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Background document
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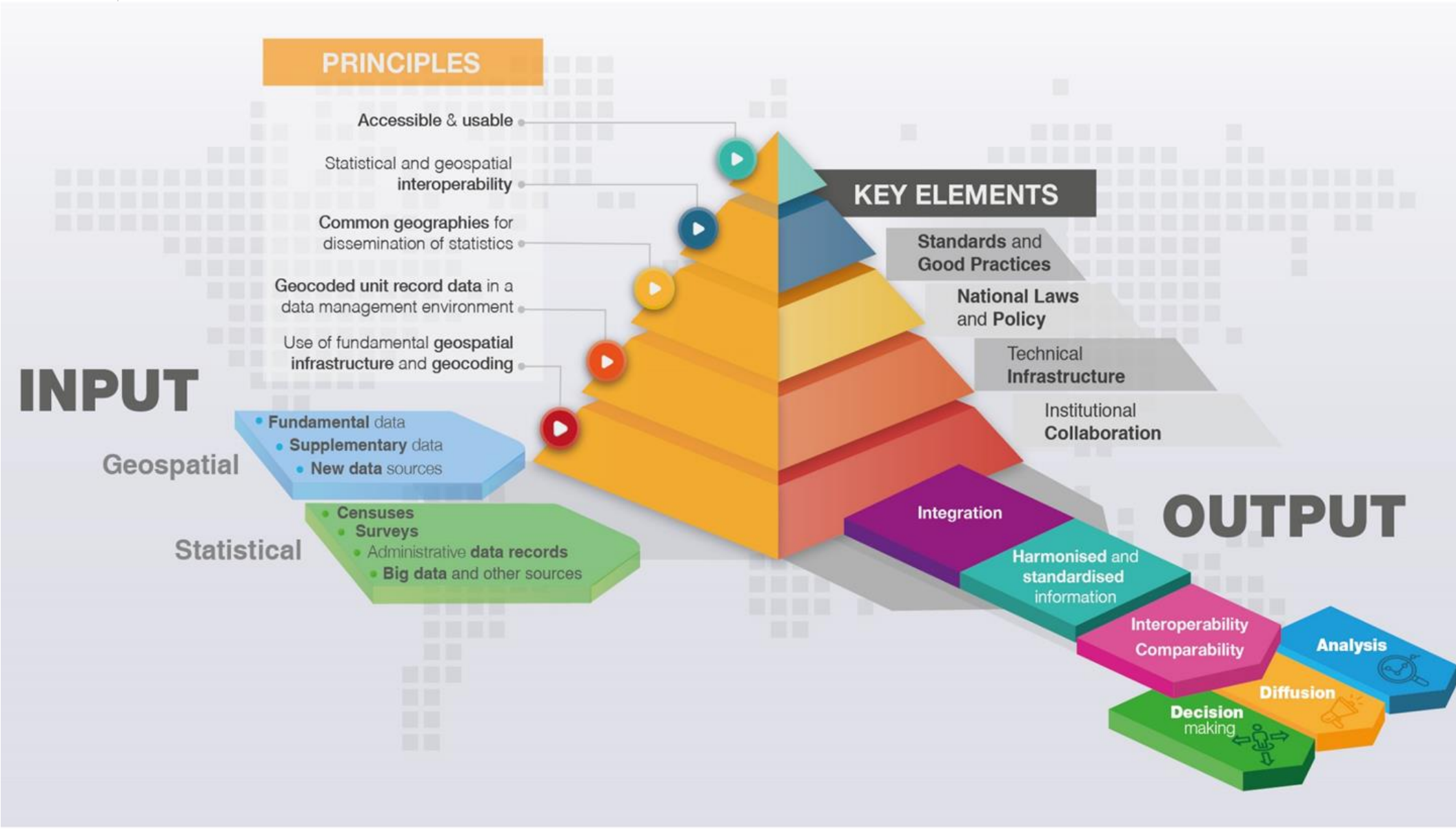
The Global Statistical Geospatial Framework:

Implementation Guide

Prepared by the Expert Group on the Integration of Statistical and Geospatial Information

The Global Statistical Geospatial Framework: Implementation Guide


PRINCIPLES
Accessible & usable
Statistical and geospatial interoperability
Common geographies for dissemination of statistics
Geocoded unit record data in a data management environment
Use of fundamental geospatial infrastructure and geocoding
KEY ELEMENTS
Standards and Good Practices
National Laws and Policy
Technical Infrastructure
Institutional Collaboration
INPUT
Geospatial
Fundamental data
Supplementary data
New data sources
Statistical
Censuses
Surveys
Administrative data records
Big data and other sources
OUTPUT
Integration
Harmonised and standardised information
Interoperability
Comparability
Analysis
Diffusion
Decision making

Department of Economic and Social Affairs
Statistics Division

Secretariat of the United Nations Committee of Experts on Global Geospatial Information Management

The Global Statistical Geospatial Framework: Implementation Guide

United Nations
New York, 2022

Department of Economic and Social Affairs

The Department of Economic and Social Affairs of the United Nations Secretariat is a vital interface between global policies in the economic, social and environmental spheres and national action. The Department works in three main interlinked areas: (i) it compiles, generates and analyses a wide range of economic, social and environmental data and information on which Member States of the United Nations draw to review common problems and to take stock of policy options; (ii) it facilitates the negotiations of Member States in many intergovernmental bodies on joint courses of action to address ongoing or emerging global challenges; and (iii) it advises interested Governments on the ways and means of translating policy frameworks developed in United Nations conferences and summits into programmes at the country level and, through technical assistance, helps build national capacities.

Statistics Division

The United Nations Statistics Division (UNSD) is committed to the advancement of the global statistical and geospatial systems. It compiles and disseminates global statistical information, develops standards and norms for statistical and geospatial activities, and supports countries' efforts to strengthen their national statistical and geospatial information systems. UNSD facilitates the coordination of international statistical and geospatial activities and supports the functioning of the United Nations Statistical Commission, the United Nations Committee of Experts on Global Geospatial Information Management, and the United Nations Group of Experts on Geographic Names as the apex entity of the global statistical and geospatial systems.

United Nations Committee of Experts on Global Geospatial Information Management

The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) is the apex intergovernmental body to discuss, enhance and coordinate global geospatial information management activities by involving Member States at the highest level, to work with Governments to make joint decisions and set directions on the use of geospatial information within national and global policy frameworks, and to develop effective strategies to build geospatial capacity in developing countries.

United Nations Statistical Commission

The United Nations Statistical Commission, established in 1947, is the highest body of the global statistical system. It brings together the Chief Statisticians from member states from around the world. It is the highest decision making body for international statistical activities especially the setting of statistical standards, the development of concepts and methods and their implementation at the national and international level. The Statistical Commission oversees the work of the United Nations Statistics Division (UNSD), and is a Functional Commission of the UN Economic and Social Council.

Notes

The designations used and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. The term “country” as used in this publication also refers, as appropriate, to territories or areas. The designations “developed regions” and “developing regions” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process.

Introduction

In its decision 51/123, the United Nations Statistical Commission (UNSC) noted the increasing relevance of and need for the integration of statistical and geospatial information as an important bridge to enable the production of harmonized, standardized and integrated, geospatially enabled statistical data to facilitate data-driven decision-making, in particular with regard to the implementation of the 2020 round of population censuses and the Sustainable Development Goals.

Developed by the United Nations Expert Group on the Integration of Statistical and Geospatial Information (EG-ISGI), the Global Statistical Geospatial Framework (GSGF), is the framework for the world that provides an underlying mechanism to integrate statistical and geospatial information and is the practical mechanism to respond to this mandate. As the bridge between the Statistical and Geospatial Information communities, the GSGF was developed by experts from both communities, reflected in its joint mandate from the UNSC and the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM).

It is in decision 51/123 that the UNSC endorsed the GSGF, as adopted by UN-GGIM in its decision 9/106 of 9 August 2019, and welcomed its adoption and implementation by Member States as a result of a broad and inclusive global consultation process. Further, in its decision 10/106, UN-GGIM urged Member States to continue efforts towards the adoption and implementation of the GSGF and to support institutional coordination and collaboration between national statistical offices, national geospatial information agencies and other relevant stakeholders to support the ongoing implementation of the Framework, especially in the context of the global coronavirus disease (COVID-19) pandemic.

In both mandates, the EG-ISGI was requested to provide practical guidance in the production and use of integrated geospatial information and to practically respond to this mandate, the EG-ISGI has developed this GSGF Implementation Guide to assist countries with implementing the GSGF and enable them to produce geospatially enabled statistical data for national to global decision-making.

Through its Task Team on Privacy and Confidentiality and its Task Team on Principles of the GSGF composed of three Work Streams: Geocoding, Common Geographies, and Interoperability), the following guidance has been developed and will exist as a living document that is periodically revised by the EG-ISGI to reflect prevailing good practices, innovations and developments in this domain.

This GSGF Implementation Guide provides guidance for each GSGF Principle and elaborate the importance of relevant sections and identify key resources and further reading. Further, to further improve the understandability of the concepts discussed within this document, the GSGF and other relevant bodies of work, this document seeks to update and agree on common definitions, within its section on “the Terminology of the Integration of Statistical and Geospatial Information”.

The Implementation Guide is complemented by the experiences of 30 Member States and five global regions, covering Africa, the Americas, Asia and the Pacific, Europe, and Western Asia. This was directly requested by UN-GGIM in its decision 10/106, which urged Member States to continue efforts towards the adoption and implementation of the GSGF and to support institutional coordination and collaboration between national statistical offices, national geospatial information agencies and other relevant stakeholders to support the ongoing implementation of the Framework, especially in the context of the global coronavirus disease (COVID-19) pandemic. The Committee also welcomed the many instances in

which the Global Statistical Geospatial Framework had been implemented in Member States and the increased focus on the exchange of knowledge and capacity-building, and suggested that the Expert Group collect national experiences relating to the integration of statistical and geospatial information to further guide Member States in the implementation and operationalization of the Framework.

Members of the EG-ISGI, both Member States and Regional Commissions were invited to submit how the GSGF has been implemented and operationalised along three main areas of interest:

1) The Overall Implementation of the GSGF
2) The Implementation of the Principles of the GSGF
    i. Elaborated by the GSGF's five principles, one submission per principle.
3) Your National Response to COVID-19
    i. How has the GSGF supported your national response to COVID-19?
    ii. How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

The 30 Member States, Australia, Botswana, Brazil, Canada, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Finland, Germany, Ghana, Honduras, India, Indonesia, Kenya, The Republic of Korea, Kuwait, Malawi, Mexico, Namibia, New Zealand, Panama, Peru, Senegal, Sierra Leone, South Africa, and Uruguay provided their national experiences, representing contributions of how the GSGF is implemented within, and by, NSOs, NGIAs individually and also collaboratively.

Complementing these contributions from Member States are case studies from Africa (provided by the Regional Committee of United Nations Global Geospatial Information Management for Africa – UN-GGIM Africa - and the United Nations Economic Commission for Africa[1]); the Americas (provided by the Regional Committee of United Nations Global Geospatial Information Management and the United Nations Economic Commission for Latin America and the Caribbean – UN-GGIM Americas); Asia and the Pacific (provided by the Regional Committee of United Nations Global Geospatial Information Management for Asia and the Pacific – UN-GGIM-AP); Europe (by Eurostat and the United Nations Economic Commission for Europe); and, Western Asia (by the United Nations Economic and Social Commission for Western Asia).

[1] UNECA submitted on behalf of Botswana, Ghana, Kenya, Malawi, and Sierra Leone, drawn by a desk review. Documents that drew on these contributions included Census Preparedness: Preliminary Report on the Status of Country Preparedness for the 2020 Round of Population and Housing Census in Africa (https://repository.uneca.org/handle/10855/23997) The Usefulness of Geo-referenced Dwelling Frames for Census Cartography during the 2010 Round of Population and Housing Census in Africa (https://repository.uneca.org/handle/10855/23999) Manual on Standard Guiding Principles on a Global Statistical and Geospatial Framework for the Integration of Statistical and Geospatial Information in Africa (under editing and translation) Study on National Mapping Agencies (NMA's) in Africa responds to the COVID-19 Crisis (under editing and translation)

List of Abbreviations

API – Application Programmable Interface
CSDA – Common Statistical Data Architecture
CSPA – Common Statistical Production Architecture
DDI – Data Documentation Initiative
DGGS – Discrete Global Grid System
EG-ISGI – (United Nations) Expert Group on the Integration of Statistical and Geospatial Information
ESS – European Statistical System
GAMSO – Generic Activity Model for Statistical Organizations
GFM – General Feature Model
GGRF – Global Geodetic Reference Frame
GSBPM – Generic Statistical Business Process Model
GSIM – Generic Statistical Information Model
GSGF – Global Statistical Geospatial Framework
HLG-MOS – High–Level Group for the Modernisation of Official Statistics
IHO – International Hydrographic Organisation
ISO – International Standards Organisation
MAUP – Modifiable Areal Unit Problem
MOU – Memorandum of Understanding
NGIA – National Geospatial Information Agency[2]
NSDI – National Spatial Data Infrastructure
NSO – National Statistical Organisation
NSS – National Statistical System
OGC – Open Geospatial Consortium
RDF – Resource Description Framework
SDGs – Sustainable Development Goals
SDO – Standards Developing Organisation
SEEA – System of Economic and Environmental Accounts
SDMX – Statistical Data and Metadata eXchange
UN-GGIM – The Committee of Experts on Global Geospatial Information Management
UNSC – United Nations Statistical Commission
UNSD – United Nations Statistics Division
UNECE – United Nations Economic Commission for Europe
W3C – World Wide Web Consortium
WMS – Web Mapping Services
WFS – Web Feature Services

[2] NGIA is used as an encompassing term to cover National Mapping, National Cartographic, National Geospatial Information Agencies and Authorities.

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Implementing Geocoding

Relevant Principles of the Global Statistical Geospatial Framework

Principle 1: Use of **fundamental geospatial infrastructure** and **geocoding**
Principle 2: **Geocoding unit record data** in a data management environment

What is Geocoding?

Generally, people prefer to use descriptions of locations instead of coordinates to navigate their environment. As an example, for the delivery of goods, we supply an address instead of the coordinates of our doorstep. However, modern geospatial technologies depend on absolute position data coordinates within a specific reference system, rather than relative location descriptions. The process of bridging this divide is referred to as geocoding.

Geocoding is the method of linking a description of a location to the location's measurable position in space. Geocoding links unreferenced location information (e.g., an address, or other location description) associated with a statistical unit (e.g., housing unit or business) to a set of coordinates within a coordinate system[3]. These resulting coordinates are the geocode. More formally stated, geocoding is generally defined as the process of geospatially enabling statistical unit records or other nonspatial data (such as address lists or housing unit records) by creating x- and y- (and potentially z) coordinates[4] and linking them to each record. Once geocoding is performed on individual statistical unit records, they (or the associated data) can be aggregated into larger geographic units (e.g., states, provinces, or municipalities) for statistical analysis. The records are ready for further applications such as methodologies to ensure confidentiality and avoid data disclosure.

Geospatial science is a rapidly growing field of study, with an evolving body of geospatial terms and concepts as the technologies are adopted in a wide variety of applications. Geocoding is often referred to with the terms geoenabling, geolocalising, or simply "linking" in some implementations. Frequently geocoding is associated with, and is considered as, a subset of georeferencing. Georeferencing, in its broadest definition, is understood to be the process of linking geospatially enabled data to a common geospatial reference frame that allows geospatial presentation and analysis of those data, usually in Geographic Information System (GIS) software. Georeferencing requires linking coordinates to a defined geospatial reference frame (i.e. a geospatial datum, ellipsoid, coordinate system, and often a projection). Georeferencing may refer to the alignment of orthoimagery or digital copies of paper maps with their inherent geographic coordinates (i.e., geocodes); or the transformation of geospatial data from a one defined geospatial reference frame to another.

Why is Geocoding needed?

Appropriately geocoding statistical unit records to a specific geospatial location fosters the greatest opportunity to reuse and aggregate statistical data. The GSGF states that *"all statistical unit records should include or be linked to a precise geographic reference (an x- and y- coordinate), and if not, the*

[3] Also referred to as a spatial reference systems.
[4] x- and y- coordinates referring to a Latitude and Longitude or an Eastings and Northings, with the z- coordinate referring to elevation are the most commonly used, but other references are in use.

smallest geographic area possible". This recommendation for using an x- and y- coordinate for geocoding was first issued by the Expert Group in 2018[5] and is reiterated by the Expert Group in 2021. By geocoding each statistical unit record in a consistent, accurate, and precise manner, aggregation and disaggregation of their associated statistical data by geospatial location becomes possible. In this manner, the dissemination of statistical data using common geographic areas is enabled, promoting the reuse and comparability of data throughout time. Subsequent principles and key elements of the GSGF guide the dissemination of geospatially enabled statistical data in-line with prevailing privacy and confidentiality concerns, and national and international norms, standards, and policies regarding data disclosure.

How can records be geocoded?

Modern geocoding processes are largely automated, involving matching captured data with a reference database with some in-built spatial intelligence to improve the matching process. The efficiency of geocoding relies on having a comprehensive reference database of addresses and locations. This is a component of a mature national spatial infrastructure. Geocoding is also helped by having a standardised, structured description of a location. For example, a street address contains a number of specific elements with formatting requirements that are used in geocoding.

Geocodes can be generated directly (i.e., coordinates accepted as being specific for the statistical unit record) or indirectly when they use an internal point of a geographic area. Conceptually the most accurate geocodes are the x- and y- coordinates that were assigned to a statistical unit record at the time it was collected by using a Global Navigation Satellite System (GNSS), such as the Global Positioning System (GPS) or coordinates from the nationally agreed geodetic reference frame. Equally specific are geocodes assigned using specific standardised structure IDs or even within structure IDs (e.g., one apartment within an apartment building). The next most specific geocodes are for addresses or standardised parcel IDs.

If this level of precision is not possible, geocodes can be generated using an internal point (e.g., a centroid) for any functional area which represents a specific geography (e.g. an enumeration unit, a small building block geographic area, or a small area grid cell up to localities, postal code areas, or even second-level administrative units). Regardless of the geographic level used to geocode a statistical unit record, the manner of geocoding must be consistently documented for each statistical unit record in a dataset along with a corresponding record of a time and date for each record when each record was geocoded.

To identify available data to geocode statistical unit records or help identify their absence (and in turn, identify gaps where capacity can be developed), the 14 Global Fundamental Geospatial Data Themes[6] may be useful. These are 14 Themes considered fundamental to strengthening a national geospatial

[5] E/CN.3/2018/33 https://unstats.un.org/unsd/statcom/49th-session/documents/2018-33-GeoInfo-E.pdf
[6] E/C.20/2020/14/Add.1 http://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/E_C.20_2020_14_GFGDT.pdf and http://ggim.un.org/documents/Fundamental%20Data%20Publication.pdf

information infrastructure. Specifically, the Global Geodetic Reference Frame (x- and y- coordinates), Addresses, and Functional Areas are directly relevant to geocode statistical unit records.

x- and y- coordinates

Addresses

Functional Areas

The Expert Group urges geocoding in the most accurate way possible to allow the most flexibility in combining various geocoded data and reiterates its previous recommendation to geocode statistical unit records with specific x- and y- coordinates. If this is not possible, it recommends geocoding (creating x- and y- coordinates) by using Addresses, or lastly by using the smallest Functional Areas possible.

Further Reading and Associated Resources

- The Global Statistical Geospatial Framework E/CN.3/2020/25 http://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/The_GSGF.pdf
- Integrated Geospatial Information Framework Strategic Pathway 4: Data https://igif.un.org/
- Australian Bureau of Statistics: Geocoding Unit Record Data Using Address and Location: https://www.abs.gov.au/websitedbs/d3310114.nsf/home/Statistical+Spatial+Framework+Guidance+Material/$File/Geocoding+Unit+Record+Data.pdf
- Academic resources: (such as Texas A&M's geocoding resources https://geoservices.tamu.edu/Services/Geocode/
- The Global Fundamental Geospatial Data Themes: http://ggim.un.org/documents/Fundamental%20Data%20Publication.pdf

Implementing Common Geographies

Relevant GSGF Principles

Principle 3: **Common geographies** for the dissemination of statistics

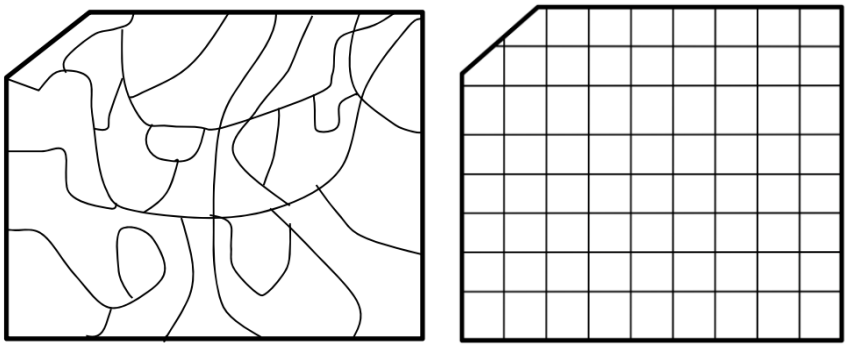
What are Common Geographies?

Common geographies are an agreed set of geographic areas for the display, storage, reporting, and analysis of social, economic and environmental comparisons across statistical datasets from different sources. They enable the production and dissemination of integrated statistics and geospatial information within a country to support informed decision-making.

Principle 3 of the GSGF recognizes and acknowledges the continuing need for country-specific dissemination geographies. New or proposed common dissemination geographies should be viewed as congruent and adjunct to the existing administrative and statistical geographies maintained by National Statistical Offices (NSOs), National Mapping Agencies (NMAs) and National Geospatial Information Authorities (NGIAs).

Why are Common Geographies needed?

The GSGF calls for *"a common set of geographies [to] ensure that statistical data is geospatially enabled in a consistent manner and is capable of being integrated at the aggregate level; and also ensures that users can discover, access, integrate, analyse, and visualise statistical information seamlessly into geographies of interest".*



Administrative Geographies Gridded Geographies

Figure 1 Administrative and Gridded Geographies

Further, through using consistent common geographies within the statistical production process ensures that statistical data is geospatially enabled in a consistent manner, whether in gridded form or using administrative or statistical boundaries. With this foundation, it is then possible to define methodologies that enable the transformation of geospatially enabled statistics amongst administrative, statistical and gridded geographies (as exemplified in Figure 4).

NSOs, NMAs and NGIAs that adopt a common dissemination geography are encouraged to move forward and begin producing social, economic and environmental data, indicators and other information

from the current and future integrated statistical geospatial infrastructure. Three objectives may be attained:

1. enhanced capacity to produce data and indicators for domestic purposes;
2. to meet emerging monitoring and reporting in support of thematic and global indicator framework requirements of international and regional initiatives (e.g. the 2020 Round of Population Censuses, the monitoring of and reporting on 2030 Sustainable Development Goals); and,
3. new emergent challenges that become immediate priorities for countries, and regional and international agencies.

Data produced by common dissemination geographies is a key facet to achieving basic comparable and interpretable statistical reporting, enabling advanced and exploratory geospatial analysis and a corner stone for producing clear and comparable data visualizations. This has become evident during the COVID-19 pandemic where the integration of statistical data with national common geographies was implemented to build web mapping tools and dashboards.

How can Common Geographies be realised?

What are the criteria needed for a country to adequately implement Principle 3?
Including:

- How to establish a geographic hierarchy?
    - Stocktaking of what geographies are currently being used? Who is maintaining them etc.? The IGIF Data Inventory Questionnaire / Dataset Profile Template[7]?
    - Identifying which existing geographies need to be used and new geographic areas created to support informed decision making for national priorities and global development agendas.
- Agreeing on the methodology for the translation of geospatially enabled statistical data from one form of geography to another?
    - Stocktaking of various methodologies and approaches (dependent on Geocode (if x- and y coordinate – point in polygon to capture the aggregation – if aggregated, is there a level of detail loss acceptable?

What sources of data can support the development of Common Geographies?

A common dissemination geography should be viewed as congruent and an adjunct to existing administrative and statistical geographies maintained by NSOs, NGIAs and other data stakeholders.

Existing national dissemination geographies, including administrative, electoral, census, and postal areas are often the foundation of common geographies in NSOs. Regional geographies such as the 1km^2 Population Grid within the European Union by Eurostat's GEOSTAT project or the Nomenclature of

[7] Appendices 4.2 and 4.3 of Strategic Pathway 4: Data of the Integrated Geospatial Information Framework https://ggim.un.org/IGIF/documents/SP4-Appendices-26Feb2020-GLOBAL-CONSULTATION.pdf

Territorial Units for Statistics (NUTS) 2 and NUTS 3 classification systems are the basis for regional and international comparison.

The nature of common geographies means that there are many potential stakeholders involved in their production, analysis or use including the National Statistical Office (NSO), National Geospatial Information Agency (NGIAs), international and regional organisations and other institutions (e.g. NGOs, the Open Geospatial Consortium (OGC) and the private sector etc.).

Further Reading and Associated Resources

- The Global Statistical Geospatial Framework https://unstats.un.org/unsd/statcom/51st-session/documents/The_GSGF-E.pdf, specifically "Comparison of the Advantages and Disadvantages of Administrative and Gridded Geographies"
- Defining the Global Statistical Geospatial Framework (prior work of the EG-ISGI): https://unstats.un.org/wiki/pages/viewpage.action?spaceKey=ISGI&title=United+Nations+Expert+Group+on+the+Integration+of+Statistical+and+Geospatial+Information&preview=/36143407/36143410/GSGF%20Principle%20Three%202018-07-25%20v2_EUgrids_added.docx
- The Integrated Geospatial Information Framework http://igif.un.org
- Tim Trainor, Challenges for Data Dissemination: Small Geographic Areas and Statistical Grids, http://ggim.un.org/meetings/2014-IGSI_Beijing/documents/04_USA_UN_Grid_Admin_Trainor_6_5_14.pdf
- Australian Bureau of Statistics, Location Index Social Architecture - Design of Institutional Arrangements https://doi.org/10.25919/5f32eab7c7d66
- Office for National Statistics, Hierarchical Representation of UK Statistical Geographies, https://geoportal.statistics.gov.uk/datasets/9c04ff58854040d09a5a7ce146ab59b4
- Eurostat, NUTS Classification https://ec.europa.eu/eurostat/web/nuts/background
- SDSN, Leaving No-One Off the Map: A Guide for Gridded Population Data for Sustainable Development https://bit.ly/35CHeqd
- OECD (2020), *Delineating Functional Areas in All Territories*, OECD Territorial Reviews, OECD Publishing, Paris https://doi.org/10.1787/07970966-en
- Eurostat et al, Applying the Degree of Urbanisation: A methodological manual to define cities, towns and rural areas for international comparisons – 2021 edition https://ec.europa.eu/eurostat/documents/3859598/12519999/KS-02-20-499-EN-N.pdf/0d412b58-046f-750b-0f48-7134f1a3a4c2?t=1615477801160

Fostering Interoperability

Relevant Principles of the Global Statistical Geospatial Framework

Principle 4: Statistical and geospatial interoperability: **Data, Standards, Processes, and Organisations**

The Importance of Interoperability

Interoperability is a crucial yet often underserved concept which touches every part of work within statistical, geospatial information, as well as the overarching pillars of the 2030 Agenda for Sustainable Development – Society, Economy, and the Environment. Interoperability concerns how data travels from the source to the end-user and as such is critical to the successful implementation of the GSGF.

As a result, interoperability issues in most cases cut across the other Principles of the GSGF rather than belonging to one Principle only. It is this cross-cutting, interlinked nature that this guidance aims to inform, highlighting resources that can support the ideals of Principle 4 and the broader GSGF.

Implementing Principle 4 is less prescriptive than the other Principles of the GSGF, and is more focused on fostering a conducive environment that enables the ability for statistical and geospatial data to be integrated, overcoming the (often) deep structural, semantic, and syntactic barriers between data and metadata from different communities and providers. This also improves the discovery, access, and use of geospatially enabled statistical data. The full implementation of interoperability described in this Principle is particularly important for Principle 5, as failure to achieve interoperability in any of the other Principles will often result in incomplete or less useful information for the end-user.

What is Interoperability?

Interoperability at a basic level ensures that different 'groups' (such as agencies within a national or global context, technology, or frameworks) can exchange data and share resources in the common interest. NSOs and NGIAs are augmented by administrative data custodians, which also act as providers of statistical data, but which are often not interoperable with statistics and geospatial information (e.g. why implementing a suitable set of common geographies is important).

There are several components to ensuring interoperability, but principally, leveraging and implementing open standards are key. Standards provide the critical architecture by which data can be discovered, collected, published, shared, stored, combined and applied and run through the four dimensions of interoperability – Legal, Organisational, Semantic, and Technical, as considered by the GSGF:

1. **Legal Interoperability** enables organisations operating under different national legal frameworks, policies and strategies to work together. National laws and policies should not block cooperation and there should be clear agreements about how to deal with differences in legislation across borders. As an example, national laws and policies on statistics should include the right of NSOs to have access to essential geospatial information with defined quality and ideally without charging;
2. **Organisational Interoperability** refers to the way in which public administrations (i.e. government agencies and organisations) align their business processes, responsibilities and

expectations to achieve commonly agreed goals. In practice organisational Interoperability means documenting and integrating or aligning business processes and relevant information exchanged. This also covers meeting the requirements from the user community and the NSS;

3. **Semantic Interoperability** ensures that the precise format and meaning of exchanged data and information is preserved and understood: "What is sent is understood". This includes syntactic aspects, such as the terminology used to describe concepts, as well describing the exact format of the information; and,
4. **Technical Interoperability** covers the linking systems and services of applications and infrastructures. Aspects include interface and services specifications, and data and metadata standards and formats.

Future Work by the Work Stream on Interoperability includes

The future work of the EG-ISGI in this area aims to demonstrate how there is no "one" way to foster Interoperability by:

- Developing guidance for developed and developing nations to promote and foster Interoperability to help implement the GSGF?
- Highlighting specific resources to advance development against for the four dimensions of interoperability;
- Examining Maturity Models and other key concepts to target and strengthen the capability of countries to foster interoperability and integrate statistical and geospatial information; and,
- Highlighting examples of Interoperability (COVID-19, needs of exchange of geospatially enabled statistical data etc.), within the National Examples of GSGF Implementation.

Further Reading and Associated Resources

- The Global Statistical Geospatial Framework E/CN.3/2020/25 http://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/The_GSGF.pdf
- Integrated Geospatial Information Framework Strategic Pathway 4: Data https://igif.un.org/
- Integrated Geospatial Information Framework Strategic Pathway 6: Standards and Appendix *ibid and* https://ggim.un.org/IGIF/documents/SP6-Appendices-7Apr2020-GLOBAL-CONSULTATION.pdf
- The Global Fundamental Geospatial Data Themes: http://ggim.un.org/documents/Fundamental%20Data%20Publication.pdf
- Data Interoperability: A Practitioners Guide to Joining Up Data in the Development Sector https://unstats.un.org/wiki/display/InteropGuide/Home
- Geo Generic Statistical Business Process Model: https://statswiki.unece.org/display/GSBPM/GeoGSBPM
- Statistical Data and Metadata eXchange 3.0: https://sdmx.org/
- Connecting Geographic and Statistical Information Standards: http://ggim.un.org/meetings/2015-2nd_Mtg_EG-ISGI-Portugal/documents/Connecting%20Geographic%20and%20Statistical%20Information%20Standards%20EG-ISGI%202015.pdf
- A Guide to the Role of Standards in Geospatial Information Management:

https://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards_Guide_2018.pdf

- Companion document on Standards Recommendations by Tier Introduction: https://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards-by-Tier-2018.pdf

Ensuring Privacy and Confidentiality

Relevant GSGF Principles

Principle 2: **Geocoding unit record data** in a data management environment
Principle 5: **Accessible and usable geospatially enabled statistics**

Introduction

To meet the growing needs of geospatial and regional analysis, an ever increasing amount of precisely geocoded data is being created by the National Statistical Offices (NSO), in collaboration with National Geospatial Information (NGIAs) and National Mapping Agencies (NMAs) or other national, regional or global official bodies. This is in turn is leading to an increased amount of geospatial data (aggregate statistics released for geographic areas), often for small area geographies.

This wealth of this data ultimately leads to crucial challenges concerning data confidentiality, since the number of features necessary to uniquely identify a statistical unit (i.e. a person, household or business) decreases as the population of a cell or geographic area decreases within which information is released. This risk is even higher in an era of big data, artificial intelligence and proliferation of open access geographical visualization and analysis tools.

NSOs have been facing a conflict between two great principles of public statistics release (VanWey, et al. 2005). On one hand, they aim at offering as much data as possible with a high quality level, and on the other, they have to manage with strong constraints to guarantee and enforce the confidentiality of information providers. We live in an age where administrative and commercial third-party data can reveal more about individuals than national census and surveys, but we should also be aware of the tensions inherent where disclosure in some scenarios is in the public interest, for example in situations where personal safety becomes a more important concern to individuals and agencies than data safety.

At the global level, the EG-ISGI is well aware of these challenges. As a consequence, in its Work Plan 2020 – 2022[8] developed at its sixth meeting held in Manchester in November 2019, it agreed to establish guidelines and recommendations with which to address the emergent statistical and geospatial privacy and confidentiality issues. To achieve this goal, the EG-ISGI set up a task team whose work had to be, as much as possible, in line with the overarching Integrated Geospatial Information Framework (IGIF). Therefore, the Task Team, developed this guidance based on rich existing academic literature, good practices shared by the EG-ISGI, and, the results of the Global Survey on Readiness to Implement the GSGF.

This work is organized as follows: The first section provides a global overview on how to manage confidentiality and privacy within NSOs with any kind of data, including current and emerging methods; the second presents the theoretical or practical specific issues of geospatially enabled statistical data within this framework; the third discusses ideas on how to deal with these issues; and the last section provides conclusions and elaborates a list of recommendations.

[8] http://ggim.un.org/meetings/GGIM-committee/10th-Session/documents/EG-ISGI_Work%20Plan_2020-2022.pdf

This document does not aim to be a comprehensive technical handbook on statistical disclosure control methods for geospatially enabled statistical data. While being hopefully educational and easy-to-read, it nevertheless requires some basic statistical knowledge. Its main goal is to increase the level of awareness of the specific issues regarding the management of confidentiality in geospatially enabled statistical data, and to foster new initiatives to reduce, mitigate and raise-awareness of the inherent risks that emanate from breaches of confidentiality.

Contextualizing Privacy and Confidentiality

For NSOs, maintaining privacy is essential to retaining the trust of data providers and meeting the prevailing nationa legal obligations, whether it be households or businesses responding to a survey, or official bodies or companies making their administrative data available for official statistical purposes. In order to safeguard personal information and to preserve confidentiality, the statistical processes have to comply with global, regional or national regulations.

The constraints inherent with ensuring the confidentiality of a defined set of data usually consist in meeting a given threshold while releasing data. No information can be disclosed if it concerns less than a given number of statistical units. The thresholds depend on various parameters such as sparsity of the area, risk aversion and sensitivity of variables.

Disclosure occurs when an user uses released data to learn some information they do not already know. As such, the user is not a « hacker » who attempts to break into a security system. They process the data in order to find how to breach of confidentiality. Disclosure may also occur in innocent use of the data, for example when the data is very detailed and/or the person knows a lot about the population. Literature often identifies three kinds of data disclosure:

- **Identity disclosure**[9] refers to finding a direct identifier of a statistical unit from the data (for example, name or address);
- **Attribute disclosure** refers to revealing an association between a statistical unit and its sensitive features. For example, the user knows someone is living in an area, while the data show that all the inhabitants of this area share a common characteristic, such as income; and,

[9] Identification as a disclosure risk involves finding yourself or another individual or group within a table. Many NSOs will not consider that self-identification alone poses a disclosure risk. An individual that can recall their circumstances at the time of data collection will likely be able to deduct which cell in a published table their information contributes to. In other words, they will be able to identify themselves but only because they know what attributes were provided in the data collection, along with any other information about themselves which may assist in this detection. However, identification or self-identification can lead to the discovery of rareness, or even uniqueness, in the population of the statistic, which is something an individual might not have known about themselves before. This is most likely to occur where a cell has a small value, e.g. a 1, or where it becomes in effect a population of 1 through subtraction or deduction using other available information. Often, with a small cell, it may not be possible to find an attribute disclosure (learning something new about an individual) but the individual who has self-identified may perceive a risk that someone else might be able to find out something about them. Identification itself poses a relatively low disclosure risk, but its tendency to lead to other types of disclosure, together with the perception issues it raises makes several NSIs choose to protect against identification disclosure. See (Hundepool, et al. 2012)

- **Inferential disclosure** refers to inferring some attribute with a high confidence level, where increasing confidence levels is a desirable outcome for statistical data users.

To comply with regulations, one approach is to consider different kinds of users, an example is discussed in Figure 2, provided by New Zealand. General purpose users will only have access to less information (aggregation methods, masking), while specific audiences will have restricted access to more data in secure centers. A complementary approach is to introduce perturbation in the data in order to reach an acceptable level of disclosure risk. Applying a Statistical Disclosure Control (SDC) method is then a three-step process that consists in identifying the units at risk, processing them according to a given method and evaluating the reduction of data utility in exchange of more protection.

As an example from New Zealand's Statistics Act of 1975, Section 37(4)(b) states:

> (4) All statistical information published by the Statistician shall be arranged in such a manner as to prevent any particulars published from being identifiable by any person (other than the person by whom those particulars were supplied) as particulars relating to any particular person or undertaking, unless—
> (b) Their publication in that manner could not reasonably have been foreseen by the Statistician or any employee of the department.

Currently, this legislation is under review, in part due to advancements in technology over the past 35 years, but still raises a valid line of inquiry for other countries to examine their own national contexts: *Do other countries have this as a bottom line? What are the common threads throughout legislation? Do other countries' legislation put the onus of protection on the user rather than the producer of the data?*

Figure 2 New Zealand's Statistics Act, 1975

Nevertheless, traditionally, SDC methods do not take spatial features and spatial correlations or patterns into account. As such they may lead to a very distorted spatial pattern after processing.

The challenge of confidentiality in managing geospatially enabled statistical data

The disclosure risk is higher when considering geospatially enabled data

Using geospatially enabled statistical data can increase the risk of disclosure, because it is an even more strongly identifying information when it is collected in different variables for different purposes or places (for example, place of birth, place of residence, of study, of work), with time being another important covariate.

Economic geographers and social studies often highlight the strong spatial autocorrelation of this phenomenon. Perhaps this is best encapsulated by Tobler's First Law of Geography "Everything is related to everything else (Tobler 1970). But near things are more related than distant things", spatial autocorrelation then refers to the pattern in which observations from nearby locations are more likely to have similar features than that from distant locations. For areas with a low number of observations, that are often those where the density is weak, the risk of attribute disclosure is then higher. Tobler's

law is the critical contribution to statistical (table-based) confidentiality methods that we use to describe, measure, and represent geospatial confidentiality methods.

The disclosure risk also increases for geospatially enabled statistical data because of geographic differencing issues, that occur when the same data is disseminated in different non-nested geographies. In some cases, attributes can be deduced for several statistical units, below the threshold, by subtracting the counting of an area from the counting of another enclosing area. Therefore, anyone proficient with geographic information systems (and subtraction) could potentially uncover the underlying statistical data, inadvertently resulting in unintended disclosure [10] (Figure 3).

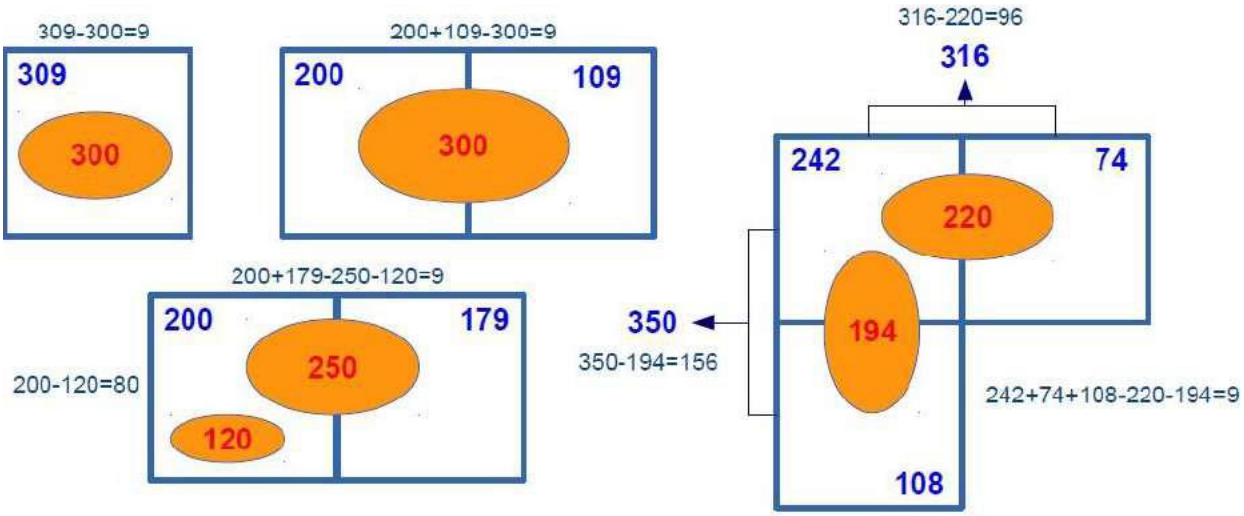


Figure 3 An exemplar of the possible cases of geographic differencing

Finally, trajectory data is a specific kind of geospatially enabled statistical data that can lead to specific breach of confidentiality. Indeed, beside Tobler's Law, a user may then use the uniqueness and regularity of human mobility to recover data without any prior knowledge.

