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Status of integration of geospatial and statistical information in Africa

I. Introduction

1. Over the years, the availability of precise geospatial data has expanded exponentially, and governments, companies and the public have increased their interest in and capacity to use those data in practical ways. Government interest in geospatial data has led to the development of national spatial data infrastructure, which is supported by data and metadata standards. Statistical agencies at the national and international levels are increasingly focused on leveraging the potential of that infrastructure to define and promote interoperability between statistical and geographical data. Improved knowledge, documentation and application of frameworks for the connections between statistics and geography have been critical to increasing interoperability.

2. The integration of geospatial information and statistics has been the missing link in the development of the information chain. Efforts to ensure this integration are being undertaken by the Economic Commission for Africa (ECA) through a working group on geography and statistics under the aegis of the Regional Committee of United Nations Global Geospatial Information Management for Africa. Equally, the Geospatial Information for Sustainable Development in Africa initiative, more commonly referred to as the African Action Plan on Global Geospatial Information Management, is intended to develop the linkage between geography and statistics.

3. Overall, the use of frameworks within the geospatial sphere is restricted to national spatial data infrastructure, and a limited number of national statistical frameworks have geography integrated into the statistical production process. The limited geographic listing undertaken by national statistical offices has been noticed in geocoding data at the level of statistical units (i.e. data for individuals, homes, houses, businesses and construction sites) during the cartographic phases of population and housing censuses. While this method is very convenient, the combining of enumeration and dissemination geographies can limit the usefulness of data disclosure.

4. The second and third most common forms of geocoding are national registries and address coding, respectively. These techniques offer extremely exact and adaptable geocodes through location codes and geographic codes for small areas. Data captured from the Geographic Positioning System is increasingly being used in the field of statistics. Most countries utilize

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administrative borders at the secondary (subnational) level as the main geographic boundaries along which resources are distributed to statistical offices for the collection of data on population distribution. While this method meets essential customer requirements, the boundaries at that level are susceptible to changes that may affect time series comparisons. Other geographic types used in conjunction with these administrative areas include geographic listing, which is linked to the geocode approach mentioned earlier; statistical geographies based on function to define urban, rural and remote regions; and postal geographies and grid-based geographies, which are increasingly being used for small areas.

5. Over the years, African countries have separately developed their respective national spatial data infrastructure and their respective national strategies for the development of statistics, all aimed at producing high-quality spatial and statistical data. Both processes were being conducted without the use of the Global Statistical Geospatial Framework, which was created both to link those two processes and to link them to other efforts.

II. Rationale for the Global Statistical Geospatial Framework

6. Since its inception, the Committee of Experts on Global Geospatial Information Management has identified the linking of geospatial data with socioeconomic and other data, or the integration of geospatial and statistical information, as a critical issue that must be tackled as a priority, since it affects a large number of national geospatial information authorities and international organizations.

7. Recognizing the critical need to incorporate the geographic dimension into statistics, the Statistical Commission and the Committee of Experts on Global Geospatial Information Management established the Expert Group on the Integration of Statistical and Geospatial Information in 2013. The Expert Group was tasked with developing and advancing the implementation of the Global Statistical Geospatial Framework. This critical need was also recognized in 2017, when the Cape Town Global Action Plan for Sustainable Development Data[1] established objective 3.4: “Integrate geospatial data into statistical production programmes at all levels”, with the following key action: “Promote the integration of modern geospatial information management systems into mainstream statistical production programmes by highlighting synergies between the two systems”.

8. At the regional level, African countries consider the integration of statistical and geospatial data to be a critical priority issue. For example, in the 2014 report entitled “*Common African Position on the post-2015 Development Agenda*”, [2] it stated that, in order for a critical enabler of sustainable development to be effective, Africa must “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”. This concern was reiterated in March 2015 in Addis Ababa, when African countries endorsed the African Data Consensus, which is a road map for developing better data standards and increasing data availability. Similarly, under the leadership of ECA, the Regional Committee, with guidance from the United Nations Initiative on Global Geospatial Information Management, established a working group dedicated to the

[1] For more information, see https://unstats.un.org/sdgs/hlg/Cape_Town_Global_Action_Plan_for_Sustainable_Development_Data.pdf.

