# A pathway towards better integration of statistics and geospatial information with the power of standards

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## Abstract

The European Commission funded an action led by the United Nations Economic Commission for Europe (UNECE) to develop capacity in the integration of geospatial and statistical information across the UNECE region. The aim of the action is to foster stronger links between the statistical and geospatial communities across the region, encouraging greater integration of geospatial and statistical information by promoting stronger institutional partnerships and the use of common standards. As part of this action, UNECE established a task force on standards issues relating to the integration of geospatial and statistical data (the INGEST Task Force), bringing together representatives from national statistical and geospatial organisations across the UNECE region to discuss the current use of standards, to explore the present issues and constraints, and to identify priorities and future actions that would strengthen the use of common standards to support data integration activities. This paper presents an overview of some of the activities of the INGEST Task Force, focusing on the importance of implementing standards across the data lifecycle and the benefits that can be gained from their use, then discussing a range of issues and obstacles which are currently limiting the use of common standards across the region, before sharing a set of recommendations which lay out a path towards the greater use of common standards to support the integration of statistical and geospatial information at national levels. A full report of the complete activities and outcomes of INGEST Task Force will be published in the coming months.

**Keywords:** data integration, statistics, geospatial, standards,

## 1.    Introduction

The adoption of the 2030 Agenda for Sustainable Development (United Nations, 2015a) has brought the need for harmonised data of increasing quality, accuracy, currency, and granularity to the forefront of global, regional, and national agendas to support the measurement and monitoring of the Sustainable Development Goals (SDGs) and other key policy drivers such as the Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations, 2015b) and the Paris Agreement (United Nations, 2016). As authoritative data providers, both National Statistical Institutes (NSIs) and National Mapping and Cadastral Agencies (NMCAs) play a

central role in this data revolution and the integration of statistical and geospatial data is described as "one of the most promising paths to provide more timely, reliable and detailed information . . . that can result in new insights that we could not otherwise gain" (Eurostat, 2019, p. 1). While global efforts to drive the greater integration of statistical and geospatial data have been ongoing for more than a decade through the work of the United Nations and other international and regional bodies, the benefits have not yet been fully realised consistently across different countries and regions. The use of data standards, that is, sets of pre-defined rules which ensure that data is consistently described, recorded, and exchanged, are an important means to improve the harmonisation and interoperability of different datasets across space and time and thus to drive the data integration agenda.

Recognising the importance of supporting countries in their data integration journeys, the European Commission funded a project, led by the United Nations Economic Commission for Europe (UNECE), to develop greater capacity in the integration of geospatial and statistical data across the UNECE region. The project aimed to foster stronger links between the statistical and geospatial communities across the UNECE region, facilitate greater collaboration, and encourage the greater integration of geospatial and statistical information by promoting stronger institutional partnerships and the use of common standards. The project was designed to support existing activities to strengthen the integration of statistical and geospatial data by Eurostat and others particularly within sixteen target countries defined as UNECE members that have not yet joined the EU, in Eastern and South-Eastern Europe, the Caucasus and Central Asia.

Under the scope of the project, UNECE established the INGEST Task Force on Standards Issues relating to the integration of statistical and geospatial data in August 2023. The Task Force was designed to bring together representatives from NSIs and NMCAs across the UNECE region (with a particular focus on the project's target countries) to discuss the current use of standards within activities to integrate statistical and geospatial information, to explore the present issues and constraints, and to identify priorities and actions that would strengthen the use of common standards to improve the harmonisation and interoperability of statistical and geospatial information. The Task Force was formed with 16 members from 12 countries, of which 7 were from project target countries (Table 1). A good balance of NSIs and NMCAs were represented, including four countries where both organisations were members which allowed valuable dual perspectives to be gained on the issues discussed. The Task Force was co-chaired by Statistics Finland and Ordnance Survey of Northern Ireland and UNECE acted as the Secretariat.

