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National Statistical and Geographical Institute of Brazil: global geographic information management

Note by the Secretary-General

Summary

The report prepared by the National Statistical and Geographical Institute of Brazil describes ongoing initiatives to improve global coordination in the area of geographic information. The report argues for the need for a global spatial data infrastructure and for the better integration of statistical and geographical information. This would strengthen the analytical potential of such information and its usefulness for policy decision-making. Recent practical experience in this regard gained from the activities of the Institute are shared. The report concludes by recommending a closer active partnership between national statistical offices and national mapping agencies. The Commission is invited to encourage the United Nations Statistics Division to launch a process to facilitate the closer integration of statistical data and geographical information. Points for discussion by the Commission are contained in section VI of the report.

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Report of the National Statistical and Geographical Institute of Brazil on global geographic information management: towards better global coordination and integration with statistical information

I. Introduction

1. The rapid development of contemporary geospatial technologies, such as satellite imagery, aerial photography, global navigation satellite systems (e.g., the Global Positioning System (GPS)), hand-held computers and geographic information systems, has created unprecedented opportunities to use geographic information. The impact of these developments on official statistics is felt in particular at all stages of population and housing censuses, where efficiency has been improved in the pre-enumeration, enumeration and post-enumeration phases largely through the use of geographic information tools. These tools are also increasingly used in the context of disaster management, environmental monitoring, natural resources protection, land use, utility services and so forth, as they facilitate quick data collection and advanced data analysis and allow for a flexible and integrated approach to information-sharing and dissemination on the basis of a spatial framework.

2. It is becoming increasingly clear that the application of these technologies and the resulting geographic information management are of strategic importance. This raises two challenges: (a) how to better manage geographic information at all levels (national, regional and global); and (b) how to address the interaction and integration of geographic and statistical information.

3. The present report broadly outlines the challenges posed by the proliferation of geographic data and their integration with socio-economic and other development data, the shortcomings in the use of technical standards, the lack of legal frameworks for managing geospatial information and, in particular, the lack of global coordination. It stresses the specific issue of the integration of statistical and geographic data and shows that statistical systems gain by being integrated with geographic information systems for the building of a geospatial infrastructure in support of census and other statistical activities. The report illustrates this through the national experience of Brazil. It concludes with some recommendations that the Statistical Commission may wish to endorse with a view to both strengthening national geographic information systems and promoting the better integration of geographic and statistical information.

II. Geographic information management

4. The use of geospatial technologies has significantly increased the quantity of spatial data being collected and archived. Today we have access to imagery that, in the past, would have cost a fortune and would have required specialized, trained experts to obtain. In just a few decades, the number of geographic data users has grown exponentially worldwide, with no end in sight; the impact can easily be seen and has been widely documented in the popular press by many experts. Data volumes have drastically increased, with the integration of descriptive data (demographic, social, economic, ecological, etc.) with maps and geographic data (geographic features). The traditional function of maps has been expanded to

support contemporary uses. In many ways, mapping services have emerged as the new geographic communication vector, with hundreds of millions of users posting, consuming and comparing data collaboratively, through mashups and other map-server services.

5. With advances in information and communication technologies driving the creation of new businesses, the cartographic/geospatial information community is facing some crucial challenges: how to harness the enormous potential of geospatial technologies and go beyond local and national to regional and global applications, and how to achieve the integrated management of geospatial data sets using the Internet and multimedia in order to disseminate information required for crucial decision-making in support of social, economic and environmentally sustainable development.

6. From a national perspective, the new context, characterized by economic competition and increased demand for geographic information products, has had a significant impact on the traditional monopolies that had been established to provide a public good, leading to greater efficiency regarding the supply of and access to spatial data. This explains the need for many active players in the area of geographic information, including national mapping agencies, to consider their position in the spatial data community with a view to ensuring effective governance at the country level. In order to improve governance and economically benefit a country, a common framework for spatial data — a spatial data infrastructure (SDI) — is required which brings together data, metadata, services, users and tools that are interactively connected with a view to allowing the use of spatial data for many applications in an efficient and flexible way.

7. At the regional level, cooperation on geographic projects is emerging, as in the case of the Geocentric Reference System of the Americas, a unique geodetic reference frame that has been established for the American continent. In Europe, larger steps are being taken to develop a comprehensive spatial data infrastructure — the Infrastructure for Spatial Information in Europe. This initiative is meant to make geospatial data more readily available for policymaking across the European Community. The African Geodetic Reference Frame project was recently set up to create a unified geodetic reference frame for Africa. In Asia, similar geodetic reference work for the region (the Asia Pacific Regional Geodetic Project) has been carried out, and the Asia Pacific Spatial Data Infrastructure clearing house portal has been developed. The United Nations has long supported geographic information management in the Americas and in Asia and the Pacific through its regional cartographic conferences.

