



Economic Commission for Africa
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Development of geospatial information standards for Africa

I. Introduction

1. In the light of recent technological developments, geospatial information has emerged as a major contributor to better policy formulation and responses to many of the current humanitarian, environmental and socioeconomic problems facing the world, given its ability to integrate both quantitative and qualitative information throughout sectors and present it to decision-makers in innovative formats. Building infrastructure for the use of geospatial information is considered to be as important to countries as the building of roads and telecommunications networks and the provision of other basic services. It is, however, becoming clear that the major barriers and impediments to building geospatial infrastructure will not be technical, but rather institutional and organizational, including the ability to have countries cooperate, learn from one another and adopt and implement common standards.

2. At a global consultation held in 2012 on the inventory of issues to be tackled by the nascent Committee of Experts on Global Geospatial Information Management during its first years, standards were identified as one of the key issues to be addressed. It was determined that, in many countries, while there was no shortage of geospatial data being collected, there was a lack of interoperability among the various sources of data, reducing its use and sharing by multiple users. In particular, while international standards in support of geospatial and location-based information had been in development since the early 1990s, mainly through the work of the International Organization for Standardization Technical Committee 211 on geographic information/geomatics, the Open Geospatial Consortium and other organizations such as the International Hydrographic Organization and the Unicode Consortium, many countries remained slow to adopt and implement the existing internationally agreed standards.

3. It was stressed at the global consultation that standardization is a key aspect in enhancing the integration process of geospatial information into daily decision-making at all levels of society. In addition, in supporting better decision-making for sustainable development, policymakers and decision makers require mechanisms and tools in which various actors can speak the same language in times of emergency and crisis. For example, in many recent disasters, reports abound of occurrences in which actors, especially first responders in the countries affected, were unable to use a cohesive geospatial language to carry out emergency responses owing to the lack of a common language implemented within their own government.

4. In this regard, adopting and implementing existing international standards at the national and regional levels in Africa require an inventory of current standards available in each country and the selection of a set of relevant

standards in accordance with the specific circumstances prevalent in Africa. It is against this mandate that the present report outlines research and a summary of existing guidelines, protocols and good practices that are aimed at playing a supporting role in promoting the internationally agreed standards, advocating their adoption and implementation and demonstrating how they may be aligned with the most recent technological developments and the specific needs of Africa.

II. Objectives

5. Standards in geospatial information underpin the creation and sharing of data sets and ultimately build and develop spatial data infrastructure.

6. The main objective of this report is to provide guiding principles on geospatial standards that could be used by national geospatial information authorities (e.g., mapping agencies) as a reference for strengthening the harmonization of fundamental geospatial data sets in Africa, including the common standards and metadata that would make statistical and geospatial information more useable and more relevant to a wider range of stakeholders.

7. The following objectives are taken into account:

(a) Provide an overview of the range of international standards that are available and applicable in the context of global geospatial information management;

(b) Highlight those areas in which the contributions of the Regional Committee of United Nations Global Geospatial Information Management for Africa can be made to advise on appropriate standards in African national contexts;

(c) Identify some best practices and experiences and outline the guiding principles for adopting common regional standards for spatial data infrastructure practices, in line with international policy and standards;

(d) Address the standardization challenges facing African countries, in particular the need for mechanisms to support their efforts in the adoption and implementation of the existing standards.

III. International geostandards

8. The work on standards for geospatial information has been carried out for quite some time by many international organizations, with a view to adopting and implementing internationally agreed standards to ensure compatibility and interoperability for a meaningful exchange and use of geospatial information. This section provides an overview of the major geostandards organizations and highlights the major geospatial information issues for which they established a set of technical standards.

A. International standards organizations

9. There are a number of international organizations whose primary objective is to develop, maintain and make publicly available open standards for geospatial information through a consensual process. This is particularly the case for the International Organization for Standardization Technical Committee 211 on geographic information/geomatics (also known as ISO/TC 211), the Open Geospatial Consortium and the International Hydrographic Organization. While ISO/TC 211 is developing international standards to support the understanding and use of geospatial information through a country-driven balloting process and membership-based consensus, the Consortium is an international industry consortium established in 1994 with more than 500

members, composed mainly of industry/private companies, governmental agencies, non-governmental organizations, academia/research communities and the open source community. It develops standard specifications for a large number of geospatial and locational sectors and establishes common interfaces that “geo”-enable the Internet and mainstream information technology. The International Hydrographic Organization is an intergovernmental consultative and technical organization that is mandated to establish and maintain international hydrographic standards to support the safety of navigation and the protection of the marine environment, an important task, given that water covers most of the Earth.