Table 1: Membership of the INGEST Task Force (*denotes a project target country)

| Country | Organisation |
| --- | --- |
| Albania* | Institute of Statistics (INSTAT) |
| Albania* | State Authority for Geospatial Information (ASIG) |
| Armenia* | Statistical Committee of the Republic of Armenia |
| Azerbaijan* | State Statistical Committee of the Republic of Azerbaijan |
| Bosnia and Herzegovina* | Agency for Statistics of Bosnia and Herzegovina |
| Bosnia and Herzegovina* | Federal Administration for Geodetic and Real Property Affairs |
| Finland | Statistics Finland |
| Finland | National Land Survey of Finland |
| France | National Institute of Statistics and Economic Studies (INSEE) |
| Germany | Federal Statistical Office (Destatis) |
| Malta | National Statistical Office |
| Moldova, Republic of* | Agency for Land Relations and Cadastre of the Republic of Moldova |
| Montenegro* | Statistical Office of Montenegro (MONSTAT) |
| Türkiye* | Turkish Statistical Institute (TURKSTAT) |
| United Kingdom | Northern Ireland Statistics and Research Agency (NISRA) |
| United Kingdom | Ordnance Survey of Northern Ireland (OSNI) |

The main objectives of the INGEST Task Force were to: identify domains where the integration of statistical and geospatial information is hampered by the lack of common standards; identify priorities for standards harmonisation work and recommend related actions that would improve the harmonisation and interoperability of statistical and geospatial information; and contribute to the creation of guidelines to support country-level implementation of the recommended actions. Other objectives of the Task Force were to: support the coordination and collaboration of the statistical and geospatial communities within the UNECE region, to promote stronger institutional partnerships, and strengthen the integration of statistical and geospatial data; contribute to the coordination and collaboration of the related work of other international organisations; and participate in the exchange of experience, knowledge, and best practice. In order to meet these objectives, the INGEST Task Force undertook a series of activities over the course of nine months from August 2023 to April 2024. This paper presents an overview of some of the work of the INGEST Task Force,

focusing on the importance of implementing standards across the data lifecycle and the benefits that can be gained from their use, then discussing a range of issues and obstacles that are currently limiting the use of common standards across the region, before sharing a set of recommendations which lay out a path towards the greater use of common standards to support the integration of statistical and geospatial information at national levels. A full report of the complete activities and outcomes of INGEST Task Force will be published in the coming months.

## 2. Why use standards?

As the International Organisation of Standardisation (ISO, 2024a) aptly defines, a standard is "a formula which describes the best way of doing something", be it building a product, managing a process, or delivering a service. Standards play a critical role in the integration of statistical and geospatial information and their use brings many benefits. Firstly, the use of standards establishes a common mechanism for how data should be created, managed, and disseminated, and when different organisations apply the same standards across their systems and applications, data becomes interoperable allowing the seamless exchange and integration of data between different sources and endpoints. Secondly, standards improve the quality and reliability of data by using common formats and definitions which ensure that errors and inconsistencies in the data are minimised. Thirdly, the use of standards improves efficiency by streamlining processes which, in turn, increases the usability of data by making it easier to find, understand and reuse. Fourthly, common standards provide a framework for data users to make meaningful comparisons between different datasets across space and time. They also enable data to be combined from diverse sources, providing new possibilities for analysis and interpretation which can reveal new insights that would not otherwise be visible. Finally, standards are designed to evolve over time and adapt to the fast pace of technological advancements and changing requirements, ensuring that organisations can future-proof their activities, processes and products with ease.

Considering the clear benefits that can be derived from standards use, organisations increasingly rely on standards to improve their practices at national, regional, and global scales. The use of internationally-agreed standards in particular can help to improve the efficiency of functions through the harmonisation of regulations; they can stimulate solutions to multi-scale issues such as energy efficiency, emergency preparedness and response, and international trade; they can help to achieve cost-savings in policy-making as much of the technical detail and safety requirements are already pre-agreed; and they can be used as solutions to policy issues which reflect a broad range of views and expertise (ISO, 2024b).