A growing demand cascades to a growing risk

The theoretical risks identified in the previous section are even more pertinent due to the growing need for geospatially enabled statistical data. The integration of statistical and geospatial information relies on specific processes, as summarized by the GSGF, that require data sources such as address and cadastral parcels registers. These capacities, whether they already exist or are yet to be built, will make identity disclosure all the easier, if these datasets are released as open data or made available by the institutional that is nationally responsible for their production and dissemination. Other globally

[10] Figure 3 presents examples of possible cases of geographical differencing. Overlapping zones between the circles (A) and rectangles (B) are highlighted in orange. In the first case, zoning B encompasses zoning A. A user could then reconstruct information about B-A by subtraction and this may lead to revealing data concerning a small number of individuals. In the second box, the user can combine two areas of zoning B to perform the operation (B1 + B2) - A and thus obtain information concerning a non-released area. The last two cases show that differencing can occur with a combination of any number of the two zonings. With the frequency counts included in these examples, if information cannot be disseminated if it concerns less than 10 individuals, then there is a breach of confidentiality by geographical differentiation in each of these four examples

available mapping tools such as Google Earth or OpenStreetMap can also help provide greater context in the production and dissemination of statistical units, and for personal data should support the obfuscation of data.

Citizens are often most affected by decisions which influence their immediate neighborhood and this has resulted in governments/local authorities/political opponents increasingly seeking information at a very precise level of detail so they may analyse and illustrate the impact of various programs and policies. As a result, policymakers and analysts are looking for detailed information across a broad range of spatial dimensions, such as cities and/or rural areas, local administrative units and/or 1 km^2 grid cells, or below. The smaller size of the areas increases the risk of attribute disclosure, while the growing need of tailor made, or non-nested geographies increases the risk of geographic differencing issues.

With the prevalence of mobile devices, human mobility data are ubiquitously collected through cellular networks and mobile applications and publicly released for academic research, commercial purposes or official statistics leading to higher and new risk of breach of confidentiality.

A more difficult management of confidentiality with geospatially enabled statistical data?

A territorial classification used for the dissemination of data is nothing else than a categorical variable like any other. It is therefore possible, through the application of standarised methods, to deal with disclosure risk without any geographical consideration, simply by considering the geography as a variable with hundreds or even thousands of modalities (Finland, Germany).

Yet, a geographically intelligent management of disclosure issues will preserve underlying spatial phenomena, but no specific methodology has yet been developed yet. In practical terms, dealing with geospatially enabled statistical data adds a layer of complexity in the disclosure control process because it requires implementing specific methods that need great computing power. On micro-data, some SDC methods involve specifying the neighborhood structure with matrices, whose size can easily become unmanageable without using big-data techniques. On tabular data as well, detecting the risky observations by differencing sometimes requires the combination of many dimensions.

Dealing with the confidentiality aspects of geospatially enabled statistical data

Traditionally, in disclosure control literature, a distinction is made between post-tabular methods applied to tables (hypercubes) and pre-tabular methods applied on micro-data. Another way of categorizing protection methods is to classify them as either information reductive/non-perturbative or perturbative.

Census data, in practical terms, most countries adopt classical statistical non-perturbative/post-tabular methods, for example aggregating cells until sufficient thresholds are reached or suppressing cells. However, for gridded-data, data suppression is not an option; there must be a numeric value in each cell. These types of methods avoid issues of disclosure risks from geographic differencing and must be applied several times. Thus, this becomes very cumbersome when different geographies are used or when consistency is required between different linked tables. Moreover, post-tabular methods or removing valuable data within dataset can distort relationships between variables (Kamlet, Klepper and Frank 1985) and spatial correlations.

Perturbative methods appear to be a very attractive alternative solution. Firstly, pre-tabular methods of this class only have to be applied once, because if microdata is safe, so all possible aggregations from them will be safe too, and consistency is preserved. Secondly, they are more customisable and they allow a great flexibility of statistical products, both with grid data or hypercubes (they also permit tailored data for users). Another advantage of pre-tabular methods (like record swapping) can be unbiased, whereas most post-tabular methods involve suppressing cells and then introducing bias in the estimation of parameters or making some parameters impossible to estimable. Further, some post-tabular pertubative methods (like addition of random noise based on cell keys) are reductive.

In practice, the development of appropriate pre-tabular perturbative methods is challenging: a single perturbed microtable table file from which every table could be safely extracted, is not realistic, because for a given level of risk, the SDC expert will have to alter too many records (Young et al. 2009), which is not reasonable for an NSI. Moreover, pre-tabular methods can lead the users to believe that nothing is done to ensure confidentiality (Longhurst, et al. 2007), (N. Shlomo 2007), because applied alone, they can lead to releasing small cells for sensitive variables.

A classic compromise is to implement basic protection in the micro-data file, and then to add protection to tables when needed (Massell, Zayata and Funk 2006), (Hettiarachchi 2013). Post-tabular information reduction (e.g. suppression) methods are indeed applied under some conditions for output products, to reduce remaining disclosure risks assessed by threshold rules (such as minimum frequency, thresholds, the n;k rule, p% rule, etc.). For example, after perturbation on micro-data, cells that are still unique regarding a given variable will be suppressed. An alternative strategy could be a combination of protection afforded by slightly perturbed microdata with post-tabular noise addition as suggested in the context of the European Census 2021 (Giessing and Schulte-Nordholt, 2017). However, in cases where users have direct access to the micro-data file itself, there might be some risk of confidentiality breach of the data due to the absence of advanced protection on the micro data.

Acknowledging the specific issues of geospatially enabled statistical data

Before identifying and processing the data at risk because of their spatial features, a preliminary condition is to be aware that there are specific issues for this type of data. Different SDC initiatives can be undertaken for different target audiences.

In its Quality Assurance Framework, Eurostat directly refers to *addresses* as identifiers. The framework currently recommends that these *identifiers* are deleted from data as soon as possible, but this is being debated in refinements to the framework. In its work to develop a *statistical and geographical information confidentiality management policy*, Mexico also refers to address as identifiers but to the broader concept of geolocation as well. The latter encompasses other kinds of spatial information such as cadastral identifiers. The Australian Bureau of Statistics releases specific Guidance Material to protect privacy for Geospatially Enabled Statistics, recommends methods for de-identification of data and explores the specific aspects of geographic differencing.

Besides national statistical or privacy laws, data release policies, nationally agreed guidelines, national, regional or global quality assurance frameworks, or just acknowledged practices (not written anywhere),

the specific issues of geospatially enabled statistical data for the management of confidentiality have attracted a lot of interest among the scholars community or official bodies over last years (Brown 2003), (Curtis, Mills and Leitner 2006), (Domingo-Ferrer and Trujillo Rasua 2011), (Hundepool, et al. 2012), (Markkula 1999), (de Montjoye, et al. 2013), (Nagy 2015), (VanWey, et al. 2005), (Xu, et al. 2017). Nevertheless, despite this profusion, no reference handbook summarizing the studies carried out so far is available.

Apart from highlighting new risks and tackling some methodological issues, many of the latter studies mention the technologies challenges of producing geospatially enabled statistical data. They mainly point out that there is no standardised tools that would help implement the various methods, while their implementation requires very specific skills in many fields, such as statistics, geography, algorithms and/or coding optimization.

Identifying datasets, groups of units and units at risk

Adapting existing methods

Several risk metrics have been developed and discussed to evaluate the disclosure risk of an entire dataset. For example, a dataset will satisfy k-anonymity if, for each combination of quasi-identifiers, there are at least k observations. L-diversity is a broader approach that encompasses the latter and allows the consideration of intra-group diversity for sensitive variables. Both approaches may be used with geospatially enabled statistical data, since it is considered as a quasi-identifier or a sensitive variable.

Whether the data is spatial or non-spatial, one approach is to build the tabular data just as if it were disseminated without any constraint, and to flag risky cells as cells that do not satisfy the dissemination constraints. Risky units are then all the units inside risky cells. For grid data or small mesh data, risky areas can be flagged with these same rules, considering the mesh or the square as a dimension like any tabular dimension.

Another approach is to work directly on the micro-data. Each observation is has a probability of being re-identified by a data user. The underlying idea is that an observation is risky if it is not surrounded by similar observations. Conditionally to a list of quasi-identifiers, a score evaluates, for each record, how likely it is to find someone else sharing the same characteristics in the neighborhood. An individual alone in an empty area will always be considered as risky, but an elderly man located in an area with mainly young people will be risky as well. Ideally, such a score requires choosing a definition of distance or neighborhood between two records, and to build a huge matrix crossing all the units of the exhaustive data. For populous areas, this computation quickly encounters computing power issues. To solve this, an alternative is to base the risk measure on frequency counts of sensitive variables (Elliot, et al. 2005) . Another solution is to adopt a simpler definition of the neighborhood: belonging to a same area at a superior hierarchical level. That supposes to have a nested system of geographical levels (Nagy 2015)

Exploring new paths

Identifying units at risk with geospatially enabled statistical data has attracted the attention of scholars and researchers in recent years. The prevalence of human mobility data has led to raise the question of confidentiality. (de Montjoye, et al. 2013), proved that in a dataset where the location of an individual is

specified hourly and with a spatial resolution equal to that given by the carrier's antennas, four spatio-temporal points are enough to uniquely identify 95% of the individuals[11]. Using only already published aggregated mobility data, (Xu, et al. 2017) revealed an attack system able to recover users' trajectories with a 73%~91% accuracy at the scale of tens of thousands to hundreds of thousands users, which indicates severe privacy leakage in such datasets.

Another recent line of research aims at identifying the units at risk because of geodifferencing issues, when disseminating the same data according to two non-nested geographies. In algorithmic research (Costemalle 2019) develops an algorithm that efficiently allows to find such units even for non-nested territorial classifications having a huge number of items. The implementation of this method with the 35,000 French municipalities and more than 2 million grid cells have led to identifying 10,000 households at risk among the 30 million geolocated households, but adding a new dwelling to a statistical area can introduce a temporal differencing issue that should be considered.

Finally, recent research involving the confidentiality of locations when publishing smoothed density maps, shows that it is possible to retrieve the underlying location of the statistical units whenever the used parameters are published (Lee, Chun and Griffith 2019), (Wang, et al. 2019), (Hut, et al. 2020).

Processing data at risk

Adapting existing methods

Regarding questions of statistical confidentiality, geospatial data is not a fundamentally a new type of data, but rather aggregated statistical data that, in principle, can be examined and processed in accordance with the already existing post-tabular methods and procedures. Using standardized methods of analysis may nevertheless lead to the distortion of data as its aggregation will be undertaken without accounting for the distance between aggregated areas, in contradiction with the underlying spatial pattern as stated by Tobler's law.

To circumvent this problem, one possible way, when the number of risky areas is low, is to aggregate the areas on a case-by-case basis (Finland). When this option is not available, for grid data for example, an intelligent aggregation or disaggregation of cells is possible while preserving spatial correlation. The idea is to benefit from an existing or purpose-built hierarchy of geographies, to aggregate or impute cells at risk with other cells belonging to the same geographical unit at the previous level. The French and Finnish Statistical Offices (Costemalle 2019), (Markkula 1999) use such a strategy to release their data, along with other classical SDC methods. The Leibniz Insitute of Ecological Urban and Regional Development used a similar approach for Building stock visualization in Germany.

Swapping in general consists in exchanging the attributes of two observations. Targeted swapping targets the riskiest records of the data for exchanging attributes. Targeted record swapping (TRS) is a pre-tabular method that has been tested for some synthetic data from census data in Great Britain. In Japan, (Ito and Hoshino 2014) has also tested targeted swapping for the 2005 Census micro-data release. The main addition of TRS is to concentrate the swapping on the observations with the greatest risk of reidentification, defined at the level of a given geography, and to coerce swapped records not to

[11] https://www.nature.com/articles/srep01376

be too distant geographically. First versions of TRS were developed for hierarchical geographies (Brown 2003), or for grid-based data in Hungary (Nagy 2015). In these initiatives, two individuals cannot be swapped if they do not belong to the same area at a superior hierarchical level.

Exploring new paths

The growing need for spatial information often concerns non-statistical geographies, such as user defined geographies defined by x- and y-coordinates increasing the risk of disclosure due to geographic differencing. Statistics New-Zealand recently explored ways to provide enough protection when disseminating data, sometimes on-the-fly, for these areas. Among the three options studied, one is recommended since it better matches some prior constraints that include easy to use and capable of being automated within output tools.

Last and not least, computer scientists have developed the concept of "differential privacy", initially as a rigorous privacy or risk measure, along with differentially private (noisy) output mechanisms that are engineered to manifestly guarantee a given differential privacy level. It's adaptability to official statistics is expected to be a major topic in the future. Differential privacy is not a single tool, but rather a criterion, which many tools for analyzing sensitive personal information have been devised to satisfy. Differential privacy essentially ensures that using an individual's data will not reveal any personally identifiable information that is specific to them. "Specific" refers to information that cannot be inferred unless the individual's information is used in the analysis. There are several national examples of how countries use differential privacy, including:

- In the United States, the US Census Bureau is engaged in a major project that uses differential privacy. When preparing for the 2020 US census, the US Census Bureau performed verifications using 2010 census data, and investigated the potential of differential privacy as a way of maintaining data accuracy, while ensuring data security for statistical tables containing nationwide data such as gender, race, age, and relation to head-of household;
- In Japan, the possibility of adapting differential privacy for detailed geographical data from the Japanese census has been examined along with the potential of this set of methods as an anonymisation method for all statistical data.

Recommendations

- Increase the level of awareness of the unique and specific issues that come with managing the confidentiality of geospatially enabled statistical data at the global, regional and national levels;
- Acknowledge these specific issues in national statistical or privacy laws, data release policies, nationally agreed guidelines, national, regional or global quality assurance frameworks;
- Foster the collaboration with the scholar community and other official bodies in order to explore new paths and collaborate with academics and official bodies to develop geospatial-statistical disclosure control tools and techniques;
- Develop a handbooks of:
    - Statistical disclosure control methods for geospatially enabled statistical data, that will identify pros and cons of each approach and help countries set up their own policy; and,
    - Spatial-statistical disclosure control techniques that are applicable regardless of the national context.

- Increasing the security level in processing and disseminating geospatial data and fostering the integration of the geographic dimension within the methodologies and techniques of existing software for the management of confidentiality;
- The geospatial data dissemination policy must pay attention to differences in authorization between the government and general users in meeting statistical needs -- to ensure governmental bodies have access to certain geospatial information for the management of confidentiality in geospatially enabled statistical data; and,
- Develop the capacity and capabilities of NSOs in the domain of statistical disclosure control methods for geospatially enabled statistical data. This would include highlighting resources for agencies that produce geospatial information, capacity development organisations and other relevant stakeholders ensure the inclusion of the geospatial dimension in existing workshops and other capacity development materials on management of confidentiality within NSOs.

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The Terminology of the Integration of Statistical and Geospatial Information

The purpose of these definitions is to propose an agreed initial set of definitions of key concepts, to help share knowledge of existing terminologies and practices and align the description of concepts in order to reach a common understanding among representatives of statistical and geospatial communities. The terms and their definitions identified are based on their usage from the reports of UN-GGIM, the GSGF and other prevailing resources used by both the statistical and geospatial communities. The EG-ISGI's WS on Interoperability undertook a review of terms, elaborating the below terminologies, building on previous work of the EG-ISGI[12]. These aim to be living definitions, updated and refined accordingly, when appropriate.

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[12] A proposal for a common statistical-geospatial terminology database, 2nd meeting of the EG-ISGI, Lisbon Portugal, May 2015: http://ggim.un.org/meetings/2015-2nd_Mtg_EG-ISGI-Portugal/documents/UN-GGIM%20EG%20Lisbon%20meeting%20session%204%20background%20paper%20terminology.pdf

Frameworks, Themes and Global Agendas

2030 Agenda for Sustainable Development

The 2030 Agenda for Sustainable Development[13] aims to be a plan of action for people, planet and prosperity. It also seeks to strengthen universal peace in larger freedom and recognises that eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development. All countries and all stakeholders, acting in collaborative partnership, are called to implement the 2030 Agenda. The Agenda resolves to free the human race from the tyranny of poverty and want and to heal and secure our planet, calling for the bold and transformative steps which are urgently needed to shift the world onto a sustainable and resilient path. Supported by five pillars of People, Planet, Prosperity, Peace and Partnership the Agenda is anchored by a pledge that no one will be left behind.

Global Statistical Geospatial Framework

The Global Statistical Geospatial Framework (GSGF) facilitates the integration of statistical and geospatial information. A Framework for the world, the GSGF enables a range of data to be integrated from both statistical and geospatial communities. Through the application of its five Principles and supporting key elements, the GSGF permits the production of harmonised and standardised geospatially enabled statistical data. The resulting data can then be integrated with statistical, geospatial, and other information to inform and facilitate data-driven and evidence-based decision making to support local, sub-national, national, regional, and global development priorities and agendas, such as the 2020 Round of Population and Housing Censuses and the 2030 Agenda for Sustainable Development.

The GSGF was developed by the United Nations Expert Group on the Integration of Statistical and Geospatial Information (EG-ISGI), to inform and report to both the UN-GGIM and UNSC (as subsidiary bodies of the Economic and Social Council – ECOSOC), with the mandate to develop an international statistical geospatial framework due to consensus for an urgent need for a mechanism to facilitate consistent production and integration approaches for geo-statistical information. The GSGF is the culmination of this work, and now the EG-ISGI moves towards developing material that enables the promotion and awareness-raising of the GSGF to enable adoption at national, regional, and the global level.

Integrated Geospatial Information Framework

The Integrated Geospatial Information Framework (IGIF) provides a basis and guide for developing, integrating, strengthening and maximising geospatial information management and related resources in all countries. It will assist countries in bridging the geospatial digital divide, secure socio-economic prosperity, and support countries with the overarching goal of the 2030 Agenda for Sustainable Development, in enabling action to leave no one behind.

[13] A/RES/70/1 https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

The IGIF comprises three parts as separate, but connected, documents: Part 1 is an Overarching Strategic Framework; Part 2 is an Implementation Guide; and, Part 3 is a Country-level Action Plan. The three parts comprise a comprehensive Integrated Geospatial Information Framework that serves a country's needs in addressing economic, social and environmental factors; which depend on location information in a continually changing world. The Implementation Guide communicates to the user what is needed to establish, implement, strengthen, improve, and maintain a national geospatial information management system and capability.

The IGIF focuses on location information that is integrated with any other meaningful data to solve societal and environmental problems, acts as a catalyst for economic growth and opportunity, and to understand and take benefit from national development priorities and the SDGs. In providing the fundamental geospatial infrastructure for a country, the IGIF provides countries with a framework that anchors a previous work to develop NSDIs and standards, technologies, policies, best practices, amongst other key elements to enable the provision of geospatial information with a country.

Global Fundamental Geospatial Data Themes

The 14 global fundamental geospatial data themes are a foundation to support global geospatial information management, notably used to support the integrated geospatial information framework, among other global initiatives to strengthen geospatial information. They are the fundamental data sets and minimum primary sets of data that cannot be derived from other data sets, and that are required to spatially represent phenomena, objects, or themes important for the realisation of economic, social, and environmental benefits consistently across local, national, sub-regional, regional and global levels.

Sustainable Development Goals

The 2030 Agenda is composed of 17 Sustainable Development Goals and 169 targets, with which to build on the progress achieved by the Millennium Development Goals and complete what was not achieved. They seek to realise the human rights of all and achieve gender equality and the empowerment of all women and girls. They are integrated and indivisible and balance the three dimensions of sustainable development: Economic, Social and Environmental.

Core Concepts

Common Geography

Related concept *Geospatially enabled statistical data*

A common geography are an agreed set of geographies for the display, storage, reporting, and analysis of social, economic and environmental comparisons across statistical datasets from different sources. They enable the production and dissemination of integrated statistics and geospatial information within a country to support informed decision-making.

Data Management Environment

A data management environment holistically encompasses the tools, storage, and environment for acquiring, validating, storing, protecting, and processing required data to ensure the accessibility, reliability, and timeliness of the data for its users.

Discrete Global Grid System (DGGS)

The Discrete Global Grid System (DGGS) represent the Earth as a hierarchy of equal area cells with progressively finer geographic resolution. Individual observations can be assigned to a cell corresponding to both the position and size (or uncertainty) of the phenomenon being observed. DGGSs provide significant benefits when encoding, scaling, threading, streaming, combining, and analysing geospatially enabled statistical data.

Geographic Feature

A geographic feature is the geometric representation of a feature; this could be a physical feature such as a unit record, a dwelling, or property or a functional area such as an administrative boundary or an economic area.

Geographic Location

Related concept: ***Place***

A geographic location describes the geographic features and their relationship to other features and associated statistical information; and can be presented in many forms and mediums including maps, satellite imagery, aerial photography, and even sophisticated, interactive and highly visual dashboards. Unlike its corollary and related concept **Place**, the concept of Geographic Location enables the establishment and measurement of accuracy and precision, whereas **Place** does not.

Geospatial Information

Synonym: geographic data, geospatial data

Geospatial Information provides the digital connection between a geographic place, location, its people and their activities, and is used to illustrate what is happening – where, how and why.

Geospatially enabled statistical data

Synonyms: location-based statistics, geospatially enabled statistics, geographically referenced statistics, location-enabled statistics, small area statistics, statistical geography, spatial statistics, geo-statistical
Related concept: Geospatial enabling

Geospatially enabling statistics provides more information and capacity to generate and use knowledge than just statistics alone. Geospatially enabled statistical data enables the geographic breakdown of an area of interest, on which statistics are collected or disseminated. An effective geospatially enabled statistical area is one which supports many uses and enables comparisons over time. They are often hierarchically nested to collect or disseminate geospatially enabled statistical data. The construction of geospatially enabled statistical data may be functional but also population or socio-economic driven.

Geographies defined by a set of rules or a methodology meant to represent a geographic concepts (e.g., metropolitan or core-based functional areas, labour market areas outside of metropolitan regions or areas, neighboorhoods, urban, rural, a rural to urban continuum). This type of geographic area is often termed statistical

Location and geographic extent are the main characteristics of geospatially enabled statistics. The geography used in geospatially enabled statistics should meet the users' perception of their area of interest, e.g. What is the situation within a neighbourhood or areas of interest, responsibility? Geospatially enabled statistics are used to answer questions from a geographic perspective, e.g. What is close? How many are within distance *x*? How many per surface area? Further, it is recommended that all statistical unit record data should be collected or associated with a location reference and that ideally, it should allow for geospatial coordinates with x- and y-values to be produced for each record.

Integrative Geographies

Geographies designed to integrate social, economic and environmental data without the requirements and limitations of administrative and statistical geographies (e.g., the grid-based approach proposed by the Discreet Global Grid System). The term integrative is used here to denote that this type of approach is not dependent on any legal or other framework.

Interoperability

Interoperability is the ability of a system to exchange and use information, enabled through the application of open standards.

Legal/Administrative Geographies

Geographies defined in law, regulations or constitution. This type of geographic area is often termed administrative.

Location information

Location information can include addresses, property or building identifiers, and other location descriptions, such as enumeration geographies and other standardised and non-standardised, e.g. village names or other geographic names.

National Spatial Data Infrastructure

Related and core conceptual framework: Integrated Geospatial Information Framework

A National Spatial Data Infrastructure (NSDI) identifies technology, policies, standards, good practices, and human resources necessary to acquire, process, store, disseminate, and analyse the use of geospatial information. The NSDI concept has been replaced by the IGIF as the overarching framework for strengthening geospatial information.

Place

Related concept: Geographic Location

Citizens, communities, business sectors, governments, and other stakeholders benefit daily, and often unknowingly, from the use of geospatial information and related location-based services. These groups understand their physical location as their **place,** which is often described through a geographical name or some other vague or fuzzy concept which lacks the capability for accuracy and precision to be measured.

Statistical Area

A unit of measurement used for the dissemination or collection of statistics.

Statistical Geography (Geo-Statistical)

***Related concept** Geospatially enabled statistical data*

Geographies are defined by a set of rules or a methodology meant to represent a geographic concept (e.g., metropolitan or core-based functional areas, labour market areas outside of metropolitan regions or areas, neighbourhoods, urban, rural, a rural to urban continuum).

Statistical Unit Records

Statistical Unit Records can include persons, households and living quarters, businesses, buildings or parcels and units of land.

Reproducibility

Reproducibility or reliability is the degree of stability of the data when the measurement is repeated under similar conditions.

Definition of Data Integration Practices

Integration of Statistical and Geospatial Information

Core conceptual framework: Global Statistical Geospatial Framework

Synonym: integrated geospatial information

The integration of statistical and geospatial information describes the use of geospatial information for the production and dissemination of statistical data, leading to geospatially enabled statistical data. Integration can occur at any stage of the statistical production process. The GGSF is a principles-based framework that guides countries with the production of geospatially enabled statistics, noting that many, if not all, statistical phenomena are connected to a geographic location.

Linking

Related term: Linked Data

Linking defines a process of connecting structured data sources using a system of unique identifiers. Linking builds upon standard Web technologies such as HTTP, RDF and URIs. While integration describes the process of combining data from different thematic communities from a conceptual viewpoint, linking refers to technically connecting data in a machine-to-machine environment irrespective of the subject.

Geographic Differencing

Geographic differencing is the process where the same data is obtained for two different, but overlapping geographic areas, where the data from the smaller of these regions is subtracted from the data for the larger region. By using this method, it is possible to obtain data for the area that is not common to both regions; however, obtaining data for small areas using this method may result in a risk to privacy or confidentiality.

Geocoding and Georeferencing

Geocode

Geocodes are, preferably, fine-scale geospatially referenced objects that are stored as a geometry data type, such as location coordinates, e.g. x-, y-, and z-coordinates, or small area geographies, e.g. mesh blocks, block faces or similar small building block geographies. Larger geographic units, such as enumeration geographies, can be used as geocodes where finer scale geospatial units are not available.

Geocoding

Geocoding is the method of linking a description of a location to the location's measurable position in space. Geocoding links unreferenced location information (e.g., an address, or other location description) associated with a statistical unit (e.g., housing unit or business) to a set of coordinates within a coordinate system (also referred to as a spatial reference systems). These resulting coordinates are the geocode. More formally stated, geocoding is generally defined as the process of geospatially enabling statistical unit records or other nonspatial data (such as address lists or housing unit records) by creating x- and y- (and potentially z) coordinates and linking them to each record (x- and y-coordinates referring to a Latitude and Longitude or an Eastings and Northings, with the z- coordinate referring to elevation are the most commonly used, but other references are in use). Once geocoding is performed on individual statistical unit records, they (or the associated data) can be aggregated into larger geographic units (e.g., states, provinces, or municipalities) for statistical analysis. The records are ready for further applications such as methodologies to ensure confidentiality and avoid data disclosure.

Georeferencing

Georeferencing, in its broadest definition, is understood to be the process of linking geospatially enabled data to a common geospatial reference frame that allows geospatial presentation and analysis of those data, usually in Geographic Information System (GIS) software. Georeferencing requires linking coordinates to a defined geospatial reference frame (i.e. a geospatial datum, ellipsoid, coordinate system, and often a projection). Georeferencing may refer to the alignment of Orthoimagery or digital copies of paper maps with their inherent geographic coordinates (i.e., geocodes); or the transformation of geospatial data from a one defined geospatial reference frame to another.

Geospatial enabling

Synonym: location enabling

Geospatial enabling describes the process of taking location information such as an address or administrative area code and linking this information to a geospatial feature. The geocodes (e.g. location coordinates, address ids, or geographic areas codes), obtained from this process can be stored directly on the statistical unit record or linked in some way to the record. Unless geographical coordinates can be stored with the unit record, linking via key relationships is safer to avoid the changing geographies disrupt the time series.

Location Information

Location information can include addresses, property or building identifiers, as well as other location descriptions, such as enumeration geographies and other standardised (e.g. postal codes) and non-standardised (e.g. village names) textual descriptions of a location.

Aggregated statistical information

Aggregated statistical information is aggregated from geocoded unit record level data into the dissemination geography instead of disaggregated statistical information created using a spatial distribution model and larger statistical geographies as source data.

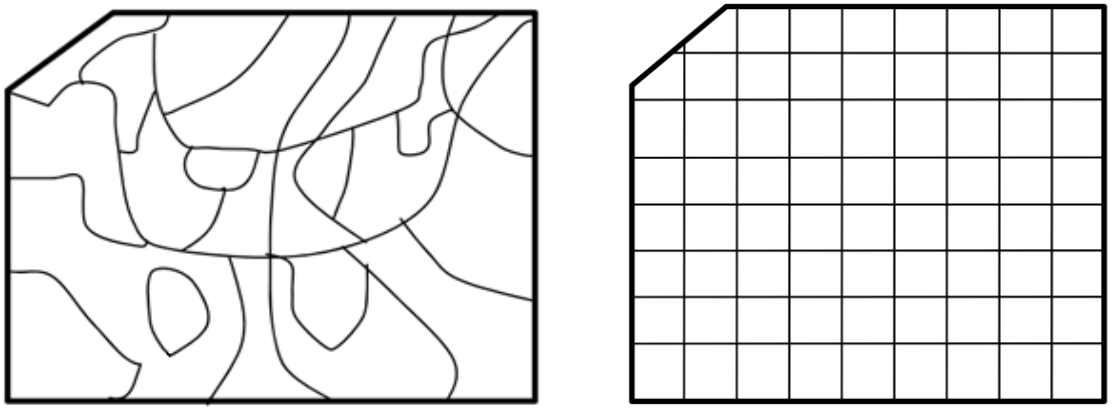
Geographical Classifications

Geographic Classification

Synonyms: Sub-national typologies, regional typologies, territorial typologies

Related concept: Gridded geographies

Geographical classifications are a method to group geographies according to objective criteria. The GSGF considers two main classifications, Administrative and Gridded Geographies respectively, from which other geographies are derived. The resulting geographies are characterised by how they are geographically represented. The GSGF, in its Annex B, considers, compares and contrasts administrative and gridded geographies.



Administrative Geographies

Gridded Geographies

Figure 4 Administrative and Gridded Geographies

Administrative Geographies

Synomym: enumeration geography, functional geographies, functional geography

Administrative geographies are primarily the geographic representation of the administrative boundaries of a country. The largest administrative subdivision of a country is called the "first-level administrative level", and often the smallest areas of measurement are enumeration areas. Enumeration geography is the division of a country into areas for census purposes. They represent the smallest area for which in most countries' population information is available. However, in certain countries, enumeration areas are further subdivided into blocks, e.g. bounded by physical features such as streets or rivers.

Functional geographies are defined by characteristics other than their surface area or administrative level. These include geographical characteristics such as mountain areas; social characteristics such as less-favoured areas, areas in need for development, areas by type of economic activity etc.

Gridded geographies

Related concept:

Administrative Geographies

Gridded geographies are of a consistent size, identified with a unique geocode and independent to the underlying geography.

Degree of Urbanisation

The Degree of Urbanisation (DEGURBA) is a classification of municipalities based on population densities and urban clusters. Based on the share of the local population living in urban clusters and urban centres, it classifies municipalities into three types of area: thinly populated area (rural area); intermediate density area (towns and suburbs/small urban area), and densely populated area (cities/large urban area).

Dissemination Geography

Synonym output system, output areas

System of often hierarchically nested geographies to be either particularly suitable for analysis (administrative geographies, gridded geographies).

Locality

A locality is a term used by different people to mean different areas, and assumptions should not be made about the term in any given usage. An increasingly important official use of the term is in connection with the census. A locality in this sense is a contiguous built-up area use for settlement reaching a minimum population threshold.

Spatial Analysis

Spatial Analysis

Synonym: location analytics

The process of examining the locations, attributes, and relationships of spatial features in spatial information through overlay, distances, spatial selection, intersection, aggregation and other analytical techniques to address a question or gain useful knowledge. Spatial Analysis extracts or creates new information from geospatial information.

Supporting Resources

Integrated Statistical and Geospatial Resources

- The European Forum for Geography and Statistics (EFGS): https://www.efgs.info/information-base/introduction/terminology/
  nb. The work of the EFGS is primarily based on work presented by Eurostat to the EG-ISGI's second meeting in Lisbon on 24 May 2015: http://ggim.un.org/meetings/2015-2nd_Mtg_EG-ISGI-Portugal/documents/UN-GGIM%20EG%20Lisbon%20meeting%20session%204%20background%20paper%20terminology.pdf
- The EG-ISGI's Wiki (for EG-ISGI members and Secretariat only): https://unstats.un.org/wiki/display/ISGI/Common+Statistical+and+Geospatial+Definitions

Geospatial Vocabularies

- ISO: https://unstats.un.org/wiki/download/attachments/36143402/Glosario%20de%20Terminos%20INEGI.pdf?version=1&modificationDate=1539014218647&api=v2
- OGC http://www.opengeospatial.org/ogc/glossary

Statistical Vocabularies:

- GSIM https://statswiki.unece.org/display/gsim/Generic+Statistical+Information+Model
- https://www.efgs.info/information-base/introduction/terminology/EUROSTAT http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Thematic_glossaries#Special-topic_glossaries
- OECD https://stats.oecd.org/glossary/
- NQAF (National Quality Assurance Framework) https://unstats.un.org/unsd/dnss/docs-nqaf/NQAF%20GLOSSARY.pdf
- EFGS: https://www.efgs.info/information-base/introduction/terminology/

Other Resources

- The UNdata Glossary: http://data.un.org/Glossary.aspx
- International Statistical Institute: https://www.isi-web.org/index.php/publications/glossary-of-statistical-terms
- Bank of International Settlements https://www.bis.org/statistics/glossary.htm
- SDMX https://sdmx.org/wp-content/uploads/SDMX_Glossary_Version_1_0_February_2016.docx
- FMI http://www.imf.org/external/np/exr/glossary/showTerm.asp
- World Bank http://databank.bancomundial.org/data/metadataglossary/all/series
- European Central Bank https://www.ecb.europa.eu/home/glossary/html/index.en.html

Implementing the GSGF: Experiences at the National Level

Australia

Name of Agency: Geoscience Australia / Australian Bureau of Statistics
Submission From: Combined NGIA/NSO

The Overall Implementation of the GSGF

Australia developed the Statistical Spatial Framework, which formed the basis of the GSGF. The SSF is referenced directly and indirectly in a range of national initiatives and activities, and has been critical in the thinking in the recently announced Australian Government initiative the Digital Atlas of Australia.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Australia has a range of fundamental data under the Foundation Spatial Data Framework that is used for statistical activities, including geocoding. In particular, the Geocoded National Address File I available for open use and is used extensively in geocoding datasets and supporting statistical activities, including maintaining the ABS Address Register which is used as the dwelling frame for household survey and censuses. A single geocoding technology is however not use, with a range of commercial providers supplying solutions to organisation undertaking geocoding – this is likely to continue.

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

The ABS conducts all of its geocoding and other data processing in a secure data management environment. ABS also supports other organisations conducting geocoding to protect data through the use of secure environments and good geocoding results through the application of best practices.

Principle 3. Common geographies for the dissemination of statistics

The ABS produces the Australian Statistical Geography Standard for the productions, dissemination and analysis of statistics and other data. It used for all ABS statistical releases and is also used widely in socio-economic datasets across government, business and the community. ABS and Geoscience have also collaborated on the establishment of a default Discrete Global Grid System definition to support the release and analysis of grid data.

Principle 4. Statistical and geospatial interoperability

Recently ABS and Geoscience have been collaborating on encouraging interoperability of data through the use and application of metadata and other standards. The Location Index project has been building shared infrastructure to enable the transformation of data between different spatial referencing systems. The Australian Climate Service collaboration, which also involves the Bureau of Meteorology and CSIRO (national science institution), is undertaking several initiatives to ensure data is accessible and interoperable within government, and the Digital Atlas program is expected to extend that more broadly.

Principle 5. Accessible and usable geospatially enabled statistics

ABS has a long history of using innovative methods to make geospatially enabled statistics available to users, including providing statistical data with open access licences. Recent work with partners in the Australian Climate Service and, in coming years, with the Digital Atlas program, is modernising this process to encourage the use of "linked open data" (web) services and building platforms to facilitate access and analysis of a wide range of geospatial and location information.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Having a wide range of existing geospatial enable statistics (from the ABS) and other data (in other government organisations) enabled rapid location-based analysis and responses to COVID-19, including analysis of at-risk populations. Having strong geospatial capability (workforce and technical infrastructure) allowed rapid response to geospatially enabling new data sources, which allowed more timely information to examine localised employment impacts from business shutdowns.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

More comprehensive implementation of GSGF principles in other organisations would have allowed for more effective integration of data from different sources, for example some health sector data was "geocoded" to postcodes, which is not a good common geography to enable integration with other datasets. This points to the need to take the GSGF principles beyond NSOs.

Botswana

Name of Agency: Stats Botswana
Submission From: Desk Review from ECA

The Overall Implementation of the GSGF

The Overall Implementation of the GSGF

Botswana is still to develop the National vision for the implementation of GSGF. Components of GSGF, were implemented during the 2021and the Demographic and Health Surveys (DHS) Ghana: 2019, 2017, 2016, 2014, 2011, 2008, 2007, 2006, 2003, 2002, 1998, 1993 and 1988. Geocoding and other principles of GSGF was extensively deployed during the above-mentioned operations.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Statistics Botswana collaborated for the automation of census cartographic exercise 2021 with GeoSpace International. The collaboration offers technical assistance, support and the implementation of a smart census application for the mapping of the 2021 census in Botswana.
To give a unique code to each enumeration region it was essential to design a coding system. The system for coding was sufficiently flexible and organized to include new and future administration divisions, which represent administrative hierarchy. A systematic program of coding was followed in order to guarantee consistency and clarity of the numeric Identifications (IDs). In this method, each

administrative hierarchy contains the geographic units. The geo-coding suggested corresponded to the geographic census framework.

The Enumeration Areas (EAs) boundaries used in 2011 acted as the foundation for the creation of the Frame (DU) for housing. The DU framework composed of residential units and points of interest (POI). Geocoding of Housing unit location (Dwelling Frames, Housing Footprints), collective living quarter locations (Dwelling Frames, Housing Footprints) a set of digital enumeration area maps or derived dissemination units, which are designed to enable the production of all output products that will be disseminated to government departments and the general public.

Geocoding of Geographic boundary files in a digital format for all statistical reporting units for which census indicators will be tabulated. Listings of all statistical and administrative reporting units, including towns and villages, their variant names and geographic coordinates. Geocoding of Geographic equivalency files that indicate how current reporting units relate to those used in previous censuses, or how one set of reporting units relates to another set as well as the Geocoding of vector layers containing feature data, such as landmarks, roads, schools, hospitals and clinics, which can be used when analysing population data spatially. Geocoding was used to determine the Centroid files that provide a representative geographic point reference for each reporting unit. It also provided for gazetteers that provide geographic coordinates for all population settlements and other important geographic features in the country. Geocoding: DHS GPS Datasets

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

Smart Census which is a WEB-based, client-server GIS viewing and data capturing application specifically developed for census mapping by GeoSpace in collaboration with Hexagon Geospatial were deployed. The latest updated version of the software based on Hexagon Geospatial M.App Enterprise platform were included in modules for Enumeration and Dissemination that helped in Geocoded unit record data in a data management environment.

Principle 3. Common geographies for the dissemination of statistics

The Smart Census product came as a direct result of years of experience in census projects where GeoSpace and Statistic Botswana developed mobile field data capturing applications with integrated data transfer functionality that complimented our usual GeoMedia desktop GIS solutions.

Principle 4. Statistical and geospatial interoperability

Dashboard were used enabling integrated reporting system enables real-time reporting at all levels of the project and within the organisation. Management (even senior management) can access the application through the Internet/Intranet with their allocated Username / Password to generate live status reports per phase of project as and when desired. Smart Census application enabled seamless statistical and geographical interpolation of data in an office as well as field environments.

