National Mapping Authority Perspective: International Geospatial Standards

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Foreword

As the joint Co-Chairs of the Committee of Experts of the United Nations Committee of Experts on Global Geospatial Information Management, or UN-GGIM as we more commonly refer to it, we are delighted to offer an insight into the very important area of international geospatial standardization from an institutional and business value perspective.

UN-GGIM was established by the Economic and Social Council of the United Nations (ECOSOC) in July 2011 in order to try and realize a vision that could help address the need for global geospatial information management – to make accurate, reliable and authoritative geospatial information readily available, in all countries, to support national, regional and global development.

ECOSOC encouraged 'Member States to hold regular high-level, multi-stakeholder discussions on global geospatial information, including through the convening of global forums with a view to promoting a comprehensive dialogue with all relevant actors and bodies'. The Second High Level Forum in Doha noted the importance being placed on the quality of outputs of the Regional Committees. There are now UN-GGIM regional organisations throughout the world, namely UN-GGIM: Americas, UN-GGIM: Arab States, UN-GGIM – Asia and the Pacific, and UN-GGIM: Europe. A number of these regional organisations are actively involved in developing and implementing international geospatial standards.

International standards enable what is often described as interoperability, which can be defined as breaking down institutional barriers, as well as addressing differences between nations, languages and cultures. Interoperability also covers diverse disciplines, professions and industries, as well as different levels of industry, government, academia and the public working together by using common formats and Information Technology protocols. At a fundamental level this means teams, departments and organisations interacting seamlessly using different technologies and software vendor products.

Through UN-GGIM there is a unique opportunity to use one voice to represent every Member State working in the global geospatial sector and to unite all the worlds' geospatial leaders, expert practitioners and users on important common issues; international standardization is one of those issues.

While written from a National Mapping Authority viewpoint, this paper addresses some of the crucial communication elements of international standards and the need to develop a culture of standards adoption. It also offers examples of national and regional initiatives to highlight good practice and lessons learned, and can be used by other organisations working with the management of geospatial information.

We invite you to read this important non-technical view of international geospatial standards and to participate in UN-GGIM to help your organisation and your nation to further develop by using global geospatial information management.

Yours sincerely,

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1 Background

In the outcome document from Rio+20 "The future we want" Governments and organisations committed to disaster risk reduction and to enhance the resilience of cities and communities to disasters. One of the main outcomes of the Rio+20 Conference was the agreement by Member States to launch a process to develop a set of Sustainable Development Goals (SDGs), which will build upon the Millennium Development Goals and converge with the Post-2015 development agenda.

Both of these activities (and many more) are underpinned by geospatial information and the need to access and share that information – information which not only contains location but also the geographic information itself, complete with metadata and the need for interoperability.

Looking at the sustainable development statistics from Rio+20 can provide an insight into the power of location or geospatial information. For example, today the world has 7 billion people; by 2050 there will be 9 billion (United Nations, 2013[1]): Where will they live? There is massive migration to cities for a variety of reasons including escaping the effect of flooding, increasing urban development and to find employment. All of these people require somewhere to live and this requires urban and social planning underpinned by high quality, authoritative geospatial information. In addition almost a billion people go hungry every day; as a result food security is extremely important. Where can food be grown or sourced or transported from? Again it is essential to have high quality, up-to-date, authoritative geospatial information available and accessible to eradicate extreme poverty and hunger.

The UN-GGIM Committee of Experts coupled with input from Member States defined a set of issues that identify areas where changes to and improvements in geospatial information management can support global challenges such as, disaster response and sustainable development. The Inventory of Issues[2] which forms the initial work programme for UN-GGIM and contains a number of topics where international standards bodies can be actively engaged with the UN-GGIM work programme.

One of the outcomes from engagement with international standardization bodies was a report jointly written by ISO/TC 211, OGC and IHO: *The UN-GGIM inventory of issues and geographic information standardization.*[3] This report relates to standard-setting issues in the international community. The report was presented at the Third Session of the Committee of Experts on Global Geospatial Information Management in Cambridge, England on 27th July 2013.

The purpose of this paper is to provide, from a National Mapping Authority (NMA) perspective on international geospatial standards, a non-technical view of the importance of readily accessing and sharing geospatial data. It is designed to be read alongside the *Guide to the role of Standards in Geospatial Information Management*[4] and the *Companion Document on Standards Recommendations by Tier*[5] (OGC, ISO, and IHO, 2014). These three documents have been written specifically to address the outcomes from UN-GGIM 3, and will be made freely available on the UN-GGIM website from August 2014 onwards.

From an NMA viewpoint and with regards to international geospatial standards Member States need to understand how to:

- Create a baseline or mechanism for data access and sharing;

[1] http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2012_Volume-I_Comprehensive-Tables.pdf

[2] http://ggim.un.org/2nd%20Session/E-C20-2012-5%20Inventory%20of%20Issues%205%20July.pdf

[3] http://ggim.un.org/docs/meetings/3rd%20UNCE/E_C.20_2013_8_ISO-OGC-IHO%20Standards%20background%20paper.pdf

[4] http://ggim.un.org/docs/meetings/GGIM4/E-C20-2014-8_Essential%20Standards%20Guide%20for%20UNGGIM.pdf

[5] http://ggim.un.org/docs/meetings/GGIM4/E-C20-2014-8_Companion%20Document%20UNGGIM%20Essential%20Standards%20Guide.pdf

- Adopt existing standards and implement them in national legal and policy frameworks;
- Support and work closely with international standardization bodies working in the field of global geospatial information management, including the International Organization for Standardization (ISO), Technical Committee 211 (Geomatics and Geographic Information), the International Hydrographic Organization (IHO) and the Open Geospatial Consortium (OGC).

2 What is a standard?

The Guide to the role of Standards in Geospatial Information Management (OGC, ISO and IHO, 2014) defines a standard as '*a documented agreement between providers and consumers, established by consensus, that provides rules, guidelines or characteristics ensuring materials, products and services are fit for purpose'.*

In the context of this paper the phrase 'standards' refers specifically to geospatial standards, which have been developed to structure and define geospatial data. In simple terms, geospatial standards help to define the communication channels and the language used to speak about geography digitally. Standards for geospatial information particularly define approaches, software interfaces or encodings for data. Software developers use these documents to build open interfaces and encodings into their products and services.