Data standards are an important element of good government practice and "are fundamental to improving how government shares, integrates and uses data . . . [by setting] a clear and common understanding of how the government must describe, record, store, manage and access data in consistent ways" (Data Standards Authority, 2021). Historically, however, it has been common for different parts of government to adopt different standards, or even create their own, to meet their specific needs or challenges. This has meant that, at national levels, government practices can be inconsistent and the resulting datasets incompatible for sharing and re-use. These problems are only compounded further as national borders are crossed and data-driven decision-making and policy development is required at regional and global levels. To realise the benefits of data standards, governments must improve coordination through the sharing of knowledge and best practices, centralise the implementation of data standards to increase their adoption, and develop and deliver clear strategies that address cross-government user requirements. In doing so, governments will ensure that data is of high quality, is accessible, interoperable, and comparable which, in turn, will promote the usability and reuse of data. This will result in greater collaboration, improved efficiency, support the adoption and implementation of new solutions, and improve the speed and effectiveness of change management processes (Data Standards Authority, 2021).

There are well-established processes and systems in place for the development and adoption of globally agreed statistical and geospatial standards. The need for standards to support the creation, management and dissemination of geostatistical information has been long been recognised and the growing use of standards in general will help to drive the closer integration of statistical and geospatial information, particularly through the work of UN-GGIM and important policy frameworks such as the Global Statistical Geospatial Framework, or GSGF, (UN-GGIM, 2017) and the United Nations Integrated Geospatial Information Framework, or UN-IGIF, (UN-GGIM, 2018). Within the GSGF, for example, standards and good practice form one of the four key elements which play an enabling role in the application of the framework and its principles. Principle 4 of the GSGF, that of statistical and geospatial interoperability "urges the use of internationally adopted standards and good practices from both [the statistical and geospatial] communities to enable greater interoperability of statistical and geospatial data, standards, processes and organisations" (UN-GGIM, 2017, p. 12). Equally, standards form one of the nine strategic pathways of the UN-IGIF as a fundamental means to "enable different information systems to communicate and exchange data, enable knowledge discovery and inferencing between systems using unambiguous meaning, and provide users with lawful access to and reuse of geospatial information" (UN-GGIM, 2018, p. 23). The Open Geospatial Consortium (OGC), in collaboration with the ISO Technical

Committee 211 Geographic Information/Geomatics (ISO/TC 211) and the International Hydrographic Organisation (IHO), has also recently developed the third edition of the UN-GGIM (2022) guide on the role of standards in geospatial information management, including interoperability with other systems and data sources. UNECE, working with groups of experts such as the High-Level Group for the Modernisation of Official Statistics (HLG-MOS), also create, enhance, and promote standards for statistical production with a particular focus on standards for metadata. In doing so, UNECE ensures that "common definitions and processes are used within and between statistical organisations, helping to remove the barriers to collaboration on technical projects, fostering the sharing of knowledge and experiences, and serving as a basis for streamlined statistical production" (UNECE, 2024). There are clear drivers and support available for the implementation of common standards to support the integration of statistical and geospatial information, yet they are still not used consistently across the region. The INGEST Task Force has explored in depth why this has been the case and is presented in Section 4 below.

## 3.   Task Force activities

In order to achieve the primary objectives of the INGEST Task Force, three activities were undertaken by the Task Force, with each activity designed to build upon the results of the previous activity. The first activity aimed to understand the current use of standards by member organisations and to share use cases and best practice. Task Force members contributed to the compilation of a database which documented the standards presently used by their organisations that specifically relate to data integration activities as defined by the GSGF (UN-GGIM, 2017). The information collected included the name of the standard, type of standard (e.g. national, international), stage of use in the data lifecycle as based on the stages outlined in the Geospatial view of the Generic Statistical Business Process Model (GeoGSBPM; UNECE, 2021), other use (e.g. data quality, metadata, archiving), type of use (e.g. live processes, pilot/testing), and additional information (e.g. benefits, problems encountered, use cases).