10. While the work carried out by ISO/TC 211, the Open Geospatial Consortium and the International Hydrographic Organization and other entities is very useful for the geospatial community and has been recognized globally, problems remain with regard to the issues of the adoption and implementation of these standards at the national level. Some countries are adopting and implementing these available international standards, but many others, in particular developing countries, continue to experience many significant gaps and challenges and are unable to do so, owing to a lack of resources and capacities or a lack of knowledge of the standardization processes, or both. This means that efforts need to be made by the United Nations Initiative on Global Geospatial Information Management and its regional committees and others to raise the awareness of geospatial standards and assist in their adoption and implementation, in particular in the context of the 2030 Agenda for Sustainable Development.

B. Internationally agreed standards

11. ISO/TC 211, the Open Geospatial Consortium and the International Hydrographic Organization have developed standards for the geospatial information community. As a way to identify these existing standards, it will be necessary to follow the approach taken by the United Nations Initiative on Global Geospatial Information Management to define the major issues for which standards have been developed. Indeed, after wide-ranging global consultations and thorough discussions with the States Members of the United Nations and relevant stakeholders, nine thematic groups had been identified to be addressed by the Initiative as priority areas.

12. ISO/TC 211, in cooperation with the Open Geospatial Consortium and the International Hydrographic Organization, provided to the Committee of Experts on Global Geospatial Information Management, at its third session, held in Cambridge, United Kingdom of Great Britain and Northern Ireland, in 2013, a detailed report indicating the existing standards relevant to the nine thematic areas. The table below indicates the number of existing geospatial information standards developed, as of 2013, by the three organizations for each major issue.

Table

Existing geographic information standards and the priority issues of the United Nations Initiative on Global Geospatial Information Management

Priority issue	Number of standards		
	ISO	OGC	IHO
Developing a national, regional and global strategic framework for geospatial information	6	5	1
Establishing institutional arrangements and legal and common frameworks	5	2	7
Building capability and capacity, especially in developing countries	5	2	2
Assuring the quality of geospatial information	7	6	8
Promoting data-sharing, accessibility and dissemination	63	24	15
Embracing trends in information technology	20	18	3
Promoting geospatial advocacy and awareness	-	4	2
Working in partnership with civil society and the private sector	-	-	-
Linking geospatial information to statistics	7	6	-

Abbreviations: IHO, International Hydrographic Organization; ISO, International Organization for Standardization; OGC, Open Geospatial Consortium.

13. While the standards of ISO/TC 211, the International Hydrographic Organization and the Open Geospatial Consortium address all the geospatial issues identified, the primary focus is on promoting data-sharing, accessibility and dissemination. It is important to note the comparatively high number of standards that contribute to the issue of embracing trends in information technology, which confirms that, in the geospatial community, similar to other communities, standards are increasingly used as a tool to facilitate innovation. While the number of standards on quality contributing to assuring the quality of geospatial information is low, compared with promoting data-sharing, accessibility and dissemination and embracing trends in information technology, one has to keep in mind that implementing standards in and of itself (e.g., standards counted under promoting data-sharing, accessibility and dissemination and embracing trends in information technology) also contributes to the quality of geographic information. While there are no standards that contribute to working in partnership with civil society and the private sector, consensus-based standards development in the three organizations, with representatives from the private and public sector, research institutes, academia and other stakeholders, is an example of a collaborative effort.

14. It is worth mentioning that there are two key types of geospatial standards that one needs to be aware of: those related to data/information and semantics (or content) standards and those dealing with technology standards, in particular regarding interfaces.¹ While most technology standards are well established today and users do not have to worry about them,² the concerns and challenges that remain to be addressed are those relating to data and semantics standards.

15. In this regard, the need for international cooperation in the adoption and implementation of standards and their related institutional strengthening and knowledge transfer to countries that are in need is arguably one of today's

¹ The following modified definition of these two standards is taken from the geospatial standards and operational policies website of the Government of Canada: "Geographic information standards provide digital coding to locate and describe features on, above or below the Earth's surface. Geographically-related features can be naturally occurring (for example: rivers, rock formations, coastlines), man-made (for example: dams, buildings, radio towers, roads) or intrinsic, implied and transient information (for example: political boundaries, electoral districts, weather systems, distribution of population ethnicity)".

² It was discovered, in a survey conducted by the magazine *GIS Professional* and the results of which were published in June 2017, that the most popular geographic information system standards were keyhole markup language (KML) (62 per cent of respondents found it useful) and web map service (WMS) (52 per cent). Other useful standards were the International Organization for Standardization metadata standards (44 per cent), geography markup language (GML) (35 per cent), and web feature service (WFS) (41 per cent). The Environmental Systems Research Institute shapefile, which was not cited, has apparently become a de facto standard for several respondents. GeoJSON is also considered to be a useful standard. See www.gis-professional.com/content/article/gis-challenges-and-trends-in-2017.

central development challenges, given that any progress in geospatial information management will depend on it.

