The Global Fundamental Geospatial Data Themes

UN-GGIM

UNITED NATIONS
COMMITTEE OF EXPERTS ON
GLOBAL GEOSPATIAL
INFORMATION MANAGEMENT

The 14 Global Fundamental Geospatial Data Themes

The Front and back covers detail the matching of the 14 Global Fundamental Geospatial Data Themes to the 17 Sustainable Development Goals during the "International Workshop on Global Fundamental Geospatial Data Themes for Africa", UNECA, Addis Ababa, Ethiopia on 25 to 27 April 2018[1].

[1] http://ggim.un.org/meetings/2018-Addis_Ababa/

Department of Economic and Social Affairs

Statistics Division

Global Geospatial Information Management Secretariat

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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.

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.

Preface

This publication presents the Global Fundamental Geospatial Data Themes as 14 themes considered fundamental to strengthening a country's geospatial information infrastructure. UN-GGIM, at its seventh session under decision 7/104, adopted the proposed minimum list of global fundamental geospatial data themes. At its eighth session, the detailed theme descriptions were presented. An interactive presentation of the themes[2], developed by the UN-GGIM Secretariat, acts as a companion piece to this publication.

Implementing the themes will necessitate the integration of information from National Geospatial Information and Mapping Agencies, National Statistical Offices and other institutions to produce standardised, fundamental data, for use within Member States, and also, to support initiatives such as the implementation of the 2030 Sustainable Development Agenda and its 17 Sustainable Development Goals (SDGs). They are also a key supporting foundation for overarching policies, such as the Integrated Geospatial Information Framework.

The themes were developed by the Working Group on Global Fundamental Geospatial Data Themes[3] and led by UN-GGIM: Europe. This Working Group comprised representatives from national governments and international organisations. The work programme of the Working Group was conducted in a highly interactive and engaging process of consultation with all of UN-GGIM's Regional Committees, Subcommittee, and Working- and Expert groups, ensuring that where possible existing resources were used. During this consultation to establish the themes and their descriptions, there was a specific focus to consider the needs of small island developing states (SIDS) and that the themes were developed to be technical in nature.

[2] https://undesa.maps.arcgis.com/apps/Cascade/index.html?appid=4741ad51ff7a463d833d18cbcec29fff
[3] http://ggim.un.org/documents/Global_Fundamental_Geospatial_Data_Themes-TOR.pdf

Table of Contents

Introduction

Geospatial information is crucial for informed social, economic, and environmental decision making – the three pillars of sustainable development. However, geospatial information is often a scarce resource, if it exists at all. When committing to developing initiatives to collect geospatial information, there is a plethora of options for countries to explore; but what are the fundamental data needs that offer the best opportunity for a country to thrive? Africa, through the United Nations Economic Commission for Africa was the first to recognise this challenge and took the lead in developing fundamental geospatial data, with their publication "Determination of Fundamental Datasets for Africa"[4], with the definition "*Fundamental data sets are the 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 Africa at the local, national, sub-regional and regional levels".* This work was recognised at the global level by the Committee of Experts on United Nations Global Geospatial Information Management (UN-GGIM), which since 2012 has led work to develop Global Fundamental Geospatial Data Themes.

At its second session, held in August 2012, UN-GGIM considered an inventory of issues gathered by the Member States that should be addressed in the coming years[5]. At the request of the Committee, considerations were given to identifying a selection of immediate and prioritized 'key issues' that were seen as being the most relevant and important, and that could be considered realistic to make tangible progress within the next few years.

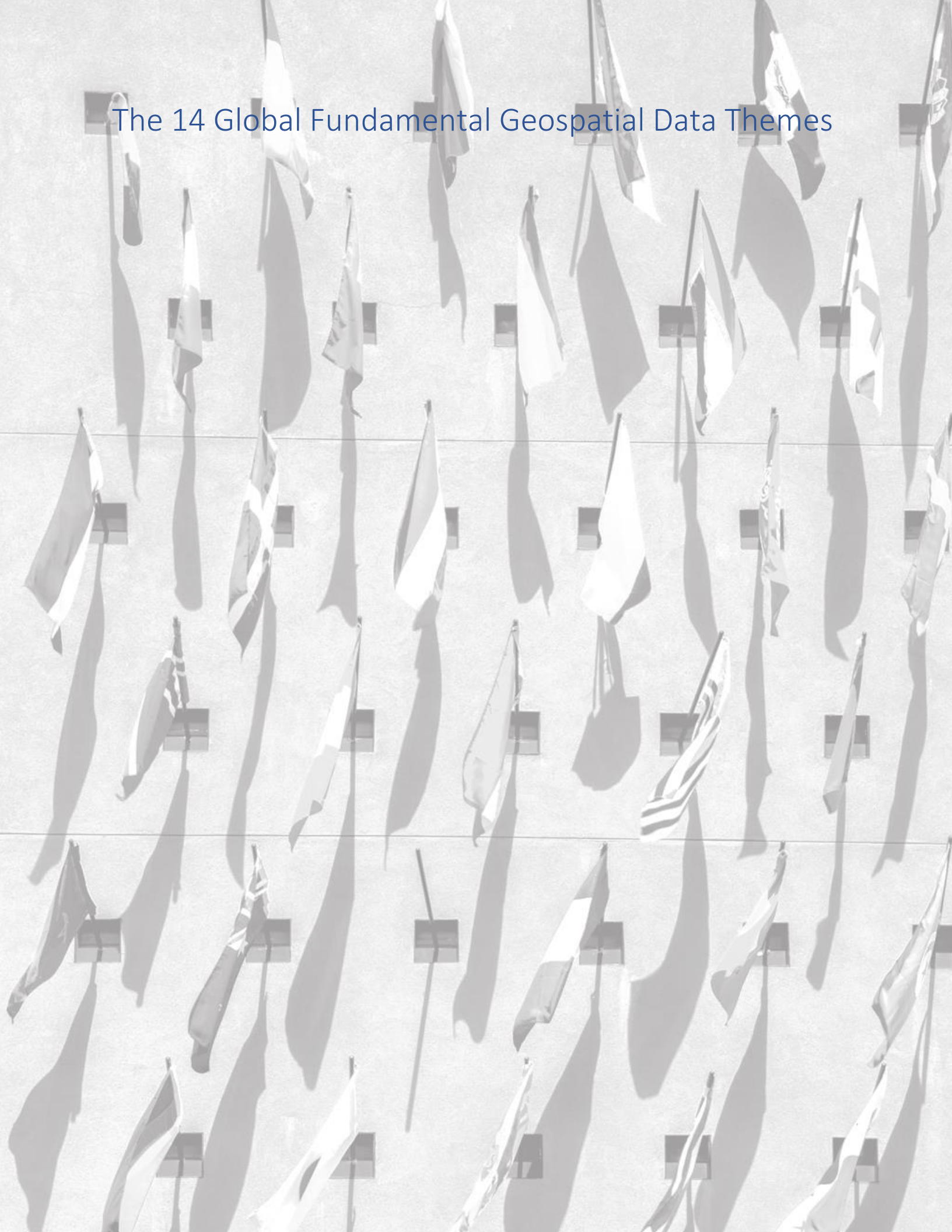
At its fourth session, held in August 2014, the Committee considered the report on determination of global fundamental geospatial data themes[6], and agreed that such data themes need to be integrated and harmonised from the national to global levels, and that actions should be taken in order for Member States and the international community to work jointly towards the preparation, improvement and maintenance of fundamental geospatial data themes, building on existing national and regional fundamental datasets. This urgent need was reinforced at its fifth session in 2015[7], where the Committee adopted decision 5/103, noting that there is "an urgent need for a set of global fundamental geospatial data themes that could be harmonized in order to enable the measurement, monitoring and management of sustainable development in a consistent way over time and to facilitate evidence-based decision-making and policy-making"