Principle 5. Accessible and usable geospatially enabled statistics

Smart Census which is a WEB-based, client-server GIS viewing and data capturing application specifically developed for census mapping by GeoSpace in collaboration with Hexagon Geospatial were deployed for accessible and usable geospatially enabled statistics.

Brazil

Name of Agency: IBGE
Submission From: Combined NGIA/NSO

The Overall Implementation of the GSGF

The implementation of the GSGF in Brazil is ongoing. In 2019, IBGE made the Geographical Reference Framework for the production, analysis and dissemination of statistics available to the public (PT-BR: Quadro Geográfico de Referência para Produção, Análise e Disseminação de Estadisticas *). In this reference publication you can find information about the geographies produced by IBGE and the functional and legal geographies. All geographies contain a form with basic information (update cycle, reference date, number of units, publication / reference legislation etc.), definition, geocoding, relationship with other geographies and map. The publication marked the beginning of a more ambitious project that aims to integrate existing systems and standardize the incorporation of new geographies present in Brazil, thus strengthening the integration between Statistics and Geography with a view to making spatially comparable and integrated available. The Geographic Reference Framework was inspired by the GSGF and the initiatives of other countries. The publication refers to global efforts to integrate statistical and geospatial information. Currently, the Brazilian initiative is in the stage of maturing its workflows and building an integrated database with an annual update that will be made available to the public. An update of the reference publication and a web application is expected in 2022. It is important to note that, since 2008, Brazil has had a spatial data infrastructure, the National Spatial Data Infrastructure (PT-BR: Infraestrutura Nacional de Dados Espaciais - INDE).

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The National Spatial Data Infrastructure - INDE (PT-BR: National Spatial Data Infrastructure - INDE). of Brazil was established by Decree no. 6,666 of November 27, 2008. INDE was conceived with the objective of cataloging, integrating and harmonizing the geospatial data produced or maintained by Brazilian government institutions, so that they can be easily located, explored with their characteristics and accessed by the most diverse purposes by any user with access. The cataloging of geospatial data is carried out through the respective metadata by the producers and / or data managers. In 2019, IBGE made the Geographical Reference Framework for the production, analysis and dissemination of statistics available to the public (PT-BR: Quadro Geográfico de Referência para Produção, Análise e Disseminação de Estadisticas) with the objective of implementing the GSGF in Brazil. IBGE updates the information on addresses, the nature of homes and buildings in the National Register of Addresses for Statistical Purposes (PT-BR: National Register of Endereços for Statistical Purposes - CNEFE). Created in 2005 from the systematization of the data collected by the 2000 Census, this registry today includes information on households and establishments throughout the country. In each Demographic Census it is fully updated, also passing through a continuous process of occasional updates according to the demand of other surveys. Brazilian censuses are collected through a mobile device using address locations (mainly in urban areas) and coordinates (mainly in rural areas). The biggest gaps in geospatial information are those related to cadastral parcels and the location of buildings whose competence belongs to other

agencies of the federal government (rural areas) and municipalities (urban areas), therefore, the data is very dispersed and heterogeneous.

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

Since 1988, IBGE has had a cadastral reference database for the division of the national territory, the Bank of Territorial Structures (PT-BR: Banco de Estruturas Territoriais - BET). This database contains information on the genealogy of the geographies, their territorial hierarchy and also their geocoding. The bank is used for IBGE's census operations and investigations. The next step in the implementation of the GSGF at the national level is the integration of this database and others (addresses, coordinates, grid, scattered geographies / not registered in BET) with the Geographical Framework database. Currently, the feeding processes of the Geographical Framework database are carried out manually. In the near future, it is expected that the Geographic Framework will be automatically fed through the communication or integration of the different databases.

Principle 3. Common geographies for the dissemination of statistics

The common Geographies for the dissemination of statistics are established in the Geographic Reference Framework for the production, analysis and dissemination of statistics. The geographies are updated annually considering changes in the limits and nomenclature of the municipalities. The inflows and outflows of geographies of the Geographic Framework are also established. Part of these geographies are incorporated into IBGE's main statistics dissemination tool, the IBGE Automatic Recovery System - SIDRA.

Principle 4. Statistical and geospatial interoperability

Recently (2019), Brazil created the Central Data Governance Committee - (PT-BR: Comitê Central de Governança de Dados - CCGD; https://www.gov.br/governodigital/pt-br/governanca-de-dados / comite-central-de-governanca-de-dice) to govern the exchange of data within the federal public administration. Resolution CCGD / ME n. 5, of January 12, 2021 instituted the Address Database and the standardization of addresses. The resolution also prohibited the creation of new address databases by the Data Consumer Agencies, unless authorized by the Address Database Management Body. The geocoding of the IBGE municipalities was incorporated into the standardization of addresses. This geocoding is widely used by public organizations and private institutions in the country. IBGE recently responded to the Executive Secretariat of the Central Data Governance Committee, which approved the proposed Agreement with the CCGD with the aim of sharing data sets of countries, political-administrative division, regions and geographical typologies of IBGE, to the constitution of Basic Registries (Reference Register) - which will be instituted by means of a Resolution approved within the scope of the CCGD.

At IBGE, part of the geographies of the Geographic Framework are incorporated into IBGE's main statistics dissemination tool, the IBGE Automatic Recovery System (PT-BR: Sistema de Recuperação Automática do IBGE - SIDRA), the other geographies are Developing. Advances are needed in service-based access and especially in machine-readable mechanisms (eg via API).

Principle 5. Accessible and usable geospatially enabled statistics

It is expected that, in the publication of the results of the 2022 Census - compiled by addresses and coordinates - progress will be made in the provision of geospatially enabled statistics. Studies and

advances have been made to make the data available in web services in different geographies, including addresses and coordinates, respecting confidentiality. IBGE already has experience with web services (Statistical Grid - http://mapasinterativas.ibge.gov.br/grade/default.html; Interactive Geographical Platform- https://www.ibge.gov.br/apps/atlas_nacional/ , Status; Environmental Information Bank-BDIA - https://bdiaweb.ibge.gov.br/#/home) that will be improved for the dissemination of the Census results. More recently, tests and advances were made in geodashboards for the dissemination of data to combat the COVID-19 pandemic (https://covid19.ibge.gov.br/paineis-sintese/).

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

IBGE took the initiative to develop interactive panels that integrate geographies with COVID-19 cases (accumulated, weekly and daily), data on vulnerable populations, health infrastructure and other indicators produced by the Institution. Three geographical levels were used to present the information: that of the municipality, that of the Federation Unit and that of the Region in search of health services of low and medium complexity (https://covid19.ibge.gov.br/).

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

What has already been implemented in the Geographic Framework served to support the construction of tools to combat COVID-19. It is understood that for the most effective implementation of the GSGF a greater integration between government institutions and their information systems is necessary. The integration promoted by the IBGE in relation to the fight against COVID-19 was one more step for the geographic information to be communicated with the statistics produced in the institutions. It is considered necessary to carry out work that extends the interoperability of data and systems..

Canada

Name of Agency: Statistics Canada
Submission From: NSO

The Overall Implementation of the GSGF

Different departments are aware of the GSGF.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Current Status

- Statistics Canada's spatial data infrastructure (SDI) exists and includes some fundamental geospatial data. It contains roads, road names and address ranges from the National Geographic Database (NGD), as well as boundary arcs of standard geographic areas that do not follow roads, all in one integrated line layer. SDI also includes a related polygon layer consisting of basic blocks, boundary layers of standard geographic areas, and derived attribute tables, as well as reference layers containing physical and cultural features (such as hydrography, railroads and power transmission lines) from the NGD;

- Registers and spatial data infrastructure support the creation of high-quality, standardized location references for residential and non-residential addresses, building footprints and other location description;
- An x- and y-coordinate or a geographic area identifier are assigned to addresses, allowing georeferenced of each statistical unit (such as a person, household, business, and building) at the microdata/unit record level. A time and date stamp adds a temporal component to the statistical unit record;
- Common and practical method of address data capture decompose the address in separated fields for geocoding purposes;
- Standardized location references (e.g. x- and y- coordinates or geographic area identifier) of the addresses are stored in registers; and,
- Other fundamental geospatial data layers exist in the spatial data infrastructure such as physical infrastructure, environment, agriculture, health, justice, transportation networks and tourism areas.

What's Next

- The Enterprise Geospatial Platform (EGP) will become Statistics Canada's single-access point for fundamental and authoritative geospatial data in the agency;
- The EGP will replace and integrate the current Spatial Data Platform and National Geographic Database; and deliver geospatial layers as a service and store geo-enabled data in a data lake;
- National Building Layer will be added to Statistics Canada's EGP;
- A spatial file of address points from the National Address Register will be added to Statistics Canada's EGP;
- Spatial layers for Canada's critical and social infrastructure will be added to EGP;
- A near time version of the National Road Network will be part of the EGP; and,
- Statistics Canada will develop new standards for civic addresses and National Road Network that will used in the GOC.

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

The Statistical Geomatics Centre of Statistics Canada is responsible for developing corporate geographic files, mapping and address Web services supporting the collection, processing and dissemination activities of the Canadian Census of population, the Census of agriculture, and economic and social surveys.

The geographical reference frame combines data from different sources such as the National Geographic Database (NGD), the National Road Network files, Elections Canada and Statistics Canada business layers, Canada Post, Natural Resources Canada (NRCan) and provincial data suppliers. The geographic files are maintained so they can be referenced by geography vintages, which can be linked over time, and are updated quarterly with the latest available data within a secured data management environment. They include standardized variables, geographic identifiers and coordinates to allow geocoding records at collection or dissemination hierarchy levels, within Statistics Canada geography framework.

The geocoding Web services offered can be described as an address locator. The services allow for an address or partial address, place name, postal code, or section, township, range and meridian fields to be provided and for which a geographic identifier (or multiple identifiers in the case of a partial address) is then returned. Mapping tools are also maintained from where a location is selected on a visual map and automatically geocoded. The precision of the geocoded results depends on either the specificity of the address fields provided or the identified location on the map, the address attributes in the reference data and the client target geocoding level needs. The database within the services are updated on a regular basis in order to permit the most accurate coding results.

The geocoded units will then allow for further statistical data integration of social and economic aspects towards analysis, data visualization and dissemination products.

Principle 3. Common geographies for the dissemination of statistics

Some of the geographic areas are national in coverage (e.g., federal electoral areas, provinces and territories, census collection units or enumeration areas). Others define a sub-set of the national territory based on regulatory requirements (e.g., provincially defined sub-municipal designated places) or delineation methodologies that define a statistical geography (census tracts, urban areas, census metropolitan areas). Other federal agencies and levels of government make use of the geographic areas maintained by Statistics Canada for statistical purposes, program development, implementation and delivery.

Legal/administrative: Geographies defined in national or sub-national laws or regulations. This type of geographic area is often termed administrative. These include: Provinces and Territories, Federal Electoral Districts, Census divisions (regional or upper tier municipalities), Census subdivisions (local or lower tier municipalities), Designated places. See the Geography Index of definitions for more information on these and other administrative geographies[14]

Geo-statistical: Geographies defined by a set of rules, or a methodology meant to represent a geographic concept (e.g., metropolitan or core-based functional areas, labour market areas outside of metropolitan regions or areas, neighbourhoods, urban, rural, a rural to urban continuum). This type of geographic area is often termed statistical.

Statistical geographies are typically defined by at least one or more statistical characteristics of an area. These include an optimal population count range (e.g., 400 to 700), minimum population concentration and density, or proxy measures as the use of journey to work or commuting data to determine the strength of the relationship between two areas. Census dissemination statistical geographies include: Geographic regions of Canada, Economic regions, Census of agriculture regions, Census metropolitan areas and census agglomerations, Population centres, Census tract, Dissemination areas and Dissemination blocks. See the Geography Index of definitions for more information on these and other statistical geographies[15].

[14] https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/az2-eng.cfm?topic=az2

[15] https://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=16553

Future objectives – improving and expanding common geographies within the national statistical system:

- With the increasing use of integrated administrative data and geospatial information, we foresee reducing the needs for a collection geography by the Census and other programs that continue to use field survey collection methodologies.
- Research and development of new geographies and revision of existing geographies in order to meet national and international partners and stakeholders needs and national and international reporting commitments (e.g., Census, SDGs reporting, Sendai Framework): further classification of the rural to urban continuum – e.g., DEGURBA, index or remoteness, review of the metropolitan area delineation methodology with the focus on the use of other indicators or proxy measures (e.g., mobile data), rural and remoteness index, Indigenous geographies and additional small area geographic areas)
- Statistics Canada is considering a review of the grid-based approach (e.g., the Discreet Global Grid System) and its future integration into and use by the national statistical system. This latter point is key to ensuring that the advantages of a grid-approach are consistent with the evolving objectives of the Agency. The timing of this review is still to be determined.

Principle 4. Statistical and geospatial interoperability

Statistics Canada applies statistical metadata standard, the Generic Statistical Information Model (GSIM), referencing data in Statistical Data and Metadata Exchange (SDMX) for macrodata and Data Documentation Initiative (DDI) mechanisms for microdata (for external users such as researchers):

- Harmonized ISO 19115 - 2003 North American Profile (HNAP) metadata is a standard for geospatial data created by the Government of Canada[16]. This metadata format is a Canadian variant of the North America Profile of ISO 19115 2003, which has a defined XML schema that supports federal government requirements. Statistics Canada applies this standard.
- A Dissemination Geography Unique Identifier (DGUID) code[17] is used within Statistics Canada's Common Output Database Repository (CODR). The DGUID is a skeleton key for linking geospatial data and statistical data. It facilitates linking every geographic area maintained by Statistics Canada with data tables.
- Statistics Canada disseminates geographic boundary files are available as a Web Map Service[18], a standard developed by the Open Geospatial Consortium (OGC).

The use of geospatial data and methods in the statistical production process occurs at all the phases of the GSBPM.

Principle 5. Accessible and usable geospatially enabled statistics

Statistics Canada produces statistics that help Canadians better understand their country—its population, resources, economy, society and culture. In addition to conducting a Census every five years, there are about 350 active surveys on virtually all aspects of Canadian life. In Canada, providing statistics is a federal responsibility. As Canada's central statistical office, Statistics Canada is legislated to serve this function for the whole of Canada and each of the provinces and territories.

[16] Ibid

[17] https://www150.statcan.gc.ca/n1/pub/92f0138m/92f0138m2019001-eng.htm

[18] https://www.ogc.org/standards/wms

Objective statistical information is vital to an open and democratic society. It provides a solid foundation for informed decisions by elected representatives, businesses, unions and non-profit organizations, as well as individual Canadians. As a member of the United Nations Statistical Commission, Statistics Canada endorses the Fundamental principles of official statistics.

Statistics Canada applies the Directive on Open Government. The Open License governs the use of most data products and other materials that are published by Statistics Canada. This license allows users to use Statistics Canada information without restrictions on sharing and redistribution, for commercial and non-commercial purposes. We at Statistics Canada are committed to protecting the confidentiality of all information entrusted to us and to ensuring that the information we deliver is timely and relevant to Canadians.

On Statistics Canada web sites, there is Census geography covers a wide range of geographic areas—from provinces and territories down to blocks. These geographic areas have boundaries, names, and other information that make it possible to locate them on the ground and relate census data to them. For some products, information is available for current and previous censuses. These products are:

- Boundary Files depicting boundaries of standard geographic areas established for the purpose of disseminating census data and providing a framework for mapping and spatial analysis;
- The Road Network File depicts the digital road line coverage for Canada and provides a framework for mapping and spatial analysis;
- Interactive mapping applications that make it easy to find many places in Canada, see them on a map, and get geographic and demographic data for those places;
- Interactive thematic mapping applications;
- Tool used for data retrieval, query and tabular output that allows users to explore the links between all standard levels of geography; and,
- A system developed to allow census users to define their own custom areas (place of residence or place of work) and retrieve census data for it.

Statistics Canada geo-enabled statistics (Census and non-Census data) are now easily accessible on the public website using the new Canadian Statistical Geospatial Explorer (CSGE and CSGE hub). CSGE improves the discovery, access, analysis and visualization of geospatial enabled statistics (using a dynamic linkage between geospatial boundary files and data), and support analysis for decision-making. Users can easily explore Statistics Canada's data, visualize statistics spatially on maps, create their own custom maps, and download geo-enabled data into their own tools.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

The integration of statistical and geospatial data is a crucial element to inform and facilitate data-driven and evidence-based decision-making during a pandemic. The maturity level of the GSGF in Canada allowed the national statistical office to support the national response to Covid-19 in a timely and responsive way.

Statistics Canada (Statistical Geomatics Centre - SGC) has co-leaded a multi-departmental geomatics task force to augment Public Health Agency of Canada geospatial and statistical data, tools and expertise capacity. This initiative was led by Public Health Agency of Canada (PHAC), Natural Resources Canada (NRCan) and Statistics Canada.

Through this collaboration a wide variety of public and internal products that integrated data from various sources were delivered.

Chile

Provided responses from both the NGIA and NSO.

National Geospatial Information Agency

Institution: Ministry of National Assets-SDI CHILE

Submission From: NGIA

The Overall Implementation of the GSGF

The Global Geospatial Statistical Framework has been implemented within the framework of the existing coordination between the National Coordination System of Territorial Information, equivalent to the Geospatial Data Infrastructure of Chile (SDI-Chile), and the National Institute of Statistics of Chile (NSO).

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Within the framework of the Road Axes Working Group coordinated by SDI Chile, a unique and public cartography of road axes with geocoding capacity has been developed. This collaborative work began in 2018, Project where it was possible to develop a methodology agreed between different public bodies, to obtain digital cartography of road axes. Thus, in 2019, 63 communes with geocoding capabilities were obtained, which are available with their respective metadata[19]. This year 2021, 16 new layers with geocoding capabilities have been added[20]. The participating institutions of this Working Group are:

- National Institute of Statistics (NSO);
- Ministry of Economy, Development and Tourism;
- Ministry of Public Works;
- Ministry of Housing and Urbanism;
- Ministry of Social Development;
- Internal Revenue Service (SII); and,
- Chilean Investigative Police (PDI)

[19] https://www.ide.cl/index.php/planificacion-y-catastro / item / 2041-street-master-2018

[20] https://www.ide.cl/index.php/planificacion-y-catastro/item/2027-maestro-de- streets-16-communes

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

This principle is implemented from the Political Administrative Division (DPA) of the country, which has a legal character, and the Census Division, which is operational in scope and allows to obtain a microdata level disaggregation.

(a) Political-administrative division: it is divided into smaller regions territorial units, which are divided, in turn, into provinces and finally, into communes. According to the current DPA, the country is made up of 16 regions, 56 provinces and 346 communes.

(b) Census division: for operational purposes, the communes are subdivided into smaller territorial units that allow the statistical survey to be better organized. The limits defined by the INE are supported and framed within the limits of the DPA according to the following:

i. Census district: it is an operational census division defined by the NSO. It is defined as the part into which the communal territory is divided and which constitutes the 7 largest basic unit for census field operations and statistical samples. The sum of the census tracts in the country is 2,771, which can be urban, rural and mixed. For the division of the districts, the general criterion is the number of dwellings in the urban area and the surface in the rural part;

ii. Geographic area (urban/rural): corresponds to the division within the districts between urban and rural areas that is expressed territorially through the Urban Census Boundary (LUC);

iii. Urban entity: an urban entity is understood to be a human settlement with continuity and concentration of buildings in a regular neighborhood with a population greater than 2,000 inhabitants, or between 1,001 and 2,000 inhabitants where less than 50% of the population that declares to have worked is engaged in activities primary;

iv. Rural entity: a rural entity is understood to be a human settlement with a population of less than or equal to 1,000 inhabitants, or between 1,001 and 2,000 inhabitants where more than 50% of the population that declares to have worked is engaged in primary activities. In addition, rural is defined as a smaller set of entities that meet the population criteria to be defined as urban, but not the requirements of blockage, continuity or concentration of buildings;

v. Census area: correspondence to the division of the urban census district and the urban area of the mixed census districts, formed by a conglomerate of blocks, whose purpose is to facilitate the organization, control and conducting of the census;

vi. Locality: corresponds to a geographical area with its own name of generalized knowledge. For purposes of a census database, it corresponds to the division of the rural census tract and the rural areas of the mixed census tracts. Both in the census zones and in the localities there is a lower disaggregation of population corresponding to blocks and entities respectively; and,

vii. Census blocks: basic geographic unit for statistical purposes that make up census zones in urban areas. It contains a group of adjoining or separate dwellings, buildings, establishments and / or properties, delimited by geographical, cultural and natural features.

Principle 3. Common geographies for the dissemination of statistics

This principle has been implemented through the definition of census blocks, which correspond to basic geographic units for statistical purposes, and which make up the census zones in the urban area.

In the case of a human settlement that is located within a locality (rural area), the entities are defined, which receives a proper name recognized by its inhabitants, and they differ from each other by the characteristics of their settlement (categories), their denomination and the functions that they carry out in the territorial scope.

In the search for more citizen territorial units that allow communities to understand and use statistical information, the NSO has developed a platform with 2017 census information and urban facilities at the NEIGHBORHOOD UNIT level, which are disseminated on the NEIGHBORHOOD DATA PLATFORM[21].

Principle 4. Statistical and geospatial interoperability

This principle is applied in some initiatives coordinated by IDE Chile:

- Geonodo Tool: open source web and mobile application, developed by the SNIT Executive Secretariat to create, publish, share, analyze and use territorial information. The objective of this tool is to be a provider node and thus increase the diversity of territorial information available to users and decision makers of SDI Chile. It should be noted that the current version considers statistical and geospatial interoperability; and,
- Multisectoral Working Group for Territorial Information in the Management of Emergencies, Disasters and Catastrophes (GTM): initiative whose objective is the coordination of territorial information to make it available to the participating actors, and in this way support the different actions within the framework of an emergency. It should be noted that this instance has considered statistical and geospatial integration and interoperability in the different events in which the group has been activated.

Principle 5. Accessible and usable geospatially enabled statistics

The NSO has statistical information represented through maps, which is available on the "Maps Portal" site[22]. Here are available various maps with statistical, census and quality of life information, their distribution and behaviour in the national territory, in addition to the download of data published in different formats and documentation of different types, useful for consultation, analysis and taking decision making.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

The existing initiatives within the GSGF in our country have allowed statistical information to contribute to the epidemiological management of the COVID-19 pandemic. The collection and access to demographic data have supported decision-making for the planning, implementation, and evaluation of measures implemented by the health authority, with the aim of establishing a policy for the prevention and control of the pandemic.

[21] https://ine-chile.maps.arcgis.com/apps/opsdashboard/index.html#/ee7c8fc3d7aa421eb75380492809dceb

[22] https://www.ine.cl/herramdamientos/portal-de-mapas

Another important aspect to highlight has been the contribution of statistical information for the programming, prioritization of the different age groups and the projection of the vaccination process against COVID-19 in our country, which has been very highlighted for its successful progress.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

The implementation of the GSGF would have contributed to having more updated statistics, disaggregated and known by all public institutions, to support the design and implementation of the different public policies that have been established during the pandemic period. Contributing to the efficiency and effectiveness in the use of resources.

National Statistical Office

Institution: Instituto Nacional De Estadísticas (Ine)

Submission From: NGIA

The Overall Implementation of the GSGF

The implementation from the Statistical Office has been developed through the strategic project of the institution called "MULTIPURPOSE GEOSTATISTIC PLATFORM", whose objective is to implement a computer platform that allows the integration of statistical and geographic information, its governance and dissemination to the different levels of the state and the general public. The specific goals are:

Objective 1: Propose a technological infrastructure that supports the proposed platform;
Objective 2: Define standards and protocols for: the gathering, processing and dissemination of geographic information;
Objective 3: Build and have a street name and address nomenclator, and a georeferenced frame of buildings;
Objective 4: Build and have an information geolocation tool based on information from the NSO;
Objective 5: Build a web tool that allows the generation of automated cartography for the national employment survey and household surveys;
Objective 6: Improve and add functionalities to web map tools to disseminate digital cartography; and,
Objective 7: Diversify the integration of administrative records from external institutions as an input for the continuous updating of the cartography.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

After the 2017 census, an infrastructure has been implemented whose core is based on the location of buildings, with the basic attribute of addresses, whose normalizations are based on a relational database structure standard at three levels: main addresses (eg : building entry), secondary addresses (eg: apartments) and uses/occupation within the units (eg: a home and a workshop).

The address database currently has approximately 8 million records associated with a single block and exact coordinates for 50% of the directory, which are in a process of continuous updating which is expected to finish by the end of 2022, as a fundamental input for the 2023 census survey.
Within this infrastructure, coordination with CHILE SDI has been fundamental, mainly in the generation of a base standard for street names[23]

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

This principle has been developed mainly through the dissemination of the census territorial structure, which has a series of layers of information that make up the cartographic base of the national territory, considering for this from the political-administrative division to the levels of urban blocks and entities rural[24].

Principle 3. Common geographies for the dissemination of statistics

In the process of looking for more citizen territorial units that allow communities to understand and use statistical information, the NSO has developed a platform with 2017 census information and urban equipment at the level of NEIGHBORHOOD UNITS, which are disseminated on the NEIGHBORHOOD DETAIL[25].

Principle 4. Statistical and geospatial interoperability

The progress made by the SDI in this principle is related to two relevant areas:

1) Internal development through the creation in 2017 of the Department of Geography, a unit in charge of governance, standards and dissemination of geospatial information inside and outside the institution. In addition, in 2019 the creation of regional infrastructure units is formalized, where the deconcentration of geographical functions in regions is developed, initiating the decentralization process with a view to greater autonomy in the long term; and,
2) Active participation in inter-institutional coordination through CHILE SDI, through the adoption of geographic information standards, participation in thematic worktables and participation in the emergency committee mainly.

Principle 5. Accessible and usable geospatially enabled statistics

Since the end of 2019, the SDI has made geospatial information available through an open data platform in order to facilitate use and interoperability. In the following link access to the open geodata platform[26].

[23] https://ine-chile.maps.arcgis.com/apps /webappviewer/index.html?id=f0acf68eea8c411b9f1d270fcf53a62d

[24] https://ine-chile.maps.arcgis.com/apps/webappviewer/index.html?id=bc3cfbd4feec49699c11e813ae9a629f

[25] https://ine-chile.maps.arcgis.com/apps/opsdashboard/index.html#/ee7c8fc3d7aa421eb75380492809dceb

[26] https://www.ine.cl/herramdamientos/portal-de-mapas

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Principle N ° 5: an application of disaggregated geospatial data queries has been carried out, whose focus is vulnerable populations and places with potential concentration of people, in addition to the integration with epidemiological data of the pandemic, whose source of information is CHILE SDI[27].

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

One of the SDI's barriers to providing more relevant support to the response to the pandemic has been the inability to make all the spatially disaggregated information available to the institution given the restrictions linked to the law of statistical secret policy.

Colombia

Institution: National Administrative Department of Statistics DANE

Submission From: NSO

The Overall Implementation of the GSGF

DANE - Colombia has the MGN National Geostatistical Framework in order to promote the integration and dissemination of statistical and geospatial information, based on the georeferencing of statistical information with the corresponding geographic locations, associating statistical data to the space of the area of land that originates it.

Additionally, the MGN supports the exchange of data to obtain a more efficient production of data, and is presented as the mandatory spatial reference framework for the entities that are members of the National Statistical System in Colombia.

The general characteristics of the National Geostatistical Framework are described below:

- Covers the entire surface of the country.
- Identify urban and rural areas.
- It facilitates different levels of geographic disaggregation.
- It is constituted by the codification of the political-administrative division of Colombia, Divipola.
- The levels of geographic disaggregation have a unique identification code, which allows association with census data.
- It should be clarified that the legal support for a National Data Infrastructure to support this process is under construction.

[27] https://ine-chile.maps.arcgis.com/apps/dashboards/e8292e6a13814b6b8bcfd3415ef4eb02

Figure 5 Colombia's National Geostatistical Framework

The link to consult and download information from the MGN is available at the following link: https://geoportal.dane.gov.co/geovisores/territorio/mgn-marco-geoestadistico-nacional

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The National Geostatistical Framework is made up of administrative geographic units (departments, municipalities, municipal capitals, populated centers, dispersed rural areas, among others), mainly delimited by natural and cultural accidents, and that are identifiable in the field, with their respective coding and statistics that facilitate the process of collecting and controlling statistical information (Figure 2).

This process includes the spatial reference to the different units that make up the MGN, as well as the capture of georeferenced information through their coordinates, using GPS devices.

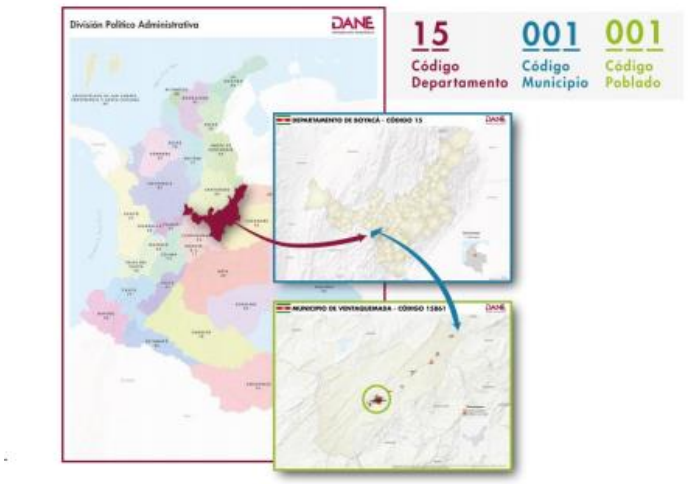


Figure 6 Structure of the geocoding environment in the MGN

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

The statistical microdata of the census operations, and some derived from the surveys, are geospatially enabled, that is, they have their georeferencing associated with the coordinates or area unit of less aggregation, for their flexible use in analysis, visualization and dissemination, supported by the implementation of processes that guarantee the statistical reserve.

Therefore, the anonymization process establishes the necessary measures to guarantee the security of the data, files and databases that contain sensitive information, to reduce the vulnerability to risks of particular identification of the source, as well as its possible destruction or alteration.

Principle 3. Common geographies for the dissemination of statistics

Implementation of this principle is ongoing. Currently, the common geographies with other sources include the main territorial levels, such as departments and municipalities, the latter as a minimum level of aggregation as common geography.

It should be noted that the exchange of information between organizations requires agreements between them to define the structures required in the exchange of data. In this sense, no methods have been established to convert data between geographies through standard conversion mechanisms (by correspondence).

Principle 4. Statistical and geospatial interoperability

DANE has a website[28] to access different geoservices and geo-viewers of information that DANE produces from its statistical operations, such as sample surveys, censuses and derived statistics. The site includes public information produced by DANE, using international standards such as Open Geospatial Consortium and Creative Commons License, to download and use georeferenced information.

DANE will continue to develop efforts to strengthen geospatial information in the production and dissemination of statistical information. Consequently, the entity will guarantee the availability of statistical information to the public and will recommend its implementation and adaptation to the National Government.

[28] https://geoportal.dane.gov.co

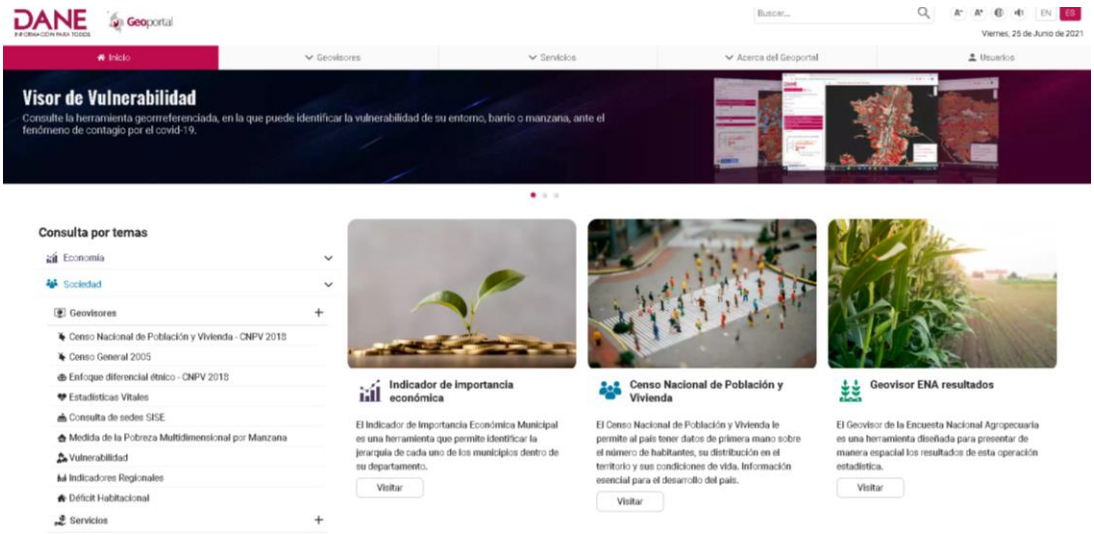


Figure 7 DANE's Geoportal

Principle 5. Accessible and usable geospatially enabled statistics

DANE has geoviewers and geographic services to facilitate the consultation, visualization and download of statistical and geospatial information, through sections classified by thematic categories. The geoviewers are easy to use and access, which allows the consultation, geo-visualization, analysis and download of robust information reaching levels of detailed disaggregation, guaranteeing access to different types of users, such as researchers, decision makers, territorial authorities and environmental , as well as the community in general.

Another outstanding product is the interactive thematic maps, generated in story map templates, for a dynamic geo-visualization, accompanied by graphics and other multimedia elements. Additionally, the DANE Geoportal has web map services, geographic metadata catalog, mobile applications for the collection and control of coverage, among others, being a support tool for the different phases of the statistical process, operating under safety and reliability standards.

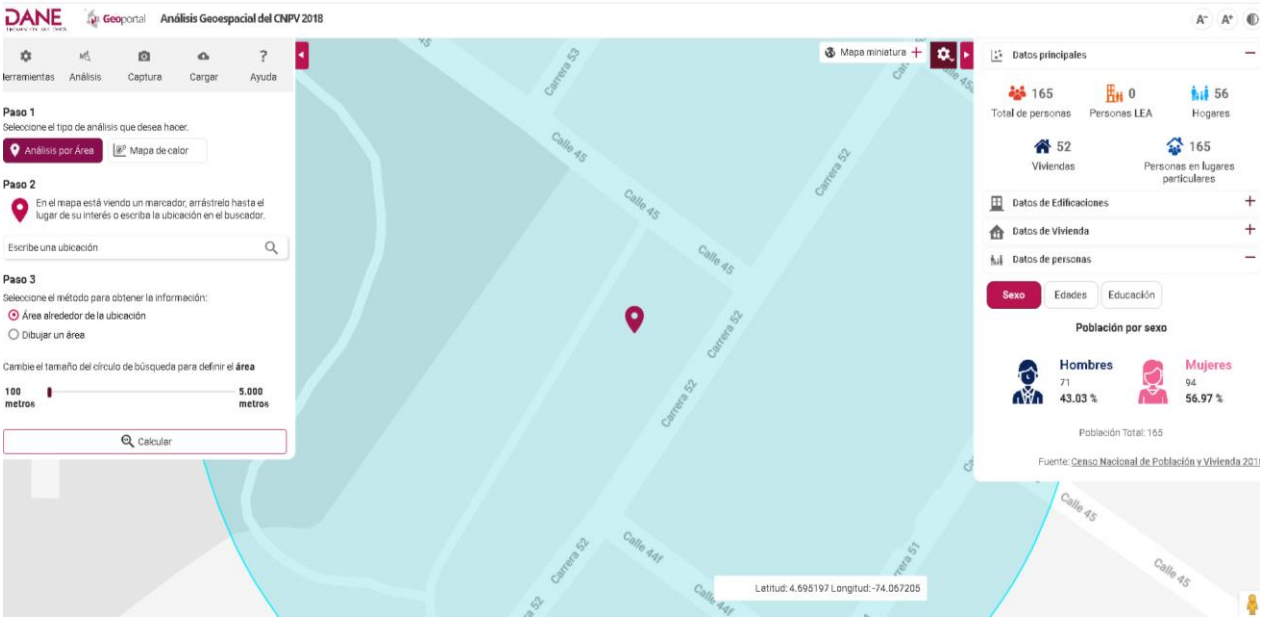


Figure 8 Geospatial analysis geovisor with information from the 2018 Population Census

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

The National Administrative Department of Statistics DANE and other government entities developed a geovisor of the vulnerability index to COVID-19[29], which allows knowing where the population is located, which due to its demographic and health characteristics could have more complications to contract the virus at a higher degree of disaggregation.

For the construction of the vulnerability index, which can be viewed at the block level of the municipal capitals, information from the National Population and Housing Census -CNPV- 2018 was used, with administrative records (the National Identification File -ANI- and the Civil Registry of Birth -RCN- of the National Registry of Civil Status; the Unique Database of Health Affiliation -BDUA-; and the individual records of health services provision -RIPS).

According to demographic variables, population comorbidities and population density, each block of the municipal capitals is located in one of the five levels of vulnerability: low, medium-low, medium, medium-high and high.

[29] https://visor01.dane.gov.co/visor-vulnerabilidad/

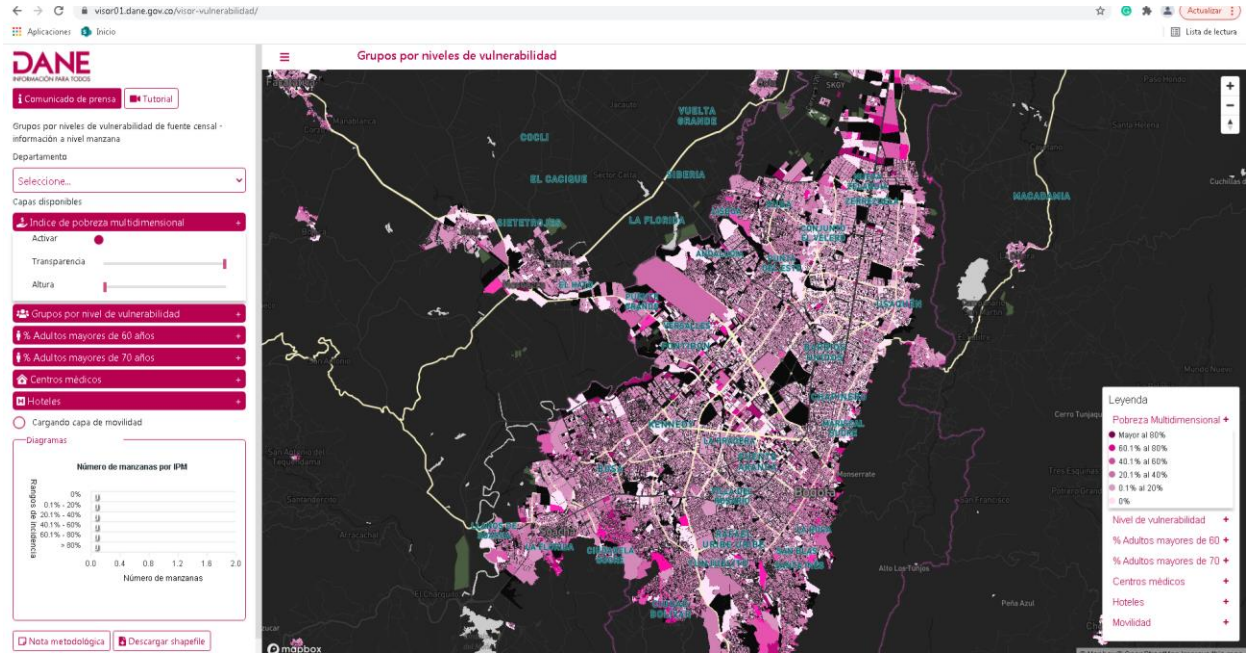


Figure 9 Geovisor of groups by vulnerability levels

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

Yes, the GSGF has supported our national response to COVID-19 to provide harmonized and standardized geospatial information.

The barriers to implementation are associated with the complexities in the use of sensitive information corresponding to the pathologies of each patient, coming from individual records of the provision of health services.

Costa Rica

Institution: National Geographic Institute / National Institute of Statistics and Censuses

Submission From: Combined NGIA/NSO

The Overall Implementation of the GSGF

The GSGF is in a fairly incipient stage of development, since as NGO and NSO are independent institutions, their mission and vision are well differentiated in their objectives by law. Isolated joint work efforts have been made at other times, but these have also been promoted by external entities such as UN-GGIM. An example of this was the collaborative work that was carried out in 2018 within the framework of the MEGA Project (Statistical and Geospatial Framework for the Americas). Where the ANIG provided the official information of the political-administrative division at the country, province and canton level, and the NSO provided data on total dwellings, total population, population by men, population by women. All data were delivered according to the standards of the MEGA Project.

