Strategic Pathway 6

Standards

*This **strategic pathway** establishes and ensures the adoption of best practice standards and compliance mechanisms for enabling data and technology interoperability to deliver integrated geospatial information and location-based knowledge creation.*

*The **objective** is to enable an efficient and consistent approach for different information systems to be able to discover, manage, communicate, exchange and apply geospatial information for a multitude of uses, improved understanding and decision making.*

Summary

The pace of societal and technological change requires new thinking about national geospatial information management roles and investments. This includes a commitment to geospatial data integration and interoperability based on open, consensus-based standards. Standards provide the critical architecture by which data can be discovered, collected, published, shared, stored, combined, and applied. The application of standards facilitates the management and sharing of geospatial information, not only from government authoritative sources, but also from the private sector, academia and citizens, and among each other. Standards support a more adaptable process for the application of geospatial information for policy.

Effective geospatial information management is characterized by the application of a mixture of best practice international and national standards and compliance mechanisms. A national, inclusive governance process and policy environment are essential to assure consistent usage of standards and to promote local, regional, and international compatibility.

Standards are essentially an agreement between providers, regulators and consumers. They provide rules, guidelines and characteristics that enable connection between systems, data, people, hardware, software and procedures. When applied, standards reduce effort, time and cost of implementing technologies, improve return on investment, and help future-proof systems by enabling new capabilities to be added with minimal effort.

Common to the effective application of standards are four key elements that are required for an interoperable and cooperative data sharing environment, to improve service and product delivery, and for evidence-based policy and decision-making

The four elements are:

- **Standards Governance and Policy** – ensures that the benefits of standards can be maximized through coordinated governance and coherent policies.
- **Technology and Data Interoperability** - enables different technologies, systems, and geospatial data to work together seamlessly, and provides the flexibility to rapidly mobilize newer technologies and data sources.
- **Compliance Testing and Certification** – leverages testing, measurement and certification processes to assure proper implementation of standards.
- **Community of Practice** - accelerates the benefits of standards and interoperability by sharing and leveraging proven, standards-based good practices between otherwise unconnected entities.

These elements are underpinned by principles that promote the successful application of standards to improve sharing and use of geospatial information and optimize geospatial information management in a country. The principles are put into practice through several strategic actions that deliver and strengthen the implementation of the Integrated Geospatial Information Framework (IGIF). Tools, such as matrices, examples and checklists, are provided in the appendices to assist countries to work through concepts and processes to successfully complete each action. The overall structure for standards is illustrated in and anchored by Figure 6.1.

When implemented the actions (and their interrelated actions[1]) will enable the achievement of the four elements, which in turn will deliver significant and sustainable national outcomes and benefits for a country. These outcomes include attaining:

- Minimized barriers to data sharing and integration in support of government-wide policy, decision-making and service delivery;
- Enhanced abilities to share geospatial information across jurisdictional boundaries (local, national, and global) and to cooperatively address issues of common importance;
- Rapid mobilization of new sources of data and new technologies, as well as avoidance of lock-in to specific technology providers;
- Improved uptake of geospatial information across government and with the private sector and citizens; and
- Efficiencies in geospatial data production and lifecycle management, saving effort, time and cost in reusing and repurposing data.

[1] Examples of the interrelated actions across Strategic Pathways are described in the introductory chapter; Solving the Puzzle: Understanding the Implementation Guide.

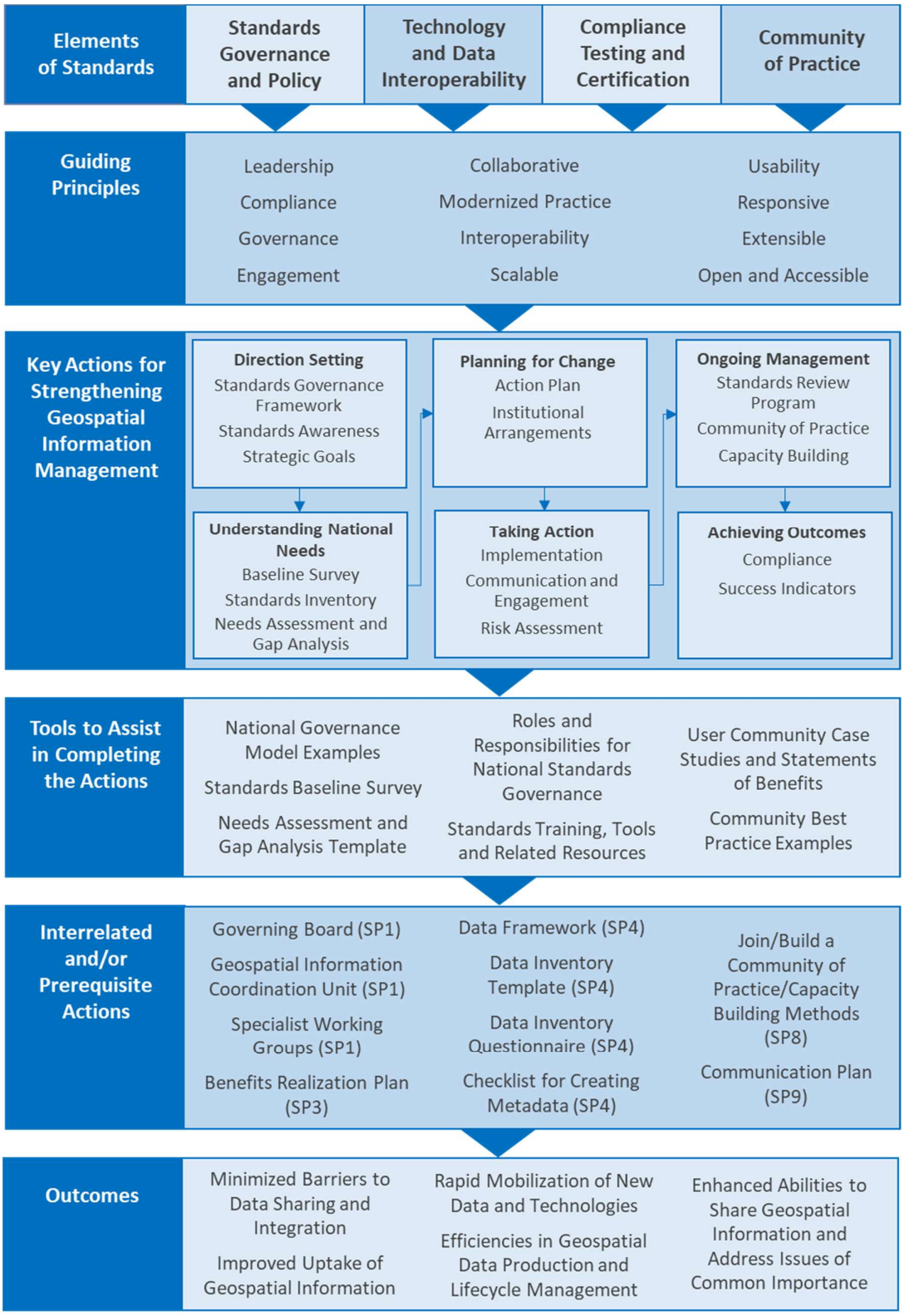


Figure 6.1: *The overall structure for the Standards Strategic Pathway - showing the four key elements, guiding principles, actions and interrelated actions, and the tools provided in the Appendices to support and achieve the outcomes.*

6.1 Introduction

Standards are essential to strengthening integrated geospatial information management.

Standards are essential to strengthening integrated geospatial information management. They provide the rules, guidelines and characteristics that enable connection between systems, data, people, hardware, software and procedures. In information technology environments, standards enable systems to communicate with one another, facilitate the integration of diverse geospatial data, and allow spatially-enabled mobile phone Apps to communicate and work anywhere across a multitude of devices.

In an ever-changing world, open standards help assure that organizations can more quickly take advantage of new geospatial information sources and new technology tools. Open standards are a central element in the growing trend to open government. A goal of open standards is to ensure that 'interoperability' (the ability to integrate datasets and related services of different types and from different sources) will minimize such costs and problems.

Effective national geospatial information management frameworks are typically characterized by a mixture of international and national standards and related compliance mechanisms. Open international standards are the recommended norm. Such standards represent the consensus of private and public sector organizations worldwide and are guided by the proven processes of voluntary consensus standards bodies. Open international standards are an empowering first choice toward improving local, national and international data sharing - enabling different vendor products, technologies and data sources to work together or 'interoperate' seamlessly.