The aim of the second activity was to assess the wider operating environment that supports the organisational use of standards and to identify the gaps present within and between organisations. Each Task Force member completed a SWOT analysis to identify the strengths, weaknesses, opportunities and threats that supported or limited the use of common standards within their organisation and to identify any notable gaps that should be addressed. For this and the following activity, the Task Force was divided into a Governance Sub-Group which focused on wider governance issues relating to standards use such as organisational

structures, financial models, workplace cultures, legislation, and policies, and a Technical Sub-Group which considered the technical aspects of standards use, such as IT systems, hardware and software requirements, security and licensing, technical knowledge and skills, and internal workflows.

The final activity aimed to identify and prioritise the requirements needed to successfully implement common standards across an organisation to achieve harmonised and interoperable data. Using the results of the SWOT analysis, each Task Force Sub-Group completed a MoSCoW analysis to identify and prioritise a set of requirements based on four prioritisation categories: Must Haves (non-negotiable needs that are mandatory for standards implementation); Should Haves (important requirements that are not vital but add significant value); Could Haves ("nice-to-have" requirements that would have a small impact if left out); and Will Not Haves (requirements which are not a priority and will not be implemented at this time). The results of this activity were used to inform the development of a set of recommendations which set out a path towards the greater use of common standards to support the integration of statistical and geospatial information at national levels.

## 4. Issues and obstacles to standards use

Despite the clear benefits gained from using common standards to support the integration of statistical and geospatial information across the data lifecycle as outlined in Section 2, a range of issues and obstacles have hampered progress. Taking a broad view, one key issue noted by Van Halderen *et al.* (2016) has been the differing professional paradigms which have driven standards development within the statistical and geospatial sectors: "the official statistical community has over fifty years of governance by the peak, international statistical standards body, the UN Statistical Commission, [whereas] within the geospatial community, the private sector has led the application of many new approaches" (2016, p. 467). Another issue is that standards have not been consistently adopted across countries with differing levels of development and it has been recognised that many organisations located within low-to middle-income countries are operating in the complete absence of standards (PARIS 21 & Statistics Sweden, 2021, p. 3). The fundamental lack of common standards and standardised methodologies specifically for the integration of geospatial and statistical information has also presented a barrier. UNECE has noted that "a single approach to the geographic dissemination of statistics isn't feasible given the differing requirements for statistical production" (2016, p. 32) and the broad range of geospatial data sources available makes it difficult to endorse common methods for all data types. While the development of standardised statistical process models, such as the GSBPM and its geospatial view (UNECE, 2021), are helping to provide

greater consistency in statistical processes, not all models can easily incorporate geospatial aspects which has created further challenges (Van Halderen et al., 2016, pp. 467-468).

As outlined in Section 3 above, the INGEST Task Force assessed the capability of their organisations operating environment to support the use of common standards for data integration activities. SWOT analyses were completed to identify the strengths, weaknesses, opportunities, and threats that supported or limited the use of common standards across member organisations from both a governance and a technical perspective. Any notable gaps present within and between organisations that would hinder the production of harmonised and interoperable data using common standards were also identified for action. The complete results of this activity will be presented in the full report of the INGEST Task Force due to be published in the near future, however, for the purpose of this paper, a summary of the key issues and obstacles to the greater use of common standards to support data integration activities are presented below.

## 4.1. Governance Issues

Governance is "the leadership of decision-making, culture, controls and accountability" (Leading Governance, 2023) which extends across hierarchies to ensure that good outcomes are consistently achieved within and between organisations. At global and regional levels, strong governance frameworks are in place which bring stakeholders together to work cooperatively to drive the greater integration of statistical and geospatial information through, for example, the work of UN-GGIM, UNECE, Eurostat, and the European Forum for Geography and Statistics. At national levels, however, governance practices may differ significantly from country to country which has led to uncoordinated and inconsistent approaches to the integration of statistical and geospatial information when viewed regionally (Eurostat, 2019). The INGEST Task Force, through its Governance Sub-Group, identified a range of issues and obstacles that have been limiting the organisational use of common standards from a governance perspective and some key findings are summarised below.

