate information.

The INSPIRE Directive established 34 geoinformation themes, which included technical specifications through a modeling framework that provides a common basis for all themes. The unification of geoinformation according to data model specifications for all themes also created an opportunity for interoperability with all data and services.

Based on the law, Albania began creating the NSDI (National Spatial Data Infrastructure), initially determining the public authorities responsible for each thematic area. In collaboration with each authority, working groups were formed to adapt thematic standards according to INSPIRE specifications and the needs of our country. This led to government approval of each standard through Council of Ministers Decisions (DCM), giving geoinformation a new dimension.

Initially, the collection of data from all sources and archives was very difficult due to the unstandardized information. However, the approval of these technical documents is significantly improving the quality of geoinformation in Albania. Currently, over 400 layers are published on the National Geoportal, including historical data as well as updated geospatial data according to thematic standards. This has facilitated the technical work of many users and state administration by providing collected, accessible, and accurate information.

2.2. Geospatial Metadata Concepts and Legal Framework in Albania

Geospatial metadata is an essential component for ensuring the accessibility, discoverability, and usability of spatial data, playing a pivotal role in data management and interoperability. It provides structured information about geospatial data sets and services, such as their geographic extent, temporal reference, lineage, accuracy, and availability, which is crucial for informed decision-making and data exchange. The concept of metadata has been defined in several ways across various sources:

Metadata refers to the information that describes spatial data, enabling the discovery, inventory, and use of geospatial datasets [2]. It is also defined as the details about data collection methodologies, data quality, format, and the management requirements for data use [3]. Inspire metadata includes structured information about spatial data sets, which is designed to facilitate cross-border data sharing within the European Union, ensuring that metadata is harmonized across Member States to support data interoperability [6, 7].

In Albania, the concept of metadata aligns with these international standards, reflecting the need for robust data management systems that support the National Geospatial Data Infrastructure. According to the definition in Albania, metadata is understood as information that describes geospatial data sets and services, facilitating their discovery, inventory, and use. It provides additional context, such as data sources and the creation methodology, to ensure that geospatial data can be effectively accessed and used [8].

The INSPIRE Directive (Directive 2007/2/EC) [8] serves as the foundational legal instrument guiding metadata creation in Albania. According to this directive, Member States are required to establish metadata for spatial data sets and services corresponding to specific thematic areas, ensuring that metadata remains up-to-date and accessible for public use. In Albania, this directive has been integrated into national law through Law No. 72/2012, which regulates the organization and operation of the National Infrastructure for Geospatial Information (NSDI). The law provides the regulatory framework for creating, managing, and maintaining metadata, ensuring compliance with European standards and fostering effective data sharing at both national and European levels.

Additionally, Albania's metadata practices are informed by the implementation of DCM No. 1077 (2015), which closely approximates Commission Regulation (EC) 1205/2008, thereby operationalizing the INSPIRE Directive's metadata provisions. This regulation stipulates the creation, maintenance, and cataloging of metadata according to internationally recognized standards such as EN ISO 19115 and ISO 15836, ensuring consistency and facilitating the seamless exchange of geospatial information across borders.

2.3. Geospatial Metadata Profile in Albania

The metadata profile in Albania is aligned with the INSPIRE Directive, ensuring its applicability to a diverse range of stakeholders, including data providers, creators, metadata service publishers, and general data users. By facilitating the harmonization of metadata standards, this profile supports seamless interaction both within national borders and across international jurisdictions, providing a robust framework for communicating geospatial information. Every data set published on the National Geoportal is accompanied by comprehensive metadata, thereby ensuring that users have the necessary context to effectively interpret and utilize the data.