In addition to those mentioned, there is a legal framework between NGO and the NSO, which is an inter-institutional cooperation agreement, in which both institutions are empowered to exchange information to further the objectives of each institution.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

At the ANIG level, the Costa Rican Spatial Data Infrastructure (IDECORI) has been created, which is legally supported by a Decree of the Republic:

> *"IDECORI will be an inter-institutional coordination mechanism of ANIG that will integrate geographic information, considering the legal framework, policies and resources of the public, private and university higher education sectors, producers and users of geographic information from the national continental and marine territory"… "Its primary objective will be to promote the management of quality data and geographic information of national interest to strengthen decision-making in all fields of public and private policy; as well as articulate, harmonize, arrange, reuse the generation of products, geoservices and publication of fundamental, thematic and general data, duly standardized, georeferenced and compatible ".*

There are also technical regulations created for the classification of geographical objects, such as the Catalog of Geographical Objects of Costa Rica and an Official Profile of Geographical Metadata for Costa Rica. To date, Costa Rica does not have a standardized coding system to give addresses in the country. Directions from landmarks known to most people continue to be used.

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

At the NSO level, a coding for disaggregated units has been implemented, which contains the codes referring to province, canton, district and Minimum Geostatistical Unit (UGM), which is a unique code for each geographic unit.

Principle 3. Common geographies for the dissemination of statistics

It has been based on what is cited in Law 9694 of the National Statistical System, which establishes in all public institutions, the publication of data at least at the level of disaggregation of province, canton and district.

Principle 4. Statistical and geospatial interoperability

This point is in an incipient phase, of methodological adaptation for the integration of statistical and geospatial data. The census is awaited for the implementation of results through geostatistical information.

Principle 5. Accessible and usable geospatially enabled statistics

Currently, only statistical and geospatial information regarding socioeconomic variables of districts with extreme poverty is associated and they are disseminated through the Information Systems and Statistical Dissemination Area.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Within the framework of the Integration of Statistical and Geospatial Information in Central America project, an exercise was carried out, where, in the framework of the COVID-19 pandemic, the ngo and NSO institutions worked together with the union of the geospatial variables and statistics that were requested in the project. The institutions that sponsored this study were the Pan American Institute of Geography and History and the UN-GGIM Americas with the support of DANE of Colombia. The NGO provided the official information of the four administrative levels of Costa Rica (Country, Province, Canton, District) and the NSO provided the statistical data of the following variables: population over 60 years of age; obese population; population with heart and respiratory problems, diabetes; population without access to drinking water, without access to sewerage; population with overcrowded housing; population density in proportion and integer.

The idea of this exercise was to calculate the vulnerability indices for each administrative unit.With the support of the institutions involved, plus the technological contribution of ESRI, a HUB was created within the ArcGis Online environment where the products and results obtained were uploaded, which were represented with Story Maps and Dashboards which in a Very interactive they showed the results obtained.

This exercise demonstrated that NGO and NSO can work in a coordinated manner to obtain results, which can eventually be used for decision-making at different levels in the country.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

The main support of the GSGF would have been in the decision-making and identification of priority geospatial units, to direct the main efforts to contain COVID-19. The main barriers that could be identified were:

- Not having up-to-date data on socioeconomic and health variables available in the country;
- Health data is administered by the Ministry of Health, which is the official institution that manages the population's health variables, therefore, access to them is not so agile to be able to use them at any time; and,
- NGO and NSO are independent institutions with particular objectives within their legal system and therefore, they must fulfil them according to their mandate. It is through coordination and cooperation mechanisms that both institutions have occasionally worked when necessary. For this, there is a cooperation agreement between both institutions.

Cuba

Institution: National Office of Hydrography and Geodesy

Submission From: Combined NGIA/NSO
National Office of Statistics and Information (ONEI)
National Office of Hydrography and Geodesy (ONHG)

The Overall Implementation of the GSGF

In our country we consider that the implementation of a GSGF would be very effective and important for decision making, giving us the possibility to carry out new work modalities, thanks to the benefits it offers us, at the moment we are working on pilot projects, case studies with the aim of preparing and being able to implement an Integrated Geospatial Information Framework. In addition, we all know that geospatial information provides a unique perspective to analyse events and processes that take place on a territory, allowing each event to be located in its geographical position, which is essential to establish relationships between processes and support decision-making. The new technologies of spatial information provide precise, detailed and fast information of great utility for the evaluation of situations and the management of resources.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

In the country, the principles of the GSGF are being developed with the objective of facilitating the implementation and use of the reference of statistical units. For which several procedures are being used to obtain its geolocation:

- Census / statistical geographic areas;
- Cadastral plots;
- Geographies of the administrative political division; and,
- Georeferenced constructions / buildings.

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

As mentioned in the previous question, the country is in the process of designing and creating a National Geostatistical Framework, as well as the creation and implementation of the National Geostatistical Framework, it will allow the integration of data from a wide variety of information, such as statistics, socio-economic, environmental and demographic.

Incorporating these data, using geospatial processing, can generate new geospatially-enabled statistical variables and indicators for analysis.

Principle 3. Common geographies for the dissemination of statistics

Work continues on strengthening the updating of the various geographic areas (thematic layers) in the national cartographic agency and other institutes and organizations producing specialized cartography that will strengthen the process of integration, analysis, interpretation, visualization and dissemination of information.

Principle 4. Statistical and geospatial interoperability

This principle calls for the use of internationally adopted standards and good practices from both communities to enable greater interoperability of statistical and geospatial data, standards, processes, and organizations.

Still in our country it is necessary to improve the definition, access and use of geospatially enabled data. To achieve interoperability of data, it is necessary to eliminate obstacles and define policies and legislation that facilitate and promote cooperation between the different actors.

Principle 5. Accessible and usable geospatially enabled statistics

At the moment there is a national SDI and several institutional SDIs that provide information, but their development and use must be encouraged. The ONEI has designed an application where Census information is disseminated, requiring further development in other areas of information beyond demographic, with the aim of greater dissemination of statistical information from geospatial web services.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

As explained above, the GSGF is being developed in our country, because its implementation would bring many benefits to our work, in any case, our country created a geoinformatics platform called Andariego Higia to face health disasters which is aimed at give a quick response of geo-referenced geographic information for the analysis of impacts of this type, which facilitates decision-making by the Government at different levels.

For the management and analysis of epidemiological information. The Andariego Higia Web GIS for the management of epidemiological files and other related information is personalized on the Andariego Fénix platform, which has the technology for creating dynamic models in real time. This allows the user to model concepts in the system, as well as easily adapt to future changes. In particular, it is configured for the management of information concerning the development of the Covid-19 disease in Cuba. The main interface of the system allows access to the different functionalities that facilitate, among others, the management of: people, epidemiological files, suspicions, confirmed cases, post-hospital surveillance, investigations, vaccine consent, EA Vaccine Survey, EAG notification to CECMED, Hospitals, Health Areas, Clinics, Specialized Centers and Isolation Centers.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

Having already created a Global Geostatistical Spatial Framework, faster and more effective decisions could be made, but nevertheless our country continues to prepare to implement a GSGF with the help of you and your experiences.

Dominican Republic

Provided responses from both the NGIA and NSO.

National Statistical Office

Institution: National Statistics Office (ONE)(NSO)

Submission From: NSO

The Overall Implementation of the GSGF

Our country has not implemented the GSGF, some efforts have been made for its implementation but it has not been possible.

Yes, the statistical data is linked to the geospatial, which allows us to make comparisons at all territorial levels, from region to neighbourhoods or places, exchange data through the interoperability of statistical and geospatial information between institutions, but a framework Generally, as such, we do not have.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Spatial information is geocoded according to the official territorial distribution, allowing integration with statistical data at the national level.

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

The data are spatially linked, using territorial units as a basis, so that the specific coordinates of where the data occurred can be obtained

Principle 3. Common geographies for the dissemination of statistics

The common geography for statistical distribution and dissemination that we use are administrative areas.

Principle 4. Statistical and geospatial interoperability

Statistical data are perfectly linked to spatial information through the standardization of territorial units.

Principle 5. Accessible and usable geospatially enabled statistics

In accordance with good practice standards, statistical data integrated into spatial information is easily accessible through our data sharing means.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

It has been possible to carry out analysis to identify areas of great impact of COVID-19, allowing the mitigation of those areas.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

Although we do not have a GSGF, as such, with the progress made we have been able to provide valuable information so that the government can respond to the population and attack COVID-19 from its different environments.

National Geospatial Information Agency

Institution: National Geographical Institute Jose Joaquin Hungria Morell

Submission From: NGIA

The Overall Implementation of the GSGF

Within the Statistical and Geospatial Framework of the Americas (MEGA), the José Joaquín Hungary Morell National Geographic Institute (IGN-JJHM) has provided the coverage of administrative political limits at the national, provincial and municipal levels and their link with the demographic data defined jointly for all countries that have assumed the MEGA.

The existing institutional relationship between the IGN-JJHM and the National Statistics Office (ONE)(NSO), as technical bodies attached to the Ministry of Economy, Planning and Development, currently facilitates and impels the efficient implementation of the GSGF, through joint work.

In the same order, the IGN-JJHM and within the facilities and opportunities offered by the Spatial Data Infrastructure, considers as a fundamental part of its implementation to incorporate and consider the standardization of statistical data, alliances between instances for the access and use of administrative records, reliability agreement for focused disclosure within SDI services.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The José Joaquín Hungary Morell National Geographic Institute (IGN-JJHM) is currently executing with technical assistance from the World Bank and funds from the European Union, in which several initiatives converge. Among them: elaboration of a national geographic information policy, definition of fundamental data (administrative political limits, addresses and postal codes, cadastral information, among others), quality model, catalog of objects and representation, updating of the Dominican Profile of Metadata.

In order to maintain coherence with the ONE(NSO), for the coding of geographic objects and their representation, and their consequent organization within the quality model, we have adopted the codes already established and made them official, this has helped maintaining and optimizing the connection between both instances.

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

Result of the cataloguing of objects based on the ISO 19110 Geographic Information standard, the IGN-JJHM promotes and promotes the management of data in a secure and interoperable way. Likewise, the

political-administrative units of municipal districts, sections and places will be included to achieve, through a greater disaggregation of the data, to have more real, exact and reliable information.

Principle 3. Common geographies for the dissemination of statistics

Within the attributions of the IGN-JJHM, it appears the one to elaborate the official map of the country and the concern to the political and administrative limits. In this sense, work is being done on the revision of its geometry, jointly with the governmental instances whose responsibilities are framed in a geographic space of a sectorial scope. Likewise, a base cartography project has been submitted at a scale of 1: 25,000 and 5,000, in order to count and have disaggregated data for greater usability in the institutions.

Principle 4. Statistical and geospatial interoperability

One of the most significant initiatives that we are executing is the elaboration of the methodological guide for the creation of the geographic gazetteer, supported within the technological infrastructure of the integrated SDI as well as its services to citizens, in an environment of interoperability, access and visualization. This tool facilitates the incorporation of geocoded statistical data.

Principle 5. Accessible and usable geospatially enabled statistics

In the formulation of the national geographic information policy, the implementation of the standardization of geospatial data management processes is contemplated to achieve better levels of quality and interoperability, promoting governance mechanisms for inter-institutional articulation, in a political and legal framework. that governs the organization, procedures and agreements for the management of geospatial data.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Since April 2020, the IGN-JJHM, through the NGO Arcoiris, hired by the Ministry of Health and its General Directorate of Epidemiology for the geolocation of COVID-19 cases, has been working on the registry of cases contagion and in the process of incorporating the data to institutional portals[30].

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

The existence of a link between the demographic data of the geocoded territorial localities would have meant greater efficiency in responses and interventions, facilitating the identification of the most exposed and vulnerable areas, allowing a better targeting of control measures, greater efficiency in assistance to those affected and better follow-up and monitoring of the development of the virus.

Traditionally, the weakness and / or absence of inter-institutional and inter-sector coordination for the access and availability of data and information is evident, which has signified one of the obstacles with the greatest impact on the effective execution of initiatives that require a joint response from the authorities.

[30] https://datos-publicos-coronavirusrd.hub.arcgis.com

Currently the IGN-JJHM leads a proposal for an agreement with the Ministry of Health through the General Directorate of Epidemiology to form an alliance, in order to share and access the administrative records of infectious-contagious diseases, so that data is available associated with territorial demarcations.

NB: The documents referenced are in the development phase. The scheduled date for their conclusion is in the month of September of this year, and they will be available on the SDI-RD page.

Ecuador

Institution:	Military Geographical Institute (IGM), National Institute of Statistics and Censuses (INEC)
Submission From:	Combined NGIA/NSO

The Overall Implementation of the GSGF

In Ecuador, we are in an early stage of implementation, with the first conversations about the GSGF among stakeholders. Such is the case that in 2018 the first technical assistance workshop was held to strengthen the use of geospatial and statistical information in decision-making and Public policies on the Framework with the collaboration and technical assistance of ECLAC and the participation of the main State entities that generate geoinformation and / or related to statistics. INEC has been working on a project to implement a National Geographic - Statistical Framework, in which various aspects of the GSGF have been considered; mainly considering the good practices acquired over the years.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The production and dissemination of Geographical information of the territory is guided by the provisions of the Geographical Framework Data of Ecuador (detailed by Executive Decree): https://iedg.sni.gob.ec/geoportal-iedg/documentos/matriz_datos_geograficos_marco.pdf

The production of statistical data, including geospatially enabled statistical data geocoded at the block and census building level, this information is georeferenced and coded according to the territorial organization of the country (province, canton, parish) and the statistical divisions (zone, sector and block): https://www.entaciónrencifras.gob.ec/institucional/home Currently the country does not have an address standard, however the use of global address systems has been explored.

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

Ecuador's statistical information is geospatially integrated by linking to a unique code, according to the level of disaggregation of statistical operations. Territorial organization (province, canton and parish) and the statistical units (zone, sector, block and building), which are coded. The information is stored in databases and geographic databases (Figure 10).

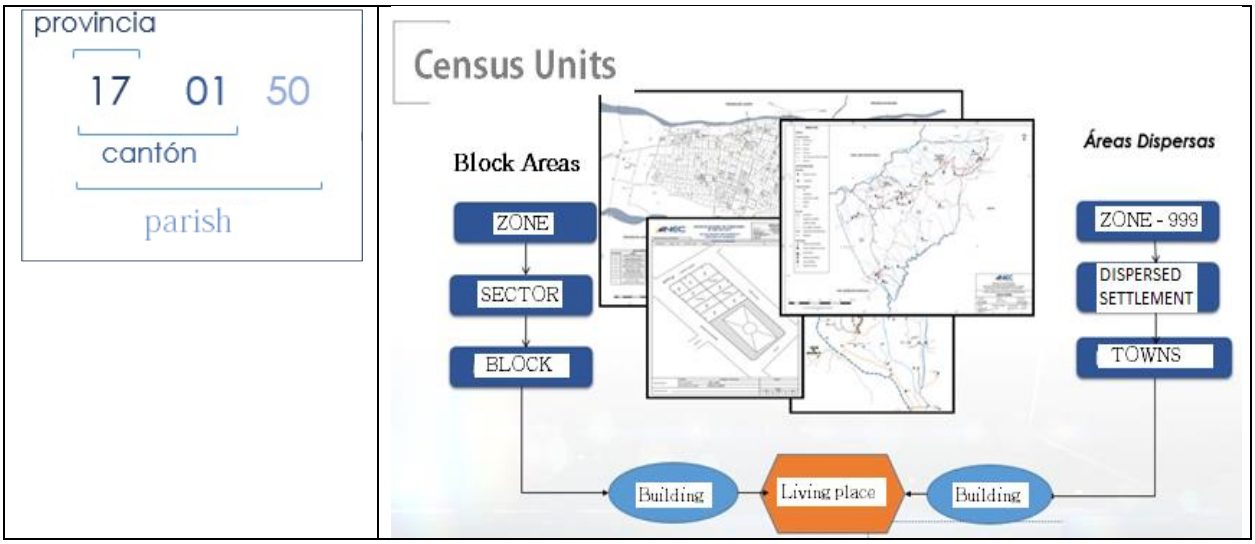


Figure 10 Geocoding statistical records

Principle 3. Common geographies for the dissemination of statistics

Administrative Geographies are used. The official information provided by the National Committee of Internal Limits (CONALI) is used, for the dissemination of statistics the territorial organization of the state (province, canton and parish) is used. Regarding methodologies, statistical operations enable the dissemination of methodologies through an official website. Figure 11 illustrates Ecaudor's Multipurpose Survey Source: *https://www.entaciónrencifras.gob.ec/encuesta-nacional-multiproposito-de-hogares*; and Poverty: *https://www.entaciónrencifras.gob.ec/pobreza-dic Diciembre-2020.*

Figure 11 Ecuador's Multipurpose Survey and Poverty Resources

With regard to metadata, they are currently generated according to the Ecuadorian Metadata Profile (PEM) in Geonetwork. Source: https://iedg.sni.gob.ec/geoportal-iedg/documentos/perfil_ecuatoriano_metadatos_pem.pdf. These are augmented by documented internal quality controls.

Principle 4. Statistical and geospatial interoperability

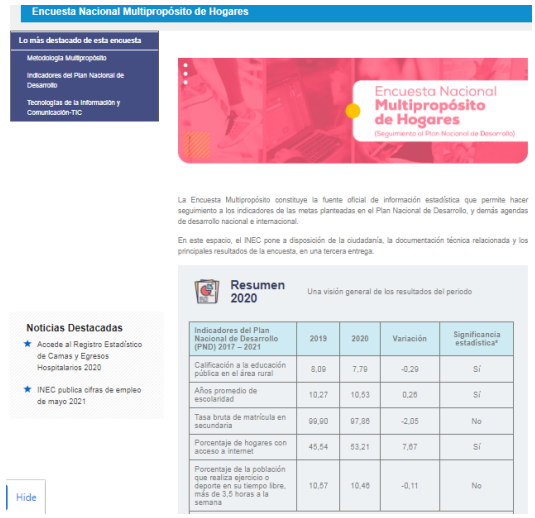
Regarding the geospatial field, work has been done since 2004 with the creation of the National Council of Geoinformatics (CONAGE), whose main objective is the creation, maintenance and updating of the Ecuadorian Geospatial Data Infrastructure (IEDG) (Source : *https://iedg.sni.gob.ec/geoportal-iedg/inicio.html*). The IGM is a member of the Coordinating Committee and Technical Secretary of CONAGE.

In the Geographic field, several technical, legal, and organizational aspects have been defined that help in interoperability, such as the establishment of the National Geospatial Information Policies (Source: *https://iedg.sni.gob.ec/geoportal-iedg /documentos/Estandares_de_informacion_geografica_cap1.pdf*) and various technical documents that can be reviewed here: *https://iedg.sni.gob.ec/geoportal-iedg/biblioteca.html*

In the statistical field, INEC is currently building its interoperability structure in accordance with the geospatial policies established by the IEDG. Since 2020, it began with a diagnosis to implement an institutional IDE, and this year we are working on the implementation of the Geoportal.

Principle 5. Accessible and usable geospatially enabled statistics

In the statistical field, INEC is currently building its interoperability structure in accordance with the geospatial policies established by the IEDG. Since 2020, it began with a diagnosis to implement an institutional SDI, and this year we are working on the implementation of the Geoportal. It is available through the official INEC website https://www.entaciónrencifras.gob.ec/estadisticas, published statistical information and geographic - statistical information (Source: https://www.entaciónrencifras.gob.ec/geografia-estadistica) in different formats, databases, methodologies, and other relevant information.



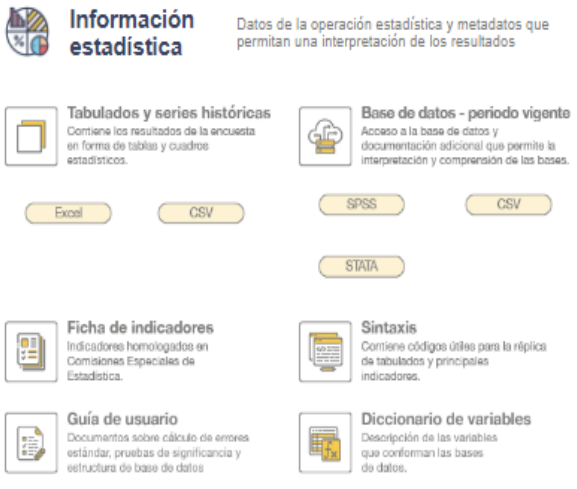


Figure 12 Ecuador's Dissemination of geospatially enabled economic statistical data.[31]

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

In Ecuador, the GSGF has not yet been implemented and we hope it can be done very soon; however, its importance in decision-making is understood.

It is worth mentioning that at the beginning of the pandemic, INEC collaborated with the Emergency Operations Committee (COE), in the generation of a vulnerability index. In addition, it was part of the situational room in conjunction with the IGM and other Institutions in which information regarding the health emergency that served for decision-making was analyzed.

The IGM, developed several applications with the philosophy of an SDI for monitoring the pandemic; but due to the sensitivity of the information, these are NOT for public use.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

If the GSGF were implemented at the national level, it would have been possible to collect and access information more easily, in order to be able to make decisions more efficiently. Having a more disaggregated implementation of the GSGF would help make better decisions.

[31] https://www.ecuadorencifras.gob.ec/encuesta-nacional-multiproposito-de-hogares/

Egypt

Name of Agency: Central Agency for Public Mobilization and Statistics (CAMPAS)
Submission From: NSO

The Overall Implementation of the GSGF

Egypt is working on establishing a National Spatial Data Infrastructure NSDI to unify the Basemap of Egypt in scale 1:2500 (using a recent Arial photos and satellite images for 125,000 Km^2 of built-up areas) linked with the statistical and detailed data of all the governmental Agencies in Egypt taking INSPIRE (European Union spatial data infrastructure) as an experiment.

In addition, all the geographical spatial data and statistical data in Egypt are identified with the smallest geographic boundary (Shyakha (Urban) - Village (Rural)). Currently Egypt is working now on putting a mechanism how to unify the administrative boundaries by formed a committee consisted of the agencies which are responsible for administrative decisions.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

CAPMAS has been finished of establishing a National Grid system with projection MTM-WGS84 (Modify Transfer Mercator) which will be used to generate a unique numbering and geocoding system for each unit in a dataset, such as a building, household or establishment.

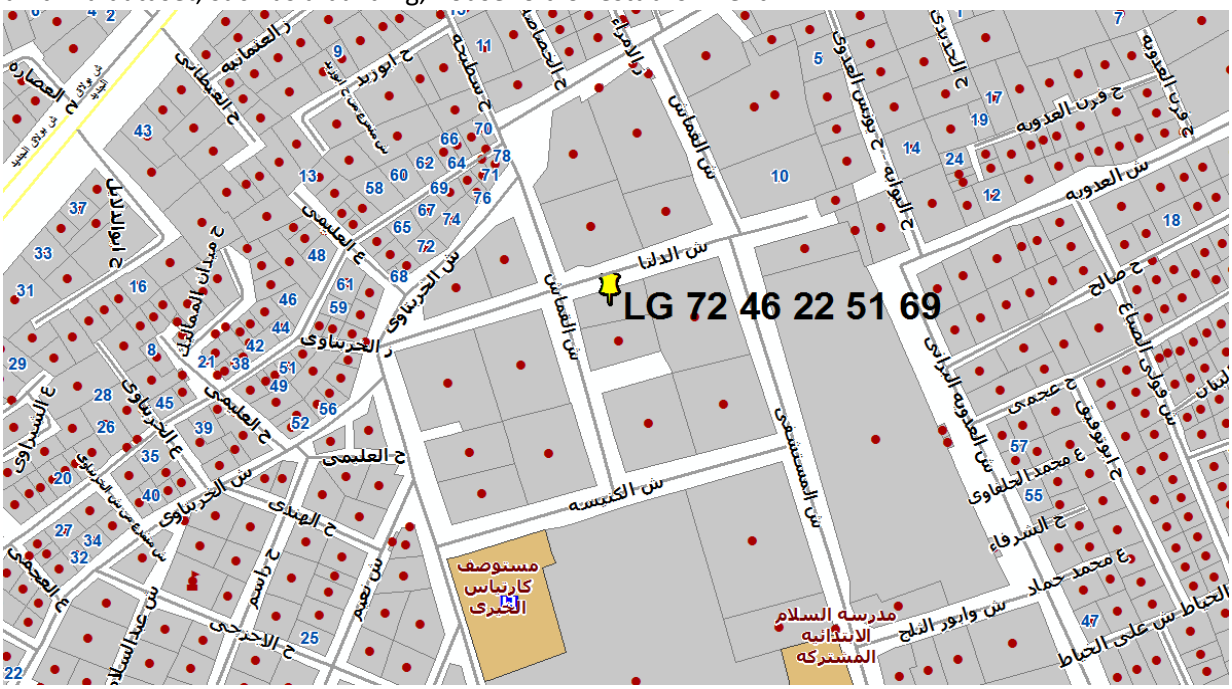


Figure Geocoding Unit Records

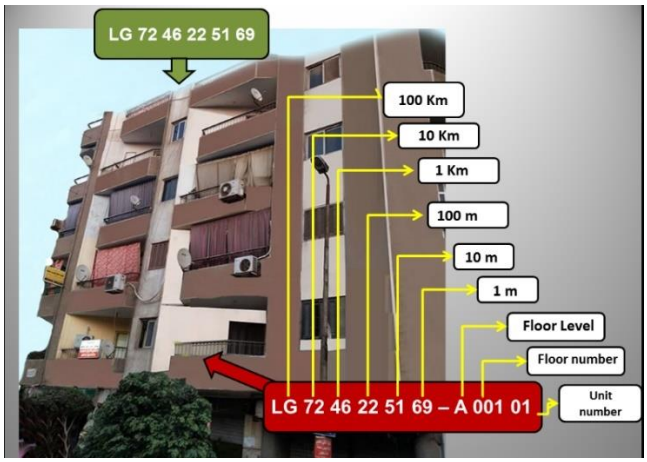


Figure 13 Creating Unique Identifiers for Buildings

Figure 14 Unique Identifier: "Unit Spatial Services Number"

Also, the Egyptian government under the leading of prime minister and CAPMAS as a main member are studding now how to create a unique identifier depending on the geographic location for all buildings over all Egypt to use it as national building ID.

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

All the geographical spatial data and statistical data are identified with the smallest geographic boundary (Shyakha (Urban) - Village (Rural)), and we had finished to make the integration and management of the geocode within dataset including spatial number identifier and the unique census number to join the detailed statistical building, household and business data of census 2017 .

Principle 3. Common geographies for the dissemination of statistics

One of the most important role of the NSDI is to unify the administrative geographic boundaries between all the Egyptian governraes, beside the mechanism of the map conflation for all spatial and attribute data existing in the governmental agencies to link with the base map of Egypt.

Principle 4. Statistical and geospatial interoperability

Egypt statistical and geospatial data operated metadata capabilities. Egypt applies standards for statistical and geospatial data, and agrees with Australia on the need to seek international agreement.

Principle 5. Accessible and usable geospatially enabled statistics

Egypt uses Open data policies and principles, and also after building and publishing the NSDI portal all the data will be accessed using Web services to enable dynamic accessing the to the geostatistical data.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

A field research was conducted on the impact of COVID_19 on the business sector, the data was linked up to the layer of the administrative boundaries of the second level (Qism/Marzas).
It was found that many sectors were affected by this pandemic, the most important of which is the industry, trade and temporary employment sector, which was the first affected sectors.

Finland

Name of Agency: Statistics Finland
Submission From: Combined NGIA/NSO

The Overall Implementation of the GSGF

Statistics Finland and National Land Survey of Finland have been fostering one-to-one collaboration on improving interoperability of statistical and geospatial domains for many years. The ultimate purpose of the collaboration is to avoid overlapping work, save costs and improve quality of services for customers.

However, a more wide-spread and permanent impact on the integration and improved interoperability of geospatial and statistical domains requires calling upon all national key players to coact. Thus, a national network for integration of statistical and geospatial data was initiated in early 2021. All the primary goals identified for the network collaboration are aiming at improving interoperability of statistical and geospatial domains. Hence, the network will be focused at working with concrete issues and overcoming barriers that are central topics for implementing all the GSGF principles too.

Since the successful implementation of INSPIRE and national base registers Finland already has a stable and wide-spread information infrastructure for maintenance and dissemination of geospatial and statistical data. This infrastructure is being utilised for fostering the implementation the GSGF principles in practice. For the moment we have not yet analysed the implementation status of each GSGF principle separately, and therefore we cannot reply specifically to section C. However, this work will be carried out by the national network.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Voluntary, cross-organisational national collaboration was started by GI experts in Finland on March 2020. Statistics Finland and National Land Survey of Finland participated that work by offering their GI-expertise and collegiate network in the work. National data sources and services were discussed and new approaches were innovated.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

Geospatial view point was not specifically noted by the Statistics Finland's corona working group. Readiness to utilise mobile network operator data (MNO) was not established at the time, due to non-existing data flow (no valid agreements with operators). This was partly corrected during the covid-19.

Germany

Name of Submitting Agency:	Federal Agency for Cartography and Geodesy
Submission From:	Combined NGIA/NSO

The Overall Implementation of the GSGF

The German national infrastructure for the integration of statistical and geospatial information - National recommendations based on an analysis of the Global Statistical Geospatial Framework. We have a MoU between the Federal Statistical Office (NSO) and the Federal Agency for Cartography and Geodesy (NGIA) since 2016.

Together with the Federal Agency for Cartography and Geodesy (BKG), the Federal Statistical Office (Destatis) has analysed and assessed the requirements and recommendations of the European Implementation guide for the Global Statistical Geospatial Framework (GSGF) in order to evaluate the situation in Germany and derive recommendations for action.

The evaluation of the five GSGF principles has shown that many requirements and recommendations of the European Implementation guide have been implemented or are currently being implemented in Germany. This survey is only accomplished on the federal level and has not been filled out in conjunction with the Länder.

The answers to this survey are captured from a joint document made by BKG and Destatis describing the evaluation of the situation in Germany. Actually this document is being translated into English language. As soon as it is available it will be disseminated if desired.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

It can be stated that almost all recommendations concerning Principle 1 “Use of fundamental geospatial infrastructure and geocoding of statistical information” are being implemented or have been implemented.

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

There are still things to do regarding Principle 2 “Geocoded unit record data in a data management environment”

Principle 3. Common geographies for the dissemination of statistics

A major part of the requirements of Principle 3 “Common geographies for production and dissemination of statistics” is being implemented together by BKG and Destatis.

Principle 4. Statistical and geospatial interoperability

There are still things to do regarding Principle 4 “Statistical and geospatial interoperability - Data, standards and processes”.

Principle 5. Accessible and usable geospatially enabled statistics

More comprehensive action is required with respect to Principle 5 "Accessible and usable geospatially enabled statistics".

Ghana

Name of Agency: Ghana Statistical Service
Submission From: Desk Review from ECA

The Overall Implementation of the GSGF

Ghana is in the process to develop the National vision for the implementation of GSGF. Some components of GSGF, were implemented during the 2021and the DHS Ghana: 2019, 2017, 2016, 2014, 2011, 2008, 2007, 2006, 2003, 2002, 1998, 1993 and 1988.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The Use of fundamental geospatial infrastructure and geocoding in the 2021 Ghana census has been noticed in the planning of urban land use patterns. Establishing boundaries of localities, constituencies, districts, and regions. Identifying localities and districts with boundary issues to seek the appropriate resolutions as well as the identification of new localities. The integration of population data with maps for geo-spatial analyses has been undertaken. Equally geocoding has enabled the identification of deserted or collapsed localities. It has facilitated population the identification density by locality, district, and region for urban planning as well as estimating the number of people displaced by natural disasters.

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

Geocoding of Housing unit location (Dwelling Frames, Housing Footprints), collective living quarter locations (Dwelling Frames, Housing Footprints) a set of digital enumeration area maps or derived dissemination units, which are designed to enable the production of all output products that will be disseminated to government departments and the general public.

Geocoding of Geographic boundary files in a digital format for all statistical reporting units for which census indicators will be tabulated. Listings of all statistical and administrative reporting units, including towns and villages, their variant names and geographic coordinates. Geocoding of Geographic equivalency files that indicate how current reporting units relate to those used in previous censuses, or how one set of reporting units relates to another set as well as the Geocoding of vector layers containing feature data, such as landmarks, roads, schools, hospitals and clinics, which can be used when analysing population data spatially. Geocoding was used to determine the Centroid files that provide a representative geographic point reference for each reporting unit. It also provided for gazetteers that provide geographic coordinates for all population settlements and other important geographic features in the country

Principle 3. Common geographies for the dissemination of statistics

A spatial geographic database, with polygonal and attribute information for the enumeration areas of the country (i.e., 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 can be released at the EA level or aggregated into new small-area dissemination units, such as population clusters

Principle 4. Statistical and geospatial interoperability

A library of digital administrative boundaries, ranging from the provincial to the municipal levels (perhaps even at the level of the land parcel). Digital census atlases, dynamic atlases and spatial analysis techniques have been deployed

Principle 5. Accessible and usable geospatially enabled statistics

Know the ease of accessibility (geometry, perimeter, compactness) within districts as well as the dentification of gaps and overlaps of the already existing district and locality boundaries.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

GSS has used geospatial information technology to develop the Ghana Government Covid-19 Tracking App. Principles 1, 2 and 3 were particularly useful to develop the Ghana national mobility patterns between densely populated settlements, which estimate the amount of travel between these locations using data on the size of population of the locations and the distances/travel time between them.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

To respond to such crisis situations in the future, GSS would like to have current and detailed national cadastre data in order to link Geospatial information with ownership information.

Honduras

Name of Submitting Agency:	Property
Submission From:	Combined NGIA/NSO

The Overall Implementation of the GSGF

The implementation of the GSGF has materialized from the integration of demographic and Cartographic information at the National at the Departmental and Municipal geographic levels, and regionally through the MEGA project. Nationally, the GSGF supports the National Geostatistical Framework National Statistics Census.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Interoperability has been achieved between statistical and geospatial data for the national, departmental and municipal levels.

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

At the country level, geocodes have been established that allow us to link geospatial information with statistical information, achieving the use of information at the departmental and municipal levels, which facilitates the linking of data on housing and People classified by gender.

Principle 3. Common geographies for the dissemination of statistics

For the administrative level, it is used at the departmental and municipal level.

Principle 4. Statistical and geospatial interoperability

The responsibilities of all institutions that handle statistics with data and information are defined by the National Institute of Statistics and there is a web page https://www.ine.gob.hn/V3/baseine/ that consolidates the data at the national level , departmental and municipal; In addition to this, there is also the Microdata Laboratory.

Principle 5. Accessible and usable geospatially enabled statistics

Within the framework of the MEGA project and the creation of the COVID-19 vulnerability index, the geodatabase integration has been carried out and information has been prepared for publication, which will allow access and use of country data.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

The support has been at the municipality level, the covid 19 vulnerability index has been calculated, with the use of the ARCGIS SERVER technological tool, which supports the publication of data for dissemination of results.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

The integration of statistical, health and geospatial information has been achieved until reaching the municipality level and we have as a challenge to reach a block level when there is availability of geospatial and health data available, which can be integrate with existing data at the statistical level.

India

Name of Agency: Ministry of Statistics and Programme Implementation

Submission From: NSO

The Overall Implementation of the GSGF

GSGF, as a framework, has not been implemented in India. However, it is observed that some of the principles of GSGF have been followed while geo-coding statistical information. Further detail on India's approaches to the integration of statistical and geospatial information are detailed within the relevant Annex on Page 121.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

NSDI in consultation with Geospatial Information Sectional Committee of Bureau of Indian Standards (BIS) (designated as LITD -22) has been involved in framing of relevant national geospatial data and process standards. LITD-22 has been the National Mirror Committee of ISO for developing and publishing the standards. Some of the Geospatial BIS Standards framed/ cobranded are IS 16439:2016 – Metadata standard for Geospatial Information, IS 16626:2017 –Geography Markup Language (GML), IS16699: 2018 -Web Map Server Interface (WMS), IS 16967:2018 –GI -Location-based Services –Tracking and Navigation, IS 16968:2018 –GI –Location-based Services –Multi-modal Routing and Navigation and IS 16970:2018 –GI –Rules for Application Schema. As of now, all agencies are recording the geo-codes of the surveyed location for spatializing the information.

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

Different agencies in India are working in a complementary manner towards collection of geo-coded information in their surveys, that allows for information to be integrated with other data.

Principle 3. Common geographies for the dissemination of statistics

Most of the agencies are using administrative boundaries for the dissemination of statistics. The maps on the administrative boundaries as released by Survey of India, the national mapping agency, are adopted for dissemination.

Principle 4. Statistical and geospatial interoperability

No specific examples of implementation

Principle 5. Accessible and usable geospatially enabled statistics

All datasets are released in the public domain by the Source Agencies. In addition, many Ministries/Departments of Government of India have developed various Geo-portals for data sharing, services and strengthen the E-learning process.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

In the context of COVID-19, agencies are integrating data from multiple sources for operational intelligence.

- Aarogya Setu, mobile application has been developed by the Government of India for real time tracking of COVID-19 infected patients. The App is being used in contact tracing of the suspected COVID-19 cases, reducing time and error in manual identification, helping the Government to take necessary timely steps for assessing risk of spread of COVID-19 infection, and ensuring isolation where required.
- NDMA (National Disaster Management Authority) has developed a dashboard that helps in keeping the track of the number of cases of COVID-19 reported in the country. The dashboard showcases the total number of cases reported in India as well as the world. It also brings the number of cases reported and the ones that resulted in the death of the patient.

- The National Mapping Agency SOI, under the Department of Science and Technology has updated its portal (www.indiamaps.gov.in/soiapp/) as the core of the integrated geospatial platform to address COVID-19 outbreak and its socioeconomic impact. For required data collection pertinent to COVID emergency management, the SAHYOG mobile app, developed and managed by SOI has been customized to collect COVID-19 specific datasets through community engagement to augment the COVID-19 response activities by Government of India.

Indonesia

Name of Agency: Badan Pusat Statistik (BPS), Statistics Indonesia
Submission From: NSO

The Overall Implementation of the GSGF

Mapping process usually takes place every 10 years right before the next census. In 2009, the delineating of the Enumeration Area (EA) was conducted using "traditional method" in which it is manually sketched in A3 paper by an appointed officer. This mapping process will only be updated as needed from time to time.

Before 2019, BPS had been producing a digital map at a village level only. This map had been used for dissemination purposes. In 2018, BPS recognized the GSGF as a framework for integration between geospatial and statistics. In the same year, we conducted a thorough planning for the Field mapping process in 2019. Different from the previous mapping process, in 2019 Geospatial technologies were implemented in the whole process.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

There are two types of statistical units enabling geospatial infrastructure for census and survey activities; Census Blocks as EA's and households. These units are presented as polygon boundaries and point coordinates respectively.

A census blocks boundaries derived from one or multiple local neighborhood areas in order to obtain a homogeneous number of buildings. The delineation process of census blocks is initiated by identification process on the field using GPS and Android application namely "WILKERSTAT BPS", before then processed in a desktop software and satellite imagery to obtain the digital map of census blocks.

