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Global Statistical Geospatial Framework

Standard guiding principles for the integration of statistical and geospatial information in Africa

I. Introduction

1. Over the past four decades, population and housing censuses and other surveys have been the main sources of data for policy formulation, monitoring, evaluation and decision-making in Africa for national and regional development programmes. It is worth mentioning that geospatial data has equally come to serve as a basis for policymaking over the past year. Geospatial data has been the backbone of economic and social development in areas including but not limited to: facility management, environment and natural resource management, street networks, planning and engineering, land information systems, applications of the Global Navigation Satellite System (GNSS) and location-based services. In most African countries, geospatial and statistical systems remain the main sources of data for decision-making. The rapid development of geospatial data and science into big data through the data revolution in Africa has proved that the dynamic nature of geospatial data, along with changes in size and spatial distribution and related characteristics, will play a central role in the national data and statistical ecosystem for the foreseeable future. Under such circumstances, it is increasingly recognized that the establishment of a viable statistical geospatial infrastructure will serve as a powerful tool to promote data exchange and improve decision-making capabilities and the timeliness of information at the national level, to support evidence-based decision-making and sustainable development. It is indeed recommended that countries in Africa establish, develop and strengthen their geospatial information infrastructure to support census and statistical activities, and that they ensure that the use of geographic-based methods is fully integrated into statistics systems. In this context, and within its mandate to promote Africa's sustainable development, the Economic Commission for Africa (ECA) is committed to assisting member States in building their statistical capacities and in working with development partners to strengthen national statistical systems by enhancing national strategies for the development of statistics. Indeed, ECA is also working to strengthen the capacities of selected African countries to develop geospatial information resources and services, in support of the implementation of activities to achieve and the monitoring of progress towards the Sustainable Development Goals. In this regard, it has commissioned the development of guidelines for the integration of statistical and geospatial information in Africa, based on recent methodological and



technological developments that can help national statistical offices and national mapping agencies to strengthen, develop and modernize their statistical and mapping systems through the integration of statistics and geography, aimed at supporting implementation, measurement and monitoring with respect to the Sustainable Development Goals and national development goals.

II. Developing a national statistical geospatial framework

2. In the data revolution era, the 2030 Agenda for Sustainable Development and the implementation of activities relating to the 2020 census round are the two main drivers of increased demand for and production and use of data, including geospatial information. It is well known that a census provides information on the demographic, social and economic characteristics of the entire population, including at an individual level, at a given point in time, and is therefore a potentially viable source of data on the Sustainable Development Goals. However, the 2030 Agenda in particular requires member States to adopt new approaches to collecting and integrating data, to provide reliable, timely, accessible, useful and disaggregated data in order to prioritize, make informed choices and implement better policies for sustainable development.

3. In addition, to meet the growing need for information on small geographic areas, so as to monitor progress towards development goals and indicators at the local and community levels, the 2030 Agenda identifies geospatial information and Earth observation as key methods for tracking progress and informing people about development-related issues. In line with the call made in the 2030 Agenda for the disaggregation of data by geography, census mapping provides countries with a platform to map their geography at granular levels, thereby allowing census data to be combined with data from other sources.

4. Recognizing the importance of geospatial information, the United Nations recommends that, in the 2020 census round, countries follow-up on the technological progress made since the last census round, especially in the areas of geographic information systems (GIS) and with respect to the Global Positioning System (GPS). The adoption of GIS is an important strategic decision. The integration of geospatial and statistical information has become an important means of discovering unprecedented new insights by viewing socioeconomic or geospatial data in isolation. Developing a national statistical-spatial framework should take into account both the national statistical development strategy and the national spatial data infrastructure, as well as other existing frameworks, in accordance with what is being developed at the global level.

III. National spatial data infrastructure

5. Spatial data infrastructure revolves around technologies, standards, institutional arrangements and human resources that facilitate the availability of and access to geospatial data. National spatial data infrastructure comprises the following five main components:

(a) Data (identification of data sets of critical national importance, with a basic reference framework of digital spatial data to act as a foundation for numerous other data collection activities);

(b) People (human resources - training, professional development, cooperation and outreach);

(c) Access network (networking technology - hardware, software, networks, databases and technical implementation plans);

(d) Policies and institutional arrangements (institutional framework - governance, data privacy and security, data sharing and cost recovery);

(e) Standards (technical standards to facilitate data collection, documentation, access and transfer, and the means to search for, find, access and use spatial data).