The metadata profile serves as a detailed descriptor of geospatial datasets, encompassing several critical elements:

- **Identification:** Provides unique identifiers and descriptive information about the dataset.
- **Classification:** Categorizes the geospatial data based on thematic geoinformation domains, thus enabling users to understand its contextual relevance.
- **Keywords:** Includes commonly used terms or phrases that facilitate search and retrieval by describing key characteristics of the data.
- **Geographic Position:** Specifies the geographic boundaries of the dataset through coordinates, ensuring spatial accuracy and precision.
- **Temporal Reference:** Details the time-related aspects of the dataset, including its creation, revision, and publication dates.
- **Quality and Validity:** Describes the lifecycle of the data, from its creation through its updates, and includes assessments of its accuracy and resolution. This section highlights the quality control measures applied to the dataset and provides insight into the dataset's usability.
- **Compliance:** Outlines the technical specifications, the degree of compliance with standards, and any limitations on the dataset's applicability.
- **Access and Use Conditions:** Specifies the legal and practical constraints associated with accessing and using the data, including restrictions based on user rights and permissions.
- **Responsible Authority:** Identifies the authority responsible for the creation, management, and dissemination of the geospatial data, ensuring accountability and transparency.
- **Metadata Information:** Includes metadata-related contact details, the date of metadata creation, and the language used in metadata documentation.
- **Other Elements:** Details the coordinate reference system, specifically the KRGJSH Coordinate System, mandated by the Council of Ministers Decision (DCM), which is a prerequisite for all geospatial data within Albania.

The utilization of metadata follows a systematic approach across three key phases:

- **Discovery:** This initial phase involves identifying potentially relevant data sources that could meet the user's specified requirements. It aims at facilitating the user's ability to locate pertinent geospatial resources.
- **Evaluation:** In this phase, users assess the quality and relevance of the discovered metadata to ensure it aligns with their research objectives or operational needs. Evaluation criteria may include data accuracy, resolution, and completeness.
- **Use:** Once a dataset has been evaluated, the user proceeds to access the data and employs the necessary tools or software to process it for analysis, decision-making, or operational purposes.

3. IMPLEMENTATION OF INSPIRE DIRECTIVE IN ALBANIA

The effective implementation of the INSPIRE Directive in Albania requires a comprehensive and multifaceted approach that integrates a variety of elements, each contributing to establishment of a functional National Geospatial Information System (NSDI). The following elements are central to realization of this directive:

- **Legislation** - It is a system of rules and social norms that people must follow in a society or country.
- **ISO** - The International Organization for Standardization (ISO) is a global group of national standards bodies. It creates and shares standards for industries and businesses. Members come from different national standards organizations.
- **Data** - It is any data that directly or indirectly refers to a specific place or geographic area.
- **Interoperability** - The ability to combine spatial datasets and enable services to interact automatically, ensuring coherent results and enhancing the value of both the data and services;
- **Technology (software)** - Software is a collection of instructions, data, or programs that enable computers to function and perform specific tasks.
- **Methodology** - Methodology knowledge refers to understanding the steps, both organizational and technical, required for successful implementation.
- **Conformity** - data or systems align with defined standards, such as those set by the INSPIRE Directive, ensuring consistency, interoperability, and quality.
- **Accuracy** - The totality of a product's characteristics related to its ability to meet declared and implied needs.
- **National GIS** - It is the National Geospatial Information System, which includes all geographic information systems built for specific themes, in accordance with the standards approved by ASIG, that interact with each other and are integrated by ASIG [9].

Figure 1 illustrates the key elements that influence the implementation of the INSPIRE Directive in Albania and their interrelationships.