The majority of international standards are developed in Standards Development Organizations (SDOs) that use a consensus process guided by documented, repeatable and well proven policies and procedures. Typically, any organization can join an SDO and participate in the standards development process. This helps ensure that the standards developed meet the needs of all users and that they are primarily "demand" rather than "supply" driven.

2.1 The open movement

A standard is said to be 'open' if it is publically available, and can be influenced, downloaded, and used by anyone. The precise meaning of 'open' is not universally defined, but the OGC defines open standards as ones which are:

- Publically available
- Unencumbered by patents and other intellectual property
- Anyone can download and use the standards (non-discriminatory)
- No license fees
- Vendor neutral
- Data neutral
- Agreed to in a consensus decision making process
- No single entity controls the standard

Over recent years an international movement has grown up which promotes the use of open standards. A number of NMAs and Governments now routinely use open standards when developing systems. Some of the advantages of open standards are that they avoid any single party monopolising the control of a data interface, data format or software approach, and they can help to reduce "lock-in" to a specific technology or architecture. Open standards are also seen to encourage market competition leading to lower total cost of ownership of systems. They may also help stimulate innovation and development of new ideas due to the collaborative nature of the standards development process. For a more detailed discussion on open standards, readers should refer to the OGC paper which is published alongside this one.

3 How and why Member States benefit

For governments, the use of standards can be categorised as short-term and longer-term benefits. Short-term benefits include increased interoperability between departments within national governments and the sharing of information and knowledge. Longer-term benefits can include improvements to national budgets through ensuring new technologies interact with older outdated technologies. Long-term benefits also relate to the need to develop a policy framework around the use of standards. The benefits of standards that are used world-wide can be supported by a clear policy framework.

3.1 Interoperability of geospatial information is enabled within and between national and international organisations

Governments are increasingly dealing with natural hazards and emergency situations where there is growing need to share geospatial information. A good example can be seen in the case of flooding, few people are interested in weather itself; it's the impacts of weather that are the concern. Where many businesses or homes are affected, as well as potentially lives, the need to share the right geospatial information at the right time to the right people in a timely manner is crucial. The range of people who want access to the geospatial information relating to a flooded area, as quickly as possible, extends from emergency services to volunteer helpers to hydrologists and meteorologists. All of these people require the same information so they can make correct decisions based on location. This could mean integrating weather and climate information with property or transport information into the hydrology domain; both of these will require the use of shared standards.

3.2 Reduction in the costs involved in sharing data

One of the largest single costs to IT projects is often from not being able to access and share data for analysis and decision making. Changing to using open standards helps manage the costs of government IT projects by ensuring long term sustainability, providing flexibility to swap-out old technology and replace with new technologies and reducing reliance on single suppliers. Open standards also enable better return on investments by providing interoperability with communications, digital sustainability and reuse of public sector information.

3.3 Utilise new technologies quicker and more efficiently

As industry delivers technologies based on open standards, users can utilise new solutions quickly and adapt easily to the rapidly changing information and communications environment, policy changes, and meet new and emerging user requirements. To quote the Open Geospatial Consortium "Standards provide a platform for realizing opportunities that would otherwise remain hidden[6]." Through an open standards consensus process, technology users can begin to influence software vendors to consider implementing geospatial standards into their products. Standards then help users maximise the return on their current and future technology investments, while reducing the time and cost of integration.

[6] http://portal.opengeospatial.org/files/?artifact_id=7376

3.4 Providing consistency for citizens, the public sector and the private sector

Government can reinforce the purchase and use of these standards-based systems through developing and implementing open standards policies within their countries. This in turn provides Member States with the best possible assurance that present and future products and technologies will interoperate with previously deployed systems. When a significant number of systems implement open standards citizens can easily publish, discover, access and use diverse sources of data and services. These benefits apply to the internet-connected nations, nations that rely heavily on mobile-connectivity as well as non-connected systems. In addition the use of open standards can make it easier for public and private sector institutions to remove some of the technical barriers to data sharing, allowing institutions to develop agreements based on their needs.

3.5 Avoiding the vendor lock-in scenario

There are a number of issues relating to what is described as 'vendor lock-in' whereby product upgrades from a single vendor can be costly and government bodies are forced to pay for these expensive software changes because they have no alternative options; open standards provide that option to switch vendors or move to open source software providers.

Ordnance Survey decided to make its data available in an open standards format called OGC Geography Mark-up Language (GML). This is a way for computers to share information about digital geographic information in a standards-based manner. As a result of this decision in 2001 a large number of vendors in Great Britain working with national mapping data had to ensure their products could work with GML. This meant that no single vendor format had to be used to work with Ordnance Survey data. It also engaged other government organisations and academic institutions to work on national geospatial information via a single standards-based format.

Example: National Mapping Authority, Ordnance Survey, Great Britain

3.6 Using geospatial technologies to drive economic growth

Globally, economic growth continues to be driven by increased industrial activity. However new technologies, such as geospatial, are being recognised by governments as important drivers to national economies as they offer different prospects for growth. In order to stimulate and support these prospects open geospatial standards offer possibilities for interoperability through data exchange. However, in order to drive such interoperability it is important that government policy refers to open standards for internal organisation use, as well as wider national government legislation. In Mexico under the eGovernment agenda, the Government requires federal institutions to use open standards in order to reduce costs, improve interoperability and increase innovation.

As demand for open standards from government increases, it is likely to provide a stimulus to the standards industry to develop better standards; this could be in terms of funding, or simple need. This in turn is likely to encourage researchers and technology developers to engage in standards development.