### 4.1.1. Differing approaches to governance and a lack of common understanding

Different organisational drivers have resulted in an incohesive approach to standards implementation. There is evidence of weak collaboration between national statistical and geospatial organisations, with little understanding of shared requirements. The implementation of the GSGF model, for example, with standards as a key element, requires a broad national consensus. At an organisational level, the presence of bureaucratic internal systems and processes that are difficult to change have inhibited standards implementation. Due to

organisational silos, there can be limited strategic awareness and understanding of the key role of standardisation, data integration and interoperability. Within organisations, standardisation is often considered as merely a technological exercise and not a strategic asset. This lack of engagement needs to be overcome to maximise the impact of standards on improving the harmonisation of statistical and geospatial information. An absence of effective national- and organisational-level strategies and policies also prevents understanding and realisation of the value of standardisation. The involvement of organisations from across government can be challenging if they cannot see the direct benefit arising from their investment of time and resource. This is particularly relevant given the environment of limited funding and financial constraints that government organisations in most countries are currently operating in.

### 4.1.2. Difficulties in communicating the benefits of standards adoption

A lack of communication of the importance and benefits of standardisation can inhibit the willingness of organisations to engage with, inform the development of, and implement standards across the data lifecycle. Some of the standards that are in place for statistical and geospatial data are not easily communicated due to their complex, highly technical nature, and their benefits are not easily grasped by decision-makers.

### 4.1.3. Challenging financial environments

There is currently a lack of sufficient funding and resourcing to drive the implementation of standardisation across government organisations. This presents a challenging environment in terms of developing financial partnerships and identifying funding sources for initiatives aimed at delivering better integration of statistical and geospatial data. Reduced organisational funding for development activities deteriorates interest and participation in standardisation work and innovative, non-standardised solutions may challenge established standards, especially if they offer more flexibility or cost-effectiveness.

### 4.2. Technical Issues

The quality and accessibility of statistical and geospatial data, and the strength of the technical infrastructure that supports its creation, management, and use, is central to the data integration agenda. The technical aspects which govern the creation, management and dissemination of data are broad and include IT systems and infrastructures, hardware and software requirements, internal workflows, security and licensing, and technical knowledge and skills. A strong data infrastructure will ensure the increased efficiency and productivity of users, ease of collaboration between different groups, and securely managed access to organisational data

for both internal and external users. Yet, technical issues at an organisational level are limiting the integration of statistical and geospatial information for a range of reasons. The INGEST Task Force, through its Technical Sub-Group, identified a number of issues and obstacles that have been limiting the organisational use of common standards from a technical perspective and some of the key findings are summarised below.

### 4.2.1. Compatibility of data received from other agencies

The compatibility of data received from other national institutions is a critical concern as this data may not meet the desired standards required for integration. While collaboration and data sharing are vital for effective decision-making and resource management, it is important to recognise that the quality and adherence to standards may vary across different agencies.

### 4.2.2. Variance in data quality, completeness and reliability

Data quality is not uniform across all geographic levels. Different organisations serve their users according to specific requirements and demands, meaning that they often work separately in silos. Consequently, datasets can have differences in key elements such as formats, structures and identifiers. This non-standardised approach presents challenges in combining, comparing and integrating data from across the different organisations for geostatistical purposes. Data quality varies at the level of municipalities, neighbourhoods and villages which influences data accuracy, completeness, and reliability. For example, there can be a lack of data at the lowest level of geographical units (towns and villages) due to inaccurate administrative boundaries. Administrative records obtained from external institutions may also contain inaccurate and/or missing information. These records may lack essential information due to gaps in data collection or reporting and inaccuracies can result from manual data entry, misinterpretation, or outdated records, use of varying data formats, codes, and terminology. The availability of qualitative data from administrative sources is also a critical concern. While administrative data provides valuable insights, its inherent limitations often result in insufficient qualitative information.