6. The basic principle behind national spatial data infrastructure is data accessibility and sharing, which is becoming easier, thanks to technological advances and the development of electronic networks. Thus, by disseminating and sharing data, the duplication of data collection efforts can be avoided, linkages among multiple stakeholders can be improved, and citizen and community involvement can be promoted. Indeed, national spatial data infrastructure is considered to be a fundamental part of national infrastructure, as important as physical infrastructure assets such as roads, communication networks and other utilities. It is now widely accepted that the development of national spatial data infrastructure will better facilitate the availability of and access to spatial data for government entities, the private sector, academia and citizens in general, as well as promote the integration of geography and statistics.

7. ECA in particular has put a great deal of effort into supporting African countries and strengthening their capacities through the methodological work it has carried out in preparing an implementation guide on national spatial data infrastructure, and through a number of advocacy and capacity-building workshops that it has conducted at the regional and national levels over the past decade. At the institutional level, ECA has been a pioneer among the other regional commissions of the United Nations in serving as the secretariat of Regional Committee for Africa of the United Nations Initiative on Global Geospatial Information Management, through which it has supported African countries in building their geospatial information infrastructure and has given a voice to Africa in the international arena.

IV. Integrated Geospatial Information Framework

8. The Integrated Geospatial Information Framework was developed by the United Nations in cooperation with the World Bank.¹ The Framework provides basic guidelines for low- and middle-income countries and can be used as a reference for the development and strengthening of their national and subnational capabilities in the field of geospatial information. The ultimate goal of the Framework is to enable governments to engage in evidence-based decision-making through the effective use of national and local geospatial information, systems and capabilities, so as to achieve sustainable social, economic and environmental development.

9. The Framework provides the strategic guidance that makes possible the preparation and implementation of country-specific action plans for developing viable geospatial information systems. The Framework allows countries to adopt new and innovative approaches to national geospatial information management, to implement solutions that are based on integrated evidence-based decision-making, and to maximize and leverage national information systems that are tailored to their individual situations and circumstances.

¹ See “Integrated Geospatial Information Framework: A strategic guide to develop and strengthen national geospatial information management – Part 1: Overarching strategic framework”. Available at <https://ggim.un.org/IGIF/overview/>.

10. The Framework is also a mechanism for articulating and demonstrating national leadership, cultivating champions and developing the capacity of leaders to take positive steps towards achieving their vision for the effective use of geospatial information to measure, monitor and achieve sustainable social, economic and environmental development, thereby leaving no one behind. In order to better integrate geography and statistics, it is important to keep in mind the goals of the Framework during the integration processes. The goals are:

- (a) Effective geospatial information management;
- (b) Increased capacity, capability and knowledge transfer;
- (c) Integrated geospatial information systems and services;
- (d) Economic return on investment;
- (e) Sustainable education and training programmes;
- (f) Leveraging of international cooperation and partnerships;
- (g) Enhanced national engagement and communication; and
- (h) Greater societal value and benefits.

V. National statistical development strategy

11. To seize the opportunities presented by the data revolution, where innovative technologies have decreased the cost and increased the volume and speed of data collection and data dissemination, national statistical offices would gain not only by investing in advanced technology and production processes to respond to the growing demand for actionable data, but also by establishing partnerships with new actors from the private sector, academia, civil society, the media and other communities. To accomplish this, it is recommended that national statistical offices revise their national statistical development strategies, national statistical acts and align them with recent data innovations, thus modernizing their official statistics and creating a national statistical system that responds to the needs of all users, especially in relation to the integration of geography and statistics.