There are three key international organizations with the objective of developing open standards for geospatial information and technologies; sometimes referred to as the Standards Development Organizations (SDO) for geospatial information. Members of the SDOs represent government, industry, research and academia, and develop standards through consensus. They are:

- **ISO/TC 211 Geographic information/Geomatics** was founded in 1994 for standardization in the field of digital geographic information. This work aims to establish 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 geographic information, methods, tools, and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting, and transferring such data in digital/electronic form between different users, systems and locations. The work shall link to appropriate standards for information technology and data where possible, and provide a framework for the development of sector-specific applications using geographic data.

- The **Open Geospatial Consortium (OGC)** is an international not-for-profit standards organization founded in 1994, and represents over 520 public and private sector organizations. The focus of OGC work is to facilitate an international forum of expertise in geospatial and location information and technologies to identify issues, and to define, document, test, and validate the implementation of standards and associated community best practices for use with geospatial content and services.
- The **International Hydrographic Organization (IHO)** is an intergovernmental consultative and technical organization established in 1921 to support safety of navigation and the protection of the marine environment. Among its main objectives, IHO is to bring about the greatest possible uniformity in nautical charts and documents (i.e., standardization). The provision of hydrographic and nautical chart services is one of the obligations of coastal State signatories to the International Convention for the Safety of Life at Sea (SOLAS) treaty under the responsibility of the International Maritime Organization (IMO).

Together the standards developed by these organizations form an integrated ecosystem. For example, OGC and IHO standards leverage the abstract standards defined by ISO/TC 211. This ecosystem facilitates the publication, discovery, access, maintenance and use of geospatial information across a range of applications, systems and business enterprises. In addition, general IT and internet standards from organizations such as the World Wide Web Consortium (W3C), ISO, the International Telecommunications Union (ITU) and the Internet Engineering Task Force (IETF), are also essential for internet and mobile communications, and other core IT infrastructures that play vital roles in geospatial information management.

When applied by government, industry and citizens, standards reduce effort, time and costs associated with the implementation of technologies, improve return on geospatial data and system investments, and help future-proof systems by enabling new capabilities to be added with minimal effort.

A broad range of geospatial information and associated technologies are available worldwide. As governments and society become increasingly digital in both service delivery and policy making, standards help to quickly mobilize these technologies. Underpinning this strategic pathway is the principle that by using these geospatial standards, it optimizes geospatial information collection, application, sharing and management to address important challenges for decision makers, improves government service delivery, address the sustainable development goals (SDGs) and save assets and lives.

6.2 Context and Rationale

Geospatial information management practices have evolved; today, best practice standards are used to enable data sharing and integration.

Geospatial information management practices have evolved over time, and typically grew from the use of proprietary software and systems. This led to organizations using different technology and data standards. The drawback to this approach is that organizations created information and technology silos that presented data producers and users with many hidden challenges, such as delays and costs in expanding or adapting data and software tools to work with other resources, software or organizations. In some countries, the consequence of early proprietary practices is still restricting cross-government data sharing and integration.

Given that geospatial information is managed and provided by a number of organizations – from national geospatial and mapping agencies to commercial data providers to volunteered geographic information – there is an overwhelming requirement to easily discover and share this information. For this to occur, countries are strongly encouraged to adopt a standards-based approach to geospatial data management.

Today, standards available for geospatial information management stem from a mature global effort to address the challenges associated with data sharing and interoperability. Organizations around the world are now adopting open geospatial standards to promote geospatial information discovery, access, integration and use, to address a range of local to international issues. Technology and data providers have implemented these standards in their products and services to assure that data will interoperate seamlessly with other technologies and across user communities.

Collectively, SDOs support the intentions of the IGIF and have been progressively addressing the need for open consensus-based standards and frameworks for geospatial information management. Standards organizations work across the public and private sectors to understand the implications of new technology and societal trends, and to develop best practices to make data from various sources and provides fit for inclusion in decision making as a valuable part of the greater information landscape.

SDO standards have been adopted and implemented in products and services worldwide to enable geospatial information sharing, integration and application to address a range of social, economic and environmental issues. International standards have been developed based upon the hard lessons learned over time by other implementers, and often represent the most efficient overall approach to technology development.

Caution should be applied when considering the use of standards not developed by an open, voluntary consensus-based standards organization, such as proprietary standards – those developed by a single entity and made openly

available. These proprietary standards are subject to change or intellectual property exploitation at any time by the owning entity, which could jeopardize data sharing and technology/systems interoperability, operations and cost. Beyond this, proprietary standardization tends to establish a dependency on products and services from a limited group of technology providers, thus increasing cost and limiting functionality over time.

Standards are a key strategic pathway of a geospatial framework to support ongoing activity, as well as adapt to change. Standards provide the critical architecture by which data can be discovered, collected, published, shared, stored, combined and applied.

The implementation of standards facilitates management and sharing of geospatial information not only from government authoritative sources, but also from the private sector and citizens. National standards should be developed and applied only when international standards do not meet national needs. Where national standards are deemed to be required, they should strive to either profile existing international standards or use defined international standards as a framework. This common approach can strike an optimal balance between meeting national requirements and also regional or international interoperability.

The pace of societal and technological change requires continuous review of national geospatial information management roles and investments. Today's global geospatial information management framework is built for connected to disconnected operations. Standards support web services and online catalogues, as well as file transfers and offline processing where connectivity is less reliable and is a more adaptable process for place-based decision-making. A commitment to interoperability based on open, consensus-based standards is essential to keeping pace with changing technology.

6.3 Approach

In this strategic pathway, the approach is to establish best practice standards and compliance mechanisms to strengthen integrated geospatial information management and, in particular, to enable different information systems to communicate and exchange data, enable knowledge discovery and inferencing between systems using unambiguous meaning.

The approach to effective data management is to establish best practice standards and compliance mechanisms.

At the national level, policy commitment and consistent governance processes aids in aligning government and other stakeholders to implement a common framework of standards for efficient geospatial information management. This strategic pathway, like standards themselves, is a truly integrative pathway, building on the recommendations of SP1: Governance and Institutions and SP2: Policy and Legal regarding overall governance and policy for standards. In

addition, the actions in section 6.6 below support, and are complementary to, the recommendations in SP4: Data.

Governance and Institutions (SP1) identifies the necessity of forming a national Governance Model and Governance Board that includes emphasis on promoting/adopting standards and interoperable systems. SP1 also identifies the need for a whole-of-government Geospatial Information Coordination Unit, along with Specialist Working Groups, to provide guidance for cross-government standards for access and use of geospatial information.

In **Policy and Legal** (SP2), standards represent a key beneficial non-binding policy component that can help advance a legal and policy framework for geospatial information management. The adoption of these standards by key government agencies responsible for geospatial information management will have a broad impact across a nation's geospatial ecosystem. Government agencies can also make standards binding by including them into requests for proposals (RFPs) or contracts.

Data (SP4) highlights the importance of metadata, data standards, data quality, and other standards to enhance the integration and interoperability of individual and disparate data sets. SP4 also underscores standards for: 1) compliance as part of comprehensive data theme roadmap and data management plans; 2) the use of international web service standards to make geospatial data accessible, and; 3) a compliance framework to support interoperability.

Partnerships (SP7) emphasizes national and global partnerships to aid in developing standards and norms for strengthening geospatial information management capabilities.

Capacity and Education (SP8) underscores that building the appropriate capacity will require collaboration across all levels of government (local, national, regional, international); particularly when it comes to information exchange. A consistent approach to capacity building is required to enable compliance with data sharing policy and data release guidelines, and the application of data and ICT standards to enable interoperability, as well as cooperation in data custodianship roles and responsibilities.

Communication and Engagement (SP9) emphasizes an engagement strategy for active interaction with community stakeholders and users to raise awareness, advocate and strengthen geospatial information management, including the exchange of information regarding the use of standards to maximize access.

The implementation of standards within the national context is often a combination of bottom-up organizationally driven activities, and top-down national incentives in policy and governance. This strategic pathway recognizes that nations have different legal, policy, governance and operational

approaches to geospatial information management. Therefore, it offers a set of recommended actions that may be implemented in various ways, and in a choice of sequences, to establish initial capability or to improve existing capabilities.

This pathway also acknowledges that individual organizations and stakeholders within a nation may have independently adopted a common set of geospatial information and technology standards to increase internal efficiencies and flexibility for growth as new enabling technologies became available. However, by following a nationally endorsed standards strategy and framework proposed in this pathway, organizations can further assure interoperability locally, nationally and internationally.

In this strategic pathway, the approach includes four key elements that are a guide for nations to ensure that standards are an integral part of geospatial information management. These elements include coordinated and consistent **standards governance and policy**, seamless **technology and data interoperability**, the ability to leverage **compliance testing and certification** processes to assure proper implementation of standards, and a **community of practice** for sharing and leveraging skills and knowledge relating to best practice standards and their implementation. These elements are explained in more detail in section 6.4 below.