[2] African Union, *Common African Position on the post-2015 Development Agenda* (Addis Ababa, 2014).

integration of geospatial and statistical information and developed the Africa Action Plan on Geospatial and Statistical Information Integration.

III. Developing a national statistical geospatial framework

9. A national statistical geospatial framework should outline policy principles that guide national statistical offices, geospatial information authorities and possibly other national data-driven organizations in their work to tackle challenges relating to the appropriate use of geospatially enabled statistics, and to achieve effective collaboration among them in the development of a common data infrastructure and interoperable systems.

10. A review of ongoing national spatial data infrastructure initiatives has been conducted, supported and assisted by ECA and its partners. In addition, a desk review of the process and a review of national strategies for the development of statistics have been conducted by ECA. These efforts have involved studying documents from countries that have completed their statistical and geospatial development strategies, and are in the process of or are about to commence implementation. In accordance with the terms of reference, the reviews are aimed at determining which approach should be adopted in integrating national strategies for the development of statistics and national spatial data infrastructure across Africa.

IV. Integration of geospatial and statistical information in Africa

11. To properly assess the integration of geospatial and statistical information in Africa, it is necessary to examine the implementation in Africa of the principles of the Global Statistical Geospatial Framework in various population and housing censuses and surveys, especially the various iterations of the Demographic and Health Survey. Over the years, countries have geocoded housing unit location (dwelling frames and housing footprints) and collective living quarter locations (dwelling frames and housing footprints) in their censuses and surveys. The geocoding of digital enumeration area maps or derived dissemination units, which are designed to enable the production of outputs that are disseminated to government departments and the general public, has been undertaken at varying scales during the various census rounds on the continent.

12. Equally, the geographic boundary files for all statistical reporting units for which census indicators are tabulated have been geocoded in a digital format. The geocoding has included the listing of all statistical and administrative reporting units, including towns and villages, their variant names and geographic coordinates. Geographic equivalency files have been developed that indicate how current reporting units relate to those used in previous censuses, and how one set of reporting units relates to another set. Vector layers containing feature data, such as landmarks, roads, schools, hospitals and clinics, are part of censuses and surveys, which can be used when analysing population data spatially. In addition, some countries have compiled street index listings for all major urban areas and centroid files that provide a representative geographic point of reference for each reporting unit. Geocoding has provided avenues for gazetteers, which contain geographic coordinates for all population settlements and other important geographic features in a given country.

13. Some national statistical offices have developed a spatial geographic database, with polygonal and attribute information for the enumeration areas of

the country (that is, the units for which the territory is allocated to canvassers during the census). A common digital base can assist with censuses of agriculture and population. Census data have been released at the enumeration area level or aggregated into new small-area dissemination units, such as population clusters.

14. In addition, some statistical offices have developed a library of digital administrative boundaries, ranging from the provincial to the municipal levels (and possibly at the level of the land parcel), and have deployed digital census atlases and dynamic atlases, along with the use of spatial analysis techniques.

15. The table below contains an assessment of data derived from the database of the Statistics Division of the United Nations Secretariat on censuses undertaken in Africa during the 1990, 2000, 2010 and 2020 rounds. Over the years, the Demographic and Health Survey has been applying the geocoding of its data sets for spatial analysis of variables.

Implementation of the principles of the Global Statistical Geospatial Framework in various population and housing censuses and surveys