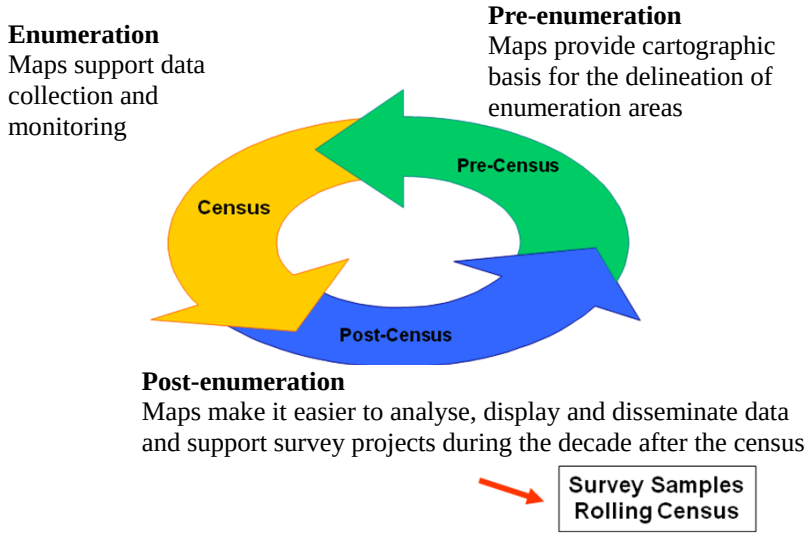
8. Given the global dimension of today’s main policy changes, including population growth, climate change, disaster management, environmental monitoring and natural resources protection (ecosystems protection, water/energy resources management, weather forecasting and warning, combating desertification, environmental factors affecting human health, etc.), there is a need for better coordination and the development of integrated solutions. It is, indeed, surprising that currently there exists no global forum comparable to the United Nations Statistical Commission in which issues related to global geographic information management can be discussed. Such an intergovernmental forum would seem to be the natural place to address such coordination and governance issues, develop common tools and provide a platform where practical experiences can be shared and, thus, national capacity strengthened, especially in developing nations.

III. Integration of statistical and geographic information

9. Statistical data, including many development data, such as economic and health data, relate to human activities that can be geographically referenced. Geography is, indeed, increasingly recognized as key to virtually all national statistics, providing a structure for collecting, processing, storing and aggregating data. The integration of geographic information and statistical applications yields considerable benefits for national statistical offices, as it reduces the cost of and the time required for collecting, compiling and distributing information and leads to a greater number of services and the much wider use of statistical information, thereby considerably increasing the return on investment in data collection.

10. Mapping is one of the most critical activities of a census. The accuracy of the delineation of enumeration areas and the quality of their representation on a map have a crucial impact on the quality of the data collected. The increasing use of hand-held devices with GPS and low-cost aerial and satellite imagery for spatial data collection and the demarcation of statistical enumeration areas, as well as geographic information systems for the display of census information, have improved census mapping in fundamental ways. Geographic data are now more easily collected, disseminated, accessed and manipulated by multiple providers and users. The three main operational phases of any national statistics office can be supported by geographic information systems: the integration of field data collection; the processing of statistical data, and the dissemination of data and support for statistical surveys using maps that can be made available through the Web for wide public access (see figure I).

Figure I
Census cycle



Source: United Nations Statistics Division.

11. The rapid integration of geospatial data with a variety of other data, including demographic and socio-economic data, and their analysis and modelling, has increased the understanding of the dynamics of socio-economic and demographic

structures and helped create more accurate, timely and unbiased information for better decision-making. For example, such integration has proved to be critical in achieving improved operational readiness and responsiveness to disasters. By using satellite imaging, scientists and demographers can compare images and statistics taken before and after earthquakes to estimate the amount of aid to be allocated to populated areas. There are many such examples related to the increased use of geospatial data in socio-economic, demographic and environmental analysis.

12. Institutional arrangements vary widely from country to country. In many cases, the collection of statistical data and the collection of spatial data, including thematic map production, are carried out by different organizations. This often results in a lack of common standards and, consequently, incompatibility of data and other quality problems, such as incomplete documentation of data. However, a close linkage between geography and statistics exists in those countries where the national statistical and mapping agencies are institutionally integrated under the same roof; this is the case in Brazil and Mexico.