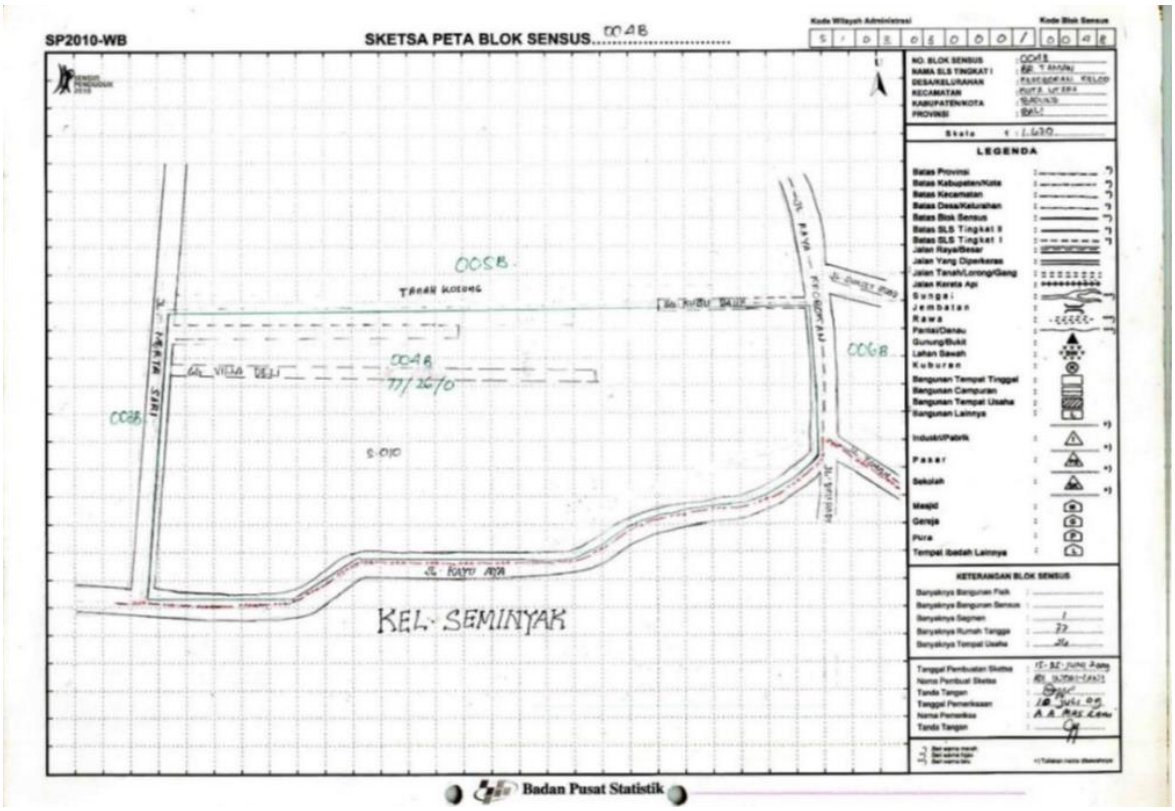


Figure 15 Enumeration by the "Traditional Method" A Sketch Map

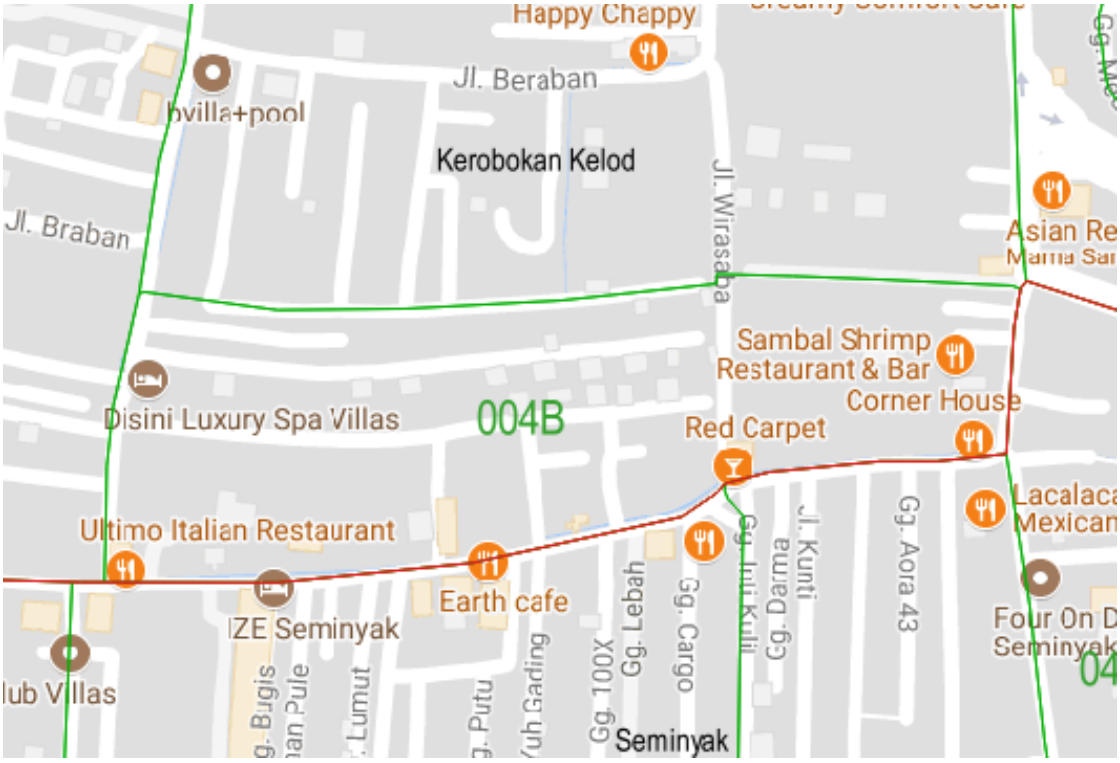


Figure 16 Digital Enumeration

Population census 2020 was initially planned to be conducted using Computer-Assisted Personal Interviewing (CAPI) method but eventually resorted to Paper-and-Pencil (PAPI) as the result of budget

cut off for pandemic handling measures. Hence, instead of obtaining the coordinate location of each building, the area was imposed to be drawn on a paper map. As a result, in 2021, all building locations on the paper map have to be digitized using desktop software. However, point coordinates of statistical units for economic statistical data such as hotels and tourist attractions have been collected since 2019.

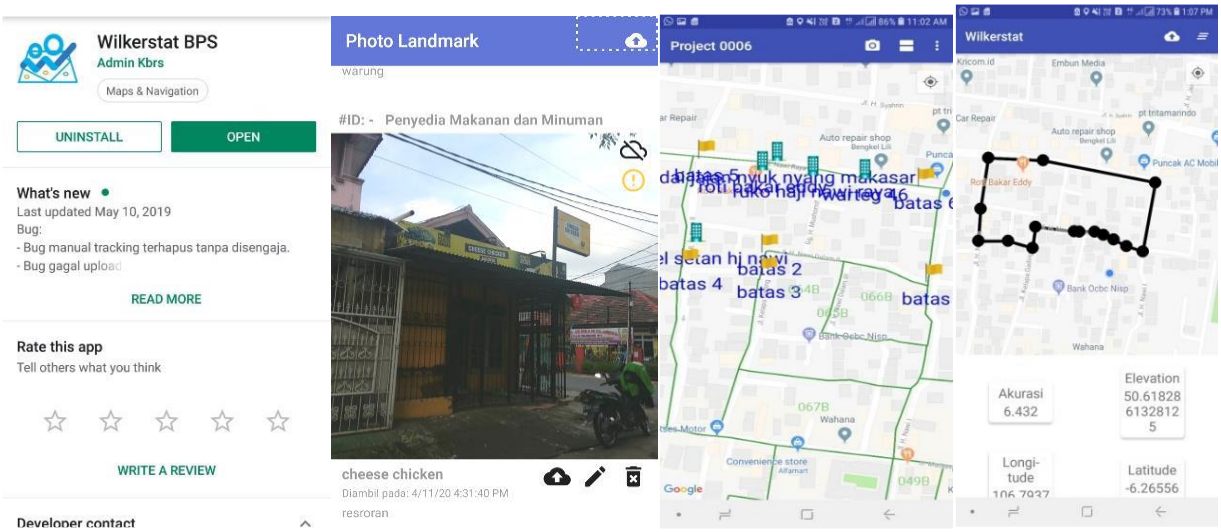


Figure 17 Android application for field mapping process

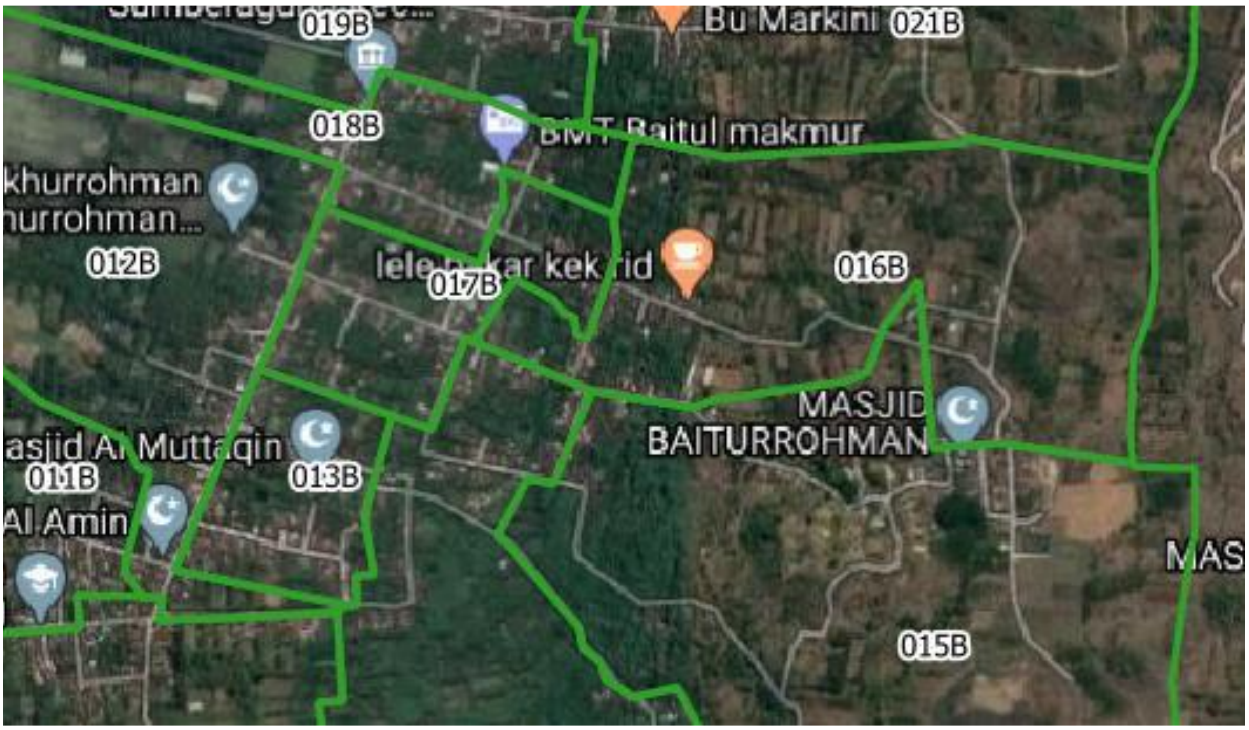


Figure 18 Subset of Census Block Map

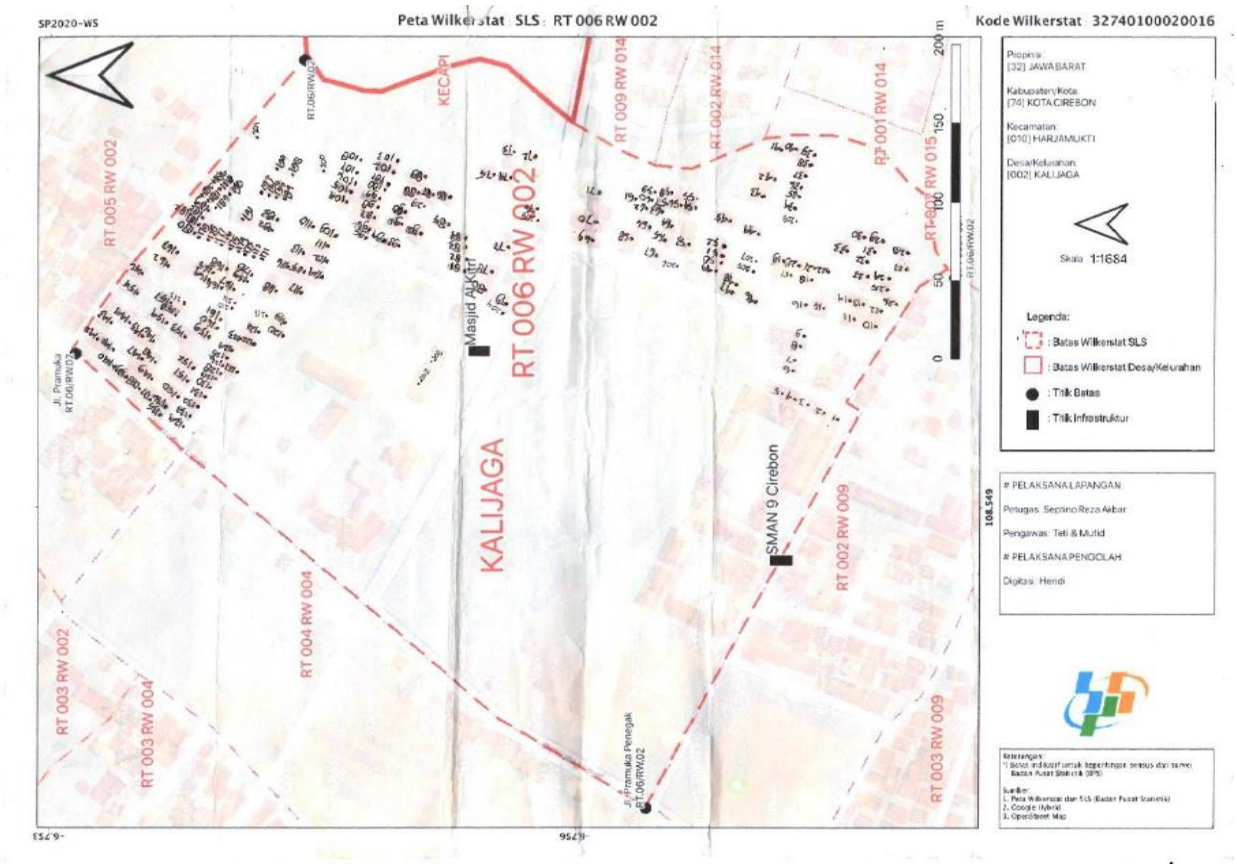


Figure 19 Building points on a paper map

Figure 20 Building points after digitalization

Figure 21 Other statistical units for economic statistical data

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

All geocoded units have a standardization in both geometry and the attributes which can't be overlapped. The quality control process of these standards is conducted using a Geospatial System. This system is used internally for delivering geospatial data from the branch offices and for quality control of the data. The quality control is processed automatically by the system using a background processing.

The geometry error such as gaps and overlaps will be marked by the system, as well as for non-standard attributes such as unmatched IDs to the master.

A tiered approval mechanism is implemented in this system, once the data is approved by Headquarter it automatically stored in the final database and produces a geospatial service for other platform consumption. In addition to that, standardized area code in every level of administration enables data to be linked with one another. These area codes are managed in such a way that changing area boundary due to new administration, splitting administration, or a merge of administration will be systematically recorded and new area code will be generated using the same standard. These records will facilitate history tracking of these changes.

For instance, sub-districts in Y city are numbered as such: 010, 020, 030, 040, 050, and 060. If in the future area X with code 030 is to split into two new areas, the new area may have the number 031. This is possible due to the systemic numbering system used by BPS-Statistics Indonesia.

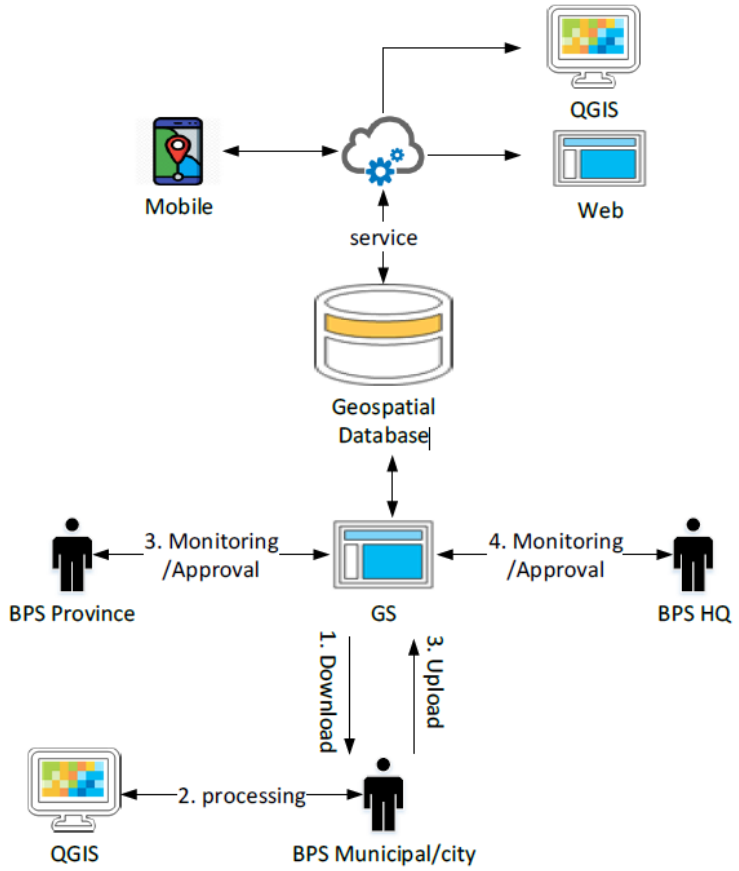


Figure 22 The infrastructure of Geospatial System (GS)

Figure 23 Geospatial System Used within NSO

Principle 3. Common geographies for the dissemination of statistics

As mentioned in the previous Principle 2, all statistical units have a standardization in its attributes including the code ID. Each spatial feature's attribute must have a standard Code ID. The ID referred to Province ID, District ID, Sub District ID, and Village ID. For example, a census block with ID: 5171030002001B means:

- 51 is Province ID, "Bali"
- 71 is District ID, "Denpasar"
- 030 is Sub District ID, "Denpasar Barat"
- 002 is Village ID, "Pemecutan Klod"
- 001B is Census "Block Number"

The rules will facilitate the process of data aggregation/disaggregation and integrating data. Since other statistical data has the same rule of the Code ID.

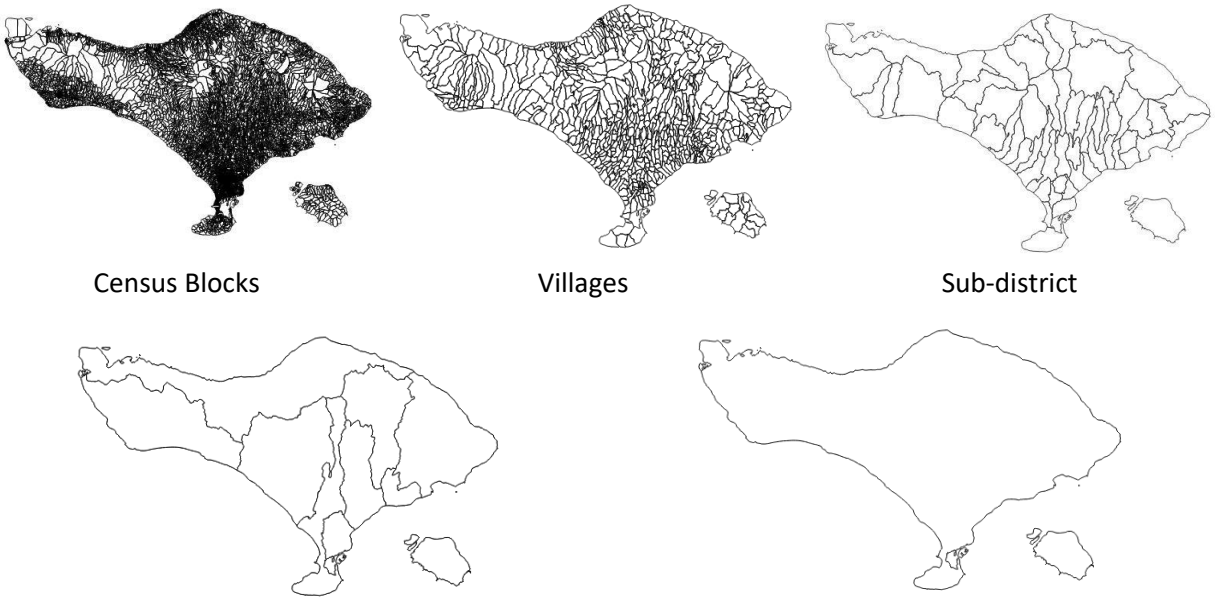


Figure 24 Aggregation Process, Province of Bali

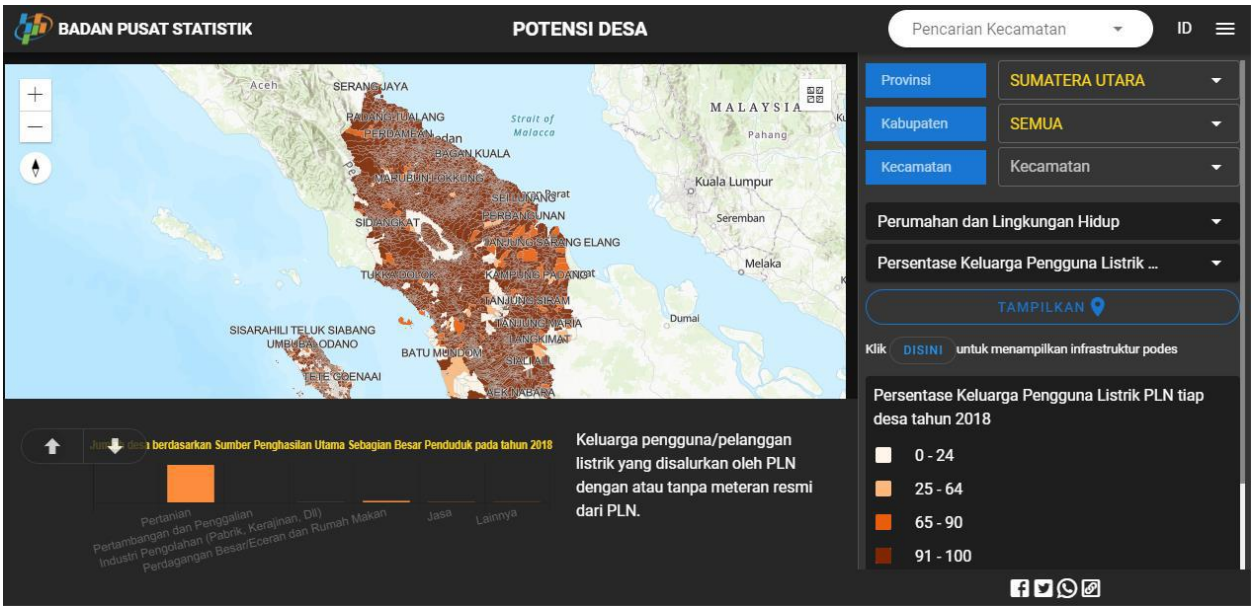


Figure 25 Sample of Dissemination Geospatial and Statistics data

Principle 4. Statistical and geospatial interoperability

This principle is related to the infrastructure of the Geospatial System (GS) that was explained in principle 2. GS provides the final data in Web Map Service and Web Feature Service Format, which are consumed by other platforms through API mechanisms. As shown in figure 8, Village Potential Statistics are presented in a digital map using Web Map Service. In addition, to support interoperability, metadata for both statistical and geospatial data are also provided, although managed in different systems.

However, for public domain, only certain data can be accessed by the API due to the confidentiality issue. Meanwhile, certain users such as the government will have different authorities to access more detailed data for statistics and decision-making purposes.

Principle 5. Accessible and usable geospatially enabled statistics

The authority for delineating administrative area boundaries belongs to the National Mapping Agency (NMA). However, for enumeration purposes, BPS-Statistics Indonesia has also delineated area boundaries as statistical work areas. In this case, BPS-Statistics Indonesia's map of statistical work areas has some limitations for public utilization and is prohibited for the calculation of the administrative area and other geographic measurement. All BPS digital maps users are required to sign the Letter of Agreement of Data and/or information Usage (LADU) prior to accessing digital maps.

In geospatial information presentation, BPS-Statistics Indonesia uses their own digital map instead of NMA's digital map to facilitate the integration of statistical and geospatial data. NMA's digital map uses different coding systems and standards, thus it cannot be directly integrated with BPS-Statistics Indonesia's statistical data. BPS-Statistics Indonesia always ensures that the digital map has been updated to the latest version during census and survey.

BPS-Statistics Indonesia has been using maps in disseminating statistics to provide an even more clear depiction of data. For example, in disseminating population census 2020 results, a Web Map Service is

used to retrieve a map. Statistics information will be layered on top of the map generating new thematic maps for users to use.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

The responsibility of National Response to COVID-19 belong to Indonesian National Board for Disaster Management (BNPB). Thus, BPS act as data provider only. In 2020, we sent all geospatial data to BNPB in order to support the risk map analysis of Covid-19.

Figure 26 Covid-19 Data Dissemination using Map (https://bnpb.go.id/covid-19/)

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

BPS has contributed to the provision of BPS digital maps for analysis of the handling of COVID 19. In producing these digital maps, BPS has implemented GSGF. GSGF is useful for producing quality BPS digital map. While the analysis of national response to COVID19 is conducted by other government agencies (BNPB).

Kenya

Name of Agency: Kenya National Bureau of Statistics
Submission From: Desk Review from ECA

The Overall Implementation of the GSGF

The Overall Implementation of the GSGF

Kenya is in the process of developing the National vision for the implementation of GSGF. Components of GSGF, were implemented during the 24-Aug-19 census and the DHS Kenya: 2015, 2014, 2010, 2008-09, 2004, 2003, 1999, 1993, 1998 and 1989.

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The implementation of preparatory activities for the 2019 KPHC started in early 2016 with cartographic mapping exercise. The process involved delineation of the country into small geographical units known as Enumeration Areas (EAs). The EAs were used in determining the number of census personnel required as well as in ensuring total coverage during enumeration. The use of modern technologies in the entire census cartographic mapping was embraced, as per the UN recommendations for countries undertaking the 2020 round of population and housing censuses. Smart phones and tablets embedded with Geographical Positioning System (GPS) were used to pick coordinates for homesteads, households and other points of interest. Satellite imageries and aerial photographs were used to prepare maps for rural and urban areas, respectively. Open Data Kit (ODK), Esri Survey 123 applications were used during field mapping while ArcGIS was used during digitization and map production. Sub-location and EA maps generated based on administrative boundaries, were then uploaded onto mobile devices for use during the enumeration exercise.

The Use of fundamental geospatial infrastructure and geocoding in the 2019 Kenyan census has been noticed in the planning of urban land use patterns. Establishing boundaries of localities, constituencies, districts, and regions. Identifying localities and districts with boundary issues to seek the appropriate resolutions as well as the identification of new localities. The integration of population data with maps for geo-spatial analyses has been undertaken. Equally geocoding has enabled the identification of deserted or collapsed localities. It has facilitated population the identification density by locality, district, and region for urban planning as well as estimating the number of people displaced by natural disasters.

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

Geocoding of Housing unit location (Dwelling Frames, Housing Footprints), collective living quarter locations (Dwelling Frames, Housing Footprints) a set of digital enumeration area maps or derived dissemination units, which are designed to enable the production of all output products that will be disseminated to government departments and the general public.
Geocoding of Geographic boundary files in a digital format for all statistical reporting units for which census indicators will be tabulated. Listings of all statistical and administrative reporting units, including towns and villages, their variant names and geographic coordinates. Geocoding of Geographic equivalency files that indicate how current reporting units relate to those used in previous censuses, or how one set of reporting units relates to another set as well as the Geocoding of vector layers containing feature data, such as landmarks, roads, schools, hospitals and clinics, which can be used

when analysing population data spatially. Geocoding was used to determine the Centroid files that provide a representative geographic point reference for each reporting unit. It also provided for gazetteers that provide geographic coordinates for all population settlements and other important geographic features in the country.

Principle 3. Common geographies for the dissemination of statistics

A spatial geographic database, with polygonal and attribute information for the enumeration areas of the country (i.e., 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 can be released at the EA level or aggregated into new small-area dissemination units, such as population clusters.

Principle 4. Statistical and geospatial interoperability

A library of digital administrative boundaries, ranging from the provincial to the municipal levels (perhaps even at the level of the land parcel). Digital census atlases, dynamic atlases and spatial analysis techniques have been deployed

Principle 5. Accessible and usable geospatially enabled statistics

Know the ease of accessibility (geometry, perimeter, compactness) within districts as well as the dentification of gaps and overlaps of the already existing district and locality boundaries.

The Republic of Korea

Name of Agency: National Geographic Information Institute (NGII), Ministry of Land, Infrastructure and Transport

Submission From: NGIA

The Overall Implementation of the GSGF

As part of a national project called “National Territorial Survey (NTS)”, NGII has conducted some works involving integration of geospatial and statistical information since 2014. In support of national planning, geospatial data production, and other reporting, NGII must carry out NTS every year, which is mandated legally, so as to produce and announce a range of spatial indicators related to population, economy, culture, transportation, environment, land use and other topics.

To integrate geospatial and statistical information in the process of NTS, NGII has used the method that Korea Research Institute for Human Settlements (KRIHS) developed in 2014. This method was presented in the 2013 meeting of UN-GGIM Expert Group on the Integration of Statistical and Geospatial Information (EG-ISGI), as well as in other related meetings hosted by UN after 2013. Our method is very similar to GSGF. With regard to integration of geospatial and statistical information, NGII had a few chances to meet some people from Statistics Korea, the NSO of South Korea. Yet, we do not know whether Statistics Korea uses our method for geospatial-statistical integration, although we are aware that Statistics Korea started to use some data from NTS recently.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

NGII carries out geocoding of various administrative registers by using the most detailed and up-to-date fundamental geospatial data of addresses, buildings, parcels, grid cells, and road networks. The precision of geocoding differs according to the detailedness of addresses recorded in registers, such as centroids of buildings and parcels. Recently we started a research project aiming at developing a new method to produce location data of individual units within multi-occupancy buildings so as to improve the precision of geocoding further. Some risks are involved with our data production business in that most of raw data used for geospatial-statistical integration for NTS come from other institutes, except data of grid cells and road networks.

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

When raw data are registers such as those of population, buildings, and parcels, we first make geocoded unit record data of them and then start developing statistics from it. For the purpose of data management, we maintain the geocoded unit record data in our own platform, but we do not share it with original data source institutes. Up to now, we do not use any raw data that statistics-producing institutes such as Statistics Korea produce as the results of some surveys.

Principle 3. Common geographies for the dissemination of statistics

We disseminate the results of integrating geospatial-statistical information in a range of administrative spatial units such as grid cells of various sizes, Eup-Myun-Dong, Si-Gun-Gu, and Si-Do. Except for grid cells, spatial data of administrative boundaries are produced, maintained, and managed by institutes other than NGII. And, there are some issues arising from differences in the boundary data sets from different institutes. To avoid these issues, NGII try to ensure consistency in boundary data by using only those from the Ministry of the Interior and Safety.

Principle 4. Statistical and geospatial interoperability

Since we do not use any data from statistical surveys, no additional effort has been made yet to ensure statistical and geospatial interoperability. However, we try to increase interoperability of NTS output data by disseminating it in the de facto standard format such as esri Shape files, and by developing, sharing and conforming to our own standard of grid cells and grid-based statistical data. This standard is applicable to NGII only as of now, but we have a plan to promote it to one of national standards. In addition to further interoperability of NTS output data, we provide supplementary metadata about its confidence, definition, data sources, and other elements so that its users can understand its meaning and applicability clearly.

Principle 5. Accessible and usable geospatially enabled statistics

The results of integrating geospatial and statistical information in NTS can be freely downloaded and visualized in the format of choropleth maps through the statistical map services of the National Land Information Platform, an online data platform of NGII. Additionally, NGII provides a variety of documents such as user guides, National Territorial Monitoring Reports in the form of paper books, pdf, and e-book.

NGII applies the privacy protection guideline from Statistics Korea to every data open to the public so that areas with a few people are not identifiable. NGII do not provide yet online services of data catalogue, data search and discovery, including APIs for data download.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Grid-based population data from NTS, an output from geospatial-statistical integration, was used to help Korea CDC grasp the current geography of COVID-19 occurrences. In addition, grid-based indicators of accessibility to emergencies and pharmacies, another set of output from geospatial-statistical integration of NTS, have been used by citizens when they need to find close facilities of medical services. We also have a plan to produce spatial indicators of densities or distributions of multi-use facilities that are considered important in the social distancing policies of Korea CDC.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

If NTS could have easy access to data of COVID-19 screening clinics, business-related registers/statistics, business opening/closing from National Tax Service, and mobile population sensing results and if we could operate NTS flexibly on an on-demand basis, we could provide more data useful for national responses to COVID-19. We think the biggest difficulty is associated with creating collaborative governance through which any institute can access various data sources immediately whenever it needs.

Kuwait

Name of Agency: Central Statistical Bureau
Submission From: NSO

The Implementation of the Principles of the GSGF

The State of Kuwait has not officially adopted or implemented the GSGF however; our framework consists of similarities to the GSGF.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Geocoding areas from governorates, districts, areas, blocks, squares and plot addresses are entirely geocoded to be able to get the x and y coordinates.

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

Linking all the statistical information from census to more periodical surveys to local addresses when applicable and all the range of geocoded areas when needed.

Principle 3. Common geographies for the dissemination of statistics

The State of Kuwait uses administrative boundaries and in the future will use grid based mapping. We allocate our data to smaller administrative segments and to statistical units.

Principle 4. Statistical and geospatial interoperability

Different government bodies from the municipality boundaries, public authority of civil information, and the statistical bodies work together to share information to benefit the common goal and increase are data's accuracy, quality for a more efficient, and precise data corroboration.

Principle 5. Accessible and usable geospatially enabled statistics

It is vital to share and release our data to the public so long as the level of data selected will not infringe national issues to protect the privacy and security of both the people and country.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Government bodies working together to assess the cases by density populations and administrative boundaries to track and understand the spreading of the COVID-19 afflicted cases. Use this data to determine and asses how to contain the spread.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

With the implementation of the GSGF COVID-19 would have been significantly helpful in a spectral of methods. It would of help sort out the data collected by other government bodies more accurately and efficiently, which would have resulted a further contained increasingly rapid view of information. The GSGF could have made clearer where the virus was emerging from and spreading to reduce the rate of infection. Administrative boundaries of virus development could have been pinpointed and contained sooner. If the Ministry of health shared, its information with other government bodies with a shorter periodical time, the response time would have been more efficient and better maps would have increasingly helped the response teams.

Malawi

Name of Agency: National Bureau of Statistics
Submission From: Desk Review from ECA

The Overall Implementation of the GSGF

The Overall Implementation of the GSGF

Malawi is still to develop the National vision for the implementation of GSGF. Some components of GSGF, were implemented during the 21 Mar--30 Mar- 2008 census and the DHS Malawi: 2017, 2015-16, 2014, 2013-14, 2012, 2010, 2004, 2000, 1996 and 1992.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The Use of fundamental geospatial infrastructure and geocoding is well noticed in the Malawian 2018 census cartographic exercise with the overall, the aim of updating the geographic frame which the NSO uses for all its data collection activities. However, the main and crucial task was to demarcate EAs so

that we have up-to-date and accurate EA maps in time for census enumeration in June 2018. Specifically, the mapping exercise accomplished the following objectives: i) coming up with credible Census Mapping strategy (CeMaS) document which will form as basis future mapping endeavours but also as reference for various methodologies, terminology and standards pertaining to 2018 Census mapping; ii) acquiring satellite imagery which will provide necessary input in updating EA; iii) generate a dwelling frame (DF) which will be used in census and other surveys to easily identify households; iv) update EA boundaries in time for the 2018 Census enumeration v) produce a range of map products such as EA maps which will be used during 2018 Census enumeration and subsequent surveys by the NSO and set up GIS, IT, and human resource infrastructure to be able to support 2018 Census enumeration activities through provision of various geography related services.

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

Geocoding of Housing unit location (Dwelling Frames, Housing Footprints), collective living quarter locations (Dwelling Frames, Housing Footprints) a set of digital enumeration area maps or derived dissemination units, which are designed to enable the production of all output products that will be disseminated to government departments and the general public.

Geocoding of Geographic boundary files in a digital format for all statistical reporting units for which census indicators will be tabulated. Listings of all statistical and administrative reporting units, including towns and villages, their variant names and geographic coordinates. Geocoding of Geographic equivalency files that indicate how current reporting units relate to those used in previous censuses, or how one set of reporting units relates to another set as well as the Geocoding of vector layers containing feature data, such as landmarks, roads, schools, hospitals and clinics, which can be used when analysing population data spatially. Geocoding was used to determine the Centroid files that provide a representative geographic point reference for each reporting unit. It also provided for gazetteers that provide geographic coordinates for all population settlements and other important geographic features in the country

Principle 3. Common geographies for the dissemination of statistics

A spatial geographic database, with polygonal and attribute information for the enumeration areas of the country (i.e., 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 can be released at the EA level or aggregated into new small-area dissemination units, such as population clusters

Principle 4. Statistical and geospatial interoperability

A library of digital administrative boundaries, ranging from the provincial to the municipal levels (perhaps even at the level of the land parcel). Digital census atlases, dynamic atlases and spatial analysis techniques have been deployed

Principle 5. Accessible and usable geospatially enabled statistics

The geocoded data has been visualized in geoportals and dashboards etc.

Mexico

Name of Agency: INEGI
Submission From: Combined NGIA/NSO

The Overall Implementation of the GSGF

The Geostatistical Framework began to be developed in 1978 by the General Coordination of the National Statistics, Geography and Informatics Services (CGSNEGI), in the absence of a cartography that would represent the clear Territorial Division of the country's Federative Entities and Municipalities. It was specifically designed to be the basis for planning, field work, coverage control and organization of results from national censuses and surveys that are the responsibility of the National Institute of Statistics and Geography.

Due to its qualities, this product has been adopted by various State Units and users for their own purposes, which has fostered communication channels, declaration of needs and cooperation alliances.

In addition to its structure in levels of disaggregation (which allow referring data from state levels to the detail of block faces), the Geostatistical Framework is in the process of incorporating new elements to fulfil its purpose, such as the characterizations of the basic geostatistical areas (AGEB) and new resources for updating.

This product aligns with the five principles of the Global Geospatial Statistical Framework developed by the United Nations Group of Experts on the Integration of Statistical and Geospatial Information (EG-ISGI). These principles cover the following aspects: use of fundamental geospatial infrastructure and geocoding; geocoded unit record data in a data management environment; common geographies for the dissemination of statistics; statistical and geospatial interoperability; and geospatially enabled statistics that are accessible and usable.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The Geostatistical Framework considers for its permanent updating a process of updating the urban and rural cartography, which is based on a pre-digitization of areas of growth from the use of high-resolution satellite images that are verified in the field and captured on mobile devices through the digitization of blocks and rural towns. This process also uses cartographic administrative records for the identification of updates and for the representation of the geostatistical delimitations of the State Geostatistical Area, Municipal Geostatistical Area and locality. It considers the legal supports available from the political-administrative limits of the federal entities, municipalities and territorial demarcations of Mexico City whose description is clear and precise that allows its cartographic transcription.

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

Since its creation, the Geostatistical Framework has been an essential part of the censuses and surveys carried out by the Institute. Its foundation is precisely to enable an environment in which statistics are linked to the geographic space that gives rise to it.

- It is represented in cartographic and tabular products, in print and digital formats. The geostatistical components are identified through their keys, with which a one-to-one relationship is achieved with the captured statistical data;
- Its cartographic parameters, based on a global coordinate system, allow the association -within tolerance margins- with georeferenced data from other sources;
- The geographical relationship of the statistics contributes to the analysis of each geostatistical area;
- Its updating and validation processes support the fundamental purpose and the location and unique identification of its components, in accordance with the applicable technical regulations;
- Its components are regulated in accordance with the Geostatistical Framework Data Dictionary and ratified in the Metadata;
- Updated according to technical criteria for its delimitation, coding, updating and integration, as well as for its availability to users; and,
- The coding of the components of the Geostatistical Framework is used for the spatial reference of the statistical data, therefore, in the publication of statistical results, the version of the Geostatistical Framework used in the corresponding census event is considered.

Principle 3. Common geographies for the dissemination of statistics

Since 1978 the Geostatistical Framework has maintained its organizational base. It is updated and new levels of disaggregation have been introduced to meet the needs of institutional censuses and surveys. A basic rule in its conformation, delimitation and updating is to keep the spaces recognizable in time and space, as well as to elaborate equivalence tables, which constitute records of the evolution of the data; they are also a common spreading factor.

- Created as the only framework to georeferenced national statistical information from institutional censuses and surveys;
- It enables the association, with the geographic space of origin, of the different statistical data;
- Defines and structures its components with the premise of referring the statistical information to the geographic space, through territorial elements called geostatistical areas;
- It is applied in the National Information Subsystems of the SNIEG (sociodemographic, economic and government); and,
- It is used in the dissemination of institutional statistical information, as a context of the country and its territorial division.

Principle 4. Statistical and geospatial interoperability

Based on its criteria, the Geostatistical Framework codes each geospatial unit. The information is integrated, organized in catalogues and ready for use in censuses and surveys. It is also a substantive geospatial input for other State Units. Its organizational foundation is based on a codification of the territorial space at different levels of disaggregation.

- Components continuously updated with INEGI's own activities, application of provisions of the territorial division and information captured in administrative records;
- Geostatistical reference associated with the statistical data of origin;
- Catalogues of the keys of the Geostatistical Framework components, linked to the geographic space they represent;

- The information of the Geostatistical Framework is available on the INEGI page in data formats that facilitate interoperability and with its documented metadata in accordance with the Technical Standard for the elaboration of Geographic Metadata; and,
- Currently, INEGI makes efforts to facilitate the online use and exploitation of the Geostatistical Framework information, such is the case of the Web Service of the Unique Catalogue of Geostatistical Keys, which facilitates access to the updated catalogues with the information and systems of the dependencies that make use of this service.