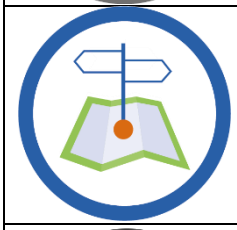
Accordingly, at its seventh session, held in August 2017, the Committee adopted decision 7/104, in which it adopted the proposed minimum list of 14 global fundamental geospatial data themes. Furthermore, at its eighth session in August 2018, the Committee welcomed the expanded theme descriptions.

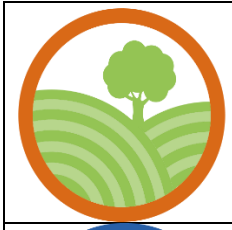
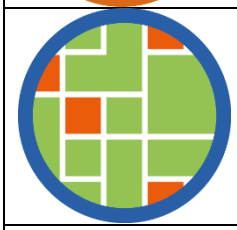
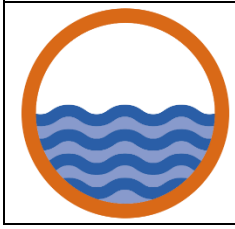
Now, in 2019, the 14 global fundamental geospatial data themes are a foundation to support global geospatial information management, notably used to support the integrated geospatial information framework, among other global initiatives to strengthen geospatial information. This publication provides key information on the themes and demonstrate what they are, how they can be used, and why they are fundamental.

[4] https://www.uneca.org/sites/default/files/PublicationFiles/geoinformation_socio_economic_dev-en.pdf
[5] E/C.20/2012/5/Add.1
[6] E/C.20/2014/4/Add.1
[7] E/C.20/2015/4/Add.1

The 14 Global Fundamental Geospatial Data Themes



Logo	Reference Frame	Brief Description
	Global Geodetic Reference Frame (GCRF)	The Global Geodetic Reference Frame is the framework which allows users to precisely determine and express locations on the Earth, as well as to quantify changes of the Earth in space and time. It is not a data theme in the sense of the other themes, but it is a prerequisite for the accurate collection, integration, and use of all other geospatial data.
	Theme	
	Addresses	An Address is a structured label, usually containing a property number, a street name and a locality name. It's used to identify a plot of land, a building or part of a building, or some other construction, together with coordinates indicating their geographic position. Addresses are often used as a proxy for other data themes such as Land Parcels.
	Buildings and Settlements	A Building refers to any roofed structure permanently constructed or erected on its site, for the protection of humans, animals, things, or the production of economic goods. Settlements are collections of buildings and associated features where a community carries out socio-economic activities.
	Elevation and Depth	The Elevation and Depth theme describes the surface of the Earth both on land and under a body of water, relative to a vertical datum.
	Functional Areas	Functional Areas are the geographical extent of administrative, legislative, regulatory, electoral, statistical, governance, service delivery and activity management areas.
	Geographical Names	Geographical Names provide orientation and identity to places. They are location identifiers for cultural and physical features of the real world, such as regions, settlements, or any feature of public or historical interest. They are often used as a proxy for other data themes such as Buildings and Settlements.
	Geology and Soils	Geology is the composition and properties of geologic materials (rocks and sediments) underground and outcropping at the Earth's surface. It includes bedrock, aquifers, geomorphology for land and marine environments, mineral resources and overlying soils. Soils are the upper part of the Earth's crust, formed by mineral particles, organic matter, water, air, and living organisms.