12. Since national statistical offices are generally not the custodians of base maps and other mapping products, which may be difficult to acquire but are much needed for census mapping operations, they would benefit from collaborating with their respective national mapping agencies to obtain those items, thereby avoiding a duplication of effort. They also need to extend their involvement and active participation, in partnership with other national authorities, in the development of national geographical information capacity, including national spatial data infrastructure. Such cooperation would constitute a win-win situation for both the national statistical office and the national mapping agency. It would be a golden opportunity to facilitate and boost the establishment of national spatial data infrastructure on one hand and to modernize the statistical system on the other hand.

VI. Global Statistical Geospatial Framework

13. The linking of geospatial data with socioeconomic and other data (i.e., integrating geospatial and statistical information) has been identified by the Committee of Experts on Global Geospatial Information Management as one of the nine key priority issues to be addressed, given its importance to many national geospatial information authorities and international organizations that are engaged in geospatial information management, in particular with regard to the linking of information through geocoding.

14. In recognition of the importance of taking into account the geographic dimension in statistics, in 2013 the United Nations Statistical Commission and the Committee of Experts established the Expert Group on the Integration of Statistical and Geospatial Information. The Expert Group had been 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.

15. The importance of that effort was also reflected in objective 3.4 of the Cape Town Global Action Plan for Sustainable Development² on the integration of geospatial data into statistical production programmes at all levels, under which were the following key actions:

(a) To promote the integration of modern geospatial information management systems within mainstream statistical production programmes by highlighting synergies between the two systems;

(b) To promote the integration of geospatial and statistical metadata;

(c) To encourage the use and adoption of technologies that promote integration of geospatial and statistical information;

(d) To support the implementation of the global statistical and geospatial framework, when it is adopted.

16. At the regional level, the integration of statistical and geospatial information is considered to be a key priority area. For example, as stated in a 2014 report of the African Union, entitled “Common African position on the post-2015 development agenda”,³ at the twenty-second ordinary session of the Assembly of Heads of State and Government of the African Union, member States committed: to investing in and strengthening national statistical capacities and geospatial information systems for the collection, analysis, production and dissemination of disaggregated data, in order to measure and evaluate policy effectiveness; and to promoting a culture of evidence-based decision-making. That commitment was affirmed in the adoption in 2015 of the Africa Data Consensus – a road map to improving data standards and availability – at a high-level conference on the data revolution in Africa. Moreover, under the leadership of ECA, the Regional Committee for Africa of the United Nations Initiative on Global Geospatial Information Management has created a working group dedicated to the integration of geospatial and statistical information, which has prepared an action plan for the integration of geospatial and statistical information in Africa.

17. At the global level, the United Nations developed the Global Statistical Geospatial Framework, which evolved from the statistical spatial framework of Australia, and was refined through a global consultation process. The Global Statistical Geospatial Framework was endorsed by the United Nations Statistical Commission at its forty-eighth session, in March 2017, and subsequently adopted by the Committee of Experts on Global Geospatial Information Management at its ninth session, in August 2019.

² Available at: <https://unstats.un.org/sdgs/hlg/Cape-Town-Global-Action-Plan/>.

³ Available at: <https://au.int/en/documents/20170829/common-african-position-post-2015-development-agenda>.

VII. Application of the Global Statistical Geospatial Framework in Africa

18. The Global Statistical Geospatial Framework is based on five principles, as summarized in paragraphs 19–23 below.

19. **Principle 1: Use of fundamental geospatial infrastructure and geocoding.** In Africa, the use of fundamental geospatial infrastructure and geocoding have to cover every level of geography, with varying types of disaggregated statistical data that is presented at the subnational, national and international levels. Therefore, it is essential to establish an institutional body to govern and be responsible for the coordination of geospatial data infrastructure and geocoding statistics.

20. **Principle 2: Geocoded unit record data in a data management environment.** There should be a common understanding between the national mapping agency and the national statistical office with respect to the harmonized development of geocoded unit records. It is worth noting that principle 2 supports the process of linking high-precision geographic references (i.e., geocodes – coordinates, small geographic area codes, and linked-data identifiers) to each microdata/statistical unit record. This process is often referred to as geospatially enabling data, and it must occur within a secure, standards-based data management environment. The process applies the address coding infrastructure and fundamental data from principle 1. Therefore, it is necessary to develop geocoded unit records standards that are accepted by both geographers and statisticians.