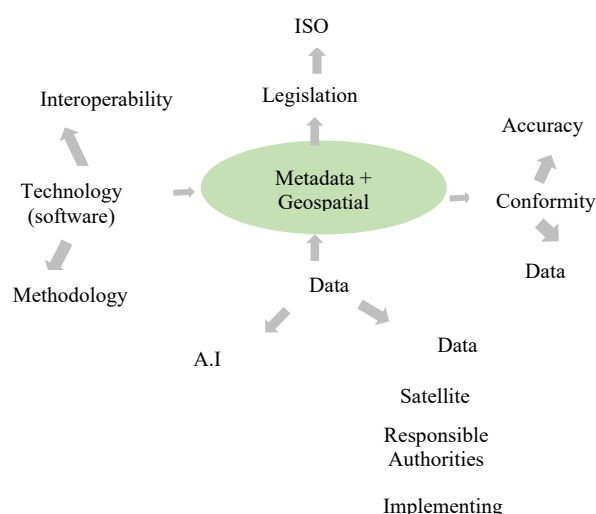


Figure 1. Elements influencing implementation of INSPIRE directive

3.1. Implementing Rules of the INSPIRE Directive in Albania

One of the key elements for the implementation of the INSPIRE Directive is the creation of implementing rules, which include:

- Identification of the Authorities Responsible for Geoinformation

The geoinformation themes defined by the INSPIRE Directive have their respective responsible authority, which creates, updates, and processes the data. The responsible public authority is legally obligated to update and deposit geospatial data so that it is published on the National Geoportal and accessible to users, who are given the opportunity to use and download the data.

- Initiatives of Public Authorities in the Field of Geoinformation

Whenever a responsible public authority initiates projects in the field of geoinformation, it is required to notify and seek opinion from ASIG. This ensures that the

data is created in accordance with the technical specifications of the INSPIRE Directive.

- Acceptance/Rejection of Data Inclusion in National GIS

Geospatial data are checked to ensure they comply with the technical specifications of geoinformation standards before being included in the National Geoportal.

- Geographic Information Systems and Their Inclusion in the National GIS

WebGIS systems created by the responsible public authorities are also checked for compliance to be included in the National Geoportal.

- Administration of Geospatial Information

For Albania, the authority responsible for the administration of geospatial information is ASIG – the State Authority for Geospatial Information. These elements for Albania are cited and approved in Council of Ministers Decision No. 451, dated July 3, 2019, "For Uniform Rules of Geospatial Information Infrastructure".