13. Independent of institutional arrangements, countries are increasingly discovering that they can leverage the strengths of national statistical and mapping agencies through what is referred to as a national spatial data infrastructure,[1] an institutional arrangement to permit data-sharing and collaboration across government at a variety of levels, including the national, regional and local levels. For example, foundational data layers, such as demography and administrative boundaries, that are produced by a national statistics office can be shared among many users, eliminating the cost associated with the duplication of efforts. Those two layers are important components of any national spatial data infrastructure.

14. However, for many developing countries, spatial data infrastructure is still at an incipient stage of development. Public policies at various levels are also lacking in relation to geographic as well as statistical information for development. It is therefore critical to sensitize politicians and policymakers about the usefulness and applications of spatial data coupled with statistical data. In this respect, the United Nations Statistics Division should continue to encourage partnerships between national statistical offices and national mapping agencies and promote the concept of national spatial data infrastructure and its critical role as the foundation of regional and global spatial data infrastructure.

IV. National spatial data infrastructure in Brazil

15. In Brazil, geospatial data are largely produced, maintained and acquired by public sector organizations in all governmental spheres. Nevertheless, it remains difficult for the user to find the geospatial data sets that are available and to learn what their features are, who maintains them, and how they can be accessed. In other words, large volumes of such data exist within Brazilian governmental organizations, but it is difficult even for decision makers in the public sector to find or access them. Hence, the very first requirement for the establishment of a spatial data infrastructure in Brazil is that geospatial metadata be made fully available for

[1] A national spatial data infrastructure is a combination of the technology, policies, standards and human resources necessary to acquire, process, store, distribute and improve the utilization of geospatial data (see the GSDI Cookbook, available at www.gsdi.org/gsdicookbookindex).

the existing geospatial information assets or collections maintained by public sector organizations.

16. Presidential Decree No. 6666 of 27 November 2008 established a legal framework for the Brazilian national spatial data infrastructure enterprise, known by the acronym “INDE”. The legal framework of INDE was created with a view to:

(a) Promoting the organization of the production, storage, access, sharing, dissemination and use of the geospatial data coming from governmental organizations at all levels, aimed at the country’s development;

(b) Promoting the use, in the production of geospatial data by governmental organizations at all levels, of the standards and specifications approved by the National Commission of Cartography;

(c) Preventing the duplication of efforts and the waste of resources in the acquisition of geospatial data by governmental organizations through the release of corresponding metadata by those organizations.

17. According to the legal framework of INDE, all federal organizations that produce and maintain geospatial data sets and information are obligated to make their collections, including the corresponding metadata, publicly available through the Brazilian Directory of Geospatial Data. The only exception to this rule concerns classified or confidential data related to social and national security. The Directory is defined in Decree No. 6666/08 as a system of data servers distributed on the Internet in order to bring together in cyberspace producers, administrators and users of geospatial data to facilitate the storage and sharing of and access to such data and related services.

18. State and local organizations in the Brazilian public sector are not required to make their geospatial information assets or their corresponding metadata publicly available. But it is expected that they will associate themselves with the INDE enterprise voluntarily, once they realize the overall benefits that may result from their support. Another role that the private sector is expected to play concerns its capacity for creating new added-value products and services that should fit the wide variety of user profiles and demands emerging from the INDE enterprise, thanks to the increasing volume of geospatial data that will be made accessible to users in an organized way.

19. The Decree also states that any user properly identified through the Brazilian geospatial data portal — also known as “SIG Brasil” — should be able to access free of charge all digital geospatial information made available through the Brazilian Directory of Geospatial Data

20. The National Statistical and Geographical Institute of Brazil and the National Commission of Cartography are playing important roles in building INDE. The Commission elaborated and submitted to the Ministry of Planning, Budgeting and Administration of Brazil on 27 May 2009 an action plan for INDE implementation (see http://unstats.un.org/unsd/geoinfo).

V. Brazilian practical experience of the integration of geography and statistics

21. Integrating statistical data into national spatial data infrastructure opens new horizons, given the possibility of correlating such data with all other data layers, such as those related to natural resources and the environment. The new Web-based technologies allow national statistics offices to produce census mapping in a fully digital way, integrating maps, enumeration area boundaries, graphics and text files, as well as address files. The current availability of low-cost high-resolution orbital and aerial imagery can help in updating census maps.