IV. Regional and national initiatives

16. A number of international and regional initiatives such as Global Spatial Data Infrastructure, Global Earth Observation System of Systems, the Economic Commission for Africa (ECA) Committee on Development Information, Science and Technology and Infrastructure for Spatial Information in the European Community have offered assistance and resources to help countries to build their national spatial data infrastructure. Relatively little attention has been paid, however, to the challenges that developing countries face in effectively adopting and implementing geospatial standards, formulating data-sharing policies and building their national technical and institutional capacities for standardization.

A. Infrastructure for Spatial Information in Europe

17. The Infrastructure for Spatial Information in Europe initiative was launched by the European Commission to build a spatial data infrastructure for the European Union, in particular with regard to environmental applications. It is intended to enable the sharing of harmonized and qualitative geospatial information among public sector organizations, facilitate public access to geospatial information throughout Europe and assist in the formulation of community policies across boundaries. The initiative is based on the infrastructures for geospatial information established and operated by the States members of the European Union using common standards and protocols and addresses 34 major geospatial data themes. It was set as a directive and came into force on 15 May 2007, to be implemented gradually, with full implementation required by 2021. Users can search and discover geospatial data sets and services through it, subject to access restrictions to view geospatial data sets from the European Union member States under the framework of the directive. The initiative constitutes an interesting example of good practice guidance and policies relating to the use of Open Geospatial Consortium and International Organization for Standardization standards for spatial data infrastructure and other enterprise applications.

B. National best practices

18. Many countries established national institutions in charge of developing, adopting and implementing standards, including geospatial-related standards. Fifteen years ago, very few mature standards were available for use by either the geospatial information or the broader information and communications technology communities. This situation has changed radically since the three major standard organizations (i.e., the International Hydrographic Organization, the International Organization for Standardization and the Open Geospatial Consortium) defined a robust, mature standards baseline for enabling geospatial interoperability and for integrating geospatial data and content into any application or software environment. These standards are now increasingly implemented in commercial and open source software and applications.

19. The need for the development of geospatial standards has increased with the building of national spatial data infrastructure, given that countries understand that standards for geospatial information underpin the sharing of data and development of a spatial data infrastructure, and that national spatial data infrastructure is necessary for effective partnerships and cooperation among a wide variety of multidisciplinary stakeholders in the public and private sectors and the end user communities.

V. Geospatial standards for Africa

20. For more than one decade, Africa has embarked on creating national and regional spatial data infrastructure, with geospatial standards and priority data areas defined by ECA³. ECA has made multiple efforts to assist in this regard by facilitating the development of key standards for the African continent, knowing that common standards are necessary to ease the effort of sharing data and understanding among organizations and applications and that many applications extend beyond national borders, requiring the integration of data sets across national borders. It is nevertheless worth mentioning some achievements. The metadata standard is one, in which an African profile has been developed, in consultation with many African countries. Another important effort of standardization at the regional level is the African Geodetic Reference Frame, the objective of which is to harmonize African geodetic reference frames, thereby providing a unique spatial referencing system for the continent, in line with the global geodetic reference frame adopted by the General Assembly in 2015.

21. At the national level, a number of African countries have developed various data standards in an effort to meet their user needs, but these standards may not be aligned with one another nor with the international standards developed primarily by the International Organization for Standardization and the Open Geospatial Consortium.

22. In this context, the Regional Committee of United Nations Global Geospatial Information Management for Africa is determined to focus on geospatial information standardization as a priority issue in its work in the coming years, as outlined in the Addis Ababa Declaration on Geospatial Information Management towards Good Land Governance for the 2030 Agenda, and work with the African countries and other stakeholders to initiate a regional initiative on geospatial standards.

23. It is worth suggesting a two-fold approach for the adoption and implementation of national standards, in line with the internationally agreed ones: (a) a set of standards relating to the fundamental data sets for African national spatial data infrastructure; and (b) an additional set of standards relating to the major issues with regional and global scope.

A. Standards relating to the fundamental data of national spatial data infrastructure

24. Many African countries are at an initial stage or in the process of building their national data spatial infrastructure. Its main components are fundamental data and their related standards. Africa had already agreed on the 10 fundamental data layers required for building a national spatial data infrastructure: (a) geodetic control network; (b) imagery; (c) hypsography (elevation); (d) hydrography; (e) administrative boundaries; (f) geographic names; (g) land management units/areas; (h) transportation (networks); (i) utilities and services; and (j) natural environment (more land cover). These layers are almost the same as the ones adopted in 2016 by the United Nations Initiative on Global Geospatial Information Management. What remains to be done is to adopt the existing (common) standards relating to the basic layers agreed upon and that are required for a national spatial data infrastructure in Africa, with the adjustments that are needed to conform to their national conditions.