21. **Principle 3: Common geographies for dissemination of statistics.** This principle applies geography as a tool for integrating data in order measure progress towards the Sustainable Development Goals. It uses a common and agreed set of geographies for the display, storage, reporting and analysis of social, economic and environmental comparisons across statistical datasets from various sources. It establishes the fundamental importance of balancing existing statistical and administrative geographies with other geographic referencing systems, such as grids, as a basis for establishing common geographies across datasets.

22. **Principle 4: Statistical and geospatial interoperability – Data, standards, processes and organizations.** This principle defines the preconditions for statistical and geospatial data to work as a data ecosystem, in which those involved interact to exchange, produce and consume data. Interoperability between statistical and geospatial data and metadata standards is needed to overcome structural, semantic and syntactic barriers between data and metadata from various communities and providers.

23. **Principle 5: Accessible and usable geospatially enabled statistics.** This principle highlights the need for data custodians to make geospatially enabled statistics accessible and usable in accordance with agreed standards and good practices, so that data users can discover, access, integrate, analyse and visualize that information seamlessly for geographies of interest. It addresses the need to identify or, where required, develop, policies, standards, good practices and technologies that support these uses.

VIII. Developing a national statistical geospatial framework

24. The desire for the development of the Global Statistical Geospatial Framework was expressed by countries both for the sake of comparability globally and to serve as a template for the development of statistical geospatial

frameworks at the national level. Indeed, the Global Statistical Geospatial Framework is driven by overarching principles that are broad enough to allow countries to adapt them to their nationally specific needs. In this regard, a country-oriented template has been prepared by the Australian Bureau of Statistics for each of the five principles to enable countries to adapt the global framework to their national conditions and to create similar frameworks for national use.

IX. Developing a national address management framework

25. Addresses are one of the most traditional ways to locate people, buildings, landmarks, places and events. They are commonly used for postal and utility delivery, emergency response, and public, private and business services. Recognizing the benefits of standardized addresses to citizens, governments, the economy and the society at large, many countries have or are building organized addressing infrastructures in that incorporate address reference systems and national address databases. Indeed, address reference systems are a key type of spatial reference system, a category that also includes coordinate reference systems, linear reference systems and geographic names (i.e., gazetteer references). However, address reference systems distinguishes themselves by being the only spatial reference systems with visible features on the ground, such as street signs and building numbers.

26. While addresses are collected from multiple sources (e.g., post offices, municipalities, utilities, land administrations and private companies), the corresponding datasets are usually maintained by public authorities. Although data may be created and maintained at the local level, it would be beneficial if they were compiled into a single national register, ideally an open national address database.

X. Requirements for capacity-building

27. Using and sharing technologies to produce timely and reliable location-linked data and statistics require increasing the capacities of national data producers and managers, chief among which are national statistical offices and national mapping agencies. It is recognized that harnessing the data revolution to achieve the ambitious Sustainable Development Goals depends greatly on how national statistical systems develop their capacities to monitor systems, design relevant indicators, and provide technical assistance in data collection and analysis. It is also widely recognized that the use of geospatial data is necessary to support the achievement of the Goals. It must be mentioned that building the required capacity is much more feasible nowadays, since the relevant technologies (e.g., GIS, GPS, satellite imagery and digital aerial photography) are a lot easier to use and integrate, and less costly than before.

XI. Developing standards for geospatially enabled statistics and related metadata standards

28. Building statistical-geospatial infrastructure enables the exchange of data and helps to improve the availability and timeliness of country information. However, creating geospatial information infrastructure requires certain building blocks, chief among which is a set of standards for allowing users to access and share data easily and in a meaningful way. Indeed, a fundamental component of the infrastructure is to adopt and implement common standards in accordance with existing international standards, taking

into account national conditions. The benefits of developing, adopting and implementing technical, geospatially enabled standards and related common metadata standards have been recognized by both the statistical and geospatial communities. It is recognized in particular that common standards and metadata enable interoperability and facilitate the integration and use of various statistical, geospatial and other data, which come from multiple sources and in multiple formats.