	Land Cover and Land Use	Land Cover represent the physical and biological cover of the Earth's surface. Land Use is the current and future planned management, and modification of the natural environment for different human purposes or economic activities.
	Land Parcels	Land Parcels are areas of land or more generally of the Earth's surface (land and/or water) under common rights (such as ownership or easements), claims (such as minerals or indigenous land) or use. This theme can include individual fields and cadastral parcels.
	Orthoimagery	Orthoimagery is geo-referenced rectified image data of the Earth's surface, from satellite or airborne sensors. Although technically not a theme in its own right, Orthoimagery is included as, when interpreted, it's a widely-used data source for many other data themes.
	Physical Infrastructure	The Physical Infrastructure theme includes industrial & utility facilities, and the service delivery facilities associated with administrative & social governmental services such as public administrations, utilities, transport, civil protection, schools and hospitals.
	Population Distribution	The Population Distribution theme covers the geographical distribution of people, including population characteristics.
	Transport Networks	Transport Networks are the suite of road, rail, air, cable and water transport routes and their connectivity.
	Water	The Water theme covers the extent and conditions of all water features including rivers, lakes and marine features.

Global Geodetic Reference Frame

The Global Geodetic Reference Frame (GGRF) is the framework which allows users to precisely determine and express locations on the Earth, as well as to quantify changes of the Earth in space and time. It is not a data theme in the sense of the other themes, but it is a prerequisite for the accurate collection, integration and use of all other geospatial data.

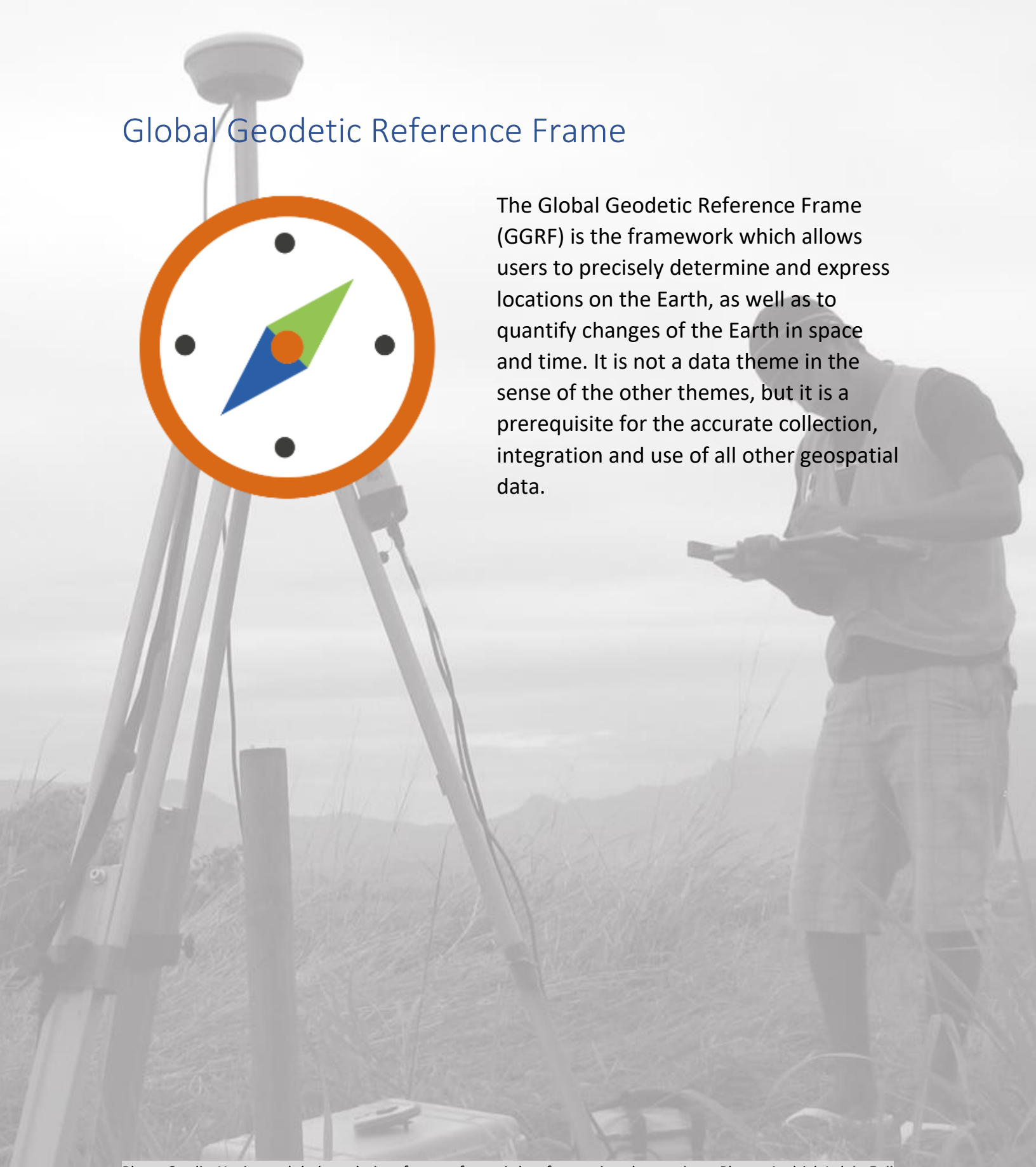


Photo Credit: Having a global geodetic reference frame is key for precise observations. Photo: Andrick Lal, in Fuji

Why is this theme fundamental?

Geospatial data is collected using diverse measurement and observation techniques, with varying levels of accuracy, and observed at different times. When this data is referenced to a Geodetic Reference Frame it obtains higher levels of usability, interoperability and therefore potential use. It allows the data to be confidently reinstated or integrated, and projected through time for use at a different epoch.

Which sustainable development goals (SDGs) will it help to meet?

Wherever geospatial data is used to contribute to a SDG, the Geospatial Reference Framework is an inseparable part. Geospatial data is most important to SDGs 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16.

Geospatial data features in more detail

The GGRF includes, but is not limited to: products that provide realisations of the international celestial and terrestrial reference frames (ICRF and ITRF); the component technique observing systems, data centres, analysis centres, and combination and product centres; gravimetric products and physical height systems; and the physical infrastructure and services that allow access to the Reference Frame.