### 4.2.3. Geographic referencing and address complexity

Geospatial data often involves multiple reference systems. These references can be based on different coordinate systems, datums, or projections. Point-based geocoding can be mistaken, and in some cases, geocoding can be more efficient based on area-based practices. Addressing formats vary from one country to another, making localisation difficult. Standardising addresses to a common format could facilitate data integration and analysis.

### 4.2.4. Inadequate data and technology infrastructures

Difficulties in integrating data from different institutions can result from a lack of common identifiers and standardisation. Location-centred data architecture can be lacking and geospatial data and concepts may not be considered an integral part of the data architecture, ultimately hampering interoperability. There can also be a long history of retaining legacy data management systems which limits the innovative use of emerging technologies and standards. Inadequate IT infrastructures are unable to support the efficient standards-based exchange of data which can lead to delays, errors, and inefficiencies across the data lifecycle. National institutions may also struggle to allocate sufficient budget for data integration projects and the necessary infrastructures due to public saving measures and budget deficits. IT costs for spatial data infrastructures can be enormous, even if open-source software is used.

### 4.2.5. Organisational skills gaps

There is limited awareness and expertise in the use of international standards and best practices. The complexity and non-understating of geospatial standards by experts and organisations creates the tendency for non-implementation of these standards. The fast pace of technological advancement can also outstrip the standardisation process, leading to outdated or irrelevant standards. The pace of technology changes also requires constant upskilling and investment. Many new data sources and methods are inherently highly technical in nature (e.g. big data, Earth Observation data, AI methods) and their management and resourcing can be a challenge. Recruiting and retaining staff with the required knowledge and skills presents difficulties and staff turnover, the rate at which employees leave an organisation and are replaced by new hires, has a significant impact on institutional continuity and the subsequent loss of expertise in critical and niche areas.

## 5. A pathway towards the use of common standards

Based on the collective outcomes of the activities undertaken by the INGEST Task Force and their contextual consideration, five recommendations have been made by the Task Force which lay out a path towards the greater use of common standards to support the integration of statistical and geospatial information at national levels. The recommendations are grouped under four themes: cooperation, collaboration and communication; strategic leadership; data and technology infrastructures; and skills and training. The INGEST Task Force recommend that:

1. Cooperation, collaboration and communication should be institutionalised through official structures and networks (e.g. national steering groups), developing shared objectives

that are supported by operating models and technical standards relevant to organisational and national activities.

2. Acquire an organisational commitment to standards adoption and the active participation in standards development where relevant, and ensure that organisational structures are in place to support the effective use of standards which are strategically driven by senior management and technically supported by skilled staff.

3. Develop a national roadmap for data integration with standards as a key element, while formalizing agreed leadership and champions to drive the implementation of this roadmap.

4. Data and technology infrastructures should be "fit for purpose" and facilitate the implementation of standards and integration across the data life cycle. Information management practices for these statistical and geospatial data infrastructures should be aligned and integrated to support these standards.

5. Identify organisational skills gaps and implement specialist training programmes which develop and maintain organisational expertise in standards use that support integration workflows across the data lifecycle.

The recommendations are designed to support national statistical and geospatial organisations in their actions to adopt and embed the use of common standards in activities to integrate statistical and geospatial information across the data lifecycle. Each recommendation is supported by a set of implementation guidelines which outline the practical steps that organisations should take to achieve them and will be made available in the full report.

Following this pathway will bring many benefits. By establishing common mechanisms to create, manage and disseminate data, data will become interoperable and facilitate the seamless exchange of data between different sources and endpoints. The use of common formats, definitions, and processes will enhance the quality, reliability, and usability of the data, allowing meaningful comparisons to be made between different datasets across space and time. By embedding standards within internal workflows, organisations can also future proof their activities, processes and products in the face of rapid technological advancements and changing requirements. Ultimately, the use of common standards within processes to integrate statistical and geospatial information will result in the harmonised, interoperable, high-quality data needed to improve decision-making, inform policy development, and realise efficiencies in processes and services within and across different organisations at national, regional and global levels.

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