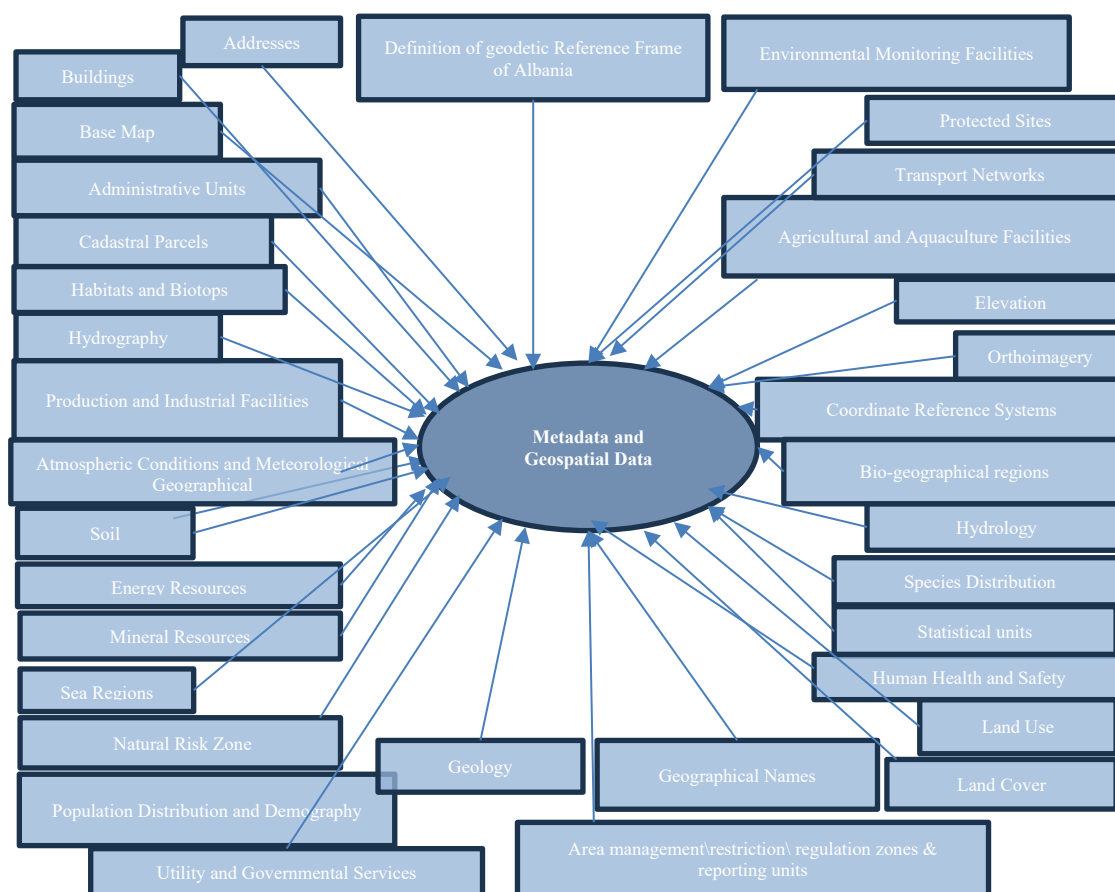


Figure 2. Thematic standards of the INSPIRE Directive

3.2. Data Specifications from Documentation Review

Technical specifications define common data models, code lists, features, layers, and metadata. They also specify the interaction methods used for exchanging geospatial data sets and services across themes, as well as with data created by other member states. The technical specifications from the INSPIRE Directive are defined by 34 geoinformation themes through their respective data models.

Data themes specifications are approved by the Council of Ministers Decision (DCM). INSPIRE data specifications have been used for the compilation of the National Standards. Figure 2 below illustrates the thematic standards as defined by the INSPIRE Directive, providing a visual representation of the data models, code lists, and thematic layers necessary for ensuring standardization across geospatial data management systems.

3.3. Interoperability

Interoperability in INSPIRE means combining spatial data and services from different sources in the European Community. This is done in a consistent way without extra work for people or systems. It can be achieved by harmonizing and storing data or by transforming it through services for publication. Interoperability is the ability of different systems to work together without repeated manual intervention, so that the result of their interaction is clear and leads to an increased added value of data sets and services.

Interoperability encompasses the interaction between geospatial data sets and services, including both existing data and data collected according to thematic standards approved by the relevant Council of Ministers Decisions, as well as the associated metadata. ASIG, in collaboration with the responsible public authorities, defines the constraints and classifications of geospatial data sets, as well as the rules for their interaction.

Data interoperability components:

- Technical Specification conform Directive INSPIRE
- Metadata
- Application schemas
- Coordinate reference system
- Data transformation
- Data capturing
- Terminology
- Data quality
- Maintenance
- Data model

3.4. Data Quality

The development and implementation of Albania's National Geospatial Information Infrastructure follow the European standards set by Directive 2007/2/EC "INSPIRE" of the European Parliament and Council. A key focus is on data quality, as improving it enhances accuracy and reliability for users.

ASIG is responsible for quality control of the geospatial data declared by the responsible public authorities according to the relevant themes, to achieve interoperability between the data/systems published on the National Geoportal.

Geospatial data quality is a critical element that describes the essential characteristics of the data, allowing users to identify and use geospatial information obtained from various sources at both local and national levels. The technical specifications of geoinformation standards outline the basic concepts of geospatial data quality and the procedures for evaluating data quality elements, as well as how these are specified using geoinformation standards.

Data quality assessment includes:

- Geospatial data quality control
- Compatibility of these data/services with standards and regulations according to the relevant Council of Ministers Decisions (DCM) for each theme.

According to the INSPIRE Directive specifications, 5 elements and 15 sub-elements are controlled for geoinformation data. The procedure is divided into two main processes: production/harmonization and interaction of these data in the National Spatial Data Infrastructure (NSDI).