The approach includes strategic pathway actions that are recommended as a means to achieve the four key elements. The actions, which are underpinned by guiding principles, provide the step-by-step guidance to implement and achieve the desired outcomes. While most of these actions may be unique to this strategic pathway, there are several interrelated and/or prerequisite actions detailed in other strategic pathways that may also need to be completed. Tools to assist in completing the actions are available in the appendices to the strategic pathway. The approach for Strategic Pathway 6: Standards is illustrated in Figure 6.2 and explained in the following sections.

The actual implementation approach of each strategic pathway action will depend on country-specific needs, which may be influenced by country priorities, existing capabilities, resourcing potential, culture and other practicalities. Whatever the implementation approach, each action should reference the guiding principles in section 6.5 below, as these describe what is important for effective and efficient geospatial information management.

6.4 Elements

6.4.1 Standards Governance and Policy

Standards are a key component of geospatial governance and policy at the national level. Nationwide success in standards requires an efficient governance model inclusive of relevant stakeholders, and a commitment to assess, establish,

and maintain a common standards framework. Establishment of a policy environment supportive of advancing a common standards framework is also paramount to success, as is a clear leadership commitment and structure.

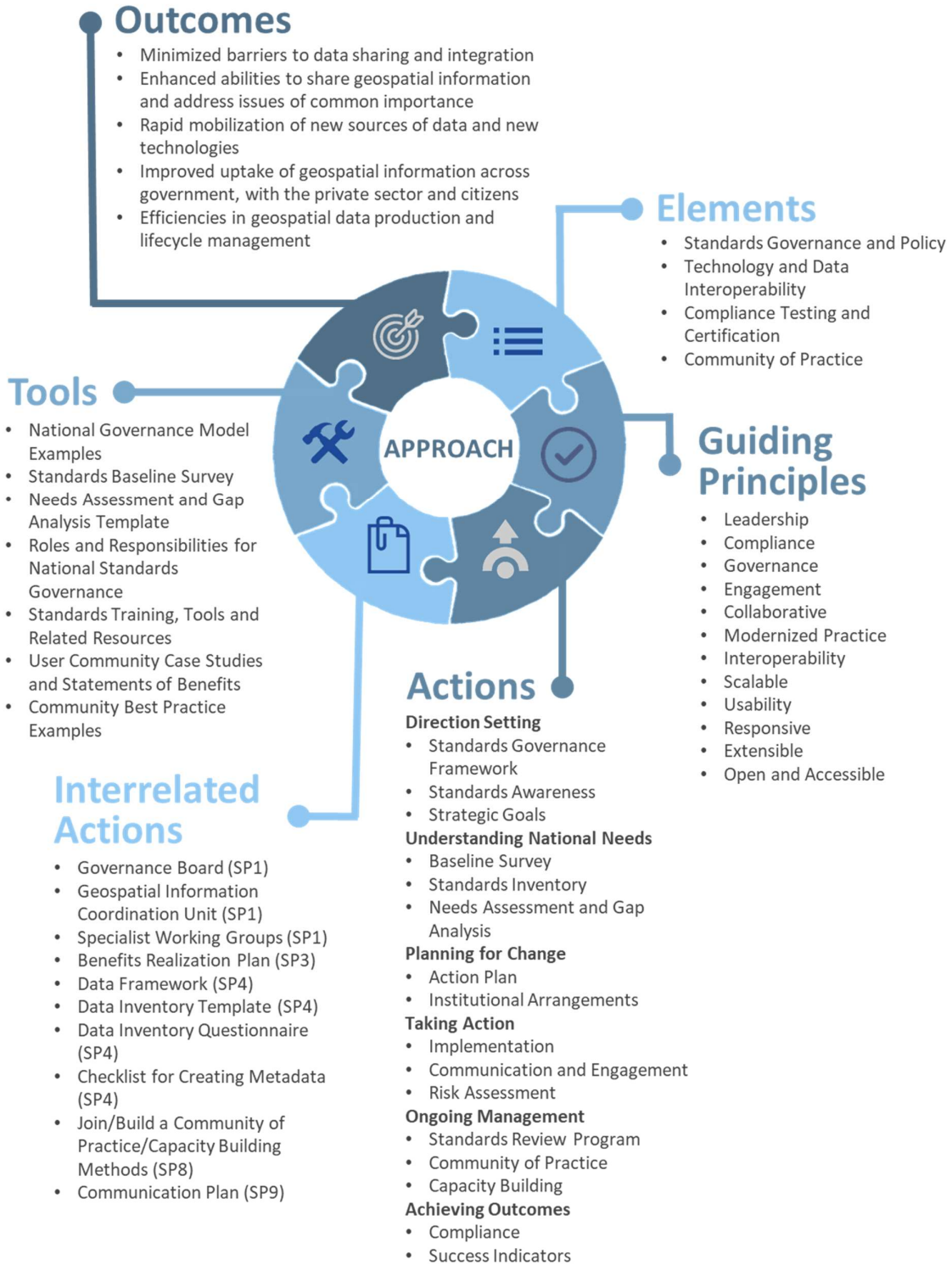


Figure 6.2: *The approach for standards.*

Major components of Standards Governance and Policy include: (a) the establishment of a National Standards Strategy; (b) a government steering committee, coordination units and working groups coordinated across all levels of government; (c) a broad, all-inclusive stakeholder representation and engagement in the standards coordination process; (d) a clearly defined and empowered organization to lead cross-government and community coordination on geospatial information management and standards; (e) a process to review, develop as necessary, and endorse a common framework of national data and technology standards; and (f) the representation of national requirements in international SDO activities.

National success in standards requires an efficient governance model, inclusive of relevant stakeholders, and a commitment to assess, establish, and maintain a common standards framework.

In practice, even though governance structures vary from country to country, the aforementioned components typically exist within such structures in one form or another. SP1: Governance and Institutions provides in-depth insight and recommendations on practical national governance models.

6.4.2 Technology and Data Interoperability

Technology and data interoperability enable different systems and diverse data types to work together seamlessly. This in turn, provides the flexibility to rapidly mobilize newer technologies and data sources in the future.

Technology and data interoperability enable different systems and diverse data types to work together seamlessly.

Technology standards, such as for Application Programming Interfaces (API), are used to specify how software components interact with each other through standard interfaces to enable different systems and services to work together. When technology standards are implemented independently in products or online services, the resulting components 'plug-and-play'. That is, they work together seamlessly, saving time, effort and cost. This is because, programming to standard interfaces reduces the dependency on implementation specifics and makes code more reusable. It also gives programmers the ability to later change the behavior of the system by simply swapping the object used with another, implementing the same interface.

Geospatial data standards provide a digital encoding to locate and describe the features and conditions that are on, above or below the Earth's land and ocean surface. This includes geographically-related features that are naturally occurring (rivers, rock formations, coastlines, etc.), man-made (dams, buildings, radio towers, roads, etc.) or intrinsic, implied, and transient information (political boundaries, electoral districts, weather systems, distribution of population, ethnicity, etc.). Data standards support the management of geographic features as coverages (elevation models, data cubes, multispectral imagery, etc.), attributes (water quality or soil classifications, etc.), and imagery (satellite imagery). Data also provides important information and context. Geospatial data standards are integral to the reuse and repurposing of information.

In terms of semantic interoperability, it is essential to agree on the semantics – or the meaning of words, terms and concepts – for the various phenomena shared between people, organizations, and governments. Between organizations, and even in the same organization, the terminology for a particular phenomenon may have many definitions. Technology and Data Interoperability standards support the 'semantic interoperability' necessary to 'mediate' these differences to produce a common meaning.

There are many examples of the critical importance of semantic mediation. The European INSPIRE[2] programme works to unite the nations of Europe to develop common data content standards and associated methods to mediate the many different languages used in the region. The OneGeology[3] alliance produced a common global geologic science standard model, the OGC Geoscience Markup Language (GeoSciML), to enable national geological surveys to map their national geological models to a global standard. The IHO has established a global digital registry of marine and maritime entities used in international charts, publications, and associated data visualization and data transfer standards. Through the semantic mediation process, national data can be combined with common meanings to address regional topics that transcend national boundaries. It is therefore an important part of standardization at national, international, and local levels.

6.4.3 Compliance Testing and Certification

A system of compliance is used to promote data sharing and use.