Principle 5. Accessible and usable geospatially enabled statistics

On the official site of INEGI you can find various options that allow you to disseminate, visualize and analyse the data, such as the Digital Map of Mexico that integrates a wide variety of both statistical and geographic information, in addition to the Geostatistical Framework.
Publication and free download of cartographic products:
- Published at least once a year on the institutional website and in the publication of census results, with the updates captured in each version.
https://www.inegi.org.mx/temas/mg/#Descargas

The availability of information from the Geostatistical Framework since its creation, in relation to censuses and institutional surveys, dates from the 1980 census round

- It is represented in cartographic and tabular products; in printed and digital formats, made available to users in different electronic media and through the Public Information Service; and,
- Components regulated in accordance with the Geostatistical Framework Data Dictionary and ratified in the metadata; both made available to users.

The results of the Population and Housing Census 2020 with information on the spatial distribution of the population and housing, are available for consultation and download associated with an element of the Geostatistical Framework, so it is possible to obtain statistical information at the national level, federal entity, municipality or territorial demarcation of Mexico City, locality, AGEB and urban block.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

The Geostatistical Framework has provided geostatistical information (that is, geographically referenced statistical data) that allows knowing the detailed distribution of population groups by sex and age, mainly at the municipal and local level, to design strategies to contain the most vulnerable groups, health and vaccination. The geographical reference allows establishing spatial relationships with other physical and economic factors that must be considered.

To facilitate departures, operational coordination strategies have been set up in the country, which, through the Geostatistical Framework, have facilitated dissemination and decision-making, in accordance with the very precepts that the GSGF dictates.

Namibia

Name of Agency: Namibia Statistics Agency
Submission From: NSO

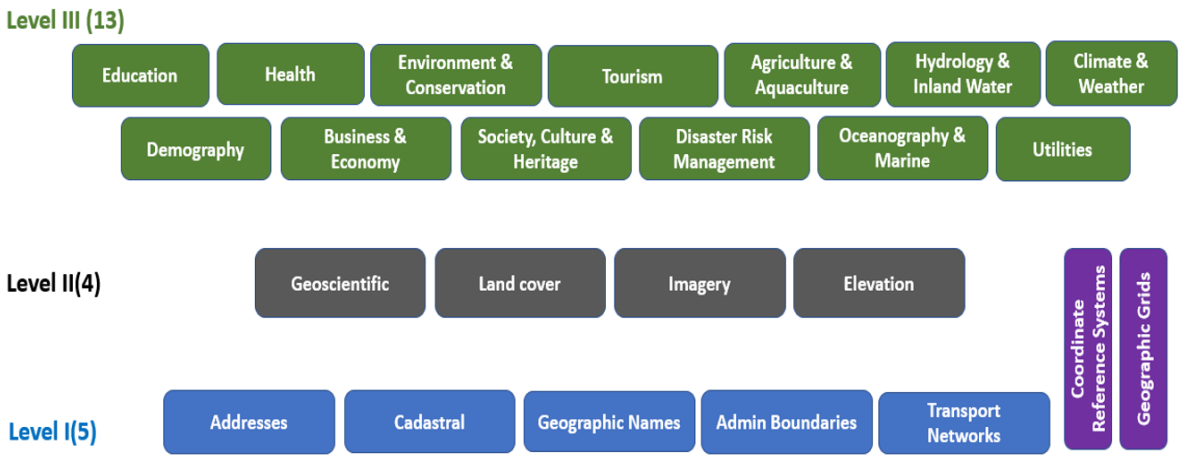
The Overall Implementation of the GSGF

The GSGF overall has been incorporated into the Namibia Statistics Agency's second strategy and action plan as a strategic objective. The strategic objective is "Objective 3.2: Improve statistical integration with spatial data." All integration activities are lined up under this strategic objective. The strategic plan is accessible on https://nsa.org.na/page/strategic-plan and the strategic objective is from page 40 of the document. The two actions under this objective are to advocate for common geographies for the dissemination of statistics and to develop a geocoded register of dwellings and other structures in the country.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

This principle is fully implemented in Namibia as part of the Namibia Spatial Data Infrastructure which is coordinated by the Namibia Statistics Agency. Namibia has formally gazetted 25 fundamental data themes of which one is addresses which is key to the implementation of the GSGF (see below). Each theme or data basket contains quality assured and nationally certified geospatial datasets with official attributes determined by the producer and NSDI stakeholders.



22 Main Fundamental Data Themes out of 25 Themes

Figure 27 Gazetted Namibia Fundamental Geospatial Data Themes

However, there is a lack of a standardized national addressing system. For instance, some urban areas use street addresses while others use house numbers. In rural areas there are no addresses apart from the general locality list.

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

Namibia as part of pre-enumeration activities in preparation for the 2021 population and housing census has developed a geographic register of buildings and households. All this data is managed in a

data management environment and managed in a GIS software. Census mapping concluded in April 2021 and the register/dataset is being cleaned and will only be available to key institutions of government.

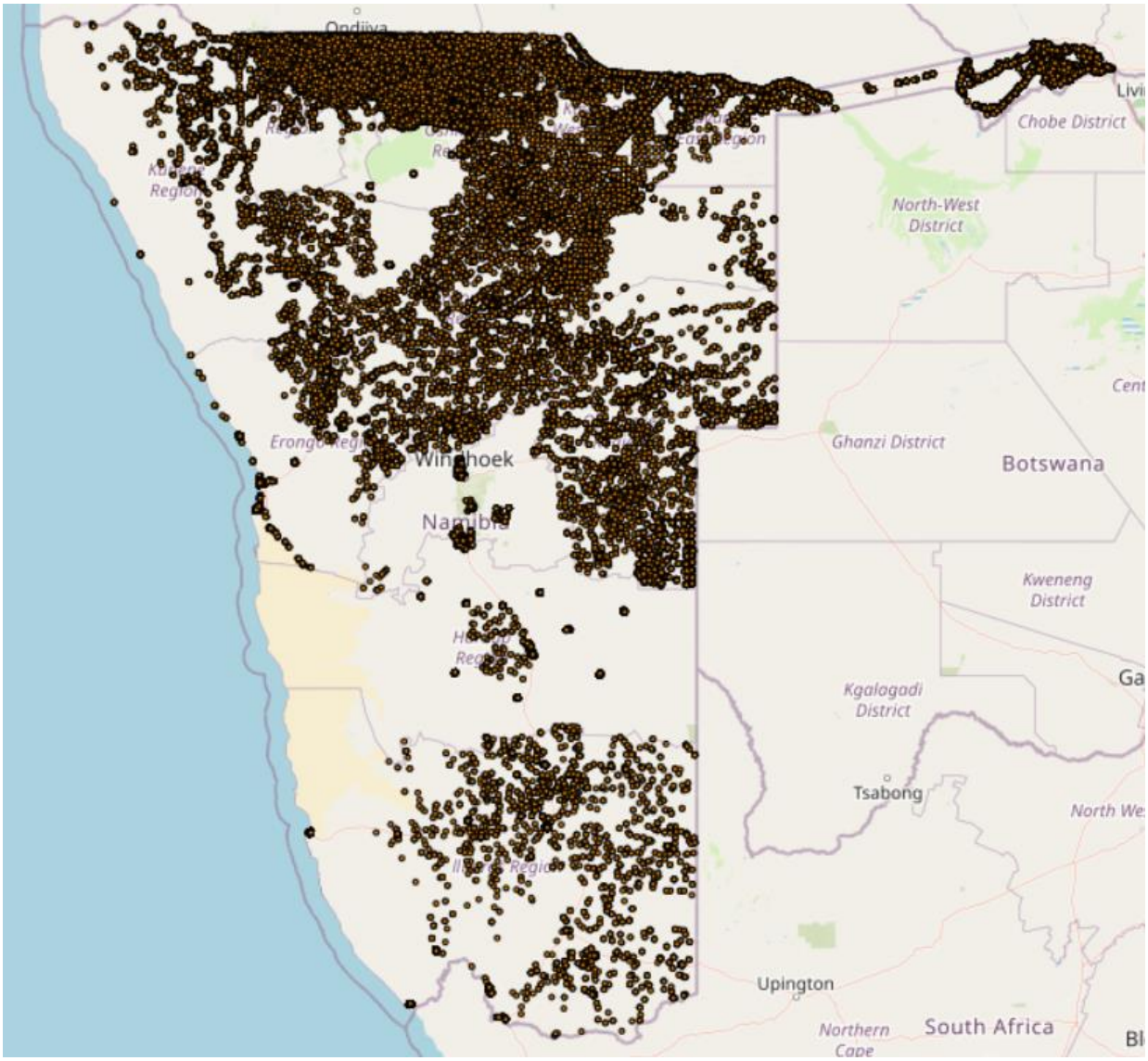


Figure 28 Geocoded Register of Buildings and Households

Principle 3. Common geographies for the dissemination of statistics

Namibia collects statistics based on enumeration areas for censuses and national sampling frame for surveys. Statistics are aggregated and disseminated at constituency, region and national levels. Calls have been made to highly disaggregate statistics to lower level boundaries. The country is challenged with the existence other sector-specific administrative boundaries that cut across enumeration areas and administrative boundaries e.g. police zones, magisterial districts, farm registration divisions, health districts, education circuits, etc. These boundaries are not harmonized with enumeration areas and when statistics are required for these functional units, projections have to be made e.g. know how many children under 5 year for the immunizations that occur in health districts.

Figure 29 illustrates how enumeration areas are harmonized within constituency boundaries.

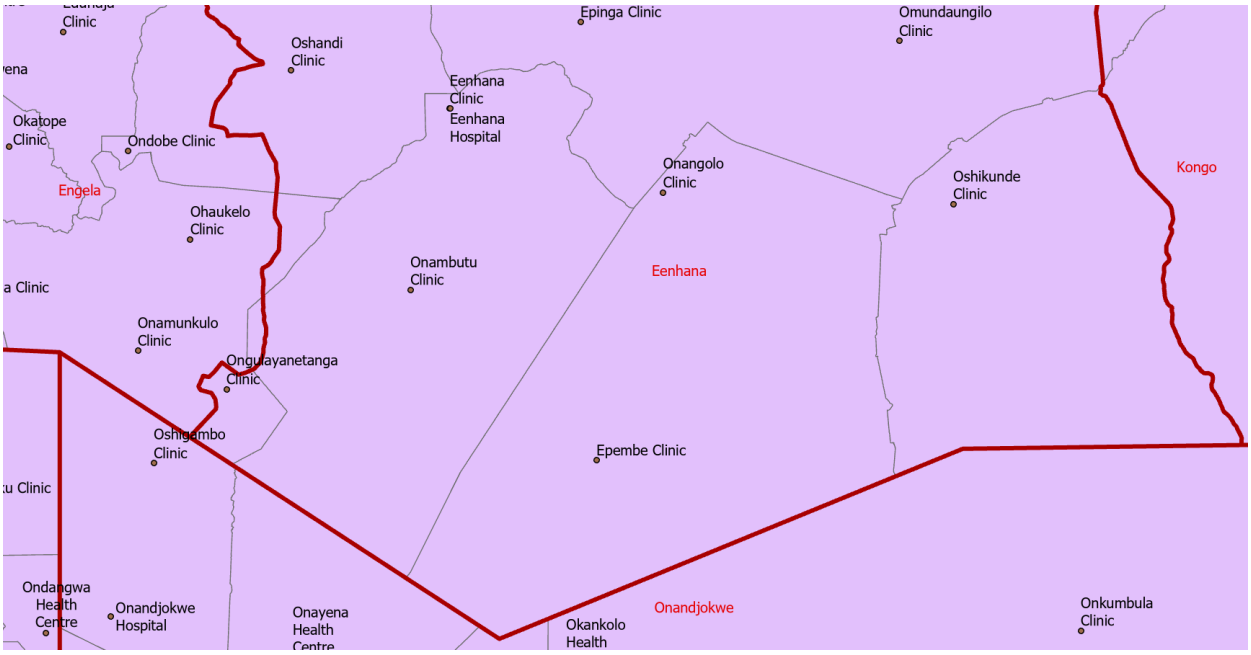


Figure 29 Overlapping boundaries of health districts (red) and constituencies (black).

As part of pre-enumeration for the envisaged 2021 population and housing census, the Namibia Statistics Agency is developing a methodology to move towards a geographic register of households linked to dwellings for statistical collection. This will ensure that statistics can be geographically disaggregated or aggregated for any functional unit without the challenges of projections. However, this will have to be done considering all the arising issues pertaining to privacy and confidentiality. The country is eagerly awaiting the guidance materials that can be provided by the EG-ISGI on handling privacy and confidentiality.

Principle 4. Statistical and geospatial interoperability

This aspect has not been attended to so far due to lack of technical capacity. A lot of assistance is required to assist the country in business process mapping based on the GSBPM. Interoperability principles are highly technical and requires building capacity.

Principle 5. Accessible and usable geospatially enabled statistics

The Namibia Statistics Agency links its major statistics to geography to aid in the dissemination/communication process. Maps are used to communicate statistics in a simpler and more user-friendly manner. These maps supplement traditional tables and graphs commonly used to disseminate statistics. Furthermore geospatially-enabled statistics are disseminated through the National Geographic Portal[32] and also through Atlases.

[32] https://digitalnamibia.nsa.org.na

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

In Namibia the Ministry of Health and Social Services have been geocoding positive cases of COVID-19 and their contacts. The spatial pattern/distribution of cases has assisted the Ministry to strengthen their surveillance. The Namibia Statistics Agency has built capacity in this geocoding exercise and maps of patterns are used to re-enforce lockdowns/surveillance.

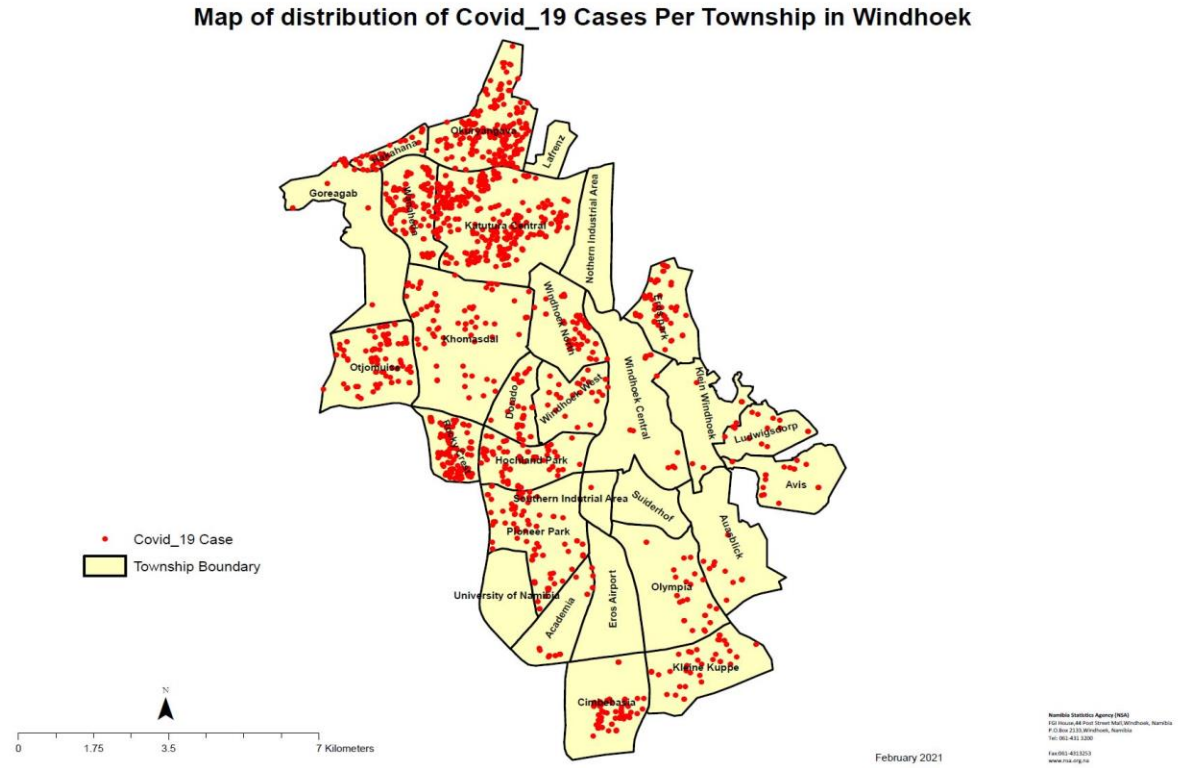


Figure 30 Distribution of COVID-19 Cases by Township - Windhoek, Namibia

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

The lack of a fully geocoded address register in the country has impaired the geocoding exercise of COVID-19 cases. The country lacks a standardised national address standard to build a proper and seamless address register. The existence of a standardised national address dataset would have made it easier to timely geocode COVID-19 cases and assist in contact tracing. This would have scaled-down the spread of cases especially in the severely affected coastal towns. No geocoding was attempted for rural areas due to lack of a proper village database or lowest locality list.

New Zealand

Name of Agency: Stats NZ
Submission From: NSO

The Overall Implementation of the GSGF

New Zealand has implemented all components of the GSGF. This process was not carried out as a single programme but was built over several years using existing technology and infrastructure – some of which pre-dates the development of the GSGF.

Key Resources include:

- Published information on about geographic classifications: https://www.stats.govt.nz/geographic-data-and-maps/
- Online map products: https://maps-by-statsnz.hub.arcgis.com/
- Downloadable geospatial data: https://datafinder.stats.govt.nz/

Having the components in place allows us to focus on making improvements to the infrastructure and looking into future technologies that will be incorporated into future versions of the GSGF. These include:

- Integrated property data that links address, property, and dwellings.
- Gridded geographies.
- Environmental geographies.
- Earth Observation for statistical production.
- Alternative location models such as building features.
- Alternative location systems such as Discrete Global Grid Systems.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

New Zealand's official street addressing system[33] was geocoded by LINZ and made publicly available. Stats NZ added in-use addresses from 3rd parties and uses field staff to verify the addresses and their location. This forms the basis for the Statistical Location Register (SLR). Street addresses were used for the first time to mail out census forms for the 2018 census.

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

Stats NZ developed an internal geocoding and street address verification system which is used to maintain the Statistical Location Register (SLR). The SLR resides in a protected environment with restricted access to personnel.

The SLR is one component of the three registers system that also includes businesses and people. Stats NZ hosts the Integrated Data Infrastructure (IDI) that contains data about citizens from core government agencies. Addresses and their locations are key linking variables and were used to augment

[33] https://www.linz.govt.nz/system/files_force/media/publications-attachments/useful_info_for_working_with_addresses.pdf?download=1

data in areas that had low responses in the 2018 Census. The IDI is also part of a restricted environment which is available to researchers on application.

Principle 3. Common geographies for the dissemination of statistics

The statistical geographies were digitised in the early 1990's and updated in 2018 with the publication of the Statistical Standard for Geographic Areas[34]. Statistical geographies begin with the Meshblock which contain between 30 and 60 dwellings. These were used originally for census enumerators. Statistical Areas developed for output, SA1 and SA2, are part of the nested hierarchy with populations of around 100 for SA1, and 1,000 for SA2. They allow for the release of data at the safest resolution to maintain confidentiality. Statistical Areas combine to create local government administration areas and electoral districts. Statistical and administrative geographies are updated annually and made available to the public as spatial data from Datafinder, our geographic data service[35]. Confidentialised population data for Statistical Areas is disaggregated to address points to calculate populations for additional geographies.

Principle 4. Statistical and geospatial interoperability

Online maps were created for the first time following the 2013 census. This was made possible by investing in an ESRI-based geospatial platform. Geospatial data products were released on the geographic data service[36]. These products were developed for geospatial users and combine the statistical table with the geography as a geospatial layer. Previously the two components were delivered separately to be joined before use by each user.

Maps and visualisations[37] are a common element of statistical releases. ESRI provide the primary platform for online mapping, along with some R/Shiny applications. The underlying data is made available as OGC and ESRI REST web services

Principle 5. Accessible and usable geospatially enabled statistics

The primary purpose of statistical geography design is to preserve confidentiality and reduce the amount of data suppression where there are low counts of a particular variable. Stats NZ established a geographic data service to disseminate geospatially enabled data for download or consumed as web services.

All publicly available data is licenced for permissive use using NZ's Creative Commons attribution data licences. This is mandated by the New Zealand Government Open Access and Licencing framework[38] (NZGOAL).

[34] https://www.stats.govt.nz/methods/statistical-standard-for-geographic-areas-2018

[35] ibid

[36] ibid

[37] https://maps-by-statsnz.hub.arcgis.com/app/3a61db9ab16d435b91b3997ed3a4b634

[38] https://www.data.govt.nz/toolkit/policies/nzgoal/

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

COVID-19 demanded geospatial products that were outside the normal statistical release programme. By using address points as an intermediate step Stats NZ was able to publish 3D gridded visualisations of vulnerable population age groups[39] and indigenous populations living in deprived areas[40]. LINZ and Stats NZ contributed data to the Manaaki Promise[41] web site designed to support Maori and Pacific people who are among our most vulnerable populations. Census 2018 data was published as web services on an ArcGIS Online platform[42] – some of which were consumed directly by Manaaki Promise's web maps.

New visualisations of statistics were also produced to aid impact to and understanding of statistical data. These include multi-variate dot-density maps of ethnicity[43] and commuting[44], ethnicity cartograms[45], and an animation of population movements[46] using cellphone data as the country moved into lockdown.

Panama

National Statistical Office

Institution: Comptroller General of the Republic / INEC

Submission From: NSO

The Overall Implementation of the GSGF

From the perspective of the NSO of Panama, we have not implemented a GSGF as such or with the fundamental purpose of providing or disseminating data to third parties. The circumstances of obtaining timely data and the lack of geostatistical information at the institutional level (either because they do not produce it or lack technical capacities); We have had to respond by offering geospatial and statistical inputs and products to educational institutions, government bodies, private companies, NGOs and the general public.

Bearing in mind that we have built a GIS since 2003, with base information for conducting National Censuses, we have contributed to generating geocoded information through the National Geostatistical Framework that somehow supplies the aforementioned needs. Currently we have had approaches with several Institutions in order to share information that strengthens the current systems.

[39] https://www.stats.govt.nz/news/where-do-over-65s-live

[40] https://www.manaakipromise.co.nz/app/a038483c635d4896ac0756a2708a12e9

[41] https://www.manaakipromise.co.nz/app/a038483c635d4896ac0756a2708a12e9

[42] https://maps-by-statsnz.hub.arcgis.com/app/3a61db9ab16d435b91b3997ed3a4b634

[43] https://storymaps.arcgis.com/stories/28ff84c3ff6640ee9f216580faa96dcc

[44] https://storymaps.arcgis.com/stories/6f8b5f981ad34f11bedaf1725e9cb698

[45] https://storymaps.arcgis.com/stories/8c8c82cfc2a6406f979519a382d0b81b

[46] https://www.rnz.co.nz/news/national/415008/new-videos-show-how-covid-19-slowed-new-zealand-s-pulse

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The fundamental data that we have determined are the administrative levels (country, province, district and township), the road network, hydrography, track gauge, populated places, neighborhoods and georeferenced structures. All of them have all their geocoded elements, in accordance with the codes of the administrative political division of the Republic of Panama, and the codes of populated place and neighborhood generated by the NSO. Similarly, each structure has a unique geocode.

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

We have the platform, structure and experience to link statistical data up to levels of populated places, however beyond those provided by the Censuses, such as external data or generated by Surveys, we have not taken the action to exploit this information. Another aspect to mention, would be that we lack a metadata as such.

Principle 3. Common geographies for the dissemination of statistics

In our case, we do not represent the geography in the form of grid units, but rather we use the administrative areas for the aggregation and disaggregation of the data. Regarding dissemination, it is a challenge to provide the user with information through virtual platforms or geovisor, we currently have a module to hang thematic maps prepared in image format.

Principle 4. Statistical and geospatial interoperability

This year our objective is the campaign (which we started) to establish interoperability with strategic institutions according to their functions for the exchange of statistical and geospatial information. We know we have a long way to go, but we find ourselves in the middle of it; this through inter-institutional agreements or conventions that are under development.

Principle 5. Accessible and usable geospatially enabled statistics

We have not implemented offering users geospatial data in a virtual way, since we do not have the tools to share information that allows you to access, view, and analyze the information easily.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

We have provided support by offering analog and digital cartographic material to entities such as: Ministry of Health, Ministry of Social Development.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

When was timely appropriate, we could have contributed experience, supplies, technical personnel and technology in order to accurately locate the contagion points by residence, establish sanitary control sites, and support monitoring and spatial follow-up tasks. The main barrier was not having been invited to participate together with other government entities that could have provided valuable contributions.

National Geospatial Information Agency

Institution: Tommy Guardia National Geographic Institute

Submission From: NGIA

The Overall Implementation of the GSGF

To implement the GSGF, an action plan was established within the country's spatial data infrastructure. In the context that the Integrated Geospatial Information framework is also being implemented, we have established common ground, and for this we have started with the establishment of fundamental data. So, we can say that the implementation refers to the Spatial Data Infrastructure.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

We are still agreeing on the implementation process. Because the subject of Geocoding is new for cartographic and statistical agencies in a common way.

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

There is geocoded data since the census definition. But there is no geospatial integration with information from a common infrastructure. Because of the previous point, a plan is formulated for their coherent and interoperable integration.

Principle 3. Common geographies for the dissemination of statistics

The common areas are among the fundamental data to be homologated, in this context, it has been possible to reach an agreement both from the NGO and the NSO. One of the fundamental geospatial basis on which statistical information must lay on.

Principle 4. Statistical and geospatial interoperability

Through the spatial data infrastructure, work has been done to ensure that all information is interoperable. However, work has yet to be done on the issue.

Principle 5. Accessible and usable geospatially enabled statistics

To date, we have access to geospatially enabled statistical data

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Provide cartographic information for logistics and transportation of vaccines, medical personnel, food.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

There are multiple barriers to implementation, there is a lack of budget for data generation, there is an excessive lack of valuation of information in general for decision-making, especially to keep the data updated. If the framework were in operation, there would be no duplication of functions and works, this benefits the country in directing resources in a focused manner. On the other hand, there would be no

uncertainty in the use of data, since they were homologated under the same source, there were not several versions of the same data in different institutions.

Peru

Name of Agency: National Institute of Statistics and Information Technology - INEI
Submission From: NSO

The Overall Implementation of the GSGF

The Global Statistical and Geospatial Framework is in the process of being implemented, but initiatives such as GeoSur, IDE and MEGA have undoubtedly contributed to its implementation. Cooperative inter-institutional work at the national or international level is very helpful for exchanging experiences and strengthening capacities.

Recently, an exchange of experiences was held between DANE (Colombia) and INEI (Peru) where it was identified that each specialist may have different interpretations of the same principles, and that the 5 principles do not necessarily work in that order, for which was an enriching experience, and that helps us to continue understanding it for the improvement and strengthening of our cartographic and geospatial work on the data that is produced.

In 2019, I participated in the MEGA project (Colombia), where the administrative limits of 3 geographical levels were unified in coordination between the INEI and the IGN (National Geographic Institute). Likewise, INEI (NSO) is participating in the training provided by SDI-Peru, in the Metadata courses.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Although the process of a single standardization for national organizations is in process, practically all the organizations of the state structure find the georeferencing of their data almost indispensable. Some are in this process, and even the same national census of 2017 carried out this process at the household level. Much of the most important cartographic layers and elements are also georeferenced, mainly in metropolitan Lima and the large cities, although all these cartographic data are not articulated between the different institutions.

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

Many of the national organizations use the national code identifier “UBIGEO” as a reference for the geocoding of their records and in the microdata, so that they can be viewed in any of the GIS tools. The use of metadata is being taken into account as well. The use of big data tools are also being applied in some specialized institutions. The roles of the functions for the custody of data and its maintenance are identified within each institution, however, there are logistical and planning problems for updating them.

This process requires the establishment and implementation of data and metadata standards so that data production is usable and consistent, both in geographic references and in small areas.

Principle 3. Common geographies for the dissemination of statistics

Normally, the information of the georeferenced and/or enabled data can be disaggregated and visualized and interpreted to a large extent up to the political-administrative level N°3, which are the districts. Regarding the aggregation and disaggregation methods, the use of grids is not yet widely used.

Regarding the use of the grids, an attempt is made to work with a geospatial framework for the next national agricultural census, which are already being piloted in two areas of the country.

Principle 4. Statistical and geospatial interoperability

SDI Peru promotes the use of standards for the geospatial information produced, and some institutions have already adopted this principle, however, the INEI(NSO) is still in the process.
The lack of standards means that information on the web cannot be interoperated and that monolithic and isolated systems are created. There is little exchange of information in public entities.

Principle 5. Accessible and usable geospatially enabled statistics

Currently, the user can view and even download much of the fundamental data such as national charts in shp format: contour lines, hydrography, toponymy. However, when it comes to more specialized layers or data, there may be more difficulties in accessing them.

Another detail that can be presented in the information is the use of a multiplicity of formats, and platforms. INEI as the NSO regularly publishes information open to the general public, through query systems that integrate the database with statistical and geospatial information, such as:

- DATACRIM (Integrated Crime Statistics System)
- SIRTOD (Regional Information System for Decision Making)
- Consultation System for Populated Centers
- Statistical Information System to support prevention for the effects of the El Niño Phenomenon and other Natural Phenomena
- Poverty Map at the Provincial and District levels.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

During COVID 19, the INEI(NSO) has collaborated with statistical, economic and social information, in addition to providing georeferenced information on blocks, homes, essential institutions such as banks, markets, among others; to the ministries and government authorities in charge of the elaboration of health and economic strategies. However, this geospatial framework had to undergo a rapid update process based on satellite images to cover the peripheral areas that had undergone changes since 2017.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

It would have allowed faster action in decision-making and in the implementation of strategies with a territorial approach. For example, the fact that some institutions do not have certain data

georeferenced, means that it has to be done in a hurry and it takes time to have that information, as well as with information that is not updated or disseminated in different institutions.

Senegal

Name of Agency: Agence nationale de l'Aménagement du Territoire
Submission From: NGIA

The Overall Implementation of the GSGF

Statistics and geospatial information are managed by two separate organizations (NSO and NGIA). These two governmental entities have signed a collaborative agreement in the form of a Memorandum of Understanding (MoU).

Besides, a working group under the responsibility of the Ministry of Finance and Planning brings together members of different governmental organizations (including both the NSO and NGIA) that produce and manage statistics/sectoral data or geospatial information to contribute to the monitoring of the SDGs with Earth Observation (Groupe technique de la plateforme des parties prenantes pour le suivi des ODD du secteur de l'environnement - GTPODDE).

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Fundamental geospatial infrastructure is being built and a lot has been achieved already (more than 90% in terms of fundamental datasets created already).

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

Our statistical data on the population is geocoded only down to the level of the locality (village or a small settlement just beneath the village), not yet to the household level (which is a desirable geocoded unit).

Principle 3. Common geographies for the dissemination of statistics

Implemented down to the fourth level administrative boundaries (communes = municipalities) although not all "communes" have their boundaries currently precisely identified and appropriately materialized.

Principle 4. Statistical and geospatial interoperability

Integrated up to the fourth level administrative boundaries for part of certain statistical data and not for all available statistics.

Principle 5. Accessible and usable geospatially enabled statistics

Already in 2013, the NSO leveraged geospatial information to conduct the national general census. It literally used the fourth level administrative boundaries that were generated by the NGIA to produce statistics on people, settlements, agriculture, etc. The operation was conducted using PDA/tablets. Though not all available statistics at the NSO are georeferenced.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

Through a web application to monitor the epidemic at the second level administrative boundaries to support the decision-making on the movements of people and where to bring more resources...

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

We could have supported decision-making better by focusing more on the areas that matter if the data was more disaggregated.

Addendum

As the national spatial planning agency, without the integration of various sectoral or statistical data with the fundamental geospatial data that we generate and manage, we could not have produced the national spatial plan that is being currently promoted by the government and mandated for implementation by all actors throughout the country. There is still significant progress to be made, especially to establish a formal cooperation framework with the NSO.

Sierra Leone

Name of Agency: Statistics Sierra Leone
Submission From: Desk Review from ECA

The Overall Implementation of the GSGF

The Overall Implementation of the GSGF

Sierra Leone is developing the National vision for the implementation of GSGF. Some components of GSGF, were implemented during the 5-18 December 2015 census and the DHS Sierra Leone: 2019, 2016, 2013 and 2008.

Principle 1: Use of fundamental geospatial infrastructure and geocoding

Cartography and Geographic Information Systems (CGIS) was introduced into mainstream Statistics Sierra Leone during the 2004 Population and Housing Census. Updating of the EA frame: The national frame used in the sampling process for all surveys/research in the office is housed in the CGIS division as a classified document. However, this frame is created as a result of each census conducted and since censuses are conducted once every ten years (decennial). The frame is updated from time to time so as to avoid getting outdated. The updating of this EA frame forms part of the routine activities of the division.

The main exercise is to re-define the boundaries of the EA; in the urban areas it involves quick household counts and updating social facilities (Markets, Schools, Health facilities etc.) which also serve as reference points around the EA boundary. For rural EAs the update is usually about localities. The challenge is mainly in the urban areas with rapid population and peripheral growth.

Census cartographic mapping: Census mapping supports enumerators and supervisors to carry out their specific assignments that include identification of enumeration areas, location of households, agricultural holdings, establishments and demarcation of supervisory areas on the basis of size, population and manageable distances.

Census mapping assists in eliminating omission and duplication of information; ensuring that data are allocated to the proper administrative units; determining the number and distribution of census personnel; and comparing data from other censuses or surveys. Maps are needed during all stages of a census or survey. They are required in the planning stages, data collection and analysis and presentation of the results.

This process involves conducting quick counts of households in localities and demarcating localities, parts of localities or a combination of localities as EAs depending on the number of households as prescribed by the census/survey methodology.

Listing and segmentation: The Cartographic section in the CGIS division plays a crucial role in the implementation of every survey conducted by the office irrespective of whichever division is coordinating that survey. Most surveys/research require listing of households before the commencement of main data collection. Segmentation of Enumeration Areas (EAs) exceeding the normal 80-120 households is required if enumerators should be given equal work loads.

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

Geocoding of Housing unit location (Dwelling Frames, Housing Footprints), collective living quarter locations (Dwelling Frames, Housing Footprints) a set of digital enumeration area maps or derived dissemination units, which are designed to enable the production of all output products that will be disseminated to government departments and the general public.

Geocoding of Geographic boundary files in a digital format for all statistical reporting units for which census indicators will be tabulated. Listings of all statistical and administrative reporting units, including towns and villages, their variant names and geographic coordinates. Geocoding of Geographic equivalency files that indicate how current reporting units relate to those used in previous censuses, or how one set of reporting units relates to another set as well as the Geocoding of vector layers containing feature data, such as landmarks, roads, schools, hospitals and clinics, which can be used when analysing population data spatially. Geocoding was used to determine the Centroid files that provide a representative geographic point reference for each reporting unit. It also provided for gazetteers that provide geographic coordinates for all population settlements and other important geographic features in the country

Principle 3. Common geographies for the dissemination of statistics

A spatial geographic database, with polygonal and attribute information for the enumeration areas of the country (i.e., 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 can be released at the EA level or aggregated into new small-area dissemination units, such as population clusters. The

division has a lot of products that are made available to MDAs and the general public; some for free and some for a fee which is basically on a cost recovery basis. Some of the products developed include:

- The new Map of Sierra Leone showing Regions, Districts, Chiefdoms and sections (these can be in A0, A1, A3, A4 and customized sizes);
- Shape files for a wide range of GIS data;
- Geospatially enabled statistical databases:
    - For all educational facilities across the country;
    - For all health facilities across the country
    - Of census data and other household survey datasets.
- For all localities, major roads, rivers, and social amenities.

Principle 4. Statistical and geospatial interoperability

A library of digital administrative boundaries, ranging from the provincial to the municipal levels (perhaps even at the level of the land parcel). Digital census atlases, dynamic atlases and spatial analysis techniques have been deployed.

Principle 5. Accessible and usable geospatially enabled statistics

Know the ease of accessibility (geometry, perimeter, compactness) within districts as well as the dentification of gaps and overlaps of the already existing district and locality boundaries.

South Africa

Name of Agency: Stats SA
Submission From: NSO

The Overall Implementation of the GSGF

At Stats SA, the GSGF, is a strategic initiative of the organisation, to deliver the organisation's vision namely …improving lives through data ecosystem. It will form the framework to collect, maintain, disseminate, and analyse spatial-statistical information.

Note, all Principles of the frame are incorporated in the organisation's GIF (Geo-spatial Information Frame). GIF is what our geographical frame is commonly known as at Stats SA.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The address data is getting focus currently for the upcoming census. Focus on maintenance and updating. Fundamental base data is continuously received to update the address data. In this was the Enumeration Areas will be updated where change is required. A geographic hierarchy of features representing the country's configuration has been adopted as a framework for the geodatabase.

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

The upcoming census requires the update of enumeration areas and place names. The address data and other fundamental data (like satellite and other photography) are used. Following the onset of Covid-19,

a strategic decision was made to adopt a multi-purpose frame to facilitate multi-modal data collection using face-to-face, telephonic and web-based self-enumeration approach. Such a frame would comprise geocoded contact details of households and institutions to enable remote data collection.

Principle 3. Common geographies for the dissemination of statistics

Stats SA works closely with the national demarcation board. Geographies are continuously maintained. Small Area Layer (SAL) was adopted for dissemination purposes. Since the President of the Republic announced the District Development Model (DDM) approach, the plan is to transition our dissemination using the DDM. The DDM is the sub-regional approach intended to provide data and planning at a more granular level of geography.

Principle 4. Statistical and geospatial interoperability

The address data and enumeration area will enable linking with census, survey and other data. In institutionalising the interoperability, an organisational structure alignment has been adopted where the Geography unit has been moved into the integrated bigger branch comprising Methodology, Standards, Business Register, Research and Innovation, thereafter renamed Methodology and Statistical Infrastructure. This development is aimed at getting Methodologists and Geographers to collaborate and work closely in ensuring the geospatial statistical frame (modified GIF) is effected.

Principle 5. Accessible and usable geospatially enabled statistics

2011 census data and its spatial information is still the main data used in analysis currently, especially in the case of low-level spatial analysis. Preparations to adopt the DDM layer to replace SAL are underway.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

YES. Stats SA has used spatial and statistical data to create a COVID Vulnerability Index.

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

Face-to-face data collection was suspended during COVID lockdowns for a few months. Face-to-face collection was resumed following the adoption of the Standard Operating Procedure that incorporate Covid-19 safety protocols. A mixed-mode data collection strategy was developed. It is dependent on a high-quality address frame linked to contact information like telephone numbers. The availability of contact numbers is a barrier to implementation, as well as the availability of standardised, updated geo-spatial addresses.

Uruguay

Name of Agency: INEGI

Submission From: Combined NGIA/NSO

The Overall Implementation of the GSGF

In Uruguay there is the Spatial Data Infrastructure (SDI), a decentralized body of the Presidency of the Republic, with technical autonomy, created by Law 19149 of 2013.

It has the articulating function regarding the production, documentation, access and use of the geographic information of Uruguay.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The SDI generates documents with technical specifications to be fulfilled by the GI producers, which they publish through geoservices that are made available on the institutional portals and the SDI portal.

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

The address base and internal addresses are being implemented in SDI with the participation of the state agencies that work on the issue.

Principle 3. Common geographies for the dissemination of statistics

At the level of the National Statistical System, it seeks to promote the same

Principle 4. Statistical and geospatial interoperability

Work is being done at the level of the National Statistical System.

Principle 5. Accessible and usable geospatially enabled statistics

With the next census it will be possible to georeference all the information at household level (in 2011, the households and rural establishments were georeferenced with the coordinates, and all the data was associated with administrative paperwork). From the census (which will be based on addresses generated by SDI) the data will be disclosed without violating the Statistical Secret Law.

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

To present the related information, the administrative limits generated by the Military Geographical Institute are used.

Implementing the GSGF: Experiences at the Regional Level

Africa

Name of Agency: UN-GGIM: Africa
Submission From: Regional Committee of UN-GGIM for Africa

The Overall Implementation of the GSGF

UN-GGIM: Africa has developed the African statistical spatial framework based on the five overarching principles of the GSGF. The framework is articulated around the following dimensions: Scale; Policy; Institutional; Modelling. Both national statistical offices and national mapping agencies can adapt, adopt, and apply the statistical framework to their national context, for instance in geo-enabling the national strategies for statistical development; in ensuring effective collaboration between statistical and geospatial community; in building basic data themes and use of common specifications and standards; and making geospatial analysis a core competency in any census office.