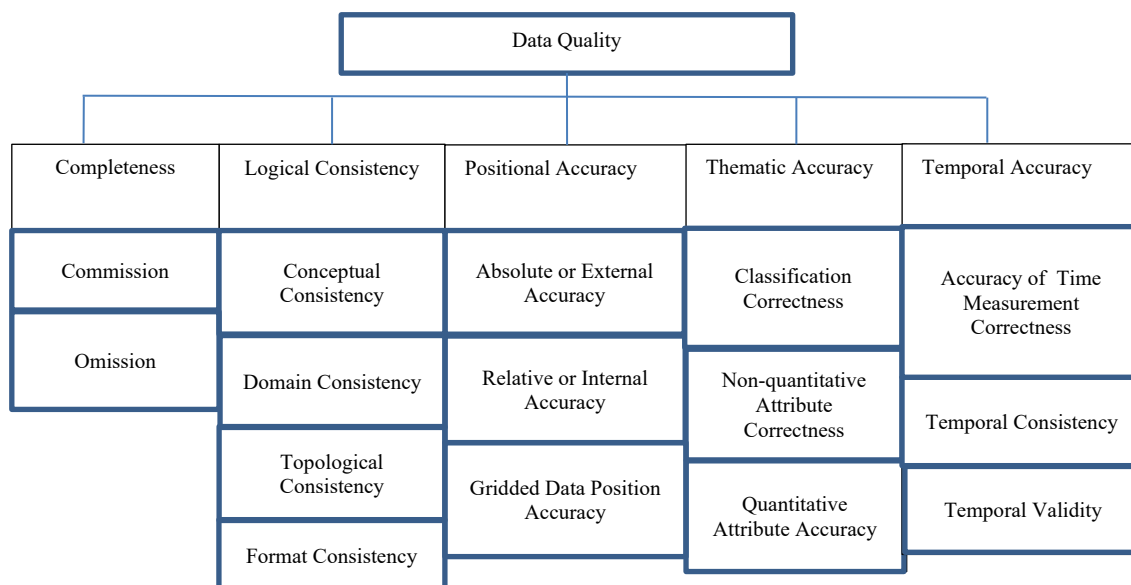


Figure 3. Data quality elements

For each geospatial dataset from responsible public authorities or created by ASIG, quality control is conducted according to the technical specifications defined by the relevant geoinformation standards and according to the quality declaration presented by the responsible public authorities in the relevant metadata.

Figure 3 illustrates the key data quality elements that are essential in assessing the reliability and suitability of geospatial datasets within the NSDI. Bearing in mind that geospatial data are considered as high value data and mostly are offered as Open data, their metadata plays a crucial role for the reuse of those information [5].

3.5. Software for Geospatial Data Implementation

Harmonized spatial data must be accessible through standardized services as per the INSPIRE directive, which aims to establish a European Spatial Data Infrastructure. To meet INSPIRE principles and requirements, existing datasets and databases usually need to be transformed and mapped into the specified INSPIRE data models.

Based on internet research on implementation of INSPIRE directive, EU member states use various software solutions to implement its requirements. Here are some common types of software used:

- Most European countries use GIS software to manage and analyze spatial data. The most commonly used are:

- QGIS - An open-source GIS application Most European countries use GIS software to manage and analyze spatial data. The most commonly used are:

- ArcGIS - A commercial GIS suite developed by Esri, known for its comprehensive tools and enterprise capabilities.

- FME (Feature Manipulation Engine) - This geospatial extract [10], transform, and load (ETL) platform, developed and maintained by Safe Software, is built on FME technology. It enhances existing features with added FME-INSPIRE logic, making the mapping process much simpler and more efficient.

- HALE-Open-source and designed to harmonize complex, structured datasets, this platform works with open standards such as OGC, ISO, INSPIRE, BIM, XPlanung, and environmental reporting.

- Enterprise Architect - the platform that creates and edits data models according to thematic standards that com

- For the creation and management of metadata, the following tools are used:

- GeoNetwork: An open-source catalog application for managing and sharing spatial data and metadata.