In the Netherlands, in March 2011, geospatial standards were added to the 'comply or explain' list of open standards of the Dutch Standardization Board (College Standaardisatie in Dutch). This means that all Dutch government organisations must now incorporate and implement these standards, where applicable. Dutch geospatial standards are managed by Geonovum, the National Spatial Infrastructure (NSDI) executive committee in the Netherlands. Some of the work Geonovum carried out includes:

- Increased interoperability between and within e-government services using open standards;
- Decreased software suppliers dependency through faster adoption of open standards and open software;

- Stimulated innovation and economy through the use of open source software, giving preference to open source software using 'comply or explain' principle.[7]

3.7 Protecting long-term technology investments

There are various types of open standards and their relevance is associated with the technology adoption lifecycle and the uptake or adoption of the standards themselves. There are currently 50 geospatial standards available from the Open Geospatial Consortium, the International Organization for Standardization (ISO) Technical Committee 211 Geographic Information/Geomatics and the International Hydrographic Organisation; these are outlined in Annexe B. The various standards are useful at different phases such as during the emergence of new technology or during the increased adoption phase of existing technologies, such as geospatial software and services.

Long-term geospatial technology investments which are underpinned by open standards are protected because software systems or solutions can be swapped if a software vendor goes out of business, tries to unfairly raise prices for software maintenance/upgrades, better tools become available from a different vendor or if the user decides to move to an open source implementation or vice versa.

3.8 Assisting in the development of international standards

Developing standards through a collaboration process can also have wider benefits as it encourages cooperation through joint research and sharing of experience. Software developers and researchers have an opportunity to contribute to standards development for new or emerging technologies that may have an impact on their organisation. Through the standards development process vendors and academics also come together with public sector professionals to assess the suitability and usability of standards that are relevant across multiple thematic areas or application domains and industrial sectors.

There are a number of co-funded programmes in standards development organisations which can support such cooperation; one example is the OGC Web Services (OWS) initiatives. This is part of the OGC Interoperability Program which offers global, collaborative, hands-on engineering, prototyping and testing designed to rapidly deliver candidate standards, change requests, demonstrable implementations and engineering reports. Sponsors provide requirements, use/business cases and funding, and then work together with participants to define and/or refine standards to provide a solution.

3.9 By creating uniformity, capability and interoperability of data

Standards have always been important for cartographic and charting purposes; for example standardizing the way geographic data is captured and portrayed on paper maps, and how nautical distance is defined and measured. In the current digital age, standards have become of significant importance for the exchange of data between data stores and through open data and document formats at a national, regional and global level. In the UN-GGIM paper *Establishment and implementation of standards for the global geospatial information community*[8] the benefits of standardization within the global geospatial information community are described:

[7] http://geostandards.geonovum.nl/index.php?title=1.1.3_What_are_open_standards%3F

[8] http://ggim.un.org/docs/meetings/3rd%20UNCE/E-C20-2013-8-Setting%20Geospatial%20Standards%20Report.pdf

"Geospatial information, spatial data infrastructures and geospatial web services are now widely accessible, shared and reused in many contexts primarily because geospatial information, systems, and services are interoperable – that is, able to be integrated and shared. Standardisation has contributed significantly to the evolution and development of the interoperability of geospatial information and services. Geographic components, such as fundamental data types for geospatial and temporal information, conceptual modelling rules, semantics of real world phenomena, metadata, services, encoding, etc. are developed into standards to set the foundation and building blocks that enable interoperability of geospatial information."

This uniformity, compatibility and interoperability that the use of standards brings have allowed the rapid expansion of digital communication across the globe. It should be realised that this use of standards is across all aspects of information technology ranging from how hardware such as servers or communication satellites are built, to the software interfaces or code structure within a software programme; the use of better integrated, available, and updated information a very powerful tool to aid decision-making.

4 How can Member States and National Mapping Authorities realise these benefits

4.1 Selection and adoption of relevant standards

Selection of appropriate standards to use is a task that must be taken seriously due to the number of considerations needed to develop a robust business case. These include: legal obligation, customer preference, interoperability, cost, and future-proofing.

Voluntary adoption brings additional considerations; whilst there is a good general case to be made for the use of standards it should be restated in each case with the specific reasoning. Criteria for voluntary adoption of standards include:

- A desire to break into a market which uses standard(s);
- Customer demand for a specific standard;
- Probable that a standard will be mandated in the future;
- A desire to promote and encourage the use of a standard;
- To drive data access and sharing;
- Operational efficiencies which can be gained;
- Protection of investment; and
- Removal of the potential for unintended barriers to digital participation.

At least one of these criteria should be valid before a standard is adopted.

Implementing standards within governments can be both top-down and bottom-up, based on a good understanding of the nature of the communities using the standards and their user requirements. A top-down approach would consider embedding standards into government policy so that they are mandated as part of IT procurement across government. There are some examples from the Infrastructure for Spatial Information on the European Community Directive (INSPIRE) and other national initiatives which are underpinned by their National Spatial Data Infrastructures. A bottom-up approach, supported by community use, would consist of a number of standards that are being developed outside the 'official' standards development process and which can be taken into consideration and ideally brought into the process to provide a framework for regulation and long-term development. Member States have the opportunity to adopt and implement international geospatial standards and to aid the development of future standards by international organisations.

The UN-GGIM document *Establishment and implementation standards for the global geospatial information community*[9], refers to the need to consider mechanisms or tools to allow simple implementation of different geospatial standards. This report also mentions encouraging and supporting Member States in their assessment of why, how and when to use standards.

In this context, standards of relevance to Ordnance Survey activities relate to data capture, management, maintenance and dissemination. The list below only provides context for the range of international geospatial standards used and is not exhaustive, it includes:

- Coordinate systems e.g. ETRS 89
- Geospatial data format e.g. GML
- Geospatial data specification e.g. INSPIRE specifications
- Web Services e.g. OGC Web Map Services (WMS) and OGC Web Feature Services (WFS)
- Code Lists, glossaries and ontologies e.g. GEMET
- Metadata, e.g. ISO 19115, 19139
- Conceptual and architecture, e.g. ISO 19109 Rules for Application Schema
- Data quality, e.g. ISO 19157 Geographic Information – Data Quality
- Data model standards e.g. UML, ISO 19109

Example: National Mapping Authority, Ordnance Survey, Great Britain

As part of the technical regulations, INEGI (the National Institute of Statistics and Geography in Mexico), as information producer and according to the powers conferred by the Law of the National System of Statistical and Geographical Information (SNIEG), strives to offer the Geographic Information of National Interest that will be integrated into the System supported by the development of regulations and guidelines on methodological, technical and conceptual standards related to gathering, processing and publication of the following data groups:

- Geodetic reference frame
- Coastal, international, state and municipality boundaries
- Continental, insular and submarine relief
- Topography
- Cadastre
- Geographical names
- Natural resources and climate

Thus, in order to have organized, structured and approved geographic data, INEGI has integrated into its Standards Development Program the following technical standards and add value of these standards is that they are available at no cost:

Technical Standard	Process Stage

[9] http://ggim.un.org/docs/meetings/3rd%20UNCE/E-C20-2013-8-Setting%20Geospatial%20Standards%20Report.pdf

• Geographic Addresses • National Geodetic System • Positional Accuracy Standards • Geographic Metadata Generation • Generation, capture and integration of Cadastre and Register Data for Statistical and Geographic Purposes • Use of the Catalog of Undersea Feature Generic Terms (Accord)	Published in the Official Journal of the Federation
Technical Standard	**Process Stage**
• Generation, updating and management of the Unique Code for the Territory Register for geographic purposes (Guideline) • Generation of Geographic Information using Digital Elevation Models which will be incorporated to the National System of Statistical and Geographical Information • Aerial Surveys using Digital Aerial Camera for Geographic Information Generation purposes • Continental and Insular Geographical Names for statistical and geographic purposes • Geostatistical Framework for statistical and geographic purposes • Satellite Image Acquisition for geographic purposes • Cadastre Information Exchange for statistical and geographic purposes (Guideline) • Geographic Information Interoperability • Use of the Catalogue for Natural and Induced Vegetation Types for statistical and geographic purposes (Accord)	In development
Example : National Mapping Authority, INEGI, Mexico	

4.2 Using international standards to create national good practice

Whilst some of the standards for geospatial information can be directly implemented in policy, processes or software, there are numerous geospatial information standards that provide a general framework and need to be made more specific for any practical use.

This applies mostly to standards that describe data than to standards that specify services. A good example for this is the ISO/TC 211 standard for metadata, ISO 19115. This standard specifies a large number of metadata attributes that may be useful to describe a dataset or service. In order to use this standard, the mandatory and optional attributes that should be used to describe the metadata of datasets in a domain, such as environmental data or data of the built environment, needs to be defined as a subset of the attributes that ISO 19115 offers.

4.3 Participating in international standards development

Geospatial standards development offers key stakeholders an independent forum to discuss technical and business issues relating to standards; this can include identifying information that exists somewhere in their organisation, trusting the source of the information and reducing duplication of effort in creating and maintain different sets of data. The focus in the standards environment is not on a specific vendor's capabilities or a certain software programme, but closely related to solving a shared set of issues. For government organisations this knowledge sharing is incredibly powerful since they can raise some key technology issues in this environment and effectively gain feedback from across a wide range of standards developers which would otherwise be costly via software vendors, consultancies or system integrators.

4.4 Communicate the benefits of standards

Many of the business benefits of standards go beyond technical issues to the issue of data sharing. It is vital therefore that senior leaders within organisations provide or use geospatial information understand the business value of international geospatial standards. There are numerous challenges around the communication of information relating to international geospatial standards, primarily because this is still perceived as a technical function in most organisations.

The Open Geospatial Consortium created a Business Value Committee (BVC) to directly engage senior managers, commercial, sales and marketing professionals to identify, organize and promote the business value of geospatial standards. The mission of the BVC is to:

1. Assess the effort (costs) and outcomes (benefits) required to successfully use geospatial standards;
2. Understand and articulate the advantages of developing and using OGC and ISO/TC 211 standards;
3. Enable the wider community of stakeholders to leverage business value as a tool to foster investment and implementation.

The BVC collects return on investment requirements from consortium members in line with having the goal of determining the value of geospatial standards and highlighting how using OGC standards can offer value across the community in a cost-effective and sustainable manner. One of the key challenges addressed is the aspect of dealing across organisational and geographical boundaries where multiple domains have different requirements for accessing and sharing geospatial data. The Business Value Committee provides an email list, which is open to both OGC members and non-members[10].

Ongoing work at Dubai Municipality in the Emirate of Dubai provides a good example of government assessing the business issues associated with interoperability often known as data access and sharing across numerous organisations to support stakeholders, including citizens.

As one of the largest government organisations in the Emirate, Dubai Municipality provides services spanning urban planning, construction and development to environmental protection and conservation. The quality, credibility and reliability of these services are dependent on Dubai Municipality and its stakeholders capturing, maintaining and sharing authoritative geospatial information. Mandated by law to provide the fundamental geospatial base data in the Emirate, the geospatial information provided by Dubai Municipality is used both within its own organisation and across 26 other government agencies.

Geographic Information System (GIS) products are used to capture, manage and disseminate data. Data is currently shared by copying data files and sharing data between stakeholders using the internet or storage media. Furthermore, in the absence of an Emirate-wide data model, this data is captured, stored and maintained in different formats and in different ways. As a consequence, information cannot be automatically exchanged between different departments within Dubai Municipality or across government agencies which

[10] https://lists.opengeospatial.org/mailman/listinfo/business.value

has resulted in:

- Increased cost and time in supplying and managing geospatial information across Dubai Municipality and its stakeholders;
- Lack of understanding and misinterpretation of data due to the absence of a common data model and specification across the Emirate;
- Inconsistencies in the geospatial information delivered by private sector data providers;
- Low data currency which does not reflect the requirements of a dynamic construction environment within in the Emirate; and
- Absence of architecture and systems for data sharing.

Dubai Municipality is taking a leading role in the cost-effective development of an authoritative, consistent and shared map of the Emirate to underpin the delivery of its citizen services and to ensure geospatial-readiness in support of the Dubai World Expo 2020. As such, Dubai Municipality recognises that use of appropriate open geospatial standards enables efficient data sharing across organisational boundaries and the establishment of a common and shared view of location and place. For Dubai Municipality and the Emirate, open standards can support:

- Geospatial-readiness through the establishment of an authoritative and shared Emirate-wide view of place and location;
- Establishment of Dubai Municipality as the definitive provider of geospatial information in the Emirate;
- Diversion of employees from non-value adding activities to 'line-of-sight' tasks which support Dubai Municipality's Vision;
- Cost savings in data capture and management enabling further investment opportunities;
- Data sharing with stakeholders enabling informed, cross-organisational decision making; and
- Development of effective government, private sector and citizen services.