	Demographic and Health Survey	*1990 census round (44 countries)*	*2000 census round (38 countries)*	*2010 census round (47 countries)*	*2020 census round (50 countries anticipated)*
Overall GSGF implementation		1990 census round (1985–1994) Baseline	2000 census round (1995–2004)	2010 census round (2005–2014)	2020 census round (2015–2024) As of December, 2021
Implementation of GSGF principles		Typically, paper-based census cartography	Digital and paper-based census cartography	Mainly digital census cartography	Completely digital census cartography
Principle 1. Use of fundamental geospatial infrastructure and geocoding	45 countries: Geocoding of DHS variables	5 countries: Baseline	30 countries: Updating GSGF	45 countries: Updating GSGF	31 countries: Updating GSGF
Principle 2. Geocoded unit record data in a data management environment	45 countries: Geocoding of DHS variables	5 countries: Baseline	30 countries: Updating GSGF	45 countries: Updating GSGF	31 countries: Updating GSGF
Principle 3. Common geographies for the dissemination of statistics	38 countries: Geocoding and spatial data repository of DHS variables	2 countries: Baseline	10 countries: Updating GSGF	3 countries: Updating GSGF	5 countries: Updating GSGF
Principle 4. Statistical and geospatial interoperability	30 countries: Statistical and geospatial interoperability	1 country: Baseline	5 countries: Updating GSGF	3 countries: Updating GSGF	5 countries: Updating GSGF
Principle 5. Accessible and usable geospatially enabled statistics	30 countries: Accessible and usable geospatially enabled statistics	1 country: Baseline	2 countries: Updating GSGF	3 countries: Updating GSGF	5 countries: Updating GSGF
Data sources	https://dhsprogram.com/Methodology/GIS.cfm.	https://unstats.un.org/unsd/demographic-social/census/censusdates/.	https://unstats.un.org/unsd/demographic-social/census/censusdates/.	https://unstats.un.org/unsd/demographic-social/census/censusdates/.	https://unstats.un.org/unsd/demographic-social/census/censusdates/.

Abbreviation: DHS, Demographic and Health Survey; GSGF, Global Statistical Geospatial Framework.

V. Principles of the Global Statistical Geospatial Framework

A. Principle 1: Use of fundamental geospatial infrastructure and geocoding

16. Although most national statistical offices have begun to implement this principle, a lot remains to be done. Since geospatial information is used to obtain locations for statistical and administrative data (geocoding) and to produce statistical content, it should be built on relevant, authoritative geospatial data and services that are grounded in the national spatial data infrastructure. Infrastructure compliance includes standardized and agreed formats; and coordinated reference systems, metadata elements, data models and exchange services such as discovery, view and download services. The various rounds of censuses and the Demographic and Health Survey have collected spatial data, but these have not followed the rules and regulations for national spatial data infrastructure. Equally, most countries are struggling to establish viable infrastructure that is linked to their national strategies for the development of statistics.

17. In many cases, the reference data needed for geocoding statistical information do not exist within a given country or the quality is not adequate for geocoding purposes. In this context, it is of utmost importance that such information be collected, enhanced, improved and provided through the national spatial data infrastructure. Priority should be given to the reference data listed as fundamental data by the Regional Committee of United Nations Global Geospatial Information Management for Africa (i.e., addresses, buildings and cadastral parcels) by meeting the core requirements for providing that data and by improving their quality. The specifications set out by the Regional Committee concerning fundamental data sets should be applied to facilitate the integration of geospatial and statistical information through consistent identifier-key relationships, and to keep track of location corrections/changes and the life cycle of each statistical unit at the micro-data level. These specifications need to be undertaken by the cluster of mapping and statistical institutions.

18. The roles and responsibilities of the various agencies involved in the production of geospatial information, including the determination of which agency maintains what information and how often data are updated, should be well-defined. Models for custodianship and stewardship may need to be established to identify the most relevant stakeholder for a given geospatial data source. These models should be implemented by mapping and statistical institutions.

19. Point-based geocoding should be adopted as the main and preferred geocoding approach in countries. Use of more general location descriptions and/or larger geographies (such as enumeration areas or other statistical geographies) should be considered only as a complementary or secondary approach when point-based geocoding fails because of partially missing data. Countries should agree on a single and uniform national infrastructure for geocoding all public and potentially private data. In order to implement a point-based foundation for statistics, authoritative information on physical address locations, buildings or cadastral parcels should be made available within the national spatial data infrastructure. In addition, information needs to be accurate and consistent, have sufficient coverage and meet internationally and nationally agreed standards. It is essential that this approach be adopted by national mapping agencies and national statistical offices.

20. All countries must have a single, national, authoritative and universal address registry that is made available to public institutions to include in their

respective business processes. National mapping agencies are encouraged to set up and provide national geocoding services, based on authoritative location data, within a service-oriented architecture that refers to common reference data sets, a common service configuration and common guidance for application. National geocoding services should be open to authorities of other countries that rely on similar methods and tools, with a view to geocoding across countries and obtaining consistent results. This would allow for the recording of the workplace addresses of citizens working abroad, among other benefits. Common services could provide a better basis for cross-border geocoding, thereby improving the calculation of statistics on cross-border commuting and migration. This would represent a break with the previously common practice of national statistical offices and national mapping agencies conducting geocoding exercises single-handedly, without the collaboration that is essential to the successful integration of geography and statistics.