A system of compliance is used to ensure that organizations are implementing nationally or internationally endorsed standards that promote data sharing and use, and to verify that technology products and services acquired by government are properly implemented against the required standards. There are several levels of standards compliance that should be considered by countries including regular assessments, government mandates, and testing and certification functions.

6.4.4 Community of Practice

A community of practice is a group of people who share skills, knowledge and experiences about the implementation of standards.

A community of practice is a group of people who share skills, knowledge and experiences about the implementation of standards. It often leverages formal and informal partnerships and agreements to share and adopt community standards best practices. A community of practice also accelerates the realization of benefits of standards and interoperability by sharing and leveraging proven, standards-based good practices between otherwise unconnected entities. It also provides commonality across diverse uses and

[2] Infrastructure for Spatial Information in the European Community Directive.
[3] www.onegeology.org

levels of operation, and helps to promote consistent, sharable training and educational programs.

6.5 Guiding Principles

The following guiding principles serve to characterize the commitments necessary to advance a common standards framework for geospatial information management, sharing, usage and decision-making, and to raise an awareness and understanding of standards at the local, national, and international levels. These principles also illustrate the value achieved by adopting and implementing open standards as part of a common framework for geospatial information management, and the need to embed standards into legislation, policies and directives. The guiding principles for standards are:

By applying these guiding principles, countries will achieve technology and data interoperability leading to effective reuse and repurposing of geospatial information.

- **Leadership:** Cross-government coordination and a well-defined lead organization or agency to promote nationwide common standards that ease data sharing, management and use.
- **Compliance:** Clear policy on the adherence to and use of open, consensus-based standards.
- **Governance:** Clearly defined and inclusive governance structure for standards development, adoption and endorsement for national implementation, and a governance model that encourages broad public, private sector and citizen engagement.
- **Engagement**: Clearly articulated policy and standards framework, agreed upon and endorsed at the national level.
- **Collaborative:** A community of practice that engenders shared experiences, success stories and lessons learned, as well as a national forum for stakeholders to coordinate standards and best practices.
- **Modernized Practice:** International, vendor-neutral, open consensus-based standards that encourage the use of geospatial data and software tools that fit today's needs.
- **Interoperability**: Standards are applied to achieve the greatest level of interoperability across all levels of government and with the private sector.
- **Scalable**: A standards framework that promotes seamless data sharing from the local to national to regional and international levels.
- **Usability:** A common, consistent standards framework that facilitates efficient reuse and repurposing of geospatial information and interoperability of systems.

- **Responsive:** Standards are adopted in way that influences and responds to National requirements, addresses gaps in capability and promotes specific technological developments.
- **Extensible:** The ability to add new geospatial capabilities as future needs demand through ongoing revision of standards and practices.
- **Open and Accessible:** Standards are available for use nationally, without restrictions, and unencumbered by patents or other limitations that restrict their use.

6.6 Actions

The strategic pathway actions are recommended as a means to achieve the four key elements.

The strategic pathway actions are recommended as a means to achieve the four key elements of standards. They are a guide to best practice collection and management of integrated geospatial information. Country-specific actions may be influenced by factors such as country priorities, existing capabilities, resources, culture and other practicalities. These will influence approaches for implementing each strategic pathway and their related actions.

For ease of use, particularly to assist countries in the initial and early stages of developing and strengthening their national geospatial information management arrangements, the actions are presented in a sequential step-by-step structure. A road map illustrating this order and where the actions typically occur and are completed, is presented in Figure 6.3. However, it is acknowledged that countries, depending on existing national arrangements, may also wish to start their actions at different steps along the pathway, and in a different sequence. Therefore, a less structured road map is additionally presented in Figure 6.4.

Some actions may have interrelated and/or prerequisite actions that need to be achieved prior to, or in conjunction with, the strategic pathway actions. These interrelated actions are also illustrated in Figures 6.3 and 6.4, are referenced in the text, and detailed under other strategic pathways.

Whatever the implementation approach, each action should take into account the guiding principles in section 6.5, as these describe drivers for attaining effective and efficient geospatial information management. The actions for the standards are divided into six categories, which are:

1. Direction Setting
2. Understanding National Needs
3. Planning for Change
4. Taking Action
5. Ongoing Management
6. Achieving Outcomes

Figure 6.3: *Standards includes several actions and tools designed to assist countries to establish best practice standards and compliance mechanisms for enabling data and technology interoperability to deliver integrated geospatial information. The actions are divided into six categories and reflect the order with which these actions are typically completed.*

Figure 6.4: *Standards includes several actions and tools designed to assist countries to establish best practice standards and compliance mechanisms for enabling data and technology interoperability to deliver integrated geospatial information. The interrelated actions provide key linkages to other strategic pathway actions.*

The following actions are typically used to address gaps in capability. They serve as a guide to building the necessary capacity to strengthen integrated geospatial information management processes and systems.

6.6.1 Standards Governance Framework

National-level policy and governance that encourages the adoption of a common framework of standards, benefits the successful implementation of geospatial standards.

National-level policy and governance that encourages the adoption of a common framework of standards, benefits the successful implementation of geospatial standards. Many nations have established policies mandating or encouraging government and stakeholders to align with a common set of nationally endorsed, open, consensus-based international and national standards to better ensure the ability to share and use geospatial information.

Standards should be a component of the national geospatial Governing Board (or Steering Committee) established to advance a nation's geospatial information framework (See SP1: Action 1.6.1). The Board would have responsibility for overall policy and strategic direction regarding standards for use across government, coordinate awareness-building activities, and recommend policies that promote adoption and alignment to the endorsed standards framework.

The following sections are suggested to be conducted within the context of the governance structure discussed above.

A Geospatial Information Coordination Unit (See SP1: Action 1.6.2), which operates under the Governing Board's guidance, and which has a whole-of-government national scope and engagement authority, would:

- Represent cross-government needs for standards;
- Develop policies and procedures promoting the procurement, implementation and use of standards-based technologies and data (See SP4: Action 4.6.7) for cross-government data access, sharing, and application for improved decision making;
- Establish and maintain a process to review, assess, develop, evaluate, and endorse national standards for geospatial information management;
- Establish, maintain and measure requirements for conformance and interoperability with trans-boundary and other international frameworks and representation of national interests within global and regional SDOs;

- Promote broad public/private sector stakeholder dialogues and forums to raise awareness and to promote the alignment of a common standards framework across the nation;
- Develop and implement policies and procedures to monitor and assess compliance with endorsed national standards; and
- Support standards knowledge and capacity building through training programs and community best practice sharing.

The Coordination Unit would also establish liaisons with relevant SDOs and professional associations to monitor emerging national, regional and global standards, represent national standards requirements, and to network with peers and industry experts regarding innovative new standards practices.

Specialist Working Groups (See SP1: Action 1.6.3) or sub-committees of the Coordination Unit should comprise technical expertise from across government agencies and departments. They would be organized to assess government's standards' needs, recommend standards for inclusion in the nationally endorsed geospatial information management standards inventory, and develop data content and encoding standards for foundational data managed by departments across government.

Examples of National Governance Models associated with standards for geospatial information management are provided in Appendix 6.1.

See Interrelated Actions on a Governing Board (SP1); Geospatial Information Coordination Unit (SP1); and Specialist Working Groups (SP1).

6.6.2 Standards Awareness

Part of the leadership role is to understand the practice of standards and to raise awareness of the benefits of moving towards a standards-based approach for geospatial data management.

Part of the leadership role is to understand the practice of standards and to raise awareness of the benefits of moving towards a standards-based approach for geospatial data management at all levels of government and with the private sector and academia. A heightened understanding and awareness of the relevance of standards, as an information sharing enabler, is crucial to strengthening capability. The following definitions are provided to help leaders raise awareness of standards and their influence on technology and data management.

The US Office of Management and Budget Circular A-119 defines 'voluntary consensus standards' [4] as standards developed or adopted by voluntary consensus standards bodies, both domestic and international. These standards

[4] OMB Circular A-119, *Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities is available at* https://www.whitehouse.gov/wp-content/uploads/2017/11/Circular-119-1.pdf.

include provisions requiring that owners of relevant intellectual property have agreed to make that intellectual property available on a non-discriminatory, royalty-free or reasonable royalty basis to all interested parties. Circular A-119 further states that a voluntary consensus standards body is defined by the following attributes: (i) Openness; (ii) Balance of interest; (iii) Due process; and (vi) An appeals process.

There are several types of standards relevant for integrated geospatial information management, in the broader context of interoperability of systems, and in relation to other Strategic Pathways, the SDGs, and e-Government initiatives. Standards address *domain-specific* geospatial applications, as well as general *geospatial information and technology* applications. These standards operate along with a family of *general-purpose ICT standards* that enable interoperability across various devices, networks, sensors and systems (Figure 6.5).