The International Terrestrial Reference System (ITRS), the ICRF and the ITRF are the fundamental geospatial data features for a Geospatial Reference Framework. An ITRS is a spatial reference system that is co-rotating with the Earth. In such a system, positions of points anchored on the Earth's surface, together with continuous and episodal observations, define geospatial coordinates which undergo only small variations with time. The ITRF is a set of physical datum points with precisely determined coordinates in a specific coordinate system attached to the ITRS. Such an ITRF is said to be a realization of the ITRS. The rotation of the Earth is measured with respect to a frame tied to stellar objects, the ICRF.

Earth Orientation Parameters (EOP) connect these two frames together. Four main geodetic techniques are used to compute accurate coordinates; Global Navigation Satellite Systems (GNSS), Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS).

Many nations have national coordinate reference systems (Datums) for application within their country. Increasingly these national systems are being closely aligned to the ITRF which allows interoperability between data collected on these national datums with coordinates derived from GNSS systems.

Possible sources of data

- International Earth Rotation and Reference Systems Service (IERS): establish and maintain the ICRF and the ITRF.
- International GNNS Service (IGS): collects, archives, and distributes GNSS observation datasets.
- International VLBI Service (IVS): data required for the determination of the ICRF, the ITRF, and EOP.
- International Laser Ranging Service: weekly station coordinates and daily EOP estimates.
- International DORIS Service (IDS): reference frame station coordinates and velocities, satellite orbits, geocenter motion, and EOP.
- Many national governments and some private corporations: provide access to real-time and post-processed GNSS data streams and Satellite-Based Augmentation Systems (SBAS).

Existing data standards

- International and National Standards covering coordinate reference systems.

The IERS has a range of conventions that contain models, constants and standards.

Addresses

An address is a structured label, usually containing a property number, a street name and a locality name. It's used to identify a plot of land, a building or part of a building, or some other construction, together with coordinates indicating their geographic position. Addresses are often used as a proxy for other data themes such as Land Parcels.

Why is this theme fundamental?

Addresses underpin government administration at all levels; and good administration is a prerequisite for achieving sustainable development goals. An address is often the unit to which a public service, such as water, is provided. Addresses also enable effective communication with citizens; informing them of policies applying to them, and notifying them of relevant incidents. The theme also helps in managing buildings and properties, and supports social surveys. Datasets relating to individuals or households are often linked to addresses, which can therefore play a role in connecting otherwise-unrelated information. Geocoding addresses relates such information to geographic location. This allows for location-based data analytics and data mining.

Which sustainable development goals (SDGs) will it help to meet?

Addresses have been identified as playing a key role in the achievement of SDGs 4,6,7, 9 and 11.

Geospatial data features in more detail

The addresses theme comprises a single feature type, address, to which a variable number of attributes may be attached. Typically, in urban areas these comprise at least one locator (building, floor or apartment number and/or name), a two-dimensional geographic position and a number of address components which place the address within other features such as a road, a locality, an administrative unit or postal code. In rural areas the locator may be less precise.

Possible sources of geospatial data

Address datasets are usually maintained by public authorities. While data may be created and maintained at local level, it should ideally be compiled into a single national register.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE Data Specification on Addresses – Technical Guidelines 3.1;
- ISO 19160-1:2015 Addressing -- Part 1: Conceptual model;
- ISA Programme Location Core Vocabulary; and,
- ISO 19160-4(UPU, Universal Postal Union) Addressing--Part4: International postal address components and template language.

Buildings and Settlements

A building refers to any roofed structure permanently constructed or erected on its site, for the protection of humans, animals, things, or the production of economic goods. Settlements are collections of buildings and associated features where a community carries out socio-economic activities.

Why is this theme fundamental?

Buildings and settlements are the structures and locations in which populations live and carry out economic activity. As such this theme's main use is to locate population and its distribution. Settlements may be used at different levels of detail - from local to global.

Buildings and settlements are required for a set of fundamental use cases, including:

- Collection of statistics;
- Provision of public services to buildings;
- Resource management;
- Emergency management;
- Planning for urban development;
- Natural disaster (flood, earthquake, fire) preparedness;
- Validation for tax purposes; and,
- Application to mapping - to represent populated places and for navigation systems.

Which sustainable development goals (SDGs) will it help to meet?

It is strongly relevant for SDGs 9,11, 12 and relevant for SDGs 1, 3,4,6,7 and 13.

Geospatial data features in more detail

Buildings are independent, free-standing structures generally covered by a roof and enclosed within external walls. However, in some cases, a building may consist of a roof with supports, in some other cases, a roofless structure consisting of a space enclosed by walls may be considered a building. Buildings also include separately usable underground constructions which people can enter.

The Buildings and Settlements theme spans various scales or resolutions. The Building is at the more granular level, which at a smaller scale might be referred to as a 'built up area'. A settlement is formed by a collection of built-up areas, including dwellings, other buildings, and associated land.

Minimum attributes for both are the location geometry and an identifier of some type. Additional useful attributes of buildings include links to its address and its functional classification. For settlements additional attributes might include an indication of population size.

Possible sources of geospatial data

Building and Settlement datasets are usually maintained by public authorities, at national and sub-national/regional or local level. It should be compiled into a single national register. Building databases are used directly as a reference dataset for locating settlements.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE Data Specification on Buildings. Land Use, Land Cover and Geographical Names;
- CityGML; and,
- BIM Data Standards.

Elevation and Depth

This theme describes the surface of the Earth both on land and under a body of water, relative to a vertical datum.

Why is this theme fundamental?

This theme recognises the importance of integrated models describing a continuous surface for land and submerged areas (e.g. an integrated land-sea model). All human activities and natural processes are influenced by the elevation or the depth of the location where they happen. Elevation is essential to help determine appropriate places for human developments and activities, to map relief in 2D maps and to build 3D models, to delimitate drainage basins in hydrology, to map floodplain areas, to support national forest inventories, to forecast the propagation of physical phenomena (such as pollution, flooding, landslide risks, etc.) to understand ecosystems, and to understand climate change. Depth plays a key role in the effective governance, management, and safe and sustainable use of the oceans, seas and marine resources

Which sustainable development goals (SDGs) will it help to meet?