21. National statistical offices and national mapping agencies should work actively to increase the mutual exchange of knowledge between the geospatial and statistical communities through initial or continuous training, information-sharing and communication, and by working on specific cooperative projects. Agreements between national statistical offices and national mapping agencies should cover the terms of access, licensing, governance and use of geospatial information. The creation of such agreements may also need to involve other stakeholders, such as municipalities or regional bodies responsible for providing data. Data acquired from the national spatial data infrastructure need to be easily accessible and usable for national statistical offices and other public institutions that conduct geocoding, at a low or affordable cost but preferably free of charge. Fruitful collaboration is encouraged between statistical and national mapping agencies in Africa through the working group on the integration of geography and statistics under the aegis of the Regional Committee. The working group should act as the steering group for the continent to facilitate and monitor the continuous and mutual exchange of knowledge between the geospatial and statistical communities across Africa.

B. Principle 2: Geocoded unit record data in a data management environment

22. Without compromising the privacy of microdata, an effective data management system should enable the linking of statistical and geographic objects at the unit record level. Implementing data warehouse solutions may be an efficient approach to integrating with confidence the broad use of geocoded microdata into a structured data architecture that provides privacy safeguards. There should be constant synchronization to preserve the connection between the geospatial infrastructure and the unit record data. The relationship between microdata and statistical or administrative geographies should also be coordinated. Location data objects should be recognized and properly incorporated into the data architecture of national statistical offices to enable effective data integration and geocoding processes.

23. Location data repositories (geocoding databases) should include references to a number of relevant and common administrative and statistical geographies to enable non-geospatial specialists to aggregate data more easily. Services (including geocoding services) offered by national mapping agencies must completely support life cycle characteristics and versioning (i.e. the ability to track changes made to a database without creating copies of the data). Incorporating such services into statistical business operations requires more than just current data. If point references are not available, statistical microdata supplied by countries should include a minimum reference of one square kilometre, in line with the standard for grill cell codes of the United Nations Initiative on Global Geospatial Information Management.

24. Countries should establish and implement standards for national geocoding processes to guarantee consistency within and across institutions. An agreement may be reached on which location data providers should be used to geo-enable certain statistics. The process standards may also contain agreed-upon ad hoc techniques to enhance unit location matching. Geocoding standards should be adopted at the African level to guarantee coherence and interoperability. A thorough analysis of country circumstances and practices is required to formulate such recommendations.

25. Geocoding findings should be as exact and consistent as feasible, and they should be recorded in accordance with agreed-upon geocoding metadata. Geocoding information should be supplied at the object level so that the correctness of the assigned location may be evaluated for individual observations. For the 2020 census round, countries should utilize one extra synthetic grid cell without spatial representation to include all individuals who cannot be geocoded to regular grid cells. Countries should establish a consistent method for handling non-matching observations (and make available an explanation thereof), which will be used to generate small-area or grid data at the national level when the approach being used continent-wide is not applicable or not appropriate.

26. Point-of-entry validation methods should be utilized when generating and maintaining administrative and statistical records to guarantee the highest possible quality of location references (e.g. addresses and other forms of building identification) contained in unit record data. To prevent discrepancies, all national public agencies that are responsible for recording addresses in public files should be required to utilize the standard geocoding infrastructure. The statistical and geospatial communities should work together to encourage the use of authoritative location data by the government entities that collect and manage administrative information.

27. For public custodians of administrative data, address services and geocoding services offered by national mapping agencies must be available through specified application programming interfaces. The release of address data under open data licenses should be explored to encourage the whole of society (including civil society and the commercial sector) to utilize and implement authoritative national address registries.

28. Legal measures should be explored to enforce data quality. Such steps may include the elimination of legislative obstacles to point-of-entry validation and legal tools to compel its use in the public sector. National mapping agencies and national statistical offices should establish defined custodian responsibilities for coding systems and boundary data for statistical and administrative geographies, respectively. All these issues are pending in the application of principle 2 of the Global Statistical Geospatial Framework.