- ISO 19115 Metadata: Tools like the ISO Metadata Editor or various extensions in GIS platforms that help in creating and managing ISO 19115 metadata.

- For publishing and sharing spatial data conform INSPIRE Directive are used:

- GeoServer: A server that is open-source, designed for sharing and editing geospatial data.

- MapServer: An open-source platform for publishing spatial data and creating web maps. Many member countries use a combination of these tools. "It is important to note that the same software, tools, and platforms are also employed for implementing the INSPIRE Directive in Albania".

4. EVOLUTION OF IMPLEMENTATION OF INSPIRE DIRECTIVE IN ALBANIA

Statistics on the progress of NSDI development and the implementation of the INSPIRE Directive in Albania will be presented below. The data is authentic and sourced from the National Geoportal: <https://geoportal.asig.gov.al/>.

The statistics cover the period from 2014 to 2023 and present the advancements in the publication of geospatial data, the adoption of technical standards, and their implementation. During 2014-2023 there are approved 34 National Standards. The approval of thematic standards through Council of Ministers (DCM) decisions has played

a significant role in enhancing geoinformation. This is because it has facilitated the unification of data with EU countries in accordance with the INSPIRE Directive.

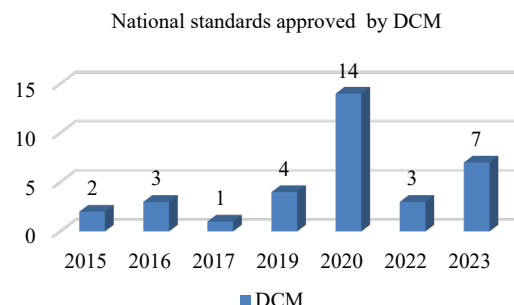


Figure 3. Standards approved by DCM over the years in Albania

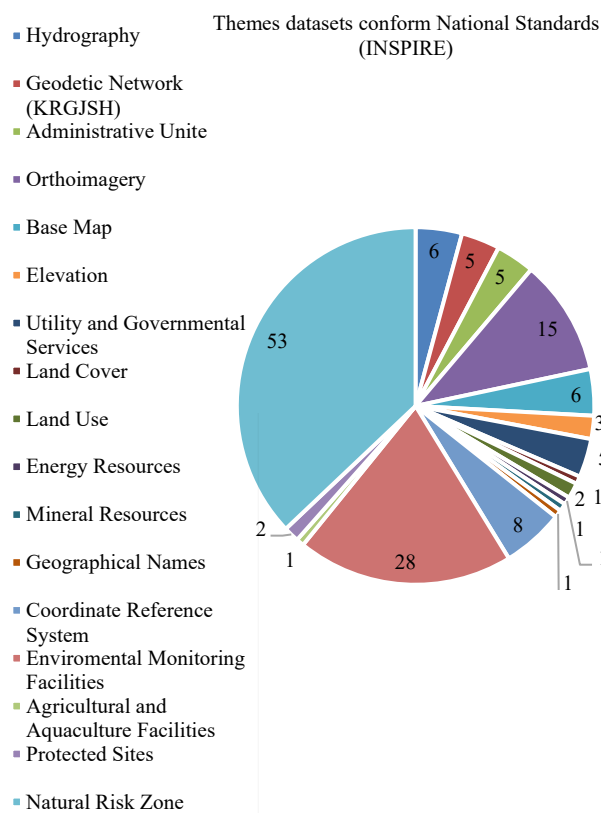


Figure 4. Data sets conform National Standards

The thematic standards have been adapted to the technical specifications of the INSPIRE Directive, and additional specifications tailored to the country's needs have been developed in collaboration with the responsible public authority. A graphical representation of the progress in the approval of these standards over the years is shown in Figure 4.