In recognition of this, Dubai Municipality issued a Request for Information seeking information from organisations on how open standards can deliver tangible value and bring measurable benefit for Dubai Municipality and its stakeholders. The outcome from this exercise will inform the wider international community about the business value of international geospatial standards and highlight the need to start with a strategy and policy topics. The OGC Business Value Committee is tracking progress in this area and will share outcomes as they emerge from this exercise and are made publicly available.

Example: National approach, Dubai Municipality, UAE

4.5 Identifying which international geospatial standards to use

The three documents, *A Guide to the role of Standards in Geospatial Information Management*, the *Companion Document on Standards Recommendations by Tier* (OGC, ISO, and IHO, 2014), and this paper provide a first point of contact for identifying which international standards to use. They have been written specifically to address the outcomes from UN-GGIM3 and build on the paper *UN-GGIM Inventory of issues and geographic information standardization*[11] which was presented in June 2013, and provided an analysis of the standardization needs relevant to the UN-GGIM Inventory of issues and currently available standards from ISO/TC 211, the OGC and the IHO.

[11] http://ggim.un.org/docs/meetings/3rd%20UNCE/E_C.20_2013_8_ISO-OGC-IHO%20Standards%20background%20paper.pdf

In the broader government arena worldwide there are programmes or initiatives underway to drive efficiencies and also provide greater accountability for public servants. The activities of these standards development organisations and the use of geospatial standards align well with international Member State agendas for eGovernment, openness and transparency.

4.6 Including standards in policy making

There are a number of ways of looking at policy relating to international geospatial standards. This paper looks at two areas in particular – How organisations can set standards policies and a wider government approach that guides organisations, the wider public sector and industry members.

Ordnance Survey has developed a Geospatial Standards Policy document which sets out the policy position relating to the adoption of geospatial or location standards for the organisation. It includes participation in standards development, and builds upon the Open Standards Principles report[12] (Cabinet Office, 2013). The Geospatial Standards Policy is concerned with standards which relate to Ordnance Surveys core business of collecting, maintaining and distributing geospatial data. It is not concerned with standards which relate to day-to-day functioning e.g. financial, procurement or health and safety standards.

The objectives of the Geospatial Standards Policy are:

- Enable our customers to avoid vendor lock-in, by providing data and services that conform to open standards;
- Continue to offer thought-leadership in the geospatial industry in the UK and overseas.
- Reduce risk to Ordnance Survey against the development of inappropriate standards, i.e. adopting standards which are then not widely adopted by others;
- Reduce cost by adopting existing standards rather than develop our own standards;
- Add to value of Ordnance Survey data and services by providing interoperability with those of other providers; and
- Comply with legal obligations and the UK Government's Open Standards Principles

Example : National Mapping Authority, Ordnance Survey, Great Britain

4.7 Including standards in legislation

Standards are effectively mandated for a national mapping authority by both law and government policy. Examples of legally mandated standards are the INSPIRE Directive in Europe and its accompanying Regulations. There is an important distinction made regarding aspects and documents that are legally binding and those that are not[13] (OGC, 2012). Where available INSPIRE references the European version of ISO standards, as published by the European Committee for Standardization (CEN); in general this is identical to the ISO version. These laws impose 'de jure' standards, although in some cases the requirement is not (yet) a published standard from a recognised standards body. It is likely, however that as compliance with the legal INSPIRE obligations increases, that the specifications and requirements laid out in the legislation and its technical guidance will become de facto standards which could apply beyond the scope of the actual law.

[12] https://www.gov.uk/government/publications/open-standards-principles/open-standards-principles

[13] http://www.opengeospatial.org/pressroom/marketreport/inspire

Standards can also become mandatory for a public authority when they are adopted as government policy. The standards coming from the Data Standards Board in the UK as a result of the Data Standards Hub activity provide a current example

5 Why should we manage the creation of GI Standards

Geospatial standards impact geospatial data capture, maintenance and dissemination in land, sea and air domains. There are many different standards that need to be considered in the design and build of a geospatial information management solution; this situation is likely to become more complex rather than less with the growing use of digital geoinformation products in daily life. This increasing and broader use will bring into play additional standards in areas, such as:

- Telecommunications to ensure provision of service;
- Legal services to control rights to data; and
- Data linking to extract the intelligence from the data.

If standards creation and management processes are not controlled at a global level there is a risk of defeating the original purpose due to the overwhelming range of standards being developed.

5.1 Business challenges and informed decision making

Geospatial information systems cut across many business domains, which can make it difficult for the user to understand what exactly geospatial information can do for them. As each business domain develops its own applications to address a specific problem or need, there is a risk of fragmentation and isolation of data and systems.

In the early days of the geospatial information industry a lack of common standards and policy meant that it was difficult for users to link up their applications and share data. Certain data formats became and still are de facto interchange formats, but with the increase of Web Mapping new and common standards were required to allow data and systems to interoperate.

The development and wide adoption of open standards has allowed this linking up of data and systems, and stimulated the discovery and sharing of geospatial data held within these systems through the use of standard query interfaces. The concept and application of Spatial Data Infrastructure (SDI) thinking, which is a logical framework in which geospatial information skills, services, products and capabilities can be combined in a common and logical fashion, has been enabled by such standards. SDIs range from corporate or enterprise level systems to a regional and potentially global scale. The European INSPIRE initiative is a leading example of a regional SDI, which would not have worked without considering interoperability and open geospatial standards.

The use of the Information Technology concept of Service Orientated Architectures (SOA), which are created through open data interfaces between systems within and SDI, is major enabler for linking and sharing data. The increasing capacities and capabilities of data networks now mean that clients do not need to process, host and manage the data themselves. This can be undertaken by a specialist in this data field who feeds or streams the data through the web to the client's digital mapping applications. This enables the client to use the data in support of their business rather than operating in a technical area which is not part of their corporate strategy. The volume of geo-referenced digital data being created on a daily basis is making this 'processing where the data is' of far greater value and importance and is significantly changing the design approach for geospatial information solutions.