Elevation and Depth have a significant contributing role in SDGs 1,2,3,6,7,11,13, 14 and 15.

Geospatial data features in more detail

This theme contains vertical distances from a reference surface. It includes the shape of the surface of the Earth both on land and under a body of water such as oceans, seas, lakes and rivers. Elevations and Depth measure the distance and the shape of the Earth and its features in relation to a reference surface (datum).

This data is usually supplied in the form of Digital Elevation Models (DEMs), Digital Surface Models (DSM), contours, isolated points, break lines, point clouds etc.

Possible sources of geospatial data

National Mapping Agencies are tasked to collect, manage and disseminate the elevations of their territory. Comprehensive and authoritative national bathymetric datasets are maintained by national Hydrographic Offices or Authorities. A global bathymetric dataset of the seas and oceans is maintained by the International Hydrographic Organization (IHO) in its Data Centre for Digital Bathymetry (IHO DCDB), which, in turn, supports the General Bathymetric Chart of the Ocean (GEBCO) project. The commercial sector also collects and sells elevation and bathymetric data - usually to meet specific customer requirements.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE Data Specification and Technical Guidelines on Elevation;
- Guidelines DGIWG 116-1, Elevation Surface Model Standardised Profile, Edition 1.0.0;
- USGS Digital Elevation Model Standards;
- S-44 - IHO Standards for Hydrographic Surveys;
- S-57 - Transfer Standard for Digital Hydrographic Data;
- S-100 - IHO Universal Hydrographic Data Model; and,
- S-102 - Bathymetric Surface Product Specification.

Functional Areas

Functional Areas are the geographical extent of administrative, legislative, regulatory, electoral, statistical, governance, service delivery and activity management areas.

Why is this theme fundamental?

Functional areas relate to, and support, the organisation and management of people, communities, society, and their activities in geographic space. These areas arise from human decisions. Linking data to administrative and functional geographies provides the spatial component that further enables data integration and broader comparability. It's also the key to informing stakeholders on the status of international, national and sub-national policy objectives and programme goals/deliverables. As a result, they are the building blocks of many processes relevant to sustainable development goals. Functional areas form the link between data collection and implementation of actions. They can be used to visualise data, but also for analytical purposes and, if stable, trends over time. In the natural environment context (including marine) they are key units for implementation and monitoring.

Which sustainable development goals (SDGs) will it help to meet?

Functional areas are relevant for most, if not all, of the SDGs which relate to people, and marine administrative units are relevant for actions which apply to sea areas.

Geospatial data features in more detail

Functional Areas are essentially human-defined virtual areas, often organised in a hierarchical way. Their key attributes are: geometry, level (in the hierarchy), code, name, and function.

Functions include protected sites, planning zones, statistical units, flood zones, school catchments, agricultural zones, administrative areas, etc.

Possible sources of geospatial data

It's mainly government functions which require Functional Areas, so the data relating to them is usually available from public sources. These sources may be at different levels of government.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE Data Specification on Area Management/Restriction/Regulation Zones and Reporting units;
- INSPIRE Data Specifications for Administrative Units;
- INSPIRE Data Specifications for Statistical Units;
- INSPIRE Data Specifications for Protected Sites;
- ISO 14825 Intelligent transport systems-Geographic Data Files (GDF)-GDF5.0; and,
- ISO 19152: Land Administrative Domain Model (Spatial Unit Group).

Geographical Names

Geographical names provide orientation and identity to places. They are location identifiers for cultural and physical features of the real world, such as regions, settlements, or any feature of public or historical interest. They are often used as a proxy for other data themes such as Settlements.

Why is this theme fundamental?

Geographical names are used throughout the world as a geographic identification system and thus have potential to inter-relate and cross-reference disparate data sources, both spatial and non-spatial. Standardised geographical names are essential for effective communication between citizens, governments of all levels, decision-makers, and policy-makers.

Geographical names are often used for geocoding and mapping. The geocoding use case consists of transforming an indirect location identifier (here a geographical name) into a direct location identifier defined by a set of coordinates. Geographical names are the most common, understandable, and widely used entry-point for broader searches for geospatial data and information and are therefore, necessary as search criteria in gazetteers, geoportals, spatial data catalogues etc. Geographical names are also required for a wide range of topographical and thematic map output at any scale. They are necessary for a consistent communication and visualisation of any SDG related issue or action.

Which sustainable development goals (SDGs) will it help to meet?

The wide use of geographical names makes them relevant for all SDGs.

Geospatial data features in more detail

The Geographical Names theme may comprise attributes of feature types that are already in another fundamental geospatial data theme, such as Transport Networks or Water, and/or as feature types that are not yet in another theme. A named place (e.g. settlement, mountain, bay) may have several names in different languages.

Many named features have indeterminate boundaries but, where feasible, their delineation should be included.

Possible sources of geospatial data

National geographical names datasets are usually maintained by public authorities for features on land, coastal or marine areas. Additionally, many datasets are published by (semi-official) bodies with a particular goal (e.g. for certain region, languages, topics...).

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- Technical reference manual for the standardization of geographical names, (UNGEGN), 2007, ISBN: 92-1-161500-5;
- INSPIRE Data Specification on Geographical Names – Technical Guidelines 3.1;
- ISO 639 Language Code List for the language of origin of geographical names; and,
- UTF-8 character set (UNICODE) for the exchange of syllabics, diacritics and other special characters.

Geology and Soils

Geology is the composition and properties of geologic materials (rocks and sediments) underground and outcropping at the land's surface. It includes bedrock, aquifers, geomorphology for land and marine environments, mineral resources and overlying soils. Soil is the upper part of the Earth's crust, formed by mineral particles, organic matter, water, air and living organisms.