22. The National Statistical and Geographical Institute of Brazil has been preparing for the 2010 demographic census operation. The census maps which it will use in planning and directing its operations are being prepared with the extensive use of satellite images and will therefore constitute a rich resource in the creation of national spatial data infrastructure. Much has been done in the past to adapt internal processes so that they can absorb the new technologies available and to improve data collection, monitoring support and the dissemination of the census results. An important advance was achieved in the 2007 census, when 80,000 personal digital assistant devices were used to ensure quality control at the time of the survey and the real-time monitoring of data collection in all municipalities. This procedure allowed rural establishments (farms, schools, etc.) to be georeferenced, as personal digital assistant devices were equipped with GPS. For the 2007 census, over 70,000 maps of census enumeration areas were converted to the new SIRGAS2000 geodetic system and, for the 2010 census, it is expected that that figure will increase to 280,000 maps of census enumeration areas.

23. Another fundamental effort initiated in the context of the 2007 census operation was the preparation of a national register of addresses. For 2010, a further step is being taken, based on the linking of address records to block faces on digital census maps. This will improve data collection, allowing the 2010 census interviewers to tap on each block face on the personal digital assistant device screen so as to gain access to the addresses and corresponding questionnaires of that specific block face. This will increase data dissemination possibilities on the basis of the association of census data with different portions of the territory. Figure II illustrates these new dissemination possibilities.

Figure II
New ways of disseminating data

24. The National Statistical and Geographical Institute of Brazil has also developed GeoBase and SisMap software tools for census map production. GeoBase is a stand-alone piece of software used to update urban maps of municipalities with less than 20,000 inhabitants, whereas SisMap is a Web-based tool for updating maps of larger cities, integrating all data produced regarding census mapping, including the maps produced using GeoBase, and monitoring the entire production process. The production scheme involves more than 500 small offices across the country, 27 State offices to ensure quality control and the Institute headquarters, which integrates all data. It is planned that SisMap will become the main geospatial information publisher for SIG Brasil. The current focus is on census mapping, but in the next stages the focus will shift to topographic and thematic map production.

25. Another example of integrating geospatial information with statistics in Brazil is related to Amazon deforestation monitoring. Owing to its continental dimensions, it is not possible to measure the impact of human actions in the Amazon without using satellite imagery. The Brazilian Government has two permanent systems to monitor deforestation in this region — DETER and PRODES — developed by the National Institute for Space Research (see http://www.obt.inpe.br/prodes and http://www.obt.inpe.br/deter, respectively). Deforestation data can be combined with forest inventories and floristic surveys, using geographic information systems, to provide indirect estimates of the volume of wood extracted from the forest in a given area or time frame. An example of such estimates for the Amazon municipality of Tailândia between 2001 and 2006 is shown in figure III. Information provided by PRODES shows that, during this period, an area of 633 km^2 was deforested. Eight forest inventory sample sites near Tailândia with the same type of vegetation indicated a mean of 262.37 m^3/ha of wood in the area (see figure IV). By means of a simple operation, the volume of wood extracted from this municipality can be computed as more than 16 million m^3 between 2001 and 2006. Such estimates could be very useful in building forest accounts.