It is not just at a technical level that standards impact the operation of geospatial organisations. At the business level, accreditation to Health and Safety Management Systems (ISO18001), Environmental Management Systems (ISO14000), Societal Security (ISO/TC223) and Information and Data Security (ISO27001) is a growing requirement for business operations.

5.2 Wider Government agenda and global trends

Traditionally, as previously mentioned in the paper, standards are created by international standards bodies. However there is an increasing need to consider standards set by national, regional and global authorities not traditionally recognised as international standards bodies. An example of this within the geospatial sector is the United Kingdom's Government GEMINI metadata standard – a national standard, and the European Terrestrial Reference System 1989 (ETRS89) – a regional standard, which itself is based on the International Terrestrial Reference Framework (ITRF) – a global standard.

A number of Governments have started to promote open standards, as it is felt they can help stimulate innovation and development. Software using these standards can be open, but proprietary licensing is still the predominant approach within large organisations.

6 Conclusion

Standards can be a powerful tool to drive both political and technological implementations, they help to refine the different choices to organisations and help information to be used and interpreted in the same way.

The role of international geospatial standards for National Mapping Authorities is growing in importance, from the need to quickly identify and share information across borders and organisations to providing economic stability for governments. The move to incorporating open standards within government policy has led to growing use of standards and the move to continual improvement and implementation.

National Mapping Authorities have an opportunity to influence the use of standards within the wider geospatial community by promoting and implementing open standards and to create best practice examples for the wider industry; this can include both public and private sector organisations. There is a crucial role to be played by UN-GGIM Committee of Experts to facilitate the discussion on international geospatial standards and to develop this opportunity further.

To develop geospatial standards it is important that a consensus approach is used where all stakeholders have the opportunity to input into the development of the standards; to this end it is important that organisations such as ISO, IHO and OGC continue to lead and promote in an international arena. Aligned to the development of the standards is the management of standards creation, without which there will be a growing number of competing standards which could lead to issues of sustainability and interoperability.

7 Recommendations

For national mapping data to have the most impact it needs to be accessed and shared quickly and seamlessly, open geospatial standards enable this activity. The key for governments around the world is for their stakeholders, customers, partners and suppliers to participate in the adoption and use of international geospatial standards, ideally in standards development where appropriate.

From a National Mapping Authority perspective it is recommended that:

- The separate but complementary papers the Guide to the Role of Standards in Geospatial Information Management and the Companion Document on Standards Recommendations by Tier, together with this paper, are used to highlight the value of developing a culture of standards adoption across Member States.
- To improve interoperability of systems and data, international geospatial standards are recognised and promoted by governments, private sector industry and individuals;

- The contribution of Member States in the development of international standards is recognised, and more Member States are encouraged to participate in the process;
- A representative group of Member States from the UN-GGIM Committee of Experts is actively involved in the development of geospatial information standards;
- National Mapping Authorities and their stakeholders work collaboratively to facilitate the development of open standards;
- The value of International Geospatial Standards is continually reviewed and integrated into the development of business cases for the wider geographic community.

A International standardization bodies and global initiatives

The work carried out by ISO/TC 211, OGC, IHO and other organizations is valuable for all levels of the global geospatial information community. These organizations are developing consistent and precise technical geographic standards that form the core building blocks to enable interoperability and facilitate the integration and use of diverse sources of geospatial data and services. It is well recognized in all sectors of the economy that standards and standardization drive competitiveness, promote innovation and benefit consumers. It is also known that government policies that mandate open geospatial standards from the OGC, ISO/TC 211 and other standards organizations play a critical role in the development of national capabilities in geospatial data, software and services.[14]

A.1 ISO – International Organization for Standardization

ISO is a non-governmental organization, which is a network of national standards institutes of about 160 countries (one member per country, representing social and economic interests internationally), supported by a Central Secretariat in Geneva, Switzerland, that coordinates the organisation.

ISO is the leading organization for the development and publication of international standards, which purpose is to facilitate the exchange of products and services by removing technical barriers to trade through the essential principles of global openness and transparency, consensus and technical coherence. The formulation of these principles is safeguarded by an ISO Technical Committee (ISO/TC) representing all stakeholders and is based on a public feedback phase (the ISO Technical Enquiry) (IPGH-Comité ISO/TC 211 2010).

Through the ISO/TC 211, Technical Committee on Geographic Information/Geomatics, ISO develops a comprehensive set of standards for geographic information. The scope of the ISO/TC 211 is the standardization of digital geographic information, so that their work is focused on the establishment of a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the earth. These standards may specify, for the case of geographic information, methods, tools and services for data management (including definition and description), and the acquisition, processing, analysis, access, representation and transference of such data in digital/electronic format between different users, systems and locations.

The general objectives of the ISO/TC 211 are to (IPGH-Comité ISO/TC 211 2010):

- Increase geographic information understanding and use;
- Increase geographic information availability, access, integration and dissemination;
- Promote the efficient, effective and non-expensive use of digital geographic information as well as related hardware and software systems;
- Contribute to a unified approach for solving global environmental and humanitarian issues.
- ISO/TC 211 standards are becoming a standardized framework for technical domains of geospatial information communities and are essential to establish and support the accelerated development of national, regional and global Spatial Data Infrastructures (IPGH-Comité ISO/TC 211 2010).

  The international standards and technical specifications already published and developed by the ISO/TC 211 are listed and summarized on the official web site (http://www.isotc211.org), and according to the IPGH-ISO/TC (IPGH-Comité ISO/TC 2010) are classified in Annexe B.

[14] http://ggim.un.org/docs/meetings/3rd%20UNCE/E_C.20_2013_8_ISO-OGC-IHO%20Standards%20background%20paper.pdf

A.2 OGC – Open Geospatial Consortium

The OGC is a non-profit organization that brings together more than 400 public and private organizations dedicated to standards consensus and promotion for open and interoperable geoprocessing in geographic information systems and the World Wide Web. The OGC pursues agreements between different companies that enable the interoperation of geoprocessing systems and facilitate the geographic information exchange for the users benefit.