Why is this theme fundamental?

Geology data can reveal risks to population in the form of earthquakes, volcanoes and landslides; and opportunities in the form of aquifers, mineral and fossil fuel resources.

The interface between rock, air and water hosts most of the biosphere. Geology reveals the parent material for soils which is a key factor in vegetative land cover. This data can also analyse the potential and limitations for agricultural production.

As population increases, the need for – and understanding of – reliable and sustainable practices to provide food, fuel, and raw materials for economies is increasingly essential. Geology and soils information has the potential to better inform us about best practices in land management, hazard avoidance, soil erosion or salinity, soil pollution, nuclear waste storage, crop suitability, and conditions that affect the structural engineering of buildings.

Which sustainable development goals (SDGs) will it help to meet?

SDGs 2,3,6,7, 8, 9, 11, 12, 13, 14, and 15 require geology and soils data.

Geospatial data features in more detail

Geology is generally characterised according to composition, structure and age. It also provides knowledge about aquifers, i.e. subsurface units of rocks or sediments of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater. Aquifers have a cross linkage to groundwater in the Water theme.

Geology and Soils features and attributes will vary in significance by area. For example, soil order, permeability, and depth, and other factors that directly determine agricultural capabilities should be foremost in regions where agriculture does, or could, form a major part of the economy.

Soils include permafrost, wetlands, non-soil environments, and underwater sediments.

Possible sources of geospatial data

Geology:

- Global Lithological Map (GLiM);
- OneGeology; and,
- National Geologic Surveys.

Soils:

- Harmonized World Soils Database; and,
- National Soil Surveys.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

INSPIRE Data specifications on Geology, Soils and Mineral Resources:

- Geology: USGS NCGMP'09, and GEOSciML;
- Soils: FAO: World Reference Base for Soils Resources 2006; and,
- USDA NRCS SSURGO Data Model.

Land Cover and Land Use

Land cover represents the physical and biological cover of the Earth's surface. Land use is the current and future planned management, and modification of the natural environment for different human purposes or economic activities.

Why is this theme fundamental?

Land Cover data is required, for example, for developing land management policy, understanding spatial patterns of biodiversity and predicting effects of climate change. It may also help to forecast other phenomena, such as erosion or flooding. It is critical data in national assessments of biodiversity, conservation efforts, and water quality monitoring.

The use of the land informs land management impacts, especially on changes in natural resources, agriculture, conservation, and urban developments. Land cover and land use affect the greenhouse gases entering and leaving the atmosphere and provide opportunities to reduce climate change. It is required at a disaggregated level to allow local planning to manage and monitor land use at land parcel level.

Which sustainable development goals (SDGs) will it help to meet?

The theme plays a role in SDGs 1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 13, 14 and 15.

Geospatial data features in more detail

Land Cover includes artificial surfaces, agricultural areas, forest, semi-natural areas, wetlands and waterbodies etc. Land Use in some ways describes the human activities and the consequences of such activities on the landscape.

Both Land Cover and Land Use are separated into different classes based on an agreed classification schema which is usually hierarchical. The data can be represented either as polygons or as a raster. It may also be found as attributes of a land parcel.

Possible sources of geospatial data

Classified Earth observation (EO) data, potentially as a Data Cube;

National datasets relating to environmental information and land parcels; and,

International organisations, Regional United Nations Centre, different levels of public authorities (in particular municipalities) and the private sector.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- ISO 19144-1:2009 – Geographic Information Classification system – Part 1 Classification system structure (last reviewed in and confirmed in 2015);
- ISO 19144-2:2012 - Part 2 - Land Cover Meta Language (LCML) (there are limitations on this standard);
- ISO 19115:2003 Geographic information – Metadata; and,
- INSPIRE data specification on Land Cover and on Land Use.

Land Parcels

Areas of land or more generally of the Earth's surface (land and/or water) under common rights (such as ownership or easements), claims (such as minerals or indigenous land) or use. This theme can include individual fields and cadastral parcels.

Why is this theme fundamental?

Land parcel data is required for land management, infrastructure management and spatial planning. They are a necessary part of a good secure land tenure system which in turn contributes to economic development by enabling investments. At a local level they may be used as basis for taxation that often provides the necessary funds needed to ensure basic services to the inhabitants. Land parcels are necessary for agriculture improvements, such as land policy and land reform.

If there is a unique, commonly-adopted parcel reference it can form a common link between many other data topics.

Which sustainable development goals (SDGs) will it help to meet?

Land parcels are a powerful governmental tool to achieve many SDGs, including 1.4, 2.4, 8, and 11.1.

Geospatial data features in more detail

The Land Parcels theme mainly comprises the feature land parcel with three basic attributes:

- The geographic location;
- A unique identification of the parcel; and,
- The type of parcel (may be implicit).

Other information may be attached to land parcels, such as land use or land cover. It is also recommended managing the land parcel's temporal information.

Land parcels may be associated with land registries (or equivalent) that establish the rights (and possibly the restrictions and responsibilities) that a party (a natural or legal person) has on a land parcel - on ground, below ground or above ground.

Possible sources of geospatial data

Land parcel data is frequently found in registers supporting the land tenure and transfer system of a country. It may also be part of a taxation or planning system.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE Data Specification on Cadastral Parcels – Technical Guidelines 3.1;
- ISO 19152: Land Administration Domain Model; and,
- International Land Measurement Standard (ILMS).

Orthoimagery

Orthoimagery is geo-referenced rectified image data of the Earth's surface, from satellite or airborne sensors.

Although technically not a theme in its own right, orthoimagery is included as, when interpreted, it’s a widely-used data source for many other data themes.

Why is this theme fundamental?

Orthoimagery is used to produce, update or complement topographic data (by providing greater detail). It's very often the main source for Land Cover data. It can be produced relatively quickly from satellite images and is therefore suitable to assess temporary phenomena, such as damages after a disaster or the impact of pollution.