Figure III
Deforestation in Tailândia municipality, 2001 and 2006

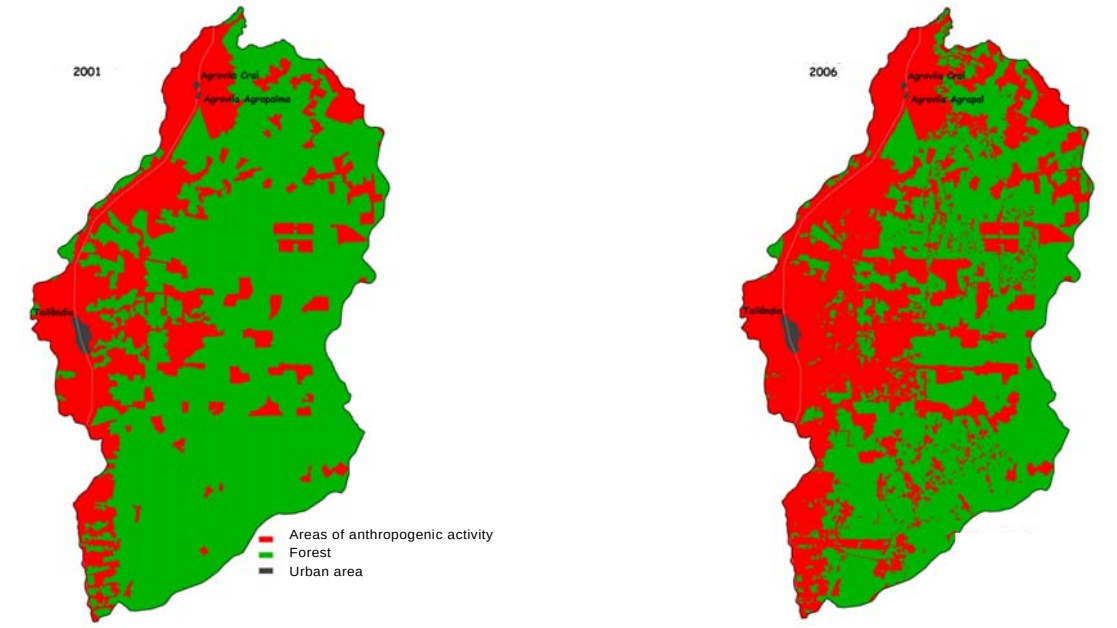
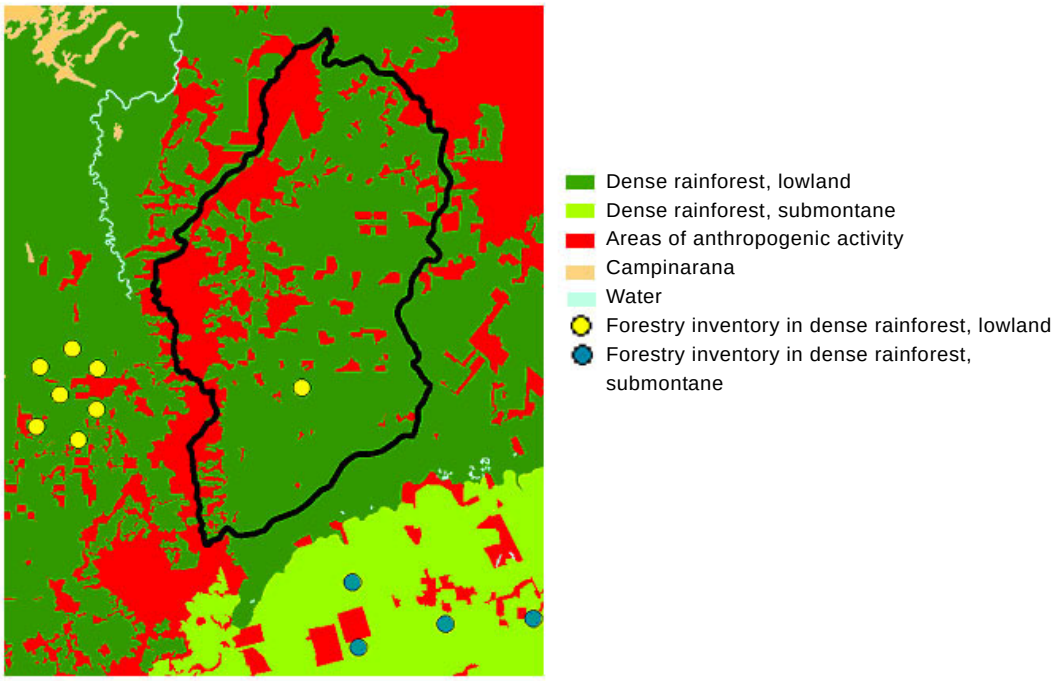


Figure IV
Forest inventory sample sites near Tailândia municipality, 2001



V. Conclusions and proposals for action

26. There is an increasing recognition that geography and statistics are interconnected and that the spatial distribution of social, economic and environmental indicators guide policy decisions in the areas of, inter alia, regional development, service provision and resource planning. A case in point is the benefits derived from linking household statistics with agricultural and rural statistics expressed in the spatial dimension. The experience of Brazil has, indeed, highlighted the potential of geospatial technologies in supporting and improving census mapping operations and underscored the fact that geography is central to census activities. It has also shown that the implementation of geographic databases in support of the whole census process is facilitated when geographic and statistical activities are managed under the same institutional framework. For many other countries, national practices in building a robust basis for census geography rely on symbiotic efforts by national statistical authorities and outsourced contractors, as well as on partnerships with national geographic authorities.