The OGC strategic objectives are to:

- Provide free and openly available standards to the market, tangible value to Members, and measurable benefits to users;
- Lead worldwide in the creation and establishment of standards that allow geospatial content and services to be seamlessly integrated into business and civic processes, the spatial web and enterprise computing;
- Facilitate the adoption of open, spatially enabled reference architectures in enterprise environments worldwide;
- Advance standards in support of the formation of new and innovative markets and applications for geospatial technologies; and
- Accelerate market assimilation of interoperability research through collaborative consortium processes.

The OGC standards are technical documents that detail interfaces or encodings that software developers use to build open interfaces and codify them as part of their products and services. These standards and supporting documents are the main OGC "product", which have been developed by the OGC members as an answer to specific challenges of interoperability and are available at no cost for any person or organization (The Open Geospatial Consortium).

The standards promoted by the OGC are listed, summarized and available on its official website (http://www.opengeospatial.org) and some key standards are listed in Annexe B.

A.3 United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM)

In 2009, the United Nations Statistics Division/DESA (UNSD) convened in New York, in conjunction with the 9th United Nations Regional Cartographic Conference for the Americas (UNRCC-A), an informal consultative meeting with geospatial information experts from different regions of the world, and discussed how to better coordinate the various regional and global activities on geospatial information and the related management issues. Subsequent to the consultative meeting, the UNSD, jointly with the United Nations Cartographic Section, convened three preparatory meetings on Global Geospatial Information Management (GGIM): the first in Bangkok in October 2009, prior to the 18th UNRCC-AP, the second in New York, in May 2010, and the third one also in New York, in April 2011.

In 2010, at the 18th United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP), and the 41st session of the United Nations Statistical Commission, the issue of global geospatial information management was also discussed. The United Nations Secretariat was requested to initiate discussion and prepare a report for the approval of the Economic and Social Council (ECOSOC) on global coordination of geospatial information management, including the consideration of the possible creation of a United Nations Forum on GGIM. In July 2010, ECOSOC requested the Secretary-General to submit to the Council at its 2011 substantive session a report on global geospatial information management[15]. This decision paved the way for subsequent GGIM preparatory activities.

[15] http://www.un.org/en/ecosoc/docs/2010/dec%202010-240.pdf

The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) aims at playing a leading role in setting the agenda for the development of global geospatial information and to promote its use to address key global challenges. The United Nations Economic and Social Council (ECOSOC) established the United Nations Committee of Experts on Global Geospatial Information Management in July 2011 (ECOSOC resolution 2011/24) as the official UN consultative mechanism on GGIM.

The main objectives of the UN Committee are to provide a forum for coordination and dialogue among Member States, and between Member States and relevant international organizations and to propose work-plans and guidelines with a view to promoting common principles, policies, methods, mechanisms and standards for the interoperability and inter-changeability of geospatial data and services.

A.4 GTnet

During the Sixth UN Regional Cartographic Conference for the Americas, held in New York, June 2 – 6, 1997, the Conference recommended the establishment of a permanent committee which will collaborate in the development of a geographic information regional infrastructure, contribute to the development of the world geographic information infrastructures, as well as exchange of experiences and perform consultations on common interest issues, creating therefore the Permanent Committee on Geospatial Data Infrastructure of the Americas (PC-IDEA).

In the 9th PC-IDEA Extended Meeting, held in Rio de Janeiro, Brazil, August 2012, the Working Group on Standards and Technical Specifications (GTnet) in collaboration with the Open Geospatial Consortium (OGC) and the participation of six countries: Bolivia, Brazil, Canada, Colombia, Honduras and Mexico is established. Mexico, through the National Institute of Statistics and Geography (INEGI), is assigned as the group coordinator. The group objective is to establish a set of standards and technical specifications that apply in the region within a common regulatory framework.

Mexico -as coordinator of the Working Group on Standards and Technical Specifications (GTnet) - developed a Core Standards or fundamental standards proposal for the Americas, which was sent to the Gtnet members for its revision in order to be agreed and refined. The diagnosis obtained from the analysis of the regulations state-of-the-art in the region, reflected from the UN-GGIM: Americas Questionnaire 2013 administration, and answered by 20 member countries, was an important reference in order to establish the guidelines in the development and implementation of regional standards that constitute the "core standards" or fundamental standards framework on which to sustain the development and strengthening of the IDEA, so contributing to the development of national initiatives.

The priority criteria for the "Core Standards" development for the region follow a number of themes.

With respect to the fundamental themes of interest:

1. Boundaries
2. Hydrography
3. Relief
4. Transportation networks (road, rail, air, ferry, etc.)
5. Geographical names

With respect to the transversal themes:

6. Geodetic reference system
7. Geospatial data model
8. Metadata
9. Interoperability
10. Geospatial data quality

In the third period of sessions held in New York, July 24 - 26, 2013, the Committee of Experts adopted the resolution 3/114, whereby the Committee encouraged the regional states to continue cooperating closely with the Secretariat so Member States will maintain a regional and global perspective, and also welcomed the initiative for the former Permanent Committee on Geospatial Data Infrastructure of the Americas, to consider aligning itself with the United Nations Committee of Experts on Global Geospatial Information Management structure.

In accordance with Resolution 7 of the Tenth UN Regional Cartographic Conference for the Americas, the Permanent Committee on Geospatial Data Infrastructure of the Americas changes its name to Regional Committee of the United Nations on the Global Geospatial Information Management for the Americas (UN-GGIM: Americas).

The responsibility of Mexico with respect to the Presidency and Executive Secretariat for the UN-GGIM: Americas is to ensure that the Committee determine the relevant regional issues for the geospatial information management and take the respectively necessary measures in order to increase the economic, social and environment benefits derived from the use of such relevant issues based on knowledge and exchange of experiences and technologies among the Member States that allow the establishment of the Geospatial Data Infrastructure of the Americas (IDEA).