The Africa region has further gone to develop a strategy for the integration of geospatial and statistical information. The strategy outlines some of the policy principles on how to mainstream geospatial technology into the work of national statistical offices all the way through training, data and processes. UN-GGIM: Africa is now currently finalizing an implementation guide with operational guidelines that will inform on the establishment and implementation of national statistical geospatial frameworks (NSGF) with experiences and best practices for the proper integration.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

UN-GGIM: Africa is actively involved in the Second Administrative Level Boundaries (SALB) project, an initiative to provide the international community with a working platform for the collection, management, analysis, visualization and sharing of sub-national data down to the 2nd sub- national level, a very fundamental data for many applications (humanitarian assistance, censuses and statistical analysis, Environment, health, poverty mapping, etc.). The focus is on presenting the historic evolution of the administrative structure in terms of geography and names at the 1st sub-national level since January 1990 and at the 2nd sub-national level since January 2000. Despite challenges of currency and reaching out to all countries, Africa is on its way to have a continental dataset on administrative boundaries.

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

Geocoding of census data at the housing unit/building level provides an outstanding opportunity to aggregate census data at different spatial levels with high accuracy using GIS tools. Integration of the geospatial information with census data facilitates the computation of several SDG indicators, and the disaggregation and visualization of all SDG indicators by various levels of geography. The core dimensions of the African spatial and statistical framework have been designed to include the geo-referencing of place of usual residence to a pair of precise geographical coordinates and linked to an address point. Through ECA, the Africa region is currently developing avenues of integrating geocoding and spatial analysis of census data into census project document protocols. The effort will help

- Develop methods of linking geocodes with census tabulation plan

- Develop a procedure for geocoding and integrating geometric data collected during census cartographic phase into the geospatial analytical phase.
- Develop a step by step procedures for geocoding census data according to the following main and sub themes of a census: 1) Population size, distribution and structure; Household size and structure; Population projection; etc.

Principle 3. Common geographies for the dissemination of statistics

UN-GGIM: Africa has based its effort on the GSGF principles to assist many African countries to develop a solid geo-referenced (GPS) database of dwelling locations, clearly delineated enumeration area boundaries and a complimentary set of high-resolution satellite imagery.
Currently the region is developing a standard web-based application to record and edit geographic names in a harmonized manner for all African countries.

Principle 4. Statistical and geospatial interoperability

The benefits of developing, adopting and implementing technical standards and common metadata has been recognized by both statistical and geospatial communities, as they enable interoperability and facilitate the integration and use of diverse sources of statistical and geospatial data and services in all sectors of a global economy.

In an effort to encourage African countries to adopt a common regional framework of standards within the GSGF, UN-GGIM: Africa is developing through the Mapping Africa for Africa (MAfA) initiative, the African Metadata Profile which is a subset of the ISO 19115 Metadata Standard. The profile selects a set of metadata elements which are relevant for Africa. This effort contributed to the development of national metadata profiles at country level.

Principle 5. Accessible and usable geospatially enabled statistics

With the support of the 2030 Agenda for Sustainable Development Sub-Fund of the UN Peace and Development Trust Fund (UN-PDF), the Africa region has developed an online application, a standard web-based application built upon ArcGIS Online software for the storage, maintenance and visualization of national data. It features an interactive web-map interface having data visualization, simple query functionalities and database access, upload and update. Countries such as Cameroon has started making their geospatial datasets available for publishing, sharing and access under this interface.
https://ecageoinfo.maps.arcgis.com/apps/webappviewer/index.html?id=30af39551b2842da875bbe79014b5744

Your Response to COVID-19

How has the GSGF supported your regional response to COVID-19?

Drawing from the guiding principles of the GSGF, the region has built an African Dashboard that tracks the status of COVID-19 in real time. The dashboard is continuously updated with new interface and data. https://arcg.is/5LCSa.
Additionally, combining statistical and geospatial datasets a research study was carried out to map community mobility patterns in Africa. Thanks to the GSGF principles, the study provide the geospatial insights into changes in population movements as a response to policies aimed at combating COVID-19.

How could the GSGF have supported your regional response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

Should the GSGF being fully implemented both at regional and national level, this would have improved the readiness of Africa region in the use of geospatial information in the tracking of the COVID-19 outbreak and, also countries preparedness to provide tools and dashboard for data geo-visualization and impact assessment.

The Americas

Name of Agency: UN-GGIM: Americas

Submission From: Regional Committee of UN-GGIM for the Americas

The Overall Implementation of the GSGF

The project of Statistical and Geospatial Framework for the Americas (MEGA) is developed under the framework of the United Nations Regional Committee on Global Geospatial Information Management for the Americas (UN-GGIM: Americas), to promote and encourage the production of geographic and statistical information, as well as the identification, development and implementation of strategies for the integration and use, based on the strengthening of partnerships of collaboration, cooperation and participation of the Member States.

MEGA defines an information infrastructure made up of statistical and geospatial information connected and conceptually integrated to describe socioeconomic attributes. MEGA allows the integration of statistical and geospatial data in a unified way for the region with principles and standards, strengthening dissemination for decision-making.

MEGA is fully aligned to the five principles that establish the global statistical and geographic framework developed by the global expert group on the integration of statistical and geospatial information and that deal with access and use, interoperability, disposition through common geographies and georeferencing.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

The MEGA project is made up of administrative and statistical geographic units that facilitate the integration process.

The administrative divisions are commonly used and defined for all the countries. The statistical information included in the first version of MEGA is disaggregated at the municipal level. Each unit has an identifier that allows its location in a standardized and open cartographic format.

The process includes the spatial reference as one of the most relevant elements to consider geospatial integration. For the specific case of the Americas, the GGRF has the regional component SIRGAS (SIRGAS stands for The Geocentric Reference System for the Americas).

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

Most of the countries in the Americas use the political-administrative division for their frameworks. In this sense, the MEGA establishes three levels of territorial disaggregation:

1. Level 1: Corresponding to the country.
2. Level 2: Corresponding to the following territorial level after country.
3. Level 3: The next territorial level after level 2.

About the statistical information, MEGA includes the following indicators:

1. Total housing units
2. Total people
3. Total men
4. Total women

Each of these indicators is registered to levels 1, 2 and 3 defined in the geospatial information of MEGA.

Principle 3. Common geographies for the dissemination of statistics

The MEGA includes the statistical and geographic information available in each country according to the parameters established in the standardization document. The MEGA framework has defined as a unified service for display and to make queries at the local level (country, department/state and any other administrative units) and also at regional (country) levels.

America´s countries disposed of the political-administrative division information and the geographic metadata for each one of the three geographic levels included for the MEGA based on ISO 19115 standard.

Principle 4. Statistical and geospatial interoperability

The MEGA project can be used as support for different fields of knowledge, facilitating the exchange of information based on quantitative data and is a fundamental tool to assist in the tasks of analysis and interpretation by local and national governments.

The MEGA version 1.0 is a unified service, where the participant countries make available through the National Statistics Agencies and Cartographic Agencies, housing units and population data in a standardized format.

Principle 5. Accessible and usable geospatially enabled statistics

The MEGA has a viewer to facilitate the consultation, visualization and download of geospatial information classified by country or whole continent[47].

Your Response to COVID-19

How has the GSGF supported your regional response to COVID-19?

Yes, the GSGF has supported our regional response to COVID-19 by allowing harmonized and standardized geospatial information, specifically in the countries of Central America. These countries

[47] http://www.un-ggim-americas.org/mega_en/

calculated the COVID19 Vulnerability Index with the information available in each of them to strengthen the decision-making process of local entities, taking as input the geographic layers provided of the MEGA, whose technical specifications respond to the principles of GSGF. The barriers are associated with the availability of statistical information at the required levels.

Asia and the Pacific

Name of Agency: UN-GGIM Asia and the Pacific
Submission From: Regional Committee of UN-GGIM for Asia and the Pacific (UN-GGIM-AP)

The Overall Implementation of the GSGF

UN-GGIM-AP promotes the ESCAP-wide implementation of the GSGF. To this end, there are ongoing activities which include conducting pilot projects in member countries to enhance the capabilities of NGIAs, technical assistance to promote and assist in the application of the GSGF, Workshops and Training sessions towards capacity building at the regional level.

With the support of the UN-GGIM-AP's experts from regional Member States, a regional geospatial data platform was proposed, with the thought to connect geospatial data sources across the Asia-Pacific region and aggregate them onto an interoperable regional geospatial data platform through to 2030.

Under the overarching framework of the Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018-2030), the inclusive plan formulated by member countries is to leverage space applications for supporting sustainable development across six thematic areas. These are disaster risk reduction (drought and floods); natural resource management (land and water); connectivity (city/urban); social development (health and pandemics); energy (renewable energy); and climate change (environment and air quality). The platform will promote more open, interoperable and orderly sharing of geospatial data among countries and data users in the Asia-Pacific region.

Some countries are conducting projects to support national planning, geospatial data production and other reporting. For example, a National Territorial Survey is legally conducted every year to produce a range of spatial indictors related to population, economy, culture, transportation, environment, land use and other topics.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

To meet national geospatial development needs, many countries have proposed their own National Spatial Data Infrastructure (NSDI). The NSDIs would be the entities responsible for the technology, policies, standards, human resources and related activities necessary to acquire, process, distribute, use, maintain and preserve spatial data throughout all levels of government, private and non-profit sectors and academia. They would provide a structure of relationships among data producers and users and focuses on processes that facilitate data sharing.

Countries in Asia and the Pacific are either at different stages of implementing their NSDI projects or are yet to begin. Recently, countries have started research projects aimed at developing a new method to

produce location data of individual units within multi-occupancy buildings to improve the precision of geocoding.

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

Countries are in the process of establishing geocoding practices, and are being guided by development partners and institutions. Guidelines dictate that integration of statistics can take place at any stage of the statistical production process. The integration entails geocoding of statistics, spatial analysis and creating statistical maps. The experience in Asia and the Pacific has been that some counties make geocoded unit record data, which is maintained in-house and then statistics are developed.

Principle 3. Common geographies for the dissemination of statistics

Countries in the region are following recommendations for a common set of geographies to be used for the display, reporting and analysis of social, economic and environmental information. A digital earth concept of new remote sensed technology has been implemented. The technical infrastructure of this project is a synthesis of several state-of-the-art components including a remote sensing satellite constellation and a common geographically distributed system of remote sensing.

Principle 4. Statistical and geospatial interoperability

The key function of the NSDI is interoperability. The interoperability enables different formats of geospatial data to be connected, exchanged, accessed, and used in different systems, applications and devices in a coordinated manner by stakeholders. The NSDI can improve the accessibility to geospatial data and reduce the costs in geospatial data generation and maintenance. In the region, The International Committee on Global Navigational Satellite Systems (ICG) promotes interoperability and compatibility among global and regional systems to maximize user benefits and facilitate developing countries in realizing the SDGs more effectively.

Principle 5. Accessible and usable geospatially enabled statistics

Divisions within ESCAP collaborated on a publication which showcases the benefits and importance of the integration of geospatial data, existing statistics and ground-based information to deliver timely information necessary for stakeholders working towards sustainable development. Drilling deeper towards SDGs, the use of earth observation data to assess SDG indicators has been researched, and it was found that there are few countries using Earth Observation Data for SDG Indicators, with fewer countries in the Asia-Pacific region doing so. Countries have shared their experiences on tracking progress of SDG indicators with Earth Observation Data.

Countries within the region are already using Earth Observation Data to produce environment statistics, with others beginning to research how to do so. Overall, governments in the region have been actively developing national geospatial frameworks to guide the use and integration of geospatial information. There are ongoing activities which include conducting pilot projects in member countries to enhance the capabilities of National Geospatial Information Agencies

Your Response to COVID-19

How has the GSGF supported your regional response to COVID-19?

Space agencies in the region are providing Governments with vital location-based data, monitoring of key metrics and dashboards to facilitate decision-making. Countries with strong legal and regulatory geospatial frameworks and infrastructure, that already had systems and processes in place for collecting, managing and disseminating this kind of information were ahead of the curve. There is an initiative to Build Back after the COVID-19 Pandemic, and these activities will include an operational platform of integrated geospatial information for decision making, online trainings organized for member countries and good practices and improved platform to be shared with other countries.

How could the GSGF have supported your regional response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

If institutions could have easy access to data from screening clinics, business-related registers, business status and mobile population, it would be easier to provide more useful data for COVID-19 National response. The biggest difficulty described is the limitations to the immediate access to the various data sources when the needs arise. While measures involving geospatial information and Big Data have proven effective, it should be noted that the pandemic risks normalizing government use of invasive monitoring and surveillance systems with implications for the right to privacy.

Europe

Name of Agency: Eurostat – European Commission

Submission From: The Geographical Information System of the European Union

The Overall Implementation of the GSGF

Eurostat as an international body/organisation receives most of the statistical and geospatial data from the EU Member States and is therefore dependent on how the data is prepared and pre-processed by them. Where needed the Geographical Information System of the European Commission (GISCO) processes the data and develops additional components that implement the GSGF and the production of geocoded statistics. However, this was not systematically done using the GSGF as a guiding framework, yet.

Eurostat data is used to support the policy departments of the Commission in their decision-making. Most of our statistical data are geocoded by the EU Member States before sending them to us for the compilation of European statistics. Statistical data are spatially aggregated by NSOs before sending them to Eurostat.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

We maintain statistical geographies (the NUTS), national and regional administrative boundaries, local administrative boundaries and a grid system. Updates on the statistical geographies follow a legislative cycle of three years, while the administrative boundaries are updated annually. The grid is stable and does not receive any updates as it covers the current European extend. We work on establishing pan-European datasets on addresses, buildings and cadastral parcels.

Eurostat provides a geocoding service as a base for the fundamental geospatial infrastructure at the European level. This service is also available to EU Member States. Additionally, Eurostat makes global geocoding capabilities available to support policy making of the European Commission outside the EU.

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

In general, statistical data provided to Eurostat are aggregated and geocoded to the NUTS statistical geography where appropriate. We also maintain a collection of pre-geocoded city statistics. Eurostat does not receive statistical unit records that are geocoded to individual address points or other point level data.

Principle 3. Common geographies for the dissemination of statistics

We disseminate administrative boundaries at country, regional and local level and respective classifications (e.g. DEGURBA) and a statistical grid system to the public for the dissemination of statistics. For further information, please see:
https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data.
The administrative boundaries are agreed with the countries every year with the help of EuroGeographics (an independent international not-for-profit organisation representing Europe's National Mapping, Cadastral and Land Registration Authorities), so that harmonised geodata is used in the countries and in the Commission.

Principle 4. Statistical and geospatial interoperability

There is a need for interoperability, despite much of the work being done at national level. Commission services and EU agencies produce own statistical datasets. By offering reference data and corresponding tools such as the geocoding service and background maps, these services are encouraged to use the same underlying geodata as the Member States when producing statistics. Interoperability is ensured at the geospatial level by using/providing data according to the INSPIRE data models and as INSPIRE services/OGC-API/OpenAPI, while at the statistical level Eurostat provides data in SDMX/JSON-stat endpoints (https://ec.europa.eu/eurostat/web/main/data/web-services).

During 2020 and 2021 UNECE[48] contributed to improving interoperability between statistical and geospatial standards by convening a team of international experts to develop a geospatial view of the Generic Statistical Business Process Model (GSBPM). The resulting paper, known as the "GeoGSBPM", shows how geospatial data can be used throughout the statistical production process, and how the GSBPM and GSGF can be used in combination to produce geospatially enabled statistics. The GeoGSBPM was released in May 2021, and can be found at: https://statswiki.unece.org/display/GSBPM/GeoGSBPM.

Principle 5. Accessible and usable geospatially enabled statistics

Our statistics are available in Eurobase, the statistical database of Eurostat. Eurostat offers complimentary services such as various visualisation tools (Regional Statistics Illustrated https://ec.europa.eu/eurostat/cache/RCI, Statistical Atlas https://ec.europa.eu/eurostat/statistical-

[48] This paragraph was directly submitted by the United Nations Econonic Commission for Europe

atlas/gis/viewer), develops own visualisation capabilities (e.g. Eurostat-map.js), which is supporting a map-making tool based on the statistical information (https://gisco-services.ec.europa.eu/image), guidance on cartographic principles, and more. The services mentioned in Principle 4 are supporting the use and access of the statistics. Various organisations have developed libraries (e.g. python, R-project, both for GISCO services and SDMX,) to facilitate machine-to-machine access.

Your National Response to COVID-19

How has the GSGF supported your regional response to COVID-19?

We compiled a dataset of health care services in the EU, and performed an accessibility study by combining point data of the services, the population grid and the transport network. These data were aggregated to regional levels (NUTS 3, NUTS 2) and by Degree of Urbanisation. We also support other European Union services e.g. with background maps.

How could the GSGF have supported your regional response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?

We feel that a full geospatial infrastructure comprising more data for geocoding, particularly buildings and addresses, could have made much more detailed analysis possible. Moreover, for understanding mobility patterns and generate related statistics, access to mobile phone data would have been useful. Extending the coverage of the GSGF to such non-traditional geospatial data could be interesting.

Western Asia

Name of Agency: UN Economic and Social Commission for Western Asia
Submission From: Regional UN Economic Commission

The Overall Implementation of the GSGF

The Arab region is slowly making steps in the area of statistical and geospatial integration, noting the opportunity and significant benefits for every country. Arab national statistical systems are already transforming, or are planning to transform their statistical infrastructure, offering an opportunity to embed geography into their national systems and processes.

UN-GGIM Arab States has an active working group dedicated to the Integration of Geospatial and Statistical Information. UN-ESCWA plays a coordinating role by bringing together national statistical offices and national geospatial authorities to develop national statistical geospatial frameworks in accordance with the GSGF at the national/country level. By promoting the strategic use and adoption of geospatial and other innovative technologies, UN-ESCWA aims at helping member states build, transform, and develop their national statistical systems in accordance with United Nations recommendations, while considering the national circumstances of the Arab region. In this regard, UN-ESCWA and its partners in the region aim to build the capacities of Arab States through bilateral exchanges between countries, and develop cooperation to its full potential, going beyond occasional exchanges between national statistical offices and including inter-regional cooperation to enhance NSO's capacities to learn from each other.

In preparation for the 13th Session of its Statistical Commission, UN-ESCWA carried out in 2018 an Arab wide survey on "The Experiences and Practices of Arab countries regarding the Use of Geospatial Methodologies and Technologies, and the Dissemination of Statistical Data". While the survey was focused on assessing the status and readiness of Arab States to use technology in official statistics, some of its findings is still relevant to statistical-geospatial infrastructure. For instance, a sizable number of countries in the region are struggling to build their geospatial infrastructure in support of their census and statistical activities. In response to a question on the nature of geospatial framework use in NSO's activities, only two countries described having a national statistical geospatial framework in accordance with the GSGF.

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding and Principle 2. Geocoded unit record data in a data management environment

The ARABREF - UN-GGIM Arab States is leading a good work and a project on infrastructure through its working group (WG3) on the Geodetic Reference Frame. ARABREF is a unified geodetic reference frame for all Arab countries which will allow the unification of geodetic/mapping applications within the Arab region, without the need for transformation. It will also enable the use of GNSS for scientific and societal applications, and the interoperability of geospatial data exchanges and of multi-lateral geodetic/geospatial projects. ARABREF will be connected to and consistent with the International Terrestrial Reference Frame (ITRF), provide support to the Global Geodetic Centre of Excellence (GGCE), and abide by the recommendations of the technical committee ISO/TC 211 and its ISO 19161-1 on Geodetic references. The project calls for collaboration, sharing, and exchange of geodetic data between 10 participating Arab States through the setup of data and analysis centers. Continuously Operating Reference Stations (CORS) data will be uploaded to various data centers to store and archive GNSS CORS RINEX and metadata. Analysis centers were established for routine daily analysis of ARABREF CORS network, and the analysis of related geodesy data (e.g. geoid, gravity, leveling, tide gauges).

While there are many Arab national statistics offices that are already transforming and building statistical-geospatial information infrastructure which can contribute to the modernization of their statistical systems, some Arab countries are still struggling to go beyond the simple use of GIS in their census operations and integrate statistical and geospatial information. As such, only three countries indicated that main components of their fundamental geospatial infrastructure included WGS84/imagery as a basic layer in their geospatial framework, which is at the core of principle 1 of the GSGF. The UN-ESCWA survey also revealed that only three Arab States are using enumeration area geocoding at the point-based level, revealing another gap to be addressed and more support and capacity building to improve geocoding of enumeration areas.

Principle 3. Common geographies for the dissemination of statistics, Principle 4. Statistical and geospatial interoperability and Principle 5. Accessible and usable geospatially enabled statistics

UN-GGIM Arab States Working Group 3 on Fundamental Data and Geo-Standards has been leading a project since 2015 to develop a common geoportal for all Arab States. The Arab Geoportal was launched in 2019, it is a bilingual (English/Arabic) portal allowing the sharing and updating of data layers which currently include Points of Interest (POI) and Road networks layers for 7 Arab States. It will be expanded to more Arab states in the future and will be updated with additional layers covering geodetic control network, imagery, elevation, administrative boundaries, land cover, hydrography, addresses, geographic

names, land parcels, and utilities. The portal which can be accessed at: (http://geoportal.un-ggim-as.org/), adopted many standards in its design such as the Open Geospatial Consortium (OGC), the World Wide Web Consortium (W3C), the International Hydrographic Organization (IHO).

Supplementary Note on Regional Capacity building

Dedicated to awareness raising and capacity building, UN-GGIM Arab States Working Group 1 has collaborated with two member States to translate and disseminate the Integrated Geospatial Information Framework (IGIF) Part 1 (Overarching Strategic Framework) and Part 2 (Implementation Guide) to Arabic. This will enable awareness raising and future capacity building activities on the framework.

Institutional coordination to support statistical and geospatial integration in some Arab States is still underdeveloped, requiring a strong political commitment from all stakeholders. Cognizant of the fact that earth observation, geospatial data and geospatial information play a critical in enabling Arab States to plan for and monitor progress towards the SDGs, UN-ESCWA published a technical study[49] with operational guidelines that can inform on the integration of geospatial information with statistical information in support of the SDG Indicators. These guidelines define the basic foundations for building a statistical-geospatial information infrastructure and outline some policy principles on how national statistical, planning, and geospatial authorities can collaborate on the development of respective data infrastructures and related systems.

For more than a decade, the Arab region has been facing unprecedented instability which poses many challenges in undergoing traditional population and housing censuses. For security reasons, some areas may become inaccessible for the traditional enumeration process. In such cases, a "hybrid" census approach using geospatial datasets and available demographic data may be used to model population estimates in the absence of complete national census data. Against this backdrop, UNFPA Arab States Regional Office (ASRO), in partnership with the Arab Institute for Training and Research in Statistics (AITRS) and in collaboration with UN-ESCWA have developed a guidance note[50] on strengthening the integration of geospatial information in census in both development and humanitarian settings to strengthen the capacity of Governments in the Arab region in the use of geospatial information for the 2020 round of censuses. The same partners also held a workshop on "Strengthening Geospatial Capacity for Population and Housing Censuses"[51] focusing on topics such as: geospatial infrastructure in support of census activities, use of GIS at all census processes, hybrid census methodology, and interpreting hybrid census population estimates.

[49] UN-ESCWA, 2021, Integration of geospatial information with statistical information in support of the SDG Indicators, E/ESCWA/CL4.SIT/2021/TP.1, available at: https://www.unescwa.org/publications/integration-geospatial-information-statistical-sdg-indicators.

[50] UNFPA, AITRS, UN-ESCWA, 2020, Guidance Note on Strengthening Geospatial Information Support to the Census in the Arab Region, available at: http://www.aitrs.org/sites/default/files/GIS_Guidance_EN_2020.pdf.

[51] http://aitrs.org/en/node/822

Supplementary Documentation

Germany – Supplemental Note

Infrastructure for the integration of statistical and geospatial information: National recommendations based on an analysis of the Global Statistical Geospatial Framework

Executive Summary

The aim of official statistics is to provide information for the development of an informed opinion and as a basis for decision-making processes in a democratic society. Integrating statistical and geospatial information adds an important facet to this goal. Georeferenced information reflects people's real life at a small-area level in particular. This will facilitate enhanced and evidence-based decision-making processes. For this reason, a current requirement is to optimise, as far as possible, the framework for producing harmonised and standardised geospatially enabled statistical data.

Together with the Federal Agency for Cartography and Geodesy (BKG), the Federal Statistical Office (Destatis) has analysed and assessed the requirements and recommendations of the European Implementation guide for the Global Statistical Geospatial Framework (GSGF) in order to evaluate the situation in Germany and derive recommendations for action.

Evaluation of the five GSGF principles has shown that many requirements and recommendations of the European Implementation guide have been already implemented or are currently being implemented in Germany. A major part of the requirements of Principle 1 "Use of fundamental geospatial infrastructure and geocoding" and Principle 3 "Common geographies for dissemination of statistics" has already been implemented together by BKG and Destatis. However, there is still a great deal of "catching up" to do regarding Principle 2 "Geocoded unit record data in a data management environment", Principle 4 "Statistical and geospatial interoperability" and Principle 5 "Accessible and usable geospatially enabled statistics". The following priority actions are required based on the analysis:

Licence policy and open data

- Uniformly regulating the provision of addresses under an open data licence for the country as a whole

Availability of fundamental geospatial data

- Regulating the federal administration's use of the central address register
- Harmonising the framework for V GeoBund und V GeoLänder

Methodological questions concerning publication

- Prioritising methodological investigations within the network of statistical offices in order to identify appropriate confidentiality procedures

Geocoding

- Destatis, where appropriate supported by BKG, implements the measures concerning the national address register
- BKG refines the geocoding tools

Service-oriented data provision

- Evaluating new standards and technologies for service-oriented data provision

Small-area reference infrastructure

- Gradually developing a grid cell database at BKG and Destatis

In a next step, concrete measures will be developed to facilitate well-targeted and successful fulfilment of the requirements of action. Implementation is planned in the context of an exchange of views and ideas between BKG and Destatis regarding the action plan based on the 2016 Memorandum of Understanding, which usually takes place every year. The next exchange of views is scheduled for 2021. Where necessary, separate working groups will be set up for certain activities.

1. Introduction

Cooperation between the Federal Agency for Cartography and Geodesy (BKG) and the Federal Statistical Office (Destatis) is always based on the current needs of policy makers, businesses, public authorities and the general public.

The aim of official statistics is to provide information for the development of an informed opinion and as a basis for decision-making processes in a democratic society. Integrating statistical and geospatial information adds an important facet to this goal. Georeferenced information describes in particular situations and circumstances of people's real life at the local level. This will facilitate enhanced and evidence-based decision-making processes. For this reason, a current requirement is to create the conditions for producing harmonised and standardised geospatially enabled statistical data.

The relevant framework provided at the global level is the Global Statistical Geospatial Framework (GSGF) (see Section 2).

Together with the Federal Agency for Cartography and Geodesy, the Federal Statistical Office has studied the requirements and recommendations of the European Implementation guide for the GSGF in order to evaluate the situation in Germany and derive recommendations for action (Section 3).

The main results of analysis have been combined in a small number of central recommendations for action. These results are listed in Section 4. On this basis, measures are to be derived to further promote the national integration of statistical and geospatial information in terms of a modern technical infrastructure. This includes standardised, service-based and metadata-based workflows – from geocoding individual statistical data through to publishing the resulting products.

2. Basis

2.1. Global Statistical Geospatial Framework

In the light of monitoring progress towards the sustainable development goals and preparing the 2020 round of censuses, the United Nations Expert Group on the Integration of Statistical and Geospatial Information (UN EG-ISGI) was set up with the aim to prepare a global framework for better data integration.

This Global Statistical Geospatial Framework has been available since 2019. The GSGF is designed to facilitate the production of harmonised, standardised and georeferenced statistical data. This goal is defined more precisely by five principles which are supplemented with so-called key elements (see **Error! Reference source not found.**). The resulting data can then be integrated with further statistical, g eospatial and other information to enable information and data based decision-making processes.

The document describes the prerequisites for and methods of successful integration of statistical and geospatial data. It comprises a detailed description of the framework, including a complete and consistent description of the inputs, five principles and four key elements.

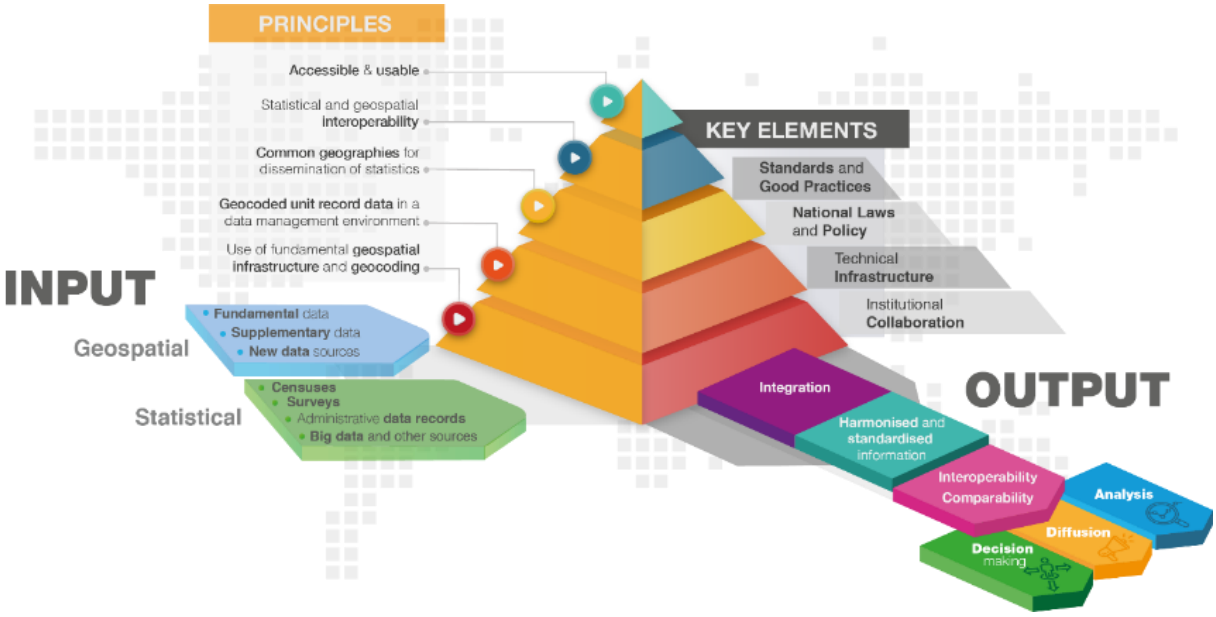


Figure 31 The GSGF (figure taken from the Global Statistical Geospatial Framework, page 5)

2.2. Implementing the GSGF in Europe

To provide a European GSGF perspective, the European Statistical System (ESS), together with European surveying and mapping agencies, developed an implementation guide (GSGF Europe) in the framework of the GEOSTAT 3 project.

The guide sets out requirements and individual recommendations for implementation for each of the five GSGF principles (see Implementation guide for the Global Statistical Geospatial Framework in Europe, pp. 70-85). The GEOSTAT 4 project was launched in February 2020. Its purpose is to propose more concrete guidelines and measures for implementing the recommendations of the GSGF Europe. National analyses and considerations regarding the European recommendations are explicitly welcome and will be incorporated into the project.

3. BKG and Destatis analysis

The GSGF Europe requirements and recommendations form the basis for evaluating national progress in integrating statistics and geospatial information and, where necessary, for developing appropriate national measures. A joint BKG and Destatis working group has analysed the requirements and recommendations in relation to the situation in Germany.

Figure 32 below shows the relevant schematic relationship:

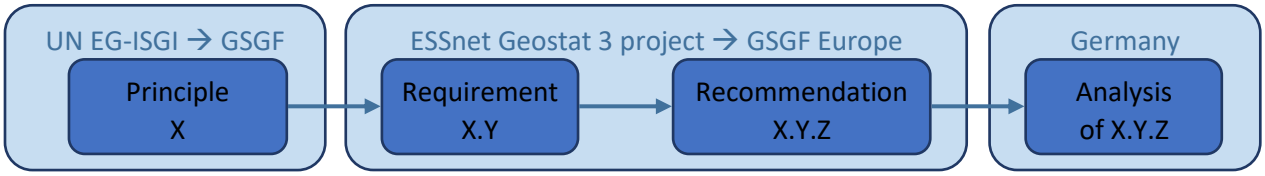


Figure 32 Relationship between principles, requirements and recommendations

Each recommendation was analysed and assessed in three areas, namely "Organisation/framework/ law", "Methods" and "Technology/standards" and, where required, a need for action was defined.

The degree of detail of the recommendations, covering the whole range from geospatial data management through to publication, varies. And there are redundancies between some recommendations. For this reason, the present recommendations for action are not structured along the lines of the corresponding GSGF Europe numbering. In the following Chapter, the findings are rather summarised to provide central requirements. Reference is made in brackets to the respective GSGF Europe recommendations.

Actions are currently not required regarding some of the recommendations. These are not outlined in this report. Some recommendations are currently already being implemented in the framework of joint activities. Here reference is made to the bilateral BKG and Destatis action plan.

4. Requirements faced by BKG and Destatis

4.1. Licence policy and open data

Successful implementation above all depends on the data and data availability. Compilation and dissemination of fundamental geospatial data[52] are coordinated both by working groups of the Federation and the Länder set up for the different domains and within the hierarchy of spatial data infrastructures. Their views differ especially in terms of costs and licences. Open data have been defined as a political goal by the German Federal Government. Not least due to the Open data directive of the European Union (Directive 2003/98/EC on the re-use of public sector information), which was amended in mid-2019, the "open data"-question has recently gained momentum in public administration. The Federal Government is determined to develop a data strategy for Germany that will not only be a major element in promoting data-driven innovations, but also a module of a European vision for the data era. The Federal Cabinet has already adopted the key elements of such a data strategy of the Federal Government[53]. This also includes geospatial data.

Some Länder support the open data goal also with respect to fundamental geospatial data. Other Länder are clearly opposed to this; they insist that users should share part of the costs of collecting and

[52] Here the term "fundamental geospatial data" refers to geometries in a narrow sense (areas, lines, points). In this case the data of official land surveying authorities are meant. Geospatial data instead are all data with a spatial reference. This may also include statistical tables containing a regional code.

[53] Key elements of the data strategy: https://blog.cosinex.de/wp-content/uploads/2019/11/2019-11-18-pdf-datenstrategie-data-1.pdf

maintaining the official fundamental geospatial data. In this context, differences in licence models and fees have increasingly turned out to be an obstacle to the integration and use of geospatial data. At the European level, an amended version of the Open data directive was adopted in 2019. The directive stipulates that public sector bodies should make certain high-value data sets available free of charge. These high-value data sets can be expected to be defined in early 2021. This will probably concern a large number of fundamental geospatial data which the majority of the Länder have so far provided against payment only.

Open data make the re-use of administrative data much easier. However, the practical use of open geospatial data reveals some difficulties, too, as there are different licence models which are not fully compatible. The following actions are required in this area:

- BKG will support refinement of the national Data Licence Germany 2.0, which is currently often used for open administrative data, to ensure compatibility of the different open data licences. The data licences concerning combined source data for publishing statistical information and geospatial data should generally be as little restrictive as possible (recommendation 5.1.2).
- BKG is promoting a uniform regulation for Germany as a whole regarding the provision of address data under an open data licence (recommendation 2.5.4).

The following priority measure should be taken by Destatis and BKG:

- Uniformly regulating the provision of addresses under an open data licence for the country as a whole

4.2. Availability of fundamental geospatial data

There is a high additional demand for fundamental geospatial data at both national and international level. Eurostat has repeatedly expressed an interest in large-scale fundamental geospatial data from Germany and the other EU Member States. A focus of using these data in statistics is on geocoding, for which addresses are required in particular. Additionally, access to cadastral parcel geometries is needed for individual specialised statistics such as environmental statistics, construction, and construction prices. This additional demand has not yet been regulated satisfactorily in Germany as this information is provided against payment only. Furthermore it is necessary to maintain and provide 'historical' information on addresses and cadastral parcels. As a rule, the list of AdV licenced fundamental geospatial data products and services can be modified or extended by a decision of an AdV[54] plenary session, based on V GeoBund[55] (Annex 1). For projects in the official statistics network, the statistical offices require a uniform framework for V GeoBund and V GeoLänder[56] (Annex 2).

[54] AdV – Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland (Working Committee of the Surveying Authorities of the Länder of the Federal Republic of Germany)

[55] V GeoBund – Vertrag über die kontinuierliche Übermittlung amtlicher digitaler Geobasisdaten der Länder zur Nutzung im Bundesbereich (Agreement on the Continuous Transmission of Official Digital Fundamental Geospatial Data of the Länder for Use by the Federal Authorities)

[56] V GeoLänder – Vertrag zur gegenseitigen Nutzung amtlicher digitaler Geobasisdaten der Länder (Agreement on the Reciprocal Use of Official Digital Fundamental Geospatial Data of the Länder), which is important for official statistics when individual offices carry out tasks on behalf of the whole statistics network.

A general regulation regarding BKG's provision of fundamental geospatial data could also be included in the Federal Statistics Act (BStatG). Here a regular submission of fundamental geospatial data to the Federal Statistical Office for purposes of keeping an address register could be added in Section 13 (2) of the BStatG. The regulation is to be achieved in the course of the legislative process to prepare a register-based census. To ensure high data quality, the federal administration's use of the central address register must be regulated by law in addition to the general data provision.
The following actions are required in this area:

- BKG will use its best efforts in the AdV committee to ensure that, in addition to addresses, cadastral parcel geometries will in the long run be provided not only for geocoding purposes at the national level (Destatis and the statistical offices of the Länder), but also for use within the European Statistical System (ESS), that is, by Eurostat (see recommendation 1.1.2).
- BKG will use its best efforts in the AdV committee to encourage the AdV to work out a concept of responsibilities for cadastral parcel geometries along the lines of the existing address concept. The aim of the concept will be to define, in a transparent manner, the roles and responsibilities in collecting and maintaining information on cadastral parcel geometries. This also includes availability of 'historical' information on addresses and cadastral parcels (recommendations 1.1.4, 1.2.1).
- BKG will use its best efforts to ensure a uniform framework regarding V GeoBund and V GeoLänder (recommendation 1.3.2).
- The Federal Statistical Office will investigate whether a general regulation of BKG's provision of fundamental geospatial data is included in the process of amending the Federal Statistics Act (BStatG) next time (recommendation 1.3.2).
- The Federal Statistical Office will use its best efforts to achieve a basic legal regulation regarding the federal administration's use of the central address register (recommendation 2.5.5).

The following priority measures should be taken by Destatis and BKG:

- Regulating the federal administration's use of the central address register
- Harmonising the framework for V GeoBund and V GeoLänder

4.3. Methodological questions of publication

A whole range of methodological questions arises in the process of integrating statistical and geospatial data - from geocoding through to publication. The following actions are required in this area:

- A core set of statistical variables (e.g. total population) for a medium grid width (1 km^2) or other small-area statistics can only be published under an open data licence if statistical confidentiality is ensured as stipulated by the Federal Statistics Act. In this context, the question of an appropriate and common confidentiality procedure arises. As small-area data provide a higher information content, the need for keeping the statistical information confidential increases, too, when using these data. This contrasts with the widespread need and wish to use open data which have a fine spatial granularity and are rich in content. As a result, the complexity of confidentiality increases many times owing to the small-area perspective and the associated higher information content. With the aim to safeguard confidentiality, Eurostat prepared a Handbook on Statistical Disclosure Control. In the light of georeferencing, this handbook needs to be extended now. To

answer the question of which confidentiality procedures are most appropriate for which information, methodological investigations are being carried out at the global (UN EG ISGI) and the national level (Destatis) (recommendation 5.1.1).

- Today, in the European open economic area, a wide range of questions can no longer be answered at the national level alone. To permit useful cross-border analyses of international statistics, both a consistent basis for compilation and consistent confidentiality standards are needed. Here coordination between the national statistical institutes is necessary (recommendation 3.2.3).
- Recommendation 5.3.3 calls for priority of European over national statistics publications. Destatis is clarifying this recommendation and exploring ways of implementing it.

The following priority measure should be taken:

- Prioritising methodological investigations in order to identify appropriate confidentiality procedures

4.4. Geocoding

The coding of geospatially enabled information using geographic coordinates is a decisive step of integration aimed at providing georeferenced information at a small-area level for evidence-based decision-making processes.