³ See Economic Commission for Africa, *Determination of Fundamental Geospatial Datasets for Africa: Geoinformation in Socioeconomic Development* (Addis Ababa, 2007). Available at www.uneca.org/sites/default/files/PublicationFiles/geoinformation_socio_economic_dev-en.pdf.

B. Standards relating to global and agreed issues

25. In addition to the standards relating to the fundamental data needed for a national spatial data infrastructure, it is important to review the other remaining major issues identified and addressed by the United Nations Initiative on Global Geospatial Information Management and not included among the basic layers, and select those of crucial relevance to African countries. The Regional Committee of United Nations Global Geospatial Information Management for Africa identified five priority issues for Africa: (a) the African Geodetic Reference Frame; (b) institutional arrangements and legal frameworks; (c) capacity and capability development; (d) fundamental data sets; and (e) the integration of geospatial and statistical information.

26. There is some obvious overlap among the fundamental data issues needed for a national spatial data infrastructure and the five major issues cited above. Additional work needs to be done to break down these issues and identify the corresponding existing standards relating to each area.

VI. Example of a geospatial statistical framework

27. Developing a national, regional and global strategic framework for geospatial information has been a long-standing goal of the geospatial community, given that it constitutes a foundation for building geospatial information infrastructure at all levels and provides a reference framework, allowing for the integration of various data in support of evidence-based decision-making for sustainable development. With regard to linking geospatial data with socioeconomic and other data, integrating geospatial and statistical information has been identified by the United Nations Initiative on Global Geospatial Information Management as one of the nine priority issues to be addressed, given that it is relevant to many national geospatial information authorities and international organizations engaged in geospatial information management, in particular with respect to linking information through geocoding.

28. At the regional level, the integration of statistical and geospatial information is considered to be a key priority area in Africa, the Americas, the Arab States and Europe. For example, it was noted in the Common African Position on the post-2015 Development Agenda that a key enabler for sustainable development to be effective was for Africa to invest in and strengthen national statistical capacities and geospatial information systems for the collection, analysis, production and dissemination of disaggregated data to measure and evaluate policy effectiveness, and promote a culture of evidence-based decision-making.

29. In this regard, the Statistical Commission and the Committee of Experts on Global Geospatial Information Management established an expert group to work on the integration of statistical and geospatial information. It is tasked with developing and advancing the implementation of a global statistical geospatial framework as a standard for the integration of statistical and geospatial information, especially in the context of the 2030 Agenda and the 2020 round of Population and Housing Censuses.

30. The global statistical geospatial framework is considered to be a high-level framework that consists of five broad principles essential for integrating geospatial and statistical information: (a) the use of fundamental geospatial infrastructure and geocoding; (b) geocoded unit record data in a data management environment; (c) common geographies for the dissemination of statistics; (d) interoperable data and metadata standards; and (e) accessible and usable geospatially enabled statistics. Each principle is defined by a set of goals and objectives and supported by international, regional and applicable domestic standards and best practice. In situations in which standards, policies or data sets required to support the framework do not exist, the global framework

provides a clear mandate for their establishment. The standards and best practice that will form the detailed guidance for countries implementing the global framework remain under consideration by the expert group.

VII. Recommendation

31. Following the establishment of the Infrastructure for Spatial Information in Europe, creating a regional spatial data infrastructure initiative for Africa would be a reasonable solution to encourage the adoption and implementation of standards for geospatial information in Africa, improving the public access to and sharing of country data. In particular, integrating statistical information and geospatial information and strengthening and standardizing geospatial data exchange capabilities of African member States will contribute to improving the availability and timeliness of country information in support of the 2030 Agenda and the 2020 round of Population and Housing Censuses.

32. As a way forward, the following action should be carried out:

(a) Develop a common regional framework of standards and tools to make it possible to maximize the impact of the total resources available in a national spatial data infrastructure, in line with the existing internationally agreed standards;

(b) Encourage African countries to establish their national standardization institutions⁴ and legal and common frameworks in order to establish a national policy on geospatial information, which prescribes data standards to be implemented;

(c) Seek international cooperation in developing and implementing geospatial standards, institutional strengthening and knowledge transfer to countries that are in need, given that standardization is arguably one of today's central development challenges and that any progress in geospatial information management will depend on it;

(d) Assist the national standard organization in establishing links with any of the International Hydrographic Organization, the International Organization for Standardization and the Open Geospatial Consortium, and in having the regional body itself establish a liaison, representing Africa, with them.

⁴ A national standard organization focusing on various aspects of data standards, including data content, data definitions and the classification of features, symbology/data representation, data transfer protocols, data exchange formats, data quality, metadata and spatial referencing using coordinates/place names.