XII. Geospatial statistical data accessibility and protection of geospatially enabled information

29. The adoption and implementation of common standards are the basic foundations for enabling the interoperability and sharing of and access to datasets. To uphold the basic principle that geospatial and statistical information should be collected once and shared by many, national statistical offices and national mapping agencies should conclude agreements on and establish mechanisms for data-sharing. For example, a one-stop geospatial information portal would make government geospatial information accessible to agencies and the wider user community. National statistical offices would gain from using such a one-stop portal to disseminate their census information and to extend their outreach to the larger user community.

XIII. Policy guidelines for the development of a national statistical-geospatial framework

30. A statistical-geospatial framework to support a national statistical system can be developed and maintained through the formulation of country-specific policies and the preparation and implementation of related action plans, in line with the five principles of the Global Statistical Geospatial Framework. Such an approach has the direct benefit of allowing a country to identify and address the most fundamental issues in building statistical-geospatial infrastructure that have an impact on the integration of geospatial information and statistical information, with a view to leveraging the interoperability of national information systems that have a geographic dimension, and forging cooperative ties among national statistical offices, national mapping agencies and other organizations.

31. **Policy/action plan 1.** The purpose of the first policy and related action plan would be:

(a) To build and develop a national geospatial infrastructure that would cater to the needs of both the geospatial and statistical communities. The end product would be a national statistical-geospatial infrastructure that is aligned with the national spatial data infrastructure, using, for example the fundamental geospatial data system and/or the national geodetic reference system.

(b) To identify the challenges to be addressed in building a national spatial data infrastructure, chief among which in many African countries are the lack of policies and legal frameworks, inadequate financial and human resources, and insufficient institutional and political leadership and support.

32. **Policy/action plan 2.** The purpose of the second policy and related action plan would be to adopt a management approach to geospatially enable the basic statistical units to which characteristics of persons, households and geographical features of interest can be attributed. This management of data through the storing of georeference data with unit-level records should take into account privacy and confidentiality considerations. The goal is to build, use,

update and share common geographies, including administrative boundaries, and related specifications and standards, to ensure that all statistical data are consistently geospatially enabled. However, since many African countries experiencing frequent changes in administrative boundaries, a (nested) grid system would provide a solution for dealing with thorny administrative boundary issues. A grid system would be also useful for disseminating, for instance, statistical data or data on Sustainable Development Goal indicators, and would bypass problems related to administrative units. In addition, a point or polygon-based data approach associated with addresses or buildings has the advantage of offering higher spatial resolution and increased spatial aggregation at any spatial unit, including for gridded statistics. Geo-enabling statistical data in such cases is done through the geocoding process of direct capture by GNSS/GPS receivers of coordinates (latitude and longitude) in the field, or indirect capture of coordinates from existing maps.

33. **Policy/action plan 3.** The third policy and related action plan would address the fundamental work that involves the national statistical office, the national mapping agency and other national organizations to develop common standards that would increase interoperability, sharing and understanding. It is particularly recommended to develop, adopt and implement standards that meet the needs of users in the country, bearing in mind that it would be beneficial if said standards were aligned with internationally-agreed geostandards, such as those developed by Technical Committee 211 of the International Organization for Standardization, the Open Geospatial Consortium, or that are under development (e.g., the work done on statistical-geospatial metadata interoperability to integrate the Statistical Data and Metadata Exchange and the Data Documentation Initiative with ISO-19115:2003).

34. **Policy/action plan 4.** The fourth policy and related action plan would be to implement a clear data policy, given that the ultimate goal for developing a statistical-geospatial framework is to make data easily accessible and for it to be used by as many users as possible. Governments must play a central role, not only to develop and implement policies, but also to address concerns about the misuse of open data, in particular that which infringes on privacy and confidentiality. One method for preparing and applying such data policies would be to conduct government-wide geospatial information consultations and evaluations to identify any practices of concern and related issues. Such consultations would involve interviewing government officials and major users from industry, academia and civil society, along with the review of laws, regulations and a sample of data-sharing agreements.