C. Principle 3: Common geographies for the dissemination of statistics

29. All national administrative, statistical, and functional geographies that are relevant in the production and distribution of official statistics should be supplied as authoritative geospatial data in accordance with the standards formulated by the Regional Committee of United Nations Global Geospatial Information Management for Africa. Entities should apply fundamental data sets that are complete and consistent in terms of the topology and coding of content relating to statistical and administrative units. This process has thus far been lacking in the application of principle 3.

30. When coding systems or boundary geometries change, updated data on national statistical and administrative geographies should be accessible to all users no later than six months from the reference date. To offer high-quality

data under open data licenses, both national mapping agencies and national statistical offices should collaborate to enhance accessibility, delivery speed, and usefulness of national data on administrative and statistical geographies. Data should be machine-readable and accessible through Open Geospatial Consortium-compliant view and download services. National mapping agencies and national statistical offices should work together to investigate the possibilities of linked and open distribution of data on statistical and administrative geographies. This will involve reviewing the previous efforts made by mapping agencies and statistical offices and, if necessary, creating guidelines and suggestions to promote harmonization.

31. A continuous framework for national statistical and administrative geographies should prioritize current data, but historical geographies should also be included since they are essential for recasting current (point-based) data onto previous administrative or statistical divisions. National mapping agencies and national statistical offices should agree on a scale, reference dates, and correctness of administrative and statistical geographies, based on the basic data sets provided by the Regional Committee and the recommendations of the Second Administrative Level Boundaries programme. Boundary precision is required for data collection, analysis, and processing (master level 0 or 1). Simplified geometries at a generic level are desirable for distribution and visualization.

32. The procedures relating to and the basic building blocks of the lowest national administrative layer, along with any data coverage issues, should be clearly defined and correctly documented in the metadata. In addition to statistical geographies, countries should also offer area statistics on the size of these geographies, based on a harmonized methodology and national data. Land area statistics are essential for density data (e.g., population density).

33. Coordination between national statistical offices and national mapping agencies in producing administrative units should be improved. When coding methods or borders change, data on national statistical and administrative geographies should be accessible to all users no later than six months from the reference date.

34. All African national mapping agencies are urged to provide a single access point for open national data on administrative geographies, cadastral parcels, addresses and buildings. It should also provide access to a Pan-African regional geolocator service and a cadastral index map. It is recommended that all national statistical offices be involved in the drafting of legislation that mandates the regular and frequent generation of population grids following the 2020 census round in order to update territorial typologies on a regular basis.

35. An African grid system with specifications on statistical units is a well-established characteristic among users of geospatial data. Additional grid sizes (e.g., 100, 125 or 200 square metres) should be explored and agreed upon at the African level in accordance with data interoperability standards for statistical units. As the use of spatial statistical data and resources expands and becomes more flexible, the necessity for and consequences of adding new grid sizes should be studied collaboratively by the statistical and geospatial communities. Disclosure concerns should also be considered. The geospatial and statistical communities should carefully watch such developments to prepare for a potential future deployment of the grid system for data at the national and continental levels.

D. Principle 4: Statistical and geospatial interoperability

36. The statistical community should be more involved in the development of new geospatial standards (e.g., Open Geospatial Consortium standards) and in increasing their usefulness to statistical output. To enhance interoperability,

ECA and the United Nations Initiative on Global Geospatial Information Management, among others, should establish a forum for cross-domain debate and participation. Geospatial statistical production should depend on both statistical models and standards, along with current geospatial standards, for data collection and distribution.

37. Geospatial data and the notion of location must be considered as part of logical data warehousing and data architecture. There should be more emphasis on the use of geographic data and techniques in the statistics production process in the Generic Statistical Business Process Model. Geospatial services in a service-oriented architecture should be part of the process. In that context, national statistical offices should share their tools.

38. Common conceptual frameworks for statistical and geographical items are required. For example, national statistical offices and national mapping agencies should search for possibilities to develop ontologies for addresses and buildings. For semantic interoperability, they should work together to inform administrative data custodians of the need for conceptual harmonization. Countries should focus on providing machine-readable open data formats for national geospatial statistics through application programming interfaces.