DGIWG	Defence Geospatial Information Working Group
WMO	World Meteorological Organization
ICAO	International Civil Aviation Organization
W3C	World Wide Web Consortium
OASIS	Organization for the Advancement of Structured Information Standards
IETF	Internet Engineering Task Force
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
OMG	Object Management Group
ISO/IEC JTC 1	ISO/IEC Joint Technical Committee 1-Information Technology

Figure 6.5: *Types of standards (Ostensen et al., 2015).*

General Information Technology, Internet and Information Standards are for defining the baseline of interdependencies between fundamental hardware and software elements relied upon by all:

- Internet, web, mobile, and other high-level IT standards.
- SDO's for these standards include the World Wide Web Consortium (W3C), International Telecommunications Union (ITU), and Institute of Electrical and Electronic Engineers (IEEE), among others.

General and Domain-specific Geospatial Information and Technology Standards are for the provision of specific data and applications by the user:

- Industry consortia: the Open Geospatial Consortium (OGC).
- *De jure* International: International Organization for Standards (ISO) Technical Committee 211 Geographic Information/ Geomatics, and the International Hydrographic Organization (IHO).

These standards are directly targeted at a certain data theme, domain, application, or user community, e.g., the global fundamental data themes of UN-GGIM (See SP4: Action 4.6.1). Examples include: Land Cover; Addressing; and Marine planning and applications.

General-purpose Information Communication Technology standards represent the majority of geospatial standards, and consist of the following types:

- *Geospatial data content (content models)* are standards relevant to all data themes and are expressed in a common standards-based data model. These include standards regarding geospatial data definitions, representation, data quality, general architecture, and other aspects of geospatial information. They collectively provide guidance on geospatial data collection, production, and maintenance (SP4). An example standard is the Referencing by Coordinates.
- Some standards aim at *describing* the data. These 'metadata' standards are important when specifying the data, or reporting the quality of the data, so that users can evaluate the fitness-for-purpose of the data for a certain application. For example, the *ISO-19115 on Metadata Standard.*
- *Geospatial technology standards* are standards specially designed to minimize the complexity of geospatial data discovery, access, integration, processing, and application across different technologies, systems, devices, and networks. The suite of *OGC Web Service Standards* is an example.

More information on Standards is available in '*A Guide to the Role of Standards in Geospatial Information Management*' (Standards Guide) and its '*Companion Document on Standards Recommendation by Tier*' (Companion Document). These documents provide detailed recommendations on key standards to consider for national adoption and implementation.

The Committee of Experts adopted, by decision 5/108, the Standards Guide and Companion Document at the Fifth Session of UN-GGIM in 2015 as the international geospatial standards best practice for spatial data infrastructure, and encouraged all Member States to adopt and implement the recommended standards appropriate to their countries level of spatial data infrastructure (SDI) maturity. At its Eighth Session of UN-GGIM in 2018, the revised version was adopted.

The Standards Guide addresses the role of standards in geospatial information management, and:

- Defines and explains what a standard is;
- Makes a case for open standards;
- Discusses why such standards are valuable;
- Describes geospatial standards and related best practices;
- Introduces a goal-based approach to standards adoption, and a multi-tiered standardization approach to attaining desired levels of geospatial capability;
- Characterizes emerging standards and trends;
- Provides concrete examples of standards in use; and
- Concludes with suggestions for next steps.

The associated Companion Document provides a more detailed look at the recommended standards based on functional capabilities required by organizations. The latest versions of both documents can be found in the proceedings from the Eighth Session of UN-GGIM, and in the UN-GGIM publications.[5]

See Interrelated Actions on Data Framework (SP4) and Communication Plan (SP9).

6.6.3 Strategic Goals

The implementation of a Standards Framework includes defining goals for what a country is endeavoring to achieve by implementing a standards-based approach to geospatial information management.

The implementation of a Standards Framework includes defining goals for what a country is endeavoring to achieve by implementing a standards-based approach.

Organizations, institutions and information communities are likely to be starting their standards journey at different points in the capability/maturity continuum, requiring a phased implementation approach that considers the different levels of experience and expertise of the people involved.

[5] *A Guide to the Role of Standards in Geospatial Information Management ("the Standards Guide") and its Companion Document on Standards, recommendation by Tier ("the Companion Document") is available at http://ggim.un.org/UN-GGIM-publications/*

Some organizations and institutions will be advanced, while others are just beginning, and some are only just considering the use of standards. The standardization maturity model (Figure 6.6) takes into account the different levels of knowledge and experience, and describes a standardization trajectory. This maturity model can be used for goal setting. These levels are identified as *tiers*. The goals for each tier are defined as follows:

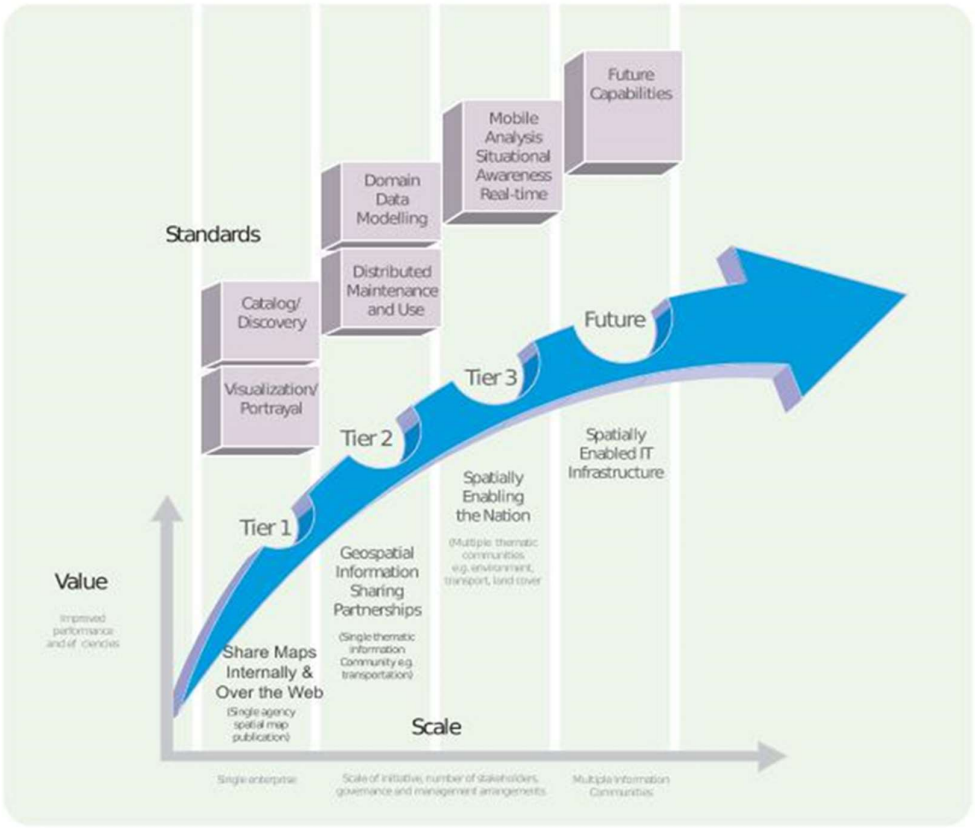


Figure 6.6: *Geospatial levels of standards use (Standards Guide).*

- **Tier 1:** Enable stakeholders (including users) to view and query interactive maps on the web. This goal is closely associated with the ability to discover, share and use geospatial information;
- **Tier 2:** Provide access to geospatial information over the web, provide geospatial information download services, and optimally, to provide specific data themes, such as roads, from multiple sources in a way that conforms to an agreed, common data model to create a consistent and integrated 'view' of the geospatial information for users. Tier 2 builds on the infrastructure, policies, technologies, and standards deployed and matured in Tier 1;
- **Tier 3:** Share foundation/framework geospatial information and services across government and with the broader community to improve knowledge and understanding, thereby contributing to

evidence-based decision making, situational awareness, and improved societal outcomes. This goal is to geospatially enable a nation to develop a comprehensive geospatial information management framework that provides access to multiple themes of information, applications for using the shared information, and access via a variety of environments (mobile, desktop, etc.);

- **The future:** Progress towards geospatially enabling the Web of Data (Semantic Web and Web 3.0) by bridging the gap between Spatial Data Infrastructures (SDI) and a broader ecosystem of information systems and spatially enabled Linked Data.