27. On the basis of the information contained in the present report, Brazil would like to suggest that the Statistical Commission recommend that countries adopt this approach as an efficient paradigm: the national statistics office should actively participate, in partnership with other national authorities, in the development of a national integrated geographic and statistical information system. In other words, national statistics offices should be encouraged to approach census-related geographic information systems and mapping activities within the scope of a pan-governmental information infrastructure, with an emphasis on institutional

collaboration through the vehicle of a spatial data infrastructure. This suggests the need for clearer national recognition of cooperation between the geographic and statistical sectors as a strategic area for development. In the context of the global statistical system, the United Nations Statistics Division should continue to stress that spatial data is an important tool for strengthening national statistical systems and continue to promote ongoing collaborative efforts at the national and regional levels, in particular within national statistical offices and national mapping agencies. Its work should continue to promote the concept of national spatial data infrastructure at the country level, as well as a coherent global spatial data infrastructure at the global level through the regional cartographic conferences.

28. Underscoring the fact that these new geospatial technologies require a commitment on the part of national Governments and the mobilization of significant resources at the national level, as well as a coordinated mobilization at the regional and global levels, Brazil also recommends that the United Nations Statistical Commission call upon the Secretary-General to prepare a report on a global vision for geographic information management that goes beyond traditional cartographic activities to a flexible and integrated approach to global, regional and national geospatial and statistical information infrastructure and proposes mechanisms for better and continued coordination between all stakeholders.

29. There is a need for a global forum to address global geographic information management on a continuous basis and allow the geospatial information community to meet, interact and be updated on new developments, products and emerging trends and issues. Such a forum would be a vehicle for the exchange of information between countries and other interested parties, in particular for sharing best practices in legal instruments, management models and technical standards for the building of spatial data infrastructures, the development of the interoperability of systems and data and the establishment of mechanisms, such as Web-based geoportals, that guarantee that geographic information is easily accessible in a timely fashion. Only through initiatives and actions at the global level — work to develop common frameworks and tools and a process of standardization, for which the United Nations has a key mandate — will it be possible for countries and regions to effectively access geographic information for common purposes and for standards-based data-sharing to become the norm.

30. The regional workshops and the expert group meetings on census mapping that have been organized by the United Nations Statistics Division in the context of the 2010 World Population and Housing Census Programme emphasized the need to exchange national experiences in the area of census geography and urged the Division to continue organizing similar meetings at the international and regional levels, thereby ensuring increased technical interchange and the strengthening of national capacities. The Statistical Commission would request the Statistics Division to convene, within a year, an international expert group meeting to prepare terms of reference taking into account the following key questions: How do we establish and promote interoperability systems and services that can improve access to and the interactive use of spatial and statistical data to enhance data-sharing and support decision-making through international standards and specifications? How do we develop and promote such technical standards and specifications? What are the best practices for an informed and cohesive legal and policy framework? What will be the future Web services standards?

31. By taking these steps, the Statistical Commission would lend its professional supporting voice to similar conclusions reached by the professional community of geo-information experts. At the eighteenth United Nations Regional Cartographic Conference for Asia and the Pacific, held in Bangkok from 26 to 29 October 2009, a resolution was adopted recognizing the absence of a United Nations consultation process which is led by Member States that deals with global geographic information management, coordinates regional efforts, promotes global norms on geographic information and brings such information to bear on global issues. The resolution also recognized the requests of Member States for a global mechanism — the work to develop common frameworks and tools and a process of standardization, for which the United Nations has a key mandate — to address the need for experience exchange and technology transfer on geographic information tools and infrastructures with specialized, regional and international organizations. The resolution requested that the Secretary-General and the United Nations Secretariat initiate discussions and prepare a report for a future session of the Economic and Social Council on the global coordination of geographic information management, including consideration of the possible creation of a United Nations global forum for the exchange of information between countries and other interested parties, in particular for sharing best practices in legal and policy instruments, institutional management models, technical solutions and standards, the interoperability of systems and data and the sharing of mechanisms that guarantee that geographic information and services are accessible easily and in a timely manner.

32. **The Statistical Commission is therefore invited to:**

(a) **Recognize the importance of the integration of geographic and statistical information;**

(b) **Call on national statistics offices to actively participate, in partnership with other national authorities, in the development of a national geographic information capacity, in the context of the spatial data infrastructures;**

(c) **Call upon the Secretary-General to prepare a report on a global vision for geographic information management, including the possibility of creating a global forum;**

(d) **Request the United Nations Statistics Division to convene an international expert group meeting to address, inter alia, the issues outlined in paragraph 30 above.**