XIV. Conclusions and recommendations

35. In conclusion, the following recommendations are proposed for consideration and adoption:

(a) Countries in Africa are adopting innovative approaches to census-taking and are increasingly using emerging technologies, including GIS, GPS and other geospatial tools, reflecting the recognition of the advantages of their use at all stages of the population and housing census process. The use of those technologies is recommended for all national censuses in Africa in the 2020 round of censuses and in support of the Sustainable Development Goals. However, it is of paramount importance to ensure the use of those technologies is continuous and universal, as they are crucial for many more applications outside census-taking and official statistics.

(b) It is advisable that, like many countries in other parts of the world, African countries also recognize geography as being key to statistics, with a view to providing a structure for collecting, processing, storing, aggregating

and disseminating data, and to significantly improving the quality of official statistics. By embedding geography into their national systems and processes, many national statistical offices are already transforming their statistical infrastructure, which will contribute to the modernization of their statistics. In that regard, it is recommended that ECA continue to support African countries in building and developing their statistical-geospatial information infrastructure in preparation for the 2020 round of censuses and for the achievement of the Sustainable Development Goals.

(c) Many countries in Africa are building or have built national census geographic databases, in recognition that such databases are fundamental to a fully digital census geography programme. It is recommended that those geographic databases be actively maintained, since they serve as a basis for spatial analysis, which is becoming a core competency in census offices. It is also recommended the means of census data dissemination be diversified by using web-based mapping, cloud applications and services and mobile technology to reach a wider audience, with a view to the increased appreciation of census products and of statistical work in general.

(d) A desk review of existing documentation has shown that countries are interested in adopting innovative approaches to census-taking, including the use of hand-held devices equipped with GPS for data collection and internet access for dissemination. It is recommended that mobile technologies, GPS, satellite imagery and unmanned aerial vehicles be used to facilitate data collection at the individual level, provided that privacy and confidentiality concerns are taken into account. It is noted, however, that doing so requires both strengthening capacity and the allocation of adequate resources, and that there is generally a lack of knowledge about the successful experiences of other countries in the use of such innovative approaches. Therefore, it is recommended that study visits be carried out to enhance the sharing of national experiences and practices, and to obtain guidance in the use of mobile devices for data collection and other supporting software applications.

(e) National statistical offices are often not the custodians of base maps and other mapping products, which may be difficult for them to acquire, but are much needed for census-related cartographic operations. In this regard, national statistical offices are encouraged to collaborate with national mapping agencies, and extend their involvement and active participation, in partnership with other national authorities, in the development of national geospatial information capacity, including national spatial data infrastructure. However, building national geospatial infrastructure in support of census activities requires technical and human capacities that may not be available in some countries in the region. Therefore, it is recommended that other mechanisms be explored to empower relevant entities, such as through bilateral exchanges between countries, study visits, regionally-coordinated training sessions and the establishment of contact networks.

(f) Coordination and institutional integration between the statistical and geospatial agencies within a country are vitally important. It has been noted, however, that, in some African countries, institutional coordination to support statistical and geospatial integration is still underdeveloped; addressing this effectively will require strong political commitment. In that regard, the benefits of linking socioeconomic data to a given location and the value-added by statistical and geospatial integration should be stressed to decision-makers and policymakers, so as to raise their awareness of the need to provide national institutions with adequate resources to achieve that integration.

(g) Standardization and data interoperability are arguably among today's central development challenges, since progress in geospatial information management and in sharing authoritative geospatial data will

depend on them. African countries are, therefore, encouraged to develop a common regional framework of standards and tools, taking into account their national specific conditions, while aligning with existing internationally agreed standards.

(h) The Expert Group on the Integration of Statistical and Geospatial Information has developed an overarching statistical-spatial framework, which can significantly improve the quality of official statistics and population censuses and support the achievement of the Sustainable Development Goals. However, its implementation at the national level is still a challenge for most countries in the region. Therefore, African countries are encouraged to develop their respective national statistical-geospatial frameworks in accordance with internationally agreed guidelines and principles.