The Standards Guide defines the specific standards associated with requirements for each level, and thus each goal, of an organization's desired capability and collaboration. The Companion Document provides recommendations on the application of specific standards for each tier (Figure 6.7) so that countries can progressively move towards improved technology and data standards for geospatial information management, sharing and use.

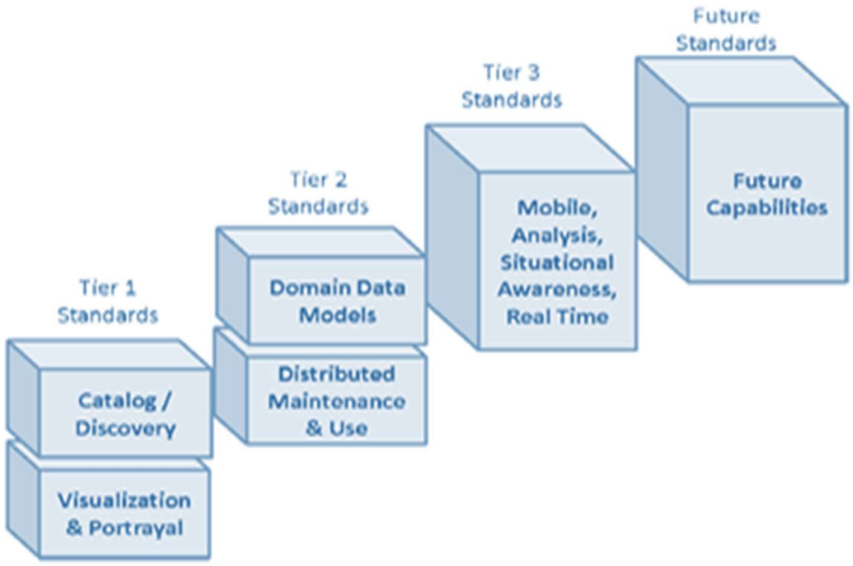


Figure 6.7: *Standards applicable to different tiers (Standards Guide).*

In addition, the Standards Guide focuses on broad data sharing and coordination via the web. The standards referenced in the Standards Guide support interoperability of data and technologies on a device, within a system, or via physical media (USB drives, DVDs etc.) within and among organizations involved in the production, management, or application of geospatial information.

The Companion Document also introduces the concept of 'Foundational Standards' which, in this context, means standards that support *all* tiers. Those types of standards form the technological basis for geospatial information exchange.

6.6.4 Baseline Survey

The first step towards understanding the needs for standards interoperability at the national level is to conduct a baseline of the current situation.

The first step towards understanding the needs for interoperability, in terms of standards at the national level, is to conduct a baseline of the current situation on data management and standards, and the level of compliance. This involves understanding the national levels of cooperation and stakeholders involved geospatial information management, including:

- How data are maintained and exchanged;
- How data is attributed (metadata);
- How it is exchanged and how frequently, and with what technologies;
- Whether data are openly accessible or restricted, and the data and system security measures that are in place; and
- How data is used today, who are the users, and what are the benefits?

The baseline is typically completed by assessing each organisation that produces, value adds and uses geospatial information via a Baseline Survey. The objective of the Baseline Survey is to gather information about the current geospatial standards ecosystem in a country. This information is an important part of the Needs Assessment and Gap Analysis as it helps to understand gaps in current capabilities.

Because the baseline only captures a particular point in time, it can be used to measure progress by conducting the survey again at a later date.

An example of a Standards Baseline Survey is provided in Appendix 6.2.

6.6.5 Standards Inventory

A standards inventory is used to understand what standards are used by participating government organizations, users, and data and technology providers.

A Standards Inventory is used to understand what government-developed, de facto/proprietary, national, or international standards are used within each participating government organization, by users, and/or by data and technology providers.

The Standards Inventory is also used to understand any national profiles of international standards in use. For example, a national metadata profile of the ISO 19115 and 19115-2 metadata standards for geospatial data and imagery, and importantly, who the users of the standards are. For efficiency, the Standards Inventory should be conducted at the same time as the Data Inventory (See SP4: Action 4.6.2).

See Interrelated Action on Data Inventory (SP4).

6.6.6 Needs Assessment and Gap Analysis

A Standards Needs Assessment and Gap Analysis is typically conducted once agreement on the strategic goals and *current* situation have been reached among the national stakeholders.

A Standards Needs Assessment and Gap Analysis is typically conducted once agreement on the strategic goals and *current* situation have been reached.

The analysis of *needs* may result in several alternative *scenarios* concerning and relating to national *goals* for standards. These scenarios should be closely considered, looking at analysis, impact assessment and feasibility, as well as considering challenges and opportunities. The model of tiers introduced in section 6.6.3 (Figures 6.6 and 6.7), in which different levels or tiers of increasing capability and collaboration are defined, is useful at this stage.

The tiers documented in the Standards Guide and its Companion Document can be used as a guide for conducting a Needs Assessment and Gap Analysis, particularly when they have been used to align the strategic goals for a country's Standards Framework.

An example of a Needs Assessment and Gap Analysis Template based on the four tiers is provided in Appendix 6.3.

6.6.7 Action Plan

The activities leading up to an adopted Country-level Action Plan typically involve generic project planning activities comparable to major programs at the national level. As such, it implies major transitions and impacts on programs, economy and people. In terms of standards, key questions to be considered in the planning process include:

The activities leading up to a Country-level Action Plan typically involve generic project planning activities comparable to major programs at the national level.

- **What**: What are the functions required? Share maps/geospatial data across networks within an organization, on the web, or institute a better cataloging system to track physical maps? Support multi-jurisdictional geospatial data collection and maintenance? Support cooperative geospatial activities with neighboring and/or like nations?
- **When**: When do we intend to reach our goals or different steps? Is there a stepwise approach with milestones that must be scheduled? What are the key priorities by which an overall schedule will be developed?

- **Who:** Who are the key experts and decision-makers needed to support the activities identified?
    - Governance and policy bodies as defined in section 6.6.1;
    - Experts needed for developing information models, specifications, and IT environments;
    - Organizations providing experts;
    - Organizations responsible as authoritative data owners; and
    - Reference groups and stakeholders.
- **Costs and funding:** What are the costs, what types of costs, how is the national plan funded etc.?
- **Relation to other initiatives or activities:** A major national project will have an impact on other ongoing projects, and there can be both synergies and challenges to deal with. Certainly, relationships to the implementation of other Strategic Pathways at a national level will be highly relevant.
- **Capacity Building**: What is the approach for capacity building and the related tools and resources available?

6.6.8 Institutional Arrangements

One of the first steps in the planning process is to confirm the organizational governance roles, structures and processes.

One of the first steps in the planning process is to confirm the organizational governance roles, structures, processes to:

- Ensure that all roles, responsibilities and organizational structures are in place according to the national plan and fostering a successful implementation;
- Identify the level of organizational capability required to meet the mission;
- Define the level of organizational engagement and resources necessary for participation in the national governance process, as described in section 6.6.1, for successful cooperation between national agencies and stakeholders for sharing and exchanging geospatial data;
- Ensure that acquisition/procurement actions include requirements for common nationally endorsed standards; and
- Consider participation in international standards organizations as part of capacity building and a means of influencing standards. IHO, OGC and ISO TC/211 have membership opportunities and support public comment processes for input on standards in development and related documents.

A summary of key Roles and Responsibilities for National Standards Governance is provided in Appendix 6.4.

6.6.9 Implementation

Once an agreement on the goals and path forward has been reached, these serve as a basis for implementing the Country-level Action Plan. The Plan should reflect the short-term national ambition, e.g. three to five years, as well as a longer-term perspective.

When applying technology and data standards, it is recommended that countries adopt the Standards Guide and the Companion Document, and take actions necessary to implement endorsed national standards at a chosen level or tier of capability. Basic steps for all countries include:

When applying technology and data standards, it is recommended that countries adopt the Standards Guide and the Companion Document.

- **Maintain an inventory of data and associated technical standards:** It is of crucial importance that the inventory of data at the national level is regularly maintained and on an ongoing basis (See SP4: Action 4.6.2). This includes discussions on related data standards and standards associated with cataloging, discovery, management and distribution of geospatial data.
- **Document Metadata:** "Without metadata it is difficult to discover and access geospatial data. Incomplete metadata will make it difficult to impossible to determine the usefulness of data for mapping and analysis" (See SP4: Action 4.6.11). For this reason, it is important to ensure that geospatial data managed by an organization has associated metadata according to ISO 19115. Several profiles of ISO 19115 have been adopted around the world, and there are a number of useful tools and training resources available on-line (See Appendix 6.5). Additionally, a checklist for establishing metadata is provided in SP4: Appendix 4.9.
- **Establish desired geospatial information management functionality:** Using the Tiers described in the Standards Guide, consult the Standards Guide and Nationally Endorsed Standards list to identify common standards for implementation with the desired level of capability. The Standards Guide supports several tiers of capability. If existing geospatial information management capabilities do not support recommended standards, identify this as a gap for action as part of future acquisition or IT development.
- **Determining Compliance with Standards:** Ensure that implementation of standards is in accordance with the standards (compliance, conformance, validation, verification) or services offering certification.