39. Unified population grids for the 2020 round of population and housing censuses, designed and evaluated by ECA, should be used to harmonize population distribution across African countries. The Statistical Data and Metadata Exchange – a statistical data interchange format – is a system that is increasing being used on the continent and, as such, national statistical offices and ECA should collaborate to find new uses for this system beyond the 2020 census round. To prevent needless duplication of effort by African countries, open and centralized services with geographies and a grid square measurement of one square kilometre and other sized grids should be provided for the entire continent, and preferably at various degrees of detail. These services may be used in conjunction with the Statistical Data and Metadata Exchange to map statistics across borders.

40. ECA, national mapping agencies and national statistical offices should work closely together to create and implement services that are based on an automated and dynamic linkage of geographies and statistical data. Ultimately, users will benefit from more flexible and open statistical-geospatial integration.

41. Although the Table Joining Service, a standard created by the Open Geospatial Consortium, should be extensively used, the geospatial and statistical communities should collaborate on its development and deployment. If it works well for the harmonization of African data, it may also be used in other statistical areas. Accordingly, African countries should note the following considerations: existing services based on the Statistical Data and Metadata Exchange should be developed; national statistical offices and national mapping agencies should begin investigating the possibilities of linked open data; semantic web technologies and linked open data may help to enhance the integration of geographic and statistical data sets; and a standard for categorizing common geographies is required in a machine-readable open data format, given that published statistical data and associated geographies may be kept in various places and by multiple organizations.

E. Principle 5: Accessible and usable geospatially enabled statistics

42. African countries should strive to provide at least a core set of statistical variables (such as total population) for mid-resolution grids (i.e. one square kilometre) or other small-area statistics under open data licensing. Geospatial statistics should be published on an open-source basis. The license for geographic statistics should be as permissive as feasible, based on the open data

licenses for the aggregated source data. The data supplier should promote and execute the respective license information inclusion policy in relation to fees and access constraints, among other things.

43. African countries should investigate the use of service-oriented dissemination systems that provide more flexibility in use and greater availability of data through application programming interfaces. Open Geospatial Consortium-compliant services and non-proprietary formats (e.g., Open Geospatial Consortium–GeoPackage for file delivery) should be utilized for dissemination to guarantee end-user flexibility. Countries should increase their efforts to facilitate a common conceptualization of and shared solutions for service-oriented and dynamic data linkage. Equally, best practices and existing accomplishments must be reinforced and effectively utilized to stimulate African growth.

44. The Economic Commission for Africa, national statistical offices and national mapping agencies should work together to promote the concept of statistics as a service, including by collecting best practices and providing proof-of-concept for the development of solutions. National mapping agencies and national statistical offices should consider making available Open Geospatial Consortium-compliant services and utilizing the basic features of standard 19125 of the International Organization for Standardization. They should consider using current encodings such as linked open data, WFS 3.0, and GeoJSON to enhance accessibility in the future.

45. African countries should adopt the procedural guidelines that have been set out in the census principles and recommendations for the distribution of census data in accordance with population grids. The suggested technique should work in all national statistical offices, notwithstanding their differing settings. African countries should establish, explain and publish their own privacy standards for the distribution of national grid data and local area statistics in accordance with current national laws and policies; take into consideration the growing amount of national and regional-level data that are being distributed locally, which poses significant confidentiality concerns; and give priority to improving the quality of African statistics. Deliberate disclosure controls put in place to prevent geographic differencing should not be used to compromise the quality of African geospatial statistics.

46. African countries should establish mechanisms for having regular discussions with users of geospatial statistics. Users may be consulted in a variety of informal and formal avenues, including user councils, focus groups and information seminars. Countries should also examine the need for an African geospatial statistics portfolio, based on user requirements. User-centred product design may better meet the needs of geographic statistics users. Statistical and geospatial communities should be encouraged to increase their online consumption of infrastructure information components, tools, geospatial services and application programming interfaces through end-user applications.

F. Geocoding data from the 2020 census round

47. Support for the 2020 census round should focus on geospatial data-driven decision-making at the national level. The current emphasis on aiding national statistical offices in the production and distribution of census data should be broadened to include a focus on the dissemination and use of geospatial census-related data, with the business model altered appropriately. Attitudes towards geospatial census data-sharing should evolve to the point that they serve as a bridge between data availability and data use for national policymaking and activism. The United Nations should support national statistical offices and national mapping agencies in developing creative means for sharing geospatial census-related data in a manner that encourages data use

for policymaking and advocacy. In addition, the United Nations, in collaboration with national stakeholders and development partners, should examine the potential benefits of combining geospatial census data with other sources of development data, such as surveys, administrative sources and big data, in order to maximize the use of census data within national statistical systems.