It's useful for either human visualisation or machine interpretation. This image data is a record of the Earth's surface at the time of imaging, which then has immense historical value in the future.

Orthoimagery may be exploited using algorithms for automatic processing to extract features and information such as buildings, roads, vegetation, soil moisture & water content, cloud cover, and to detect changes such as land use.

Which sustainable development goals (SDGs) will it help to meet?

Orthoimagery is a potential data source for SDGs 2,6,9,11,14,15.

Geospatial data features in more detail

The Orthoimagery theme includes image products generated from sensors aboard drones, aircraft or satellites. Sensors may produce multispectral data, giving images either in true colours, black and white, or scenes based on infrared or radar sensors. Once captured by the sensor, these images may be subject to a variety of treatments which are designed to increase data interpretation capabilities.

Possible sources of geospatial data

Many organisations produce and distribute orthoimagery for several purposes. National Mapping Agencies usually carry out periodical space/aerial photo capture and orthophoto production through national programmes. Some private companies do the same for commercial reasons, covering large parts of the Earth. Public and private remote sensing satellite operators capture massive amounts of satellite images which are distributed through multiple channels, both commercial and non-commercial.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE Data Specification on Orthoimagery – Technical Guidelines;
- FGDC content standards for digital orthoimagery; and,
- USGS National Geospatial Program. Digital Orthoimagery Base Specification V1.0.

Physical Infrastructure

This theme includes industrial & utility facilities, and the service delivery facilities associated with administrative & social governmental services such as public administrations, utilities, transport, civil protection, schools and hospitals.

Why is this theme fundamental?

This theme is fundamental as many sustainable development targets explicitly mention the accessibility to basic services. The infrastructure of a country is the means by which services are delivered to the population, be that hospitals, schools, energy or telecommunications.

Which sustainable development goals (SDGs) will it help to meet?

As a minimum, it is required for SDGs 3, 4, 6, 7, 9, 11.

Geospatial data features in more detail

A country's physical infrastructure consists of a broad array of systems and facilities that house and transport people & goods, and provide services. Among other things, this infrastructure includes industrial and utility facilities, civil protection sites, roads and railways, water supply, sewerage, storm water drainage, dams, levees, weirs, schools, hospitals, and postal & telecommunications services.

These are human-made features and this theme relates mostly to the built environment, and focuses on the service infrastructure.

Key attributes are the geometry, an identifier, a name (if any) and the type of service (school, hospital, …) and other relevant attributes.

Possible sources of geospatial data

National and local government Utility and services companies

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE environmental facilities specification and guidance;
- INSPIRE Utility and governmental services specification and guidance; and,
- INSPIRE production and industrial facilities specification and guidance.

Population Distribution

Geographical distribution of people, including population characteristics.

Why is this theme fundamental?

It's vital to understand the spatial distribution of the population and its characteristics, as well as how population impacts urbanisation, regional development or sustainability. More than half of the world's population already lives in urban areas, while the remaining rural population increasingly depends on urban centres for social and economic progress. The theme supports policies to improve and create sustainable rural and urban living conditions. Some populations are transitory as a result of mass immigration, refuge, or displacement by large natural disasters or war. It's important to understand how policy and programmes impact migration and population growth, as well as economic activity, social well-being, and quality of life.

Which sustainable development goals (SDGs) will it help to meet?

Population distribution is relevant to all of the SDGs, whether related to people or the environment.

Geospatial data features in more detail

There are two relevant types of population: 1) where people live, and 2) where people are at a given time. Usually this is expressed as a count of people within an area unit such as a census tabulation area, or an estimate within a city, postal code area, country, state or province. Recently, several global 'gridded population' footprint estimates have been created, which specifically estimate where people are located and where there are no people. Ideally 5-year age cohorts by gender would exist globally, which allow for groupings to include specific at-risk populations, such as elderly, family composition, children, indigenous population, immigrant/ethnic origin, and education. In the absence of such detailed cohorts, estimates of these at-risk populations are needed. Additional demographics include rates of employment, personal income, household income, and living conditions, i.e., the types of materials used for dwelling units.

Possible sources of geospatial data

- United Nations Population Division, and individual country census agencies;
- National Statistical Institutes;
- Commercial providers include: Michael Bauer Research GmbH, Environics, Esri, and Facebook;
- Other potential providers include: The European Union's Joint Research Commission; Center for International Earth Science Information Network (CIESIN), Columbia University; NASA Socioeconomic Data and Applications Center (SEDAC); Oak Ridge National Laboratory (Landscan products); and,
- KAPSARC.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- U.N. Demographic manuals;
- ISO: 18391:2016; and,
- INSPIRE data specification on Population Distribution.

Transport Networks

Transport Networks are the suite of road, rail, air and water transport routes and their connectivity.

Why is this theme fundamental?

There are many use cases supporting this theme's importance, including:

- Infrastructure, construction, asset management etc. – for effective planning and delivery;
- Mobility management (routing, traffic control, journey planning, car information systems, etc.) - for a more sustainable transport sector;
- The transport industry itself - critical to the flow of goods and economy of a country; and,
- Management of environmental pollution as a result of the use of the networks.

Which sustainable development goals (SDGs) will it help to meet?

Transport is strongly relevant for the following SDGs: 2,3,8,9,11 as well as for many others which require people to have access to services.

Geospatial data features in more detail

The Transport Networks theme mainly comprises four transport modes:

- **Road** includes roads, urban streets (as a subclass of road), pathways and routes;
- **Rail** includes train, tramway, metro, and funicular cog railways;
- **Water** includes marine and inland waterways, and ferry crossing features types; and,
- **Air** includes navigation facilities, air routes, and aerodromes.

Their main attributes are: location, name, identification codes, category, classification and connectivity.