The ISO/TC 211 package of standards (numbers typically between ISO 19000 and 19199) offer annexes with self-evaluations in the standards, along with ready-made test cases. OGC offers on-line test and certification procedures for their standards, and a list of products that have been certified as compliant with specific OGC standards (See section 6.6.2).

- **Adopt common geospatial terminology:** Common vocabularies should be used throughout the nation.
- **Standards for semantic mediation:** Harmonization at the national level (See section 6.4.2), geospatial data maintained across cooperating organizations may need to be mediated to address differences in the data standards chosen for a particular theme of geospatial data. The action required is to identify needs for the creation of standards-based encodings to support semantic mediation of similar data themes managed by cooperating organizations.
- **Set up IT and test environment:** To address compliance of systems to adhere to nationally endorsed standards.

A list of Standards Training, Tools and Related Resources are provided in Appendix 6.5.

See Interrelated Actions on a Data Inventory Template (SP4) and a Metadata Creation Checklist (SP4).

6.6.10 Communication and Engagement

Communicating the Action Plan is an ongoing task during all phases of implementation and operations.

As part of the establishment of the Standards Governance Framework (See section 6.6.1), raising awareness among project teams across government and with relevant national stakeholders will be key. Communicating the Action Plan is an ongoing task during all phases of implementation and operations. The aim is to communicate the benefits of implementing the plan, the approach for how the plan will proceed, what the impact will be, and how this affects different groups and stakeholders. After the implementation phase, the responsibility goes back to the governance bodies to ensure that long term benefits are made at the national level.

Besides making the public aware of the national plan and its progress, communication is also of vital importance at an operational level as an ongoing process, facilitating stakeholder and community involvement. Communication plans should emphasize the value of implementing international open standards to:

- Mobilize new technologies and data sources quickly;
- Avoid being locked into a particular technology or vendor;

- Reduce costs over the lifecycle of a system or systems;
- Ensure the ability to share data when necessary:
- Enable interoperable sharing and operations; and
- Support disconnected or local operations.

Strategic Pathway 9: Communication and Engagement emphasizes an engagement strategy for active interaction with community stakeholders and users to raise awareness, advocate and strengthen geospatial information management, and including exchanges regarding the use of standards to maximize access.

See Interrelated Action Communication Plan (SP9).

6.6.11 Risk Assessment

Major barriers to implementing standards can be reduced by policy and/or legislation supportive of standards, awareness raising and education.

A recent survey conducted by ISO/TC 211, IHO and OGC identified major barriers to implementing standards today (Figure 6.8). Barriers can be reduced by implementing policy and/or legislation supportive of standards, and by raising awareness, education across the community, and assuring adequate resources to address standards implementation throughout the geospatial information management IT lifecycle. Appendix 6.4 discusses the various roles and responsibilities in standardization, for management as well as for developers and users. Allocating roles and responsibilities is one way to reduce risk and overcome barriers to the implementation of standards.

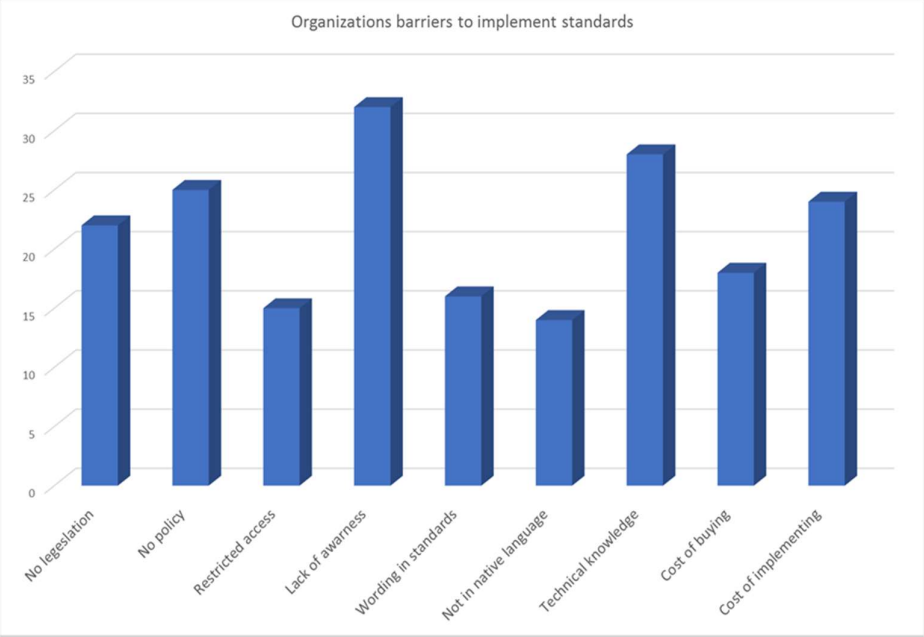


Figure 6.8: *Organizations' barriers to implement standards (Survey by Standards Development Organizations for UN-GGIM, 2018). Lack of awareness and technical knowledge are prominent barriers.*

International open standards are emphasized in the Standards Guide as a first choice, and will best position countries to support interoperability and compatibility of geospatial information and systems from the local to global level. Many countries adopt international standards as part of their National Standards policy.

National data standards and related encoding standards should leverage fundamental data themes established at the international level (See SP4: Action 4.6.1) whenever possible to promote data sharing across national borders when multi-national issues arise.

Caution should be taken when considering the use of proprietary or de facto standards[6]. These standards should be adopted and used only when equivalent international or national open standards do not exist.

6.6.12 Standards Review Program

While geospatial standards are quite mature, they do not remain static and require periodic updates.

It is important to understand that geospatial standards, like the technology they support, are quite mature and are broadly implemented in technologies globally. However, they do not remain static. To ensure consistent flow of geospatial data, they require periodic updates by the SDO community as they accommodate new technologies and user requirements. As such, it is important that any government organization that employs the use of standards should maintain an ongoing process for review in order to update their systems, as necessary. To quote the Standards Guide: "Policymakers should also keep in mind that advances in technology inexorably changes organizational structures, workflows and business models."

Data standards and technical specifications are subject to change for several reasons, and may trigger a review for the following reasons:

- Stakeholder needs have changed since the standards were developed, and will do so again;
- Standards are impacted by new policy and/or legislation. For example, Government Information Classification Code and new privacy laws; and other government mandates;

[6] ***Open standards*** *which specify formats are sometimes referred to as* ***open*** *formats. Many specifications that are sometimes referred to as* ***standards*** *are* ***proprietary*** *and only available under restrictive contract terms (if they can be obtained at all) from the organization that owns the copyright on the specification. Source: Wikipedia. Many proprietary standards are openly available, but are subject to the decision of a single organization rather than through broad consensus by an official standards organization.*

- Standards may need to be brought in line with related National standards, such as those pertaining to a change in the horizontal or vertical datum;
- Standards may need to be updated to reflect a change in the technology used to manage geospatial information. For example, hardware/software upgrades, new equipment, a change to formats of external data sources, and/or a paradigm shift in technology used;
- Business key performance indicators (KPI) require standards to be periodically reviewed based on the date of the last revision; or
- Standards may be reviewed as a result of lessons learned, such as from feedback from the public or regulator, non-compliance reports and subsequent resolutions, and incidents resulting from poor data management. These may include inadequate emergency response times, and changing business needs.

A Standards Review Program is typically used to prompt a review of data standards and technical specifications to keep abreast of new policy initiatives and changing stakeholders needs. It may be used to:

- Reinforce the ongoing commitment to the development, implementation, and maintenance of a comprehensive data standards program;
- Facilitate an efficient and effective regulatory review process;
- Promote innovation in the development and use of standards;
- Implement common data standards to improve the quality and integrity of data; and
- Ensure effective continuous communication and collaboration with stakeholders on data standards.

A Standards Review Program will typically be coordinated by the Geospatial Coordination Unit or at an organization level. A Standards Review Program will typically include:

- Goals and objectives of the Standards Review Program;
- Governance process for ongoing review including roles and responsibilities;
- Review timeframes and schedule;
- Communication strategies for conducting the review;
- Approval processes for new or revised standards;
- Scope of the review e.g. what data standards and technical specifications are to be brought under the review process; and
- Communication strategies for releasing new and revised data standards and technical specifications.