From 2014 to 2023, datasets of themes that are conform to the geoinformation standards and are published on the National Geoportal consists of 142 datasets, covering 17 themes and are conform to the Council of Ministers (DCM) geospatial standards. Figure 5 illustrates the distribution of datasets that conform to national standards, providing an overview of Albania's ongoing commitment to geospatial data interoperability.

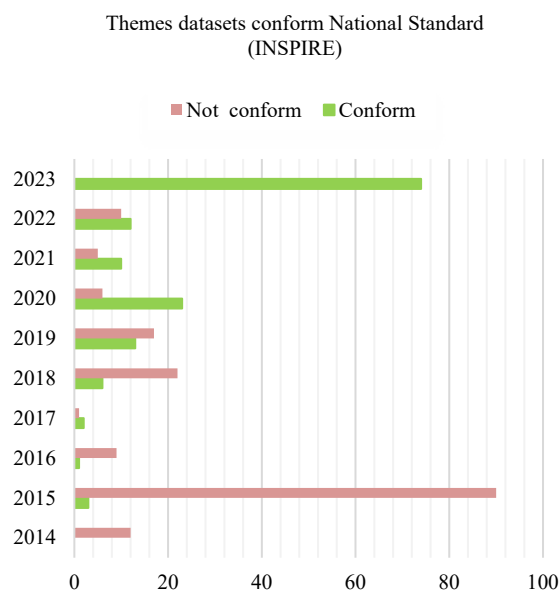


Figure 5. Published data on the national geoportals over the years by conform

The progress between geospatial data published on the National Geoportals in accordance with standards and not in accordance with standards over the years. The comparison between compliant and non-compliant datasets demonstrates the significant strides made in improving data quality and standardization, as in Figure 6.

5. CONCLUSIONS

Albania has made significant advancements in the field of geospatial information, positioning itself in alignment with international standards and demonstrating notable progress relative to both regional and global counterparts. The enhancements in data quality have not only increased the reliability of geospatial data but have also fostered greater confidence among its users. Geospatial data, as an integral element in communication, decision-making, and data exchange, now occupies a critical role in facilitating informed choices across diverse sectors. Since 2014, concerted efforts have been directed towards improving data accuracy through the creation and georeferencing of data, alongside the establishment of a national reference coordinate system for Albania. These initiatives have minimized inaccuracies, consolidated geospatial data, and ensured its alignment with European standards.

The findings of this study underscore the successful integration of international geospatial standards and methodologies within the Albanian context, as well as the significant impact of these efforts on the national geospatial infrastructure. By focusing on metadata and the establishment of a National GIS, Albania is progressively developing a standardized system for geospatial data interoperability, in full compliance with the provisions of the INSPIRE Directive. The establishment of this National GIS framework will enable the efficient identification, development, and application of procedures, technologies, and guidelines to ensure data interoperability.

Furthermore, it will foster cross-institutional collaboration in the creation, updating, and management of geospatial information, thereby enhancing the coherence and usability of geospatial data across various sectors. Looking ahead, the continued implementation and refinement of geospatial data quality in Albania will require sustained focus on several key areas. These include:

- Full adoption of geoinformation standards,
- Further development of the National GIS infrastructure,
- Raising of human capacity through enhancing targeted training programs for public authorities.
- Improving data quality adopting advanced GIS tools for automatic quality verification,
- Fostering stronger collaboration with data creators, and ensuring real-time updates will be essential to maintaining the relevance and accuracy of geospatial data landscape.

By addressing these critical areas, Albania is poised to significantly enhance the quality, accessibility, and utility of its geospatial data, ultimately supporting more effective decision-making and contributing to the achievement of national and regional development goals. Moreover, advancing the technology and software used in the implementation of these systems will be crucial in ensuring their scalability and adaptability to future challenges to achieve interoperability within EU.

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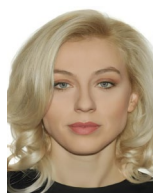
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BIOGRAPHIES



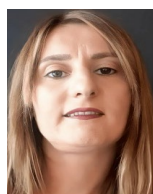
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