Possible sources of geospatial data

- National Mapping Agencies;
- Transport Ministries; and,
- International Civil Aviation Authority.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

- INSPIRE Data Specification on Transport Networks – Technical Guidelines 3.2;
- ISO 19148 : 2021 Geographic Information –location based services – Linear referencing System;
- ICAO Standards and Recommended Practices; and,
- ISO 14825 Intelligent transport systems-Geographic Data Files (GDF)-GDF5.0.

Water

Extent and conditions of all water features including rivers, lakes and marine features.

Why is this theme fundamental?

Water, as a gas, liquid and solid, covers more than 70% of the Earth's surface. Water is critical to almost every process on Earth. It is essential to all living things – plant and animal.

Water is critical to sustainable development. From a human-centred systems perspective, water is a precious natural resource, vital for life, development and the environment, depending on how it occurs and how it is managed. Study of the Earth's water cycle helps understand how it interacts with the environment and how much is available for human use. Conversely, it's also a potential danger to people and property. Coastal and transitional waters as well as the shoreline and the shore are relevant since these areas of land-water proximity are significant in terms of environment and intense economic activity.

Which sustainable development goals (SDGs) will it help to meet?

This theme has strong relevance for SDGs 6 and 14, and relevance to SDGs 2,3,7,9,11,12,13,14, and 15.

Geospatial data features in more detail

Water within this theme includes water in all three states – fresh, brackish and salt. Features include rivers, lakes, reservoirs, marine & glacial features and groundwater. All features will have a geometric location and identifier of some type. This might be a name. Possible attributes will vary by sub-theme i.e. marine features may require different attribution such as salinity or temperature, as compared with terrestrial rivers e.g. size and flow, but all can be thought of as relating to water quality, quantity and form.

- Quality: e.g. physical parameters such as temperature, pH, e-coli, turbidity, salinity, etc;
- Quantity: e.g. volume, direction, velocity; and,
- Form: e.g. ice, snow, fresh, salt, season patterns e.g. monsoons.

Possible sources of geospatial data

- AQUASTAT - FAO database on water;
- UN-Water statistics and UN Statistics Division environment indicators;
- International Hydrological Programme (IHP) Water Information Network System (IHP-WINS);
- Global Water Forum and Global Water System Project; and,
- The International Water Management Institute (IWMI) Eco-Hydrological Databases.

Existing geospatial data standards

Note: This is indicative. Other lists of standards exist and UN-GGIM will seek to work with thematic experts to develop a list of relevant data standards.

Some relevant standards for water resources related data:

- INSPIRE data specification on Hydrography;
- S-44 - IHO Standards for Hydrographic Surveys;
- S-57 - Transfer Standard for Digital Hydrographic Data;
- S-100 - IHO Universal Hydrographic Data Model;
- ISO 1900 - Series of geographic standards for hydrographic, maritime and related issues;
- ISO 14046:2014 - Environmental management -- Water footprint;
- ISO/TC 147 - Water quality;
- UNSD - International Recommendations for Water Statistics (IRWS); and,
- OGC® WaterML 2 Part 3 - Surface Hydrology Features (HY_Features) - Conceptual Model.

In Summary

The maxim 'everything happens somewhere' is an undeniable truth and one which we are wise to embrace. We live in a world with increasing challenges which have to be met at national, regional, and global levels. Hence the importance of having a universal understanding of ***where*** - a fundamental set of global geospatial themes which are critical to understating, measuring and monitoring the world around us.

Tasking a Working Group to identify and describe the Global Fundamental Geospatial Data Themes was an important step forward in addressing this gap. The overarching principle of the 2030 Agenda for Sustainable Development[8] is that no one should be left behind, calling for "data which is high quality, accessible, timely, reliable and disaggregated by income, sex, age, race, ethnicity, migration status, disability and geographic location and other characteristics relevant in national contexts". To support implementation at all levels, the 2030 Agenda included the need to exploit the contribution to be made by a wide range of data, including Earth observations and geospatial information, the Global Fundamental Geospatial Data Themes provide this foundation.

The Working Group on Global Fundamental Geospatial Data Themes did not embark onto a barren landscape when it first started its task. Many countries and regions were already independently working with fundamental geospatial data in their own parts of the world, albeit in varying degrees of implementation and maturity. The exercise to identifying and then describing the themes was therefore one of collaboration and global consensus, making use of existing knowledge and resources. This enabled the activities of the Working Group to be clear and concise, purposely to ensure clear and achievable outcomes. The endeavour to identify the common list of themes provided opportunities for bring countries and stakeholders together in global and regional fora, to not only identify the themes but to also understand their relevance and importance in the wider context.

The journey for the Working Group has not been long, only about four years. Since its inception, the group has delivered the 14 Global Fundamental Geospatial Data Themes and their high-level descriptions, which have subsequently been adopted by the Committee of Experts. However, defining these themes was not an end in itself, but a springboard to greater heights. At the global level, they have been incorporated within the wider work programme of the Committee of Experts, namely through the Integrated Geospatial Information Framework and the Global Statistical Geospatial Framework; At the regional level, each of UN-GGIM's Regional Committees have subsequently included fundamental data within their work plans; and, At the national level some Member States have adopted the themes within their national programmes.

Now, the next steps include defining detailed regional specifications, and this is already underway at the regional level. Ultimately, the Global Fundamental Geospatial Data Themes are in themselves a fundamental building block for global geospatial information management and will no doubt continue to be embedded in the work and activities of the Committee of Experts in the years to come.

It has been exciting watching the geospatial themes evolve from a dry list of possible themes into the threads and links that help provide the global insight into why the ***where*** is important. 'Everything happens somewhere' and the Global Fundamental Geospatial Data Themes provide the mechanism for the ***where***.

Ms. Clare Hadley
Working Group Technical Lead
United Kingdom

Ms. Carol Agius
UN-GGIM: Europe Administrator
EuroGeographics

[8] A/RES/70/1

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