A.5 INSPIRE

INSPIRE refers to a Directive of the European Parliament and Council and also to the European Spatial Data Infrastructure being established as a result of that Directive. INSPIRE has implemented a number of OGC and ISO/TC 211 standards to create a specific framework for exchange of environmental geospatial data in Europe. It is a good example for the use of the wide portfolio of OGC and ISO/TC 211 standards and building a set of more specific rules on top of these standards. Governance and ongoing development are run in line with other European initiatives. This recognises that any Spatial Data Infrastructure should be longer lived than the technology which currently underpins it.

INSPIRE is based on a number of common principles:

- Data should be collected only once and kept where it can be maintained most effectively;
- It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications;
- It should be possible for information collected at one level/scale to be shared with all levels/scales; detailed for thorough investigations, general for strategic purposes;
- Geographic information needed for good governance at all levels should be readily and transparently available;
- Easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used; and
- INSPIRE and OGC and ISO/TC 211 standards.

INSPIRE currently uses the following ISO and OGC standards:

Services: OGC Catalogue Services for the Web; ISO 19128 Web Mapping Service (equal to OGC WMS); OGC Web Map Tiling Service; OGC Web Feature Service or ISO 19142 Web Feature Service; Atom

Data encoding: ISO 19136 Geography Markup Language (equals OGC GML3.2.1); GeoTIFF. Various themes are also based on relevant domain specific international standards, such as from the World Meteorological Organisation.

Metadata: ISO 19115 Metadata; ISO 19119 Metadata for Services; ISO 19139 Metadata encoding

B ISO/TC 211 and OGC Standards

- Standards that specify the infrastructure for geospatial standardization
  ISO 19101 Geographic Information – Reference Model
  ISO/TS 19103 Geographic Information – Conceptual Schema Language
  ISO/TS 19104 Geographic Information – Terminology
  ISO 19105 Geographic Information – Conformance and testing
  ISO 19106 Geographic Information – Profiles

- Standards that describe data models for geographic information
  ISO 19109 Geographic information – Rules for application schema
  ISO 19107 Geographic information – Spatial Schema
  ISO 19123 Geographic information – Schema for coverage geometry and functions
  ISO 19108 Geographic information – Temporal schema
  ISO 19141 Geographic information – Schema for moving features
  ISO 19137 Geographic information – Core profile of the spatial schema
  ISO 19111 Geographic information – Spatial referencing by coordinates
  ISO 19112 Geographic information – Spatial referencing by geographic identifiers

- Standards for geographic information management
  ISO 19110 Geographic information – Methodology for feature cataloguing
  ISO 19113 Geographic information – Quality principles
  ISO 19114 Geographic information – Quality evaluation procedures
  ISO 19115 Geographic information – Metadata
  ISO 19131 Geographic information – Data product specifications
  ISO 19135 Geographic information – Procedures for item registration
  ISO/TS 19127 Geographic information – Geodetic codes and Parameters
  ISO/TS 19138 Geographic information – Data quality measures

- Standards for Geographic information services
  ISO 19119 Geographic information – Services
  ISO 19116 Geographic information – Positioning services
  ISO 19117 Geographic information – Portrayal
  ISO 19125-1 Geographic information – Simple feature access – Part 1: Common architecture
  ISO 19125-2 Geographic information – Simple feature access – Part 2: SQL option
  ISO 19128 Geographic information – Web map service interface
  ISO 19132 Geographic information – Location based services – Reference model
  ISO 19133 Geographic information – Location bases services – Tracking and navigation
  ISO 19134 Geographic information – Location based services – Multimodal routing and navigation

- Standards for encoding of geographic information
  ISO 19118 Geographic information – Encoding
  ISO 6709 Standard representation of geographic location by coordinates
  ISO 19136 Geographic information – Geography Markup Language (GML)
  ISO/TS 19139 Geographic information – Metadata – XML schema implementation

- Standards for specific thematic areas
  ISO/TS 19101-2 Geographic information – Reference model – Part 2: Imagery
  ISO/TS 19115-2:2008 Geographic information – Metadata – Part 2: Extensions for imagery and gridded data

- Standards for objects and geographic information access and processing
  OpenGIS Geographic Objects Implementation Specification
  OpenGIS Implementation specification for geographic information – Simple feature access – Part 1: Common architecture
  OpenGIS Implementation Specification for Geographic Information – Simple feature access – Part 2: SQL option
  OpenGIS Simple Features Implementation Specification for OLE/COM
  OpenGIS Implementation Specification for coordinates transformation service

- Standards for Web Services Implementation
  OpenGIS Catalogue Service Implementation Specification
  OpenGIS Web Map Service (WMS) Implementation Specification
  OpenGIS Web Feature Service (WFS) Implementation Specification
  OpenGIS Web Coverage Service (WCS) Implementation Specification
  OpenGIS Web Coverage Processing Service (WCPS) Implementation Standard
  OpenGIS Web Processing Service (WPS)
- Standards for Geographic Objects Encoding
  OpenGIS Geography Markup Language Encoding Standard (GML)
  OpenGIS KML
  OpenGIS GeoXACML Implementation Specification

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D Glossary

CEN: European Committee for Standardization

FIG: International Federation of Surveyors

GSDI: Global Spatial Data Infrastructure

GTnet: PC-IDEA Working Group on Standards and Technical Specifications

IETF: Internet Engineering Task Force

IHO: International Hydrographic Organization

INEGI: National Institute of Statistics and Geography

INSPIRE: Infrastructure for Spatial Information in Europe

ISO: International Organization for Standardization

ISO/TC 211: International Organization for Standardization/ Technical Committee on Geographic Information/Geomatics

ISPRS: International Society for Photogrammetry and Remote Sensing

OASIS: Organization for the Advancement of Structured Information Standards

OGC: Open Geospatial Consortium

OGC BVC: Open Geospatial Consortium Business Value Committee

PC-IDEA: Permanent Comite for Geospatial Data Infrastructure of the Americas

SDI: Spatial Data Infrastructure

SDO: Standards Development Organizations

SNIEG: National System of Statistical and Geographical Information

UN-GGIM: United Nations Committee of Experts on Global Geospatial Information Management

W3C: World Wide Web Consortium