48. Mapping is widely acknowledged as one of the most significant census activities, given that it provides the spatial foundation for the actual enumeration process. Recent advancements in geographic information systems and other geospatial technologies have expanded the scope of census mapping to include data analysis and distribution, resulting in increased efficiency in data gathering and enumeration. However, there are some challenges associated with adopting a fully digital census mapping approach. The use of these technologies has significant implications for mapping activities and for the collection, processing, analysis, dissemination, evaluation and archiving of data, all of which should be considered at an early stage of the census planning process. A geographic information systems-based census should be planned and executed consistently and on schedule.

49. The core problem seems to be the failure of countries to implement the Global Statistical Geospatial Framework, which has led to ineffective utilization and geospatial analysis of census data. A user-friendly census enables the main data users (e.g. government agencies, local governments, universities and research entities, and corporations) to rapidly obtain access to and a clear understanding of information, which will allow them to profit from census findings. One of the most significant consequences of a geographic information system-based census is the expansion of the user population that is interested in statistics that have a spatial dimension. In this case, the assessment of needs should include consultation regarding desired demographic and geographic content; geographic structures such as the administrative hierarchies or geographic units that are required for data collection or aggregation; and geographic base products (e.g. maps, imagery, and other remotely sensed data) that aid in the analysis and dissemination of census data. Consultation with key users is required to determine the format and breadth of data to be distributed and, ultimately, to understand user expectations in respect of census-based spatial data products.

50. The Economic Commission for Africa must strengthen the capacity of national statistical organizations and census offices on the continent to manage geospatial data and develop a geocoding scheme for the geospatial analysis of 2022 census data. The objectives are to contribute to the coordination of the census analytical process by integrating the geospatial component into census analytical efforts; associating the collected geocoded data from census cartography with the analytical process (i.e. creating the architecture to link census cartography and analysis); developing a geocoding scheme for at least 13 of the selected census analytical thematic topics; and establishing a geospatial dissemination strategy for census results using geospatial tools. Efforts in respect of those objectives were highlighted in a training workshop held in Douala, Cameroon from 6 to 11 June 2022, on strengthening the efforts of the Central Bureau of Census and Population Studies of Cameroon to manage geospatial data and develop a geocoding scheme for the geospatial analysis of the data from the 2022 population and housing census. Advisory missions targeting several countries will be undertaken as part of efforts to support the implementation of the Global Statistical Geospatial Framework.

VI. Enhancing the implementation of the Global Statistical Geospatial Framework at the national level

51. In addition to the technical and methodological recommendations concerning the principles under the Global Statistical Geospatial Framework, the following recommendations relating to the governance of the Framework in Africa and the process for its implementation should be considered:

(a) African countries should formally adopt a methodology for implementing the Framework through the Regional Committee mechanism for providing support to countries working on statistical-geospatial integration in Africa;

(b) African countries should work in partnership with ECA and the Regional Committee in firm agreement and with a clear mandate to execute the provisions under the Framework;

(c) The working group on the integration of geography and statistics should provide continuous guidance in the implementation of the Framework, with a view to achieving the common goal of improving the integration of statistical and geographical information, with reference to other important methodological frameworks, such as the Generic Statistical Business Process Model and the Common Statistical Production Architecture;

(d) The strategy for the implementation of the Global Statistical Geospatial Framework that has been developed for Africa should be the official authorized road map, under which milestones and priorities should be established and specific proposals for implementation should be consolidated. That road map must collectively be supported by the geospatial and statistical communities at the national and global levels because of the intersectoral nature of the strategy's application;

(e) The concepts outlined above have to be further developed through the collaborative efforts of various stakeholders, including those in the statistical and geospatial communities, before they can be applied in a harmonious way. Some of the following goals should be considered: testing the feasibility of requirements in the current production process; exploring national benchmarking; examining how process and operational tools work; and facilitating training;

(f) The implementation of the Global Statistical Geospatial Framework must be thoroughly and continuously monitored throughout Africa. A framework should be developed to assess the quality of performance of national statistical offices and national mapping agencies in fulfilling the requirements of the Framework.