The Standards Review Program should be collaborative, flexible and adaptable to stakeholder needs and the changing environment. Stakeholders should be notified that a data or technology standard, or technical specification is under review, and a time set aside to consult with these stakeholders. A list of interview questions or survey is a suitable method for seeking input on changes and requesting feedback on proposed variations.

The review process should follow an agreed approach, and adopt communications strategies and approval processes set out in the Standards Review Framework.

6.6.13 Community of Practice

A community of practice can accelerate the process of strengthening geospatial information management and the realization of benefits.

A community of practice can accelerate the process of strengthening geospatial information management and the realization of benefits, as it provides the opportunity to share and leverage proven standards-based good practices. It also provides an opportunity for organizations and business enterprises to have a voice in building and learning about standards.

A wealth of experience and knowledge is available from across the international community regarding the successful implementation of standards to support a range of topics and challenges. These include in areas such as public safety, water resources, environmental management, land administration, and smart, safe and resilient communities. By building a Community of Practice through partnerships with other nations, with SDOs and their expansive public and private sector membership, and with professional associations, countries can identify, assess, and adapt best practices of others, which can greatly reduce the time and effort to improve interoperability for data sharing and application to national issues.

Academia has a key role to play in supporting communities of practice and to assure readiness of students entering public and private sector professions. Universities should be encouraged to ensure the inclusion of up-to-date geospatial standards training and education as part of their overall geospatial management and information technology curriculum.

Examples of User Community Case Studies and Statements of Benefits are provided in Appendix 6.6.

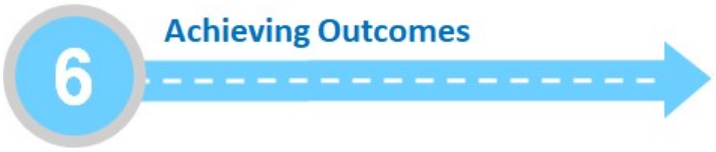
6.6.14 Capacity Building

Capacity building underscores a consistent approach to standards compliance.

Capacity building underscores a consistent approach to standards compliance to enable data management, sharing and reuse. The application of data and ICT standards to enable interoperability, as well as cooperation in data custodianship roles and responsibilities, is essential. Building the appropriate capacity in standards will require collaboration across all levels of government (local, national, regional, international); particularly when it comes to

information exchange. Capacity building methods that can be used to enhance the management of technology and data standards are presented in SP8: Capacity and Education. Other important resources, such as standards training programs, are also available across the community, and may be usable in their current form, or updated to address national contexts.

See Interrelated Action to Join/Build a Community of Practice/Capacity Building Methods (SP8).



6.6.15 Compliance

A system of compliance is encouraged to ensure that organizations are implementing the nationally (or internationally) endorsed standards that promote data sharing and use, and to verify that technology products and services acquired by government properly implement the required standards. There are four levels of standards compliance that should be considered by countries:

A system of compliance is encouraged to ensure that organizations are implementing the endorsed standards that promote data sharing and use.

1. Regular assessment and validation of organizational compliance in implementing endorsed standards in their geospatial information management activities, and based on national policy;
2. Inclusion of nationally endorsed geospatial information management standards as a requirement for all organizational procurements/tenders delivering geospatial technologies and data products and services, with a mandate or preference for delivery of products and services that have been tested and certified as compliant (where such compliance tests are available) with the standard by the appropriate compliance authority;
3. Facilitation of testing and certification functions which can provide formal certification nationally as well as certification recognition under international testing and certification standards, frameworks, and conventions; and
4. Use of available technology compliance testing resources to confirm proper implementation of standards related to any government developed technologies.

ISO geospatial standards include self-evaluation resources that can be useful. OGC offers freely accessible on-line test procedures, and manages a certification

program for technology providers to certify products as compliant to one or more OGC standards[7].

The OGC Compliance Interoperability Test Engine and test scripts are available as open source technology, and can be implemented by government organizations for testing of internal government systems which use, or may have been modified to use, OGC standards.

IHO has a long history of supporting international testing frameworks for certification against global standards supporting the SOLAS convention. These testing and compliance regimes are the result of global harmonization efforts by many national agencies.

6.6.16 Success Indicators

The benefits of implementing a common standards framework are achieved over time, and reinforce the need for a national standards strategy and Benefits Realization Plan.

It is important to have a Benefits Realization Plan and establish success indicators to gauge whether benefits have been realized. Success indicators typically set targets and define how the benefits will be measured, and what evidence will be used as the basis. It is valuable to know when the objective of implementing standards has achieved overarching goal(s), for example, enhanced interoperability and data integration.

The benefits of implementing a common standards framework are achieved over time, and reinforce the need for a national standards strategy while verifying that implementations had the desired impact in reaching overarching goals and objectives.

By implementing geospatial information management and systems based on a common, open, standards framework, technological barriers to geospatial information sharing can be significantly minimized. This allows the decision to share geospatial information among organizations from the local to global level, to be one of policies; regarding open data, as well as data that should be restricted from sharing due to clearly defined privacy or security policies.

Without a common standards framework, organizations risk creating technical barriers to data sharing and locking their organizations into a particular technology solution. When data sharing becomes a requirement in such an environment, costly and time-consuming custom software development is often required to solve data compatibility challenges – raising system lifecycle costs, and more importantly, causing missed opportunities to share and cooperate on urgent, time sensitive issues.

By adopting and implementing a common geospatial information management standards framework across government and with other stakeholders, governments can better assure that geospatial information managed by

[7] *OGC standards are available at http://www.ogc.org/compliance.*

different organizations can be discovered, accessed, and applied to address a range of important issues. Organizations reduce their IT lifecycle costs and make it easier to add new standards-based capabilities as they are offered by industry. They also take advantage of the interoperability enabled by the variety of geospatial and IT products and services available on the market that implement these standards. Various case studies regarding the benefits of adopting international geospatial standards are summarized in the Standards Guide.

Other indicators may include assessing, monitoring and evaluating as part of an internal/external auditing exercise, and may include factors such as:

- Improvements in geospatial data production and management efficiencies that save time and effort;
- Improved ability to share geospatial information with ease under normal operational and urgent situations; and
- Cost savings of reusing/repurposing geospatial data vice duplicative data collection and maintenance.

Examples of Community Best Practice are provided in Appendix 6.7.

See Interrelated Action for a Benefits Realization Plan (SP3).

6.7 Deliverables

The list of deliverables below are the outcomes typically created as a result of completing the actions in this pathway. They are key success indicators in realizing an Integrated Geospatial Information Framework. Examples include:

- A Standards Governance Framework
- Standards Awareness Raising
- Strategic Goals
- Standards Baseline Survey
- Standards Inventory
- Needs Assessment and Gap Analysis
- Action Plan including Institutional Arrangements
- Implementation and Communication of Standards
- Standards Review Program
- Standards Community of Practice
- Standards Capacity Building Programs
- Compliance Program
- Success Indicators for Benefits Realization

6.8 Outcomes

The following outcomes result from the successful application of standards to improve sharing and use of geospatial information and optimize geospatial information management in a country:

- Minimized barriers to data sharing and integration in support of government-wide policy, decision-making and service delivery;
- Enhanced abilities to share geospatial information across jurisdictional boundaries (local, national, and global) and to cooperatively address issues of common importance;
- Rapid mobilization of new sources of data and new technologies, as well as avoidance of lock-in to specific technology providers;
- Improved uptake of geospatial information across government and with the private sector and citizens; and
- Efficiencies in geospatial data production and lifecycle management; saving effort, time and cost in reusing and repurposing data.

6.9 Resources

As part of the work programme of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM), there are a number of initiatives and activities including by the subcommittee, expert and working groups of the Committee of Experts. These initiatives and activities are multi-stakeholder when arriving at outcomes and outputs. This inclusive and participatory nature of work has allowed the preparation of a number of resource documents/publications that are helpful and useful when addressing the complexities in governance and institutions that impacts geospatial information management. This includes specifically the work and contributions of the Standards Development Organizations to the work of UN-GGIM. These include:

- A Guide to the Role of Standards in Geospatial Information Management (Standards Guide)[8]; and
- Companion Document on Standards Recommendations by Tier (Companion Document)[9].

6.10 References

O. Ostensen, D. McKenzie & R. Ward (2015). Standards Report to UN-GGIM 2015. Available at: https://ggim.un.org/UN-GGIM-publications/

[8] *http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards_Guide_2018.pdf*

[9] *http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards-by-Tier-2018.pdf*