The following actions are required:

- A national address register represents an important set of reference data for geocoding purposes (recommendation 1.2.3). Currently, the relevant efforts are being intensified. Concepts have been developed for both a permanent address register within the system of statistics (DAR) and a register of buildings and dwellings (GWR) in the form of a general administrative register. A decision is yet to be taken as to how these two registers can be used in combination in the future. For this reason, “a national register” will sometimes be referred to here in rather general terms. The activities aimed at setting up a national address register have been included in the action plan relating to the Memorandum of Understanding (MoU).
- The geocoding process requires a service-based and OGC-compliant infrastructure (recommendation 1.2.4). The geocoding tools provided by BKG and used by Destatis must be further refined to meet the requirements of statistics. To this end, the requirements need to be communicated by Destatis and then be taken into account by BKG. Views and ideas are shared in the Georeferencing sub-working group of the AG SteP[57]. BKG attaches high priority to this measure.
- Successful geocoding requires quality-assured input data (addresses). This validation should take place directly when the data are captured (recommendation 2.5.1). To ensure appropriate data capture validation, addresses should not only be compared but also be checked at the time of geocoding based on the stock of reference data used and irrespective of who captures or supplies the addresses.

[57] Georeferencing sub-working group of the Standardisation of Processes Working Group (AG SteP). The sub-working group discusses questions of process standardisation in the context of georeferencing. It comprises both Federation and Länder representatives.

- Common definitions and harmonised semantics are needed for successfully geocoding information from most varied domains. In some domains, this is already the case (e.g. streets, Official Municipality Code - AGS), while actions are still required in other areas (e.g. harmonisation of the spelling of addresses). Here common object models (ontologies)[58] should be created as a well-founded basis (recommendation 4.2.1).

The following priority measures should be taken by Destatis and BKG:

- Destatis, where appropriate supported by BKG, implements the measures concerning the national address register.
- BKG refines the geocoding tools.

4.5. Service-oriented data provision

A modern spatial data infrastructure (GDI) is essential to ensure sustainable integration of statistical and geospatial information. The data needed are made available via web services and can thus be accessed through standardised interfaces. The standards that are important for the spatial data infrastructure are mainly developed by the Open Geospatial Consortium (OGC). While special technologies were developed for the geospatial information sector in the past, the OGC has increasingly supported the general web trends more recently (cf. Spatial Data on the Web, an initiative of W3C and OGC[59]).

GSGF Europe generally recommends to explore the use of service-oriented distribution platforms, offer greater flexibility in terms of usability and support data access through a variety of interfaces via APIs. OGC-compliant services and non-proprietary formats (e.g. OGC Geopackage for file downloads) should be used for dissemination in order to ensure flexibility from an end-user perspective (see recommendation 5.2.1). As far as possible, these recommendations will be considered by Destatis and BKG in future developments. To further enhance the existing spatial data infrastructure, the following actions are required in particular:

- Geospatial services in a service-oriented architecture (SOA) are recommended for the standardisation of components used to create geospatial products. The national statistical offices should aim to share common tools (recommendation 4.1.6). Therefore, the creation of a GIS IT infrastructure at the Federal Statistical Office should be aimed at sharing specified, central and common components and tools in a well-considered, redundancy-free and well-defined overall system. Coordination with similar existing or planned applications (e.g. data hub, grid cell database, geospatial platform, address register) should be ensured when developing new applications.
- Under the banner of “Statistics as a Service” (SaaS), the efforts for service-oriented dissemination via APIs should be intensified in order to provide machine-readable open data formats for national statistics (recommendations 4.3.1, 5.2.4). This requires to monitor and, where applicable, to implement the related OGC developments regarding the introduction of new interfaces (OGC API).

[58] Ontologies are used to define the meaning of geospatial information in a structured manner (geosemantics).

[59] A basic document on the topic is available at: https://www.w3.org/TR/sdw-bp

Here the BKG activities are still at an initial stage. In addition Destatis, and where appropriate BKG, should encourage Eurostat to include SaaS in the ESS strategy.

- The potential of disseminating administrative and statistical geographies as Linked Open Data (LOD) should be explored (recommendations 3.1.5, 4.5.1, 4.5.3). Here a GDI-DE project is in place that is operated by BKG. However, further analyses will be needed to assess the extent to which the project results can be operationalised and used by BKG as a standard form of data dissemination.
- Definitions of common conceptual models for objects for both statistical and geospatial communities should be developed like, for example, ontologies for addresses and buildings (recommendation 4.2.1). Action is required to harmonise the spelling of addresses in particular. Generally, further developments regarding ontologies for LOD should be followed closely.
- Although the OGC Table Joining Services (TJS) standard has not yet been widely implemented, the geospatial and statistical communities should jointly take part in developing the standard and in consolidating and implementing it (recommendation 4.4.2). So far BKG has not yet tested the opportunities of TJS. The development of TJS 2.0 should be followed with the aim of potential implementation.
- To improve usability in GIS systems, simple geometries as specified by OGC and in ISO 19125 should be published (recommendation 5.2.5). The geospatial data as defined by the INSPIRE data models are partly too complex; the INSPIRE data models require complex geometries. Modern non-proprietary formats, such as OGC Geopackage, must therefore be introduced by BKG as standard formats. This is in line with the intentions of the “Spatial Data on the Web” initiative of W3C and OGC.

Technological development regarding service-oriented data provision is highly dynamic. It is sometimes difficult to guess which of the new standards will establish themselves in the long term. The options for action listed above need to be assessed against this background. Furthermore, the staff resources required by the individual options for action as well as the impact on well-established technologies must be analysed. For these reasons, prioritisation is difficult and will only be feasible after further analysis.

4.6. Small-area reference infrastructure

An appropriate organisational and technical infrastructure is needed to make exhaustive use of spatial references in all domains and phases of official statistics production. Comprehensive support is required especially in the context of small-area references as an essential addition to the “traditional” regional statistics, which are based on data at administrative levels down to municipalities.
In technical terms, an appropriate data management environment is needed for the permanent storage of geocoded data, including associated linkage and analysis options - and, consequently, database technologies with supplementary functions for processing geospatial data. The following functions are of essential importance:

- Supporting INSPIRE-compliant geographical grids as statistical units.
  A grid with grid cells of 100 m x 100 m (“hectare” grid) provides the smallest possible permanent spatial reference for official statistics.

- Making sure that the grid cell IDs of common grid width can be related permanently to the regional codes of administrative and other territorial units used in official statistics
- Provision of “timestamps“ and ability to handle time series
- Recalculating statistical data across different territorial units
- Expanding this functionality by adding tools and procedures must be possible, if required.

The aim is to permanently ensure, to the extent permitted by law, the integrative use of data from different sources based on their spatial reference. This comprises the interlinking of data from various specialised statistical domains and the linking of statistical data with fundamental geospatial data from the official surveying and mapping agencies.
The following actions are required:

- Establishing a grid cell database with the INSPIRE-compliant “hectare” grid as the basic spatial reference frame for data management (recommendation 3.3.1) and an appropriate data management concept for efficient data use. This concept should comprise in particular functions for efficient aggregation and disaggregation of statistical data across geographical grids of different grid width, territorial units of different administrative levels, and other relevant spatial classifications of specialised statistics, such as river basin districts in the area of environmental statistics (recommendation 2.1.2). Such an infrastructure can serve as a basis for both standard publication programmes and flexible ad hoc evaluations (“Statistics as a Service“, see also Chapter 4.5). Integrating functions to safeguard statistical confidentiality would be desirable (recommendation 2.1.2, see also Chapter 4.3).
- Implementing procedures for the calculation of accessibility areas (distance and time), relating to the cells of the hectare grid - for example accessibility information for selected points of interest (POI) like important infrastructure facilities.
- Unlike geographical grids, most fundamental geospatial data are subject to changes over time - regarding administrative territorial units, for instance, this concerns continuous territorial reforms. To ensure full interlinkage, the grid cells of typical grid width must be assigned in all cases to the respective fundamental geospatial data and the interlinked codes stored centrally. Synchronisation workflows should be set up at the statistical offices (recommendation 2.1.3). Interlinkage must be feasible at any time between grid cells of any grid width and other spatial units if need arises.
- Surveying and mapping agencies should provide current fundamental geospatial data in a timely manner (recommendation 3.1.3) and, at the same time, build time series of historical fundamental geospatial data (recommendations 2.2.2, 3.1.6). To build time series or support historisation concepts, the underlying fundamental geospatial data must comprise standardised “timestamps” (validity period information). The surveying and mapping agencies of the Länder should be encouraged to ensure this - via the Working Committee of the Surveying Authorities of the Länder of the Federal Republic of Germany (AdV) (recommendations 2.2.2, 2.2.3).
- The permanent address register of official statistics (DAR), which is currently being set up, can be expected to play an important role for purposes of allocating small-area references, especially regarding historisation concepts, in the future, irrespective of whether the AdV launches activities concerning the requirements mentioned above (recommendations 1.2.3, 2.2.2). In the medium

term, the address register should be integrated into the infrastructure supporting small-area references. The addresses stored by the surveying and mapping agencies and BKG (house coordinates for Germany (HK-DE data) and georeferenced address data (GA data)) will serve as a major data source in setting up and maintaining the address register.

NB: The action plan, which is an integral part of cooperation between BKG and Destatis, includes already measures to meet the needs of action described above: 2019-6 “Grid cell database“ and 2020-3 “Further development of the address register”. Plans are already in place to implement identical grid cell databases for different groups of recipients at BKG (federal administration, possibly further target groups) and Destatis (official statistics). The Thünen Institute will provide scientific advice during this process.

Priority measure: Successively setting up a grid cell database at BKG and Destatis including the features described above.

4.7. International activities

Destatis and BKG are jointly represented in several international bodies performing geospatial activities: UN-GGIM, the Regional Committee of UN-GGIM:Europe, United Nations Expert Group on the Integration of Statistical and Geospatial Information (UN EG-ISGI) and Working Group on Integration of Statistical and Geospatial Information (GISCO) (at Eurostat). To be able to present joint positions in these bodies, close coordination takes place in the preparatory and follow-up phases of the respective meetings. In international terms, the main focus of future actions is on the European geospatial agencies’ creation of a European spatial data infrastructure. The goal is to provide fundamental geospatial data for use at the European level.

Actions are required regarding coordination and permanent operational implementation. As far as the latter is concerned, the ideas of the European Location Services (ELS) project coordinated by EuroGeographics[60] should be taken into consideration (recommendation 3.2.2).

5. Outlook

The evaluation has shown that many requirements and recommendations of the European Implementation guide have been already implemented or are currently being implemented in Germany. It can be stated that almost all recommendations concerning Principle 1 “Use of fundamental geospatial infrastructure and geocoding” are being implemented or have been implemented. However, there is still a great deal of “catching up” to do regarding Principle 2 “Geocoded unit record data in a data management environment” and Principle 4 “Statistical and geospatial interoperability”. A major part of the requirements of Principle 3 “Common geographies for dissemination of statistics” is already being implemented together by BKG and Destatis. More comprehensive action is required with respect to Principle 5 “Accessible and usable geospatially enabled statistics”.

Implementation has been and continues to be based on the action plan relating to the Memorandum of Understanding (MoU), which was agreed between Destatis and BKG in 2016 as a basis for organising and

[60] https://eurogeographics.org/maps-for-europe/open-els-project/

institutionalising close cooperation between the two authorities. The fruitful long-term cooperation between both agencies has been characterised by many products and projects that have been completed successfully or are still in progress:

- BKG provides current fundamental geospatial data at the national level, e.g. for the population census, or information on the size of areas and length of the road and rail networks.
- Potential options of using existing and future satellite and remote sensing data for statistical purposes are explored (Sentinel, Cop4Stat).
- Analysis projects are carried out on the basis of georeferenced statistical information.
- Destatis and BKG are partners in the area of data integration in the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM). A basic precondition for linking geospatial reference data with statistical information is the availability of the respective stocks of data at BKG and Destatis.
- The leading European conference on integrating statistical and geospatial information of the European Forum for Geography and Statistics (EFGS Conference in 2021) is organised jointly.
- Projects that focus on integrating statistical and geospatial information. An example is the creation of a generic database in which geospatially enabled information is stored based on a square 100 m INSPIRE grid.
- Including BKG as the first authority in Europe in the area of geospatial information and cartography in the list of Other National Authorities (https://ec.europa.eu/eurostat/de/web/european-statistical-system/overview). This list maintained by Eurostat comprises the National Statistical Institutes and, in addition, all national authorities which are responsible for developing, compiling and disseminating official statistics in the individual Member States.

On this basis, the results and recommendations for action compiled in the present analysis are summarised in few central requirements. Measures are to be worked out which, based on the recommendations for action, are aimed at optimising the national integration of statistical and geospatial data and establishing a modern technical infrastructure. The measures are to include standardised, service-based and metadata-based workflows - from geocoding individual statistical data through to publishing the resulting products.

The next step is to develop concrete activities that are aimed at implementing the recommendations for action. Usually, BKG and Destatis exchange their views and ideas on an annual basis to plan implementation of the action plan based on the 2016 Memorandum of Understanding. The next exchange of views is scheduled for 2021. Where necessary, separate working groups will be set up for certain activities.

India – Supplemental Note

Activities undertaken by India for the integration of statistical and geospatial information

1. It is well-appreciated that geo spatial layer on official statistics & socio-economic survey data will add visualization and easy interpretation of data by the user. Application of geospatial technology

in data visualisation will make monitoring mechanism more effective. If the common geospatial coding structure can be identified and agreed upon, which to a large extent already exists, the integration can make the statistics extremely relevant and pivotal. Different agencies in India are working in a complementary manner to enable and implement the integration of statistical and geospatial information.

2. While ISRO has developed geospatial data standards for India, the Survey of India has developed a High Resolution National Topographic Database (HR-NTDB) that can facilitate the integration. The Ministry of Statistics & Programme Implementation (MoSPI) is also working for adding Geo Spatial layer on various MoSPI data products, like the Consumer Price Indices, Economic Census, Urban Frame Survey in a phased manner etc.
3. Other Ministries, like the Ministry of Health and Family Welfare (MOHFW) and Ministry of Education, have also initiated a range of initiatives for creating geo- databases at micro level for improving overall quality, easy accessibility and better utility of the statistics of their respective domains. In the National Family Health Survey (NFHS) conducted by MOHFW, location (longitude and latitude) of the Primary Sampling Units (PSUs) are being recorded. These Geocodes are particularly useful in linking NFHS data to other important information on population, climate and environment factors etc. A Government to Government (G2G) web-based Monitoring Information System viz., Health Management Information System (HMIS) has also been developed to monitor the National Health Mission and other Health Care Schemes and to provide key inputs for policy formulation and appropriate programme interventions. Under this system, a provision through which a State can map its facilities as per its latitude and longitude and data can be rendered into a map (like heat maps) is under development phase and would be made live soon.
4. Similarly, D/o Higher Education, M/o Education is conducting an annual survey on all higher education institutions in the country in which geographical references (latitude and longitude) of institutions are being collected. Ministry of Tourism maintains geospatial information for approved Hotels and recognized Tour operators (Inbound, Domestic, Adventure), travel agents & tourist transport operators.
5. A more detailed discussion of these efforts is given in Annexure. However, certain proactive measures need to be taken to accelerate the pace of this integration of statistical and geospatial information. The measures can be described under two broad headings – (i) those related to the digital revolution which is accompanied by 'big' datasets and (ii) those related to the Global Statistical Geospatial Framework.

(i) Measures for taking care of new datasets emerging from the digital revolution

1. There is an immediate need for greater investments in ICT infrastructure.
2. Geospatial industry is moving from analysing and presenting discrete data sets towards working with streams of spatially-enabled data (e.g. real time location-based) so more focus needs to be diverted towards accuracy of field data.
3. To enable tabulations and spatial aggregations of statistical nation-wide datasets, to be referenced to any small geographic or administrative subdivisions up to village level boundary, updated large scale map is required. So, availability of imagery and further feature extraction needs to be carried out at a faster pace. Use of Machine learning and Artificial intelligence techniques needs to be adopted.

4. Institutional arrangements need to be put in place for operationalizing an integrated and coherent approach with other information infrastructures of other organisation.
5. The policy push is necessary at all levels this will help to initiate and harmonise the strategies and related regulations to achieve full integration.
6. It is important to have guidelines and a framework to manage and maintain the geospatial data throughout its lifecycle.

(ii) Measures for Implementation of the GSGF

7. The GSGF is a very good step towards global geospatial data harmonization and exchange.
8. For Global sharing of data, only gridded geography should be considered for all spatial information. For instance, for India, area estimations at Country level are best derived from Albers Equal Area projection.
9. While there is a benefit with gridded geography, some of the thematic information in India is in vector form. Appropriate methodology needs to be worked out for converting these data sets to gridded geographies.
10. Standards for temporal consistency should be achievable with methodology currently available for deriving information about a particular theme.
11. Launching a global level physical infrastructure to host open global geospatial data under GSGF will help preservation & curation of datasets.

Details of work done by different organisations for the integration of statistical and geospatial information

Indian Space Research Organisation (ISRO)

6. ISRO has developed geospatial data standards for India during 2005 and bought out NNRMS standards document with the active participation of experts drawn from various survey organizations across India. The title of the publication is "NNRMS STANDARDS: A NATIONAL STANDARD FOR EO IMAGES, THEMATIC & CARTOGRAPHIC MAPS, GIS DATABASES AND SPATIAL OUTPUTS", ISRO: NNRMS: TR: 112: 2005. This contains standards to be adopted in India for raster and vector data along with theme-wise standards for classification.
7. Under Natural Resources Census programme, geospatial mapping of various themes was carried out. Besides, themes like waste land mapping, ground water resources, etc were mapped with the funds provided by various Ministries. All the thematic information is spatially harmonized and hosted on Bhuvan Geo-platform for public visualization. Download access was also provided to selected outputs like satellite data, Digital Elevations Model, products generated under NICES program.
8. India has good technical infrastructure and institutional collaboration with respect to Geospatial data generation and use. Several national organizations like ISRO & SOI are engaged in geospatial data generation and analysis and are closely working with Ministries for customized geospatial data generation and solutions. Private entrepreneurs are also actively engaged in geospatial industry and have developed customized geospatial solutions to various users. Nowadays most of the detailed Project reports of any major project considers including geospatial inputs for site analysis.

9. ISRO has developed incubation centre at NRSC (Jeedimetla) for geospatial industry to support entrepreneurs interested in geospatial start-up.

Survey of India

10. The major challenge in the integration of statistical and geospatial information is that data from different sources with different semantics, data models, and acquisition methods requires data conversion and/or integration like data conflation. If standard spatial data model structure is not adopted, then integrating all the data generated under different project under one standard Spatial Data Model Structure (SDMS) is the foremost task.

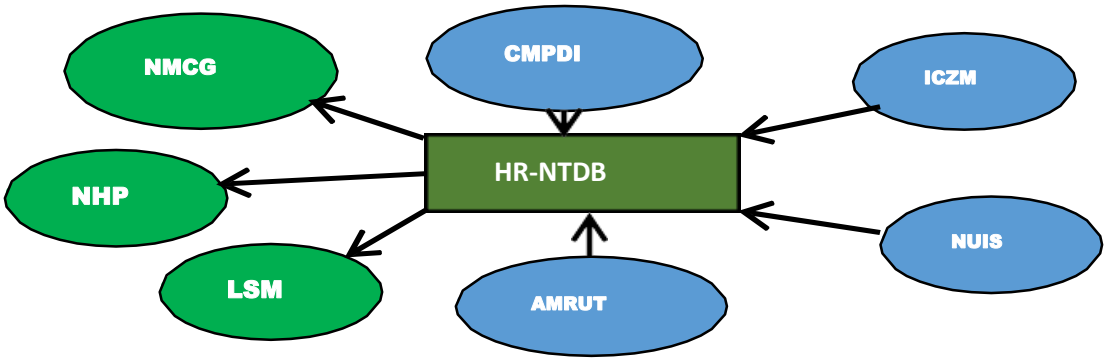


Figure 33 Data Model of the High Resolution National Topographic Database (HR-NTDB)

11. For example, in India, different projects like ICZM, CMPDI, NUIS, AMRUT (shown in blue) were generated with different Data Model structure, required to be integrated in one data model structure by carrying out re-engineering of structure. Therefore, some more features related to large scale mapping were been made integral part of the features in the data model structure and this new model was named as High Resolution National Topographic Database (HR-NTDB). Thereafter, for all new projects (shown in green colour), the features were assigned as subfeatures from the HR-NTDB. Further to above, the ICZM data was reengineered in to HR-NTDB and the data was hosted on the SOI portal over web on g2g.indiamaps.gov.in as shown below.

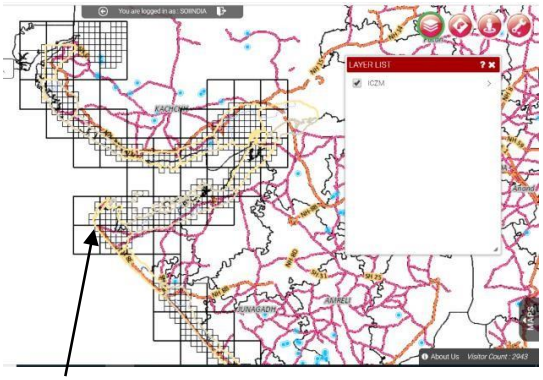


Figure 34 ICZM data on portal on the west side coast

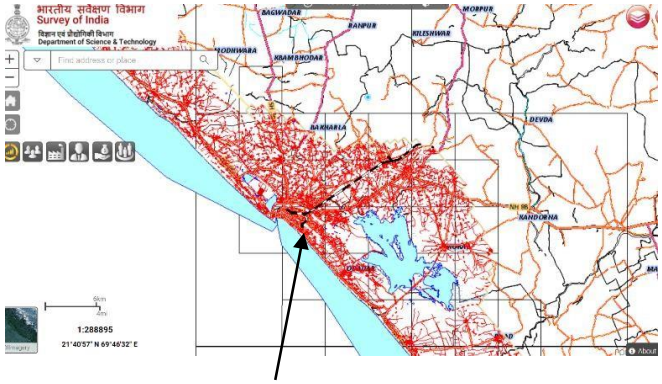


Figure 35 Zoom level

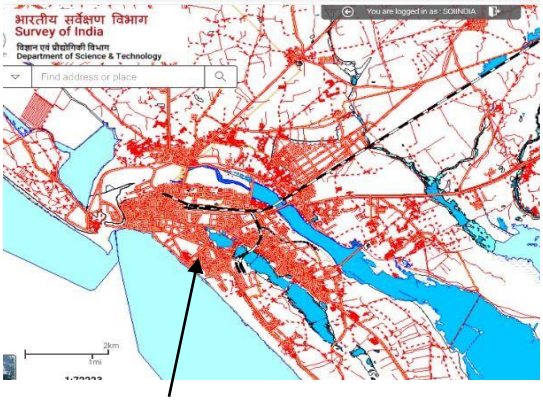


Figure 36 ICZM data

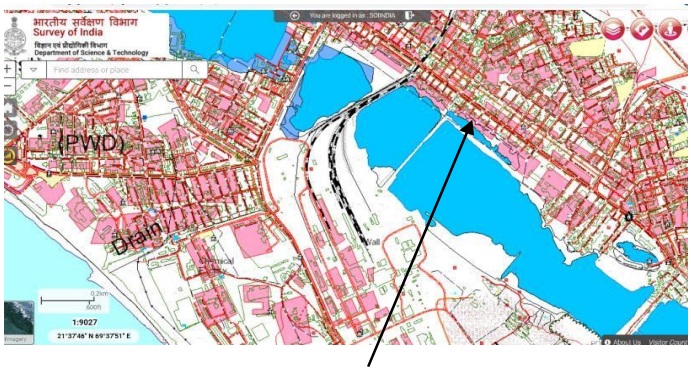


Figure 37 ICZM

12. A similar example of integration of data from varied sources is that of integration of SOI boundary data up to district level with the census data. The result with respect to indicators and year of census can be analysed as shown below.

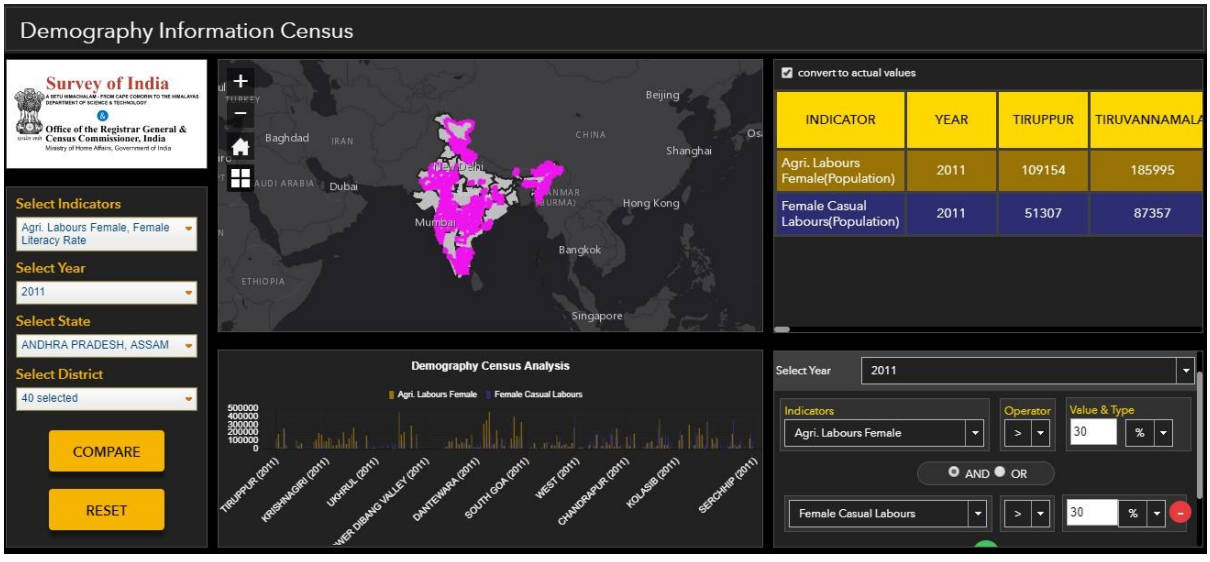


Figure 38 The integration of Survey of India boundary data up to district level with the census data

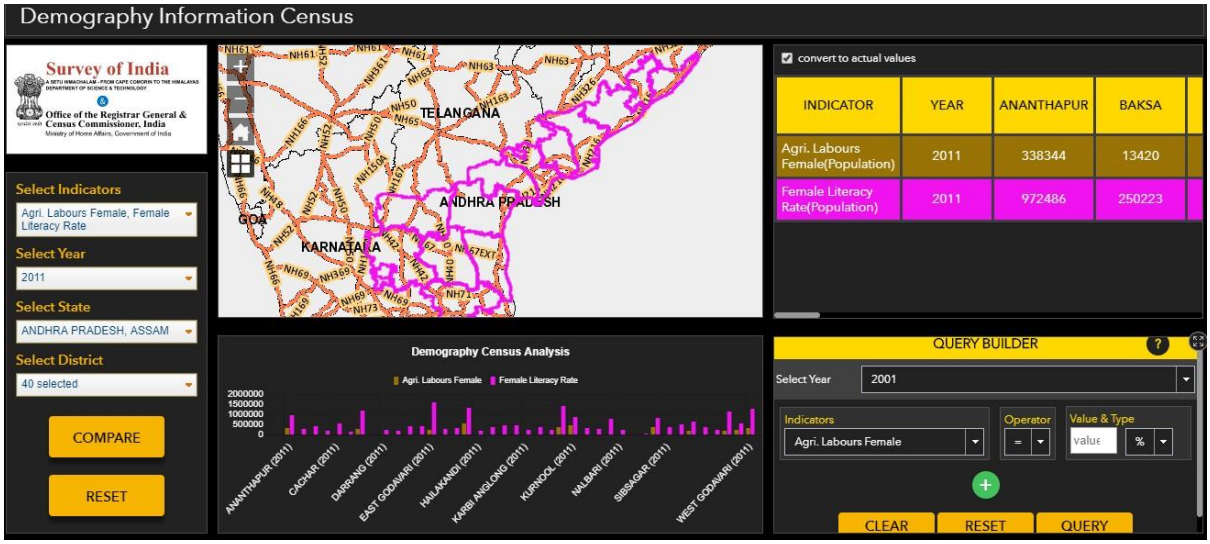


Figure 39 Analysis of Census data over base map of Survey of India on indiamaps.gov.in portal

13. The main purposes of this data-sharing framework are two-fold: one is to facilitate users to access data at the feature level from distributed sources, and to automatically propagate the updated features to users through portal web service, i.e., when the data are updated at one data source, that update would be automatically reflected in any data or applications that connect with it through web services.

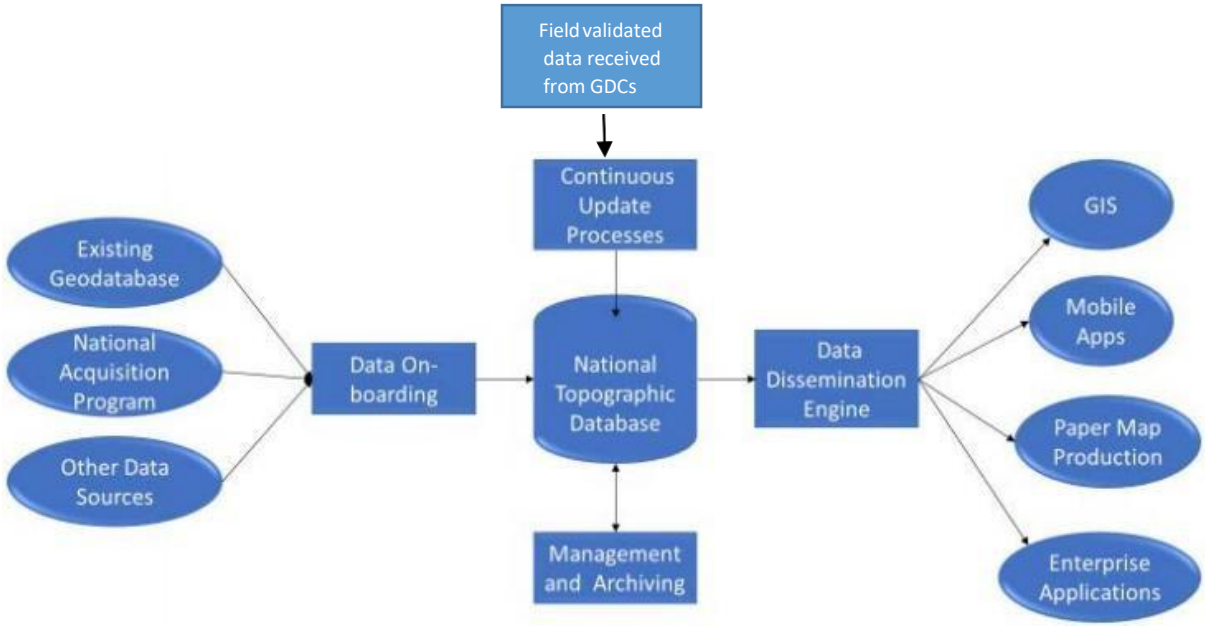


Figure 40 Database integration and standardization

14. To address the above issue, the main challenge is database integration and standardization were in data integration is a process of assimilating data from different sources and formats into a uniform format.
15. Several Ministries of the Government of India have undertaken the task of integrating statistical and geospatial information and are working on adding the geospatial layer to their data products in a phased manner. Assuming that similar frameworks are adopted by these initiatives, these

data products can allow for analysis across domains, enabling better decision making. Some of these initiatives are given in the following table:

Name of the Ministry	Name of the initiative	Remarks
Ministry of Statistics and Programme Implementation (MOSPI)	Consumer Price Indices	The future roadmap for CPI compilation includes collection of consumer prices through a Generalised Survey Solution (GSS) wherein the geo reference of surveyor as well as that of the surveyed outlets/markets are to be captured
	Seventh Economic Census	**The Census is a door-to-door enumeration exercise to locate establishments and obtain information on various economic parameters relating to them from each EC House across length & breadth of the country. In the seventh economic census, in addition to economic and locational details, each record also contains geospatial information.**
	Urban Frame Survey	Geo-referenced maps are being developed for UFS blocks, wards and towns for all the towns in India
Ministry of Health and Family Welfare	National Family Health Survey (NFHS)	In NFHS-4(200-15-16) and NFHS-5 (2019-20) survey, location (longitude and latitude) of the Primary Sampling Units (PSUs) were recorded using GPS instruments. These Geocodes are particularly useful in linking NFHS data to other important information on population, climate and other environment factors.
	Ayushman Bharat scheme	to help in identifying the underserved locations for establishing the health and wellness centers and tracking the effectiveness of various initiatives such as child immunization, management, control and pre-emptive steps taken to contain vector-borne diseases such as dengue and malaria[61].
	Health Management Information System (HMIS)	the sub-national governments can map their health facilities and track their performance for framing appropriate programme interventions under the National Health Mission and other Health Care Schemes.
Ministry of Education	Annual Survey on Higher Education	Geographical references (latitude and longitude) of all higher education institutions are collected.
	UDISE+	A data collection mechanism of School Education System in India, this records the location of each school. The location of schools is analysed by the Government vis-à-vis the population to find out sufficiency/ requirement of different types of schools (primary/ upper primary/ secondary/ higher secondary) as per norms fixed for this purpose.

[61] Ayushman Bharat PM-JAY, Best Practices and Innovations, 2019-20

Name of the Ministry	Name of the initiative	Remarks
Ministry of Tourism		The Ministry maintains geospatial information for approved Hotels and recognized Tour operators (Inbound, Domestic, Adventure), travel agents & tourist transport operators.
Ministry of Animal Husbandry, Dairying and Fisheries	Integrated Sample Survey (ISS) for estimation of livestock products	The survey is now being conducted online through an ISS App developed for the purpose and in this App, the location of each surveyed household is recorded by device GPS.
Ministry of Agriculture & Farmers Welfare	CHAMAN (Coordinated Horticulture Assessment and Management using geo-informatics)	remote-sensing datasets are combined with ground level data for better horticulture assessment and development[62]
	PM Fasal Bima Yojana	Under this scheme for agriculture insurance, geocoded information is used by insurance companies in assessment of the damage to crops by location, and faster and accurate processing of insurance claims in the event of a loss to farmers when their crops are destroyed due to flooding or drought.
	Soil Health Card Scheme	Soil Health Card provides information to farmers on nutrient status of their soil along with recommendations on appropriate dosage of nutrients to be applied for improving soil health and its fertility. The geo-tagged information has been used to develop and publish Soil Health Maps.[63]
Ministry of Rural Development	Watershed management	The Ministry has deployed Mobile App and Web Applications for online monitoring and evaluation of about 86,000 micro-watersheds in the country.
		Geo-tagged information to monitor the implementation of the programmes aimed at generating employment and socio-economic development of the area by creating/ monitoring infrastructures & assets in rural area of India and providing services for amenities.
Ministry of Jal Shakti (Water Resources)		GIS is an integral part of various water sector initiatives, from the perspective of not only planning the network from 'source to Tap' but also for effective water resources. Some States have established GIS based state level water data centers for addressing all water management issues – like, watershed management, aquifer mapping, surface and ground water

[62] https://www.ncfc.gov.in/chaman.html

[63] https://www.soilhealth.dac.gov.in/

Name of the Ministry	Name of the initiative	Remarks
		management.
	Accelerated Irrigation Benefit Program	Satellite data is used to monitor the inventory of canal network and other irrigation infrastructure.
Ministry of Environment, Forest and Climate Change	National Forest Management	Forest Survey of India has a regular system of integrating all forest-related information with geospatial information, to provide robust forest inventories
Ministry of Housing and Urban Affairs	National Urban Information System (NUIS)	Under the NUIS, geospatial thematic database (comprising of 12 layers) for 152 towns on 1: 10,000 scale and Aerial survey of 132 towns at 1: 2,000 scale have been developed for enabling formulation of Master Plans by state town planning departments.

16. **Geo-Portals**

Many Ministries/Departments of Government of India have developed various Geo-portals for data sharing, services and strengthen the E-learning process. Brief description of the few is as follows:

- **E-Nakshe** (https://soinakshe.uk.gov.in/Home.aspx) has been hosted by Survey of India, as a part of their web map service. This enables the Indian users to download SOI authenticated Open Series Map (OSM) on 1:50,000 scale free of cost for any part of the country.
- **BHARATH Maps** (https://bharatmaps.gov.in) is a Multi-Layer GIS Platform depicts core foundation data as "NICMAPS", an integrated base map service using 1:50,000 scale reference data from Survey of India, ISRO, FSI, RGI and so on. This encompasses 23 layers containing administrative boundaries, transport layers such as roads & railways, forest layer, settlement locations etc., including terrain map services. NIC established RS & GIS Division, in 1996 to carry out innovative projects in the emerging areas of Geographical Information System and Remote Sensing.
- **India Geo portal** (https://nsdiindia.gov.in/nsdi/nsdiportal/index.jsp) developed by NSDI has been increasingly making accessible the data holdings of various national agencies through interoperable geographic information services like Catalogue Service on Web (CSW), Web Map Service (WMS), Web Feature Service (WFS), and Web Processing Service (WPS). The metadata of the various States having State Geoportals have been also being linked to the Portal.
- **BHOOMI Geo Portal** (http://www.bhoomigeoportal-nbsslup.in) is developed by National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) which is maintained on the digital India platform by the name of soil information system maintained by National Centre of Geoinformatics. In the Geo-portal Bhoomi the soil and site characteristics in terms of polygon,

line and point data and administrative division of the country are arranged in systematic manner and the database structure is kept open to link cadastral boundary.

- **BHUVAN Web portal** (https://bhuvan.nrsc.gov.in/bhuvan_links.php)
- NRSCISRO launched the beta version of its web-based GIS tool, Bhuvan. It evinces the Indian Earth Observation capabilities from the Indian Remote Sensing (IRS) series of satellites. It is an interactive versatile Earth-Browser which showcases multi-sensor, multi-platform and multi temporal images with capabilities to overlay thematic information, interpreted from such imagery as a vector layer, along with near real-time information from Automatic Weather Stations (AWS), Potential Fishing Zone (PFZ) information, disaster support related information like forest fire alerts, periodic agricultural drought assessment etc.
- **KRISHI Geo Portal (**https://krishi.icar.gov.in **)** is Knowledge based Resources Information Systems Hub for Innovations in agriculture, is an initiative of Indian Council of Agricultural Research (ICAR) to bring its knowledge resources to all stakeholders at one place. It is being developed as a centralized data repository system of ICAR consisting of Technology, Data generated through Experiments/Surveys/ Observational studies, Geo-spatial data, Publications, Learning Resources.
- **VEDAS** (https://vedas.sac.gov.in) **-** Visualization of Earth observation Data and Archival System (VEDAS) developed by ISRO. VEDAS is an online geo processing platform using optical, microwave, thermal and hyper spectral EO data covering applications particularly meant for academia, research and problem solving. It also offers Mobile applications particularly Solar and Wind Calculator.
- **Biodiversity Information System** (https://bis.iirs.gov.in/) - National Biodiversity Characterization at Landscape Level, a project jointly sponsored by Department of Biotechnology and Department of Space, was implemented to identify and map the potential biodiversity rich areas in India. This project has generated spatial information at three levels viz. Satellite based primary information (Vegetation Type map, spatial locations of road & village, Fire occurrence); geospatially derived or modelled information (Disturbance Index, Fragmentation, Biological Richness) and geospatially referenced field samples plots. This relatively large spatial information on the above-mentioned facets of biodiversity has been organized in a web-based Biodiversity Information System (BIS) for prioritization, conservation and bio-prospecting. The major products are Vegetation Type, Fragmentation, Disturbance Index, Biological Richness spatial data on 1:50,000 scale for entire India and Phytosociological database for 16,000+ sample plots for entire India.
- **Indian Bioresource Information Network** (http://ibin.gov.in/) – IBIN, a project funded by the Department of Biotechnology (DBT), Government of India, has bio-resource data from distributed systems and online data search utility with geo-locations on dynamic maps.
- **India-WRIS** (https://indiawris.gov.in/wris/**) -** India Water Resources Information System developed using technologies like GIS and remote sensing, is a centralised platform to act as a repository of water resources and related data at National level with administrative granularity up to the smaller units of governance at state level as well as hydrological level such as basin and sub basins.

Template Questions

The following structure was used to guide responses to this section:

The Overall Implementation of the GSGF

The Implementation of the Principles of the GSGF

Principle 1: Use of fundamental geospatial infrastructure and geocoding

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

Principle 3. Common geographies for the dissemination of statistics

Principle 4. Statistical and geospatial interoperability

Principle 5. Accessible and usable geospatially enabled statistics

Your National Response to COVID-19

How has the GSGF supported your national response to COVID-19?

How could the GSGF have supported your national response to COVID-19, if it had been implemented? What were/are the barriers in its implementation?