SDGs Geospatial Roadmap

Drafted by the IAEG-SDGs Working Group on Geospatial Information (WGGI)
For the 11th meeting of the IAEG-SDGs 3-5 November 2020
Version: October 30, 2020.

Introductory Note

This Roadmap aims to communicate the value of the support provided to the IAEG-SDGs, UN custodian agencies, and Member States by the WGGI and elaborates on the vision to see geospatial and location-based information being recognised and accepted as official data for the SDGs and their global indicators. Therefore, this Roadmap outlines how to 'build the bridge' between the statistical and geospatial actors working within the global indicator framework, through three phases:

- Phase 1: Prepare and Plan
- Phase 2: Design, Development and Testing
- Phase 3: Measuring, monitoring and reporting geospatially enabled SDG indicators

This Roadmap recognises the immense contribution and the role of national statistical offices (NSOs) and systems (NSS) that currently provide a significant contribution to the data needs of the global indicator framework. Primarily, it will be NSOs that will take the recommendations and guidance contained within towards implementing the various frameworks that enable for the integration of data across the national data ecosystem; an ecosystem that extends beyond the NSO, but which the NSO is a key actor. This can include the National Geospatial Information Agency (NGIA), the national (or regional) space agency, custodian agencies of the UN System and other stakeholders within the data community. Significantly, innovations within the geospatial information and Earth observations communities, and their enabling technologies, can be leveraged to transform the measurement, monitoring and production of indicators to support the transformation 'leapfrogging' of countries that currently lag behind.

This draft elaborates on Phase 1 (*Prepare and Plan*) of the SDG Geospatial Roadmap and provides further detail on Phases 2 (*Design, Development and Testing*) and Phase 3 (*Measuring, monitoring and reporting geospatially enabled SDG indicators*) and is structured by a series of Guiding Questions highlighted in yellow. These questions aim to provide context to the reader and structure the **why** and **how** to further guide and inform. The questions are not meant to be exhaustive, and as the Roadmap is developed, WGGI members are urged to add, refine and edit questions and their responses to better reflect national experiences, prevailing good practices and other contribution.

The development of the SDGs Geospatial Roadmap is a truly collaborative effort by the membership of the WGGI. Composed of Member States, SDG Custodian Agencies, representatives of the UN System and invited technical experts, WGGI members are independently proposing and drafting responses to guiding questions, based on their own national or technical experience. Following the initial drafting, the next stage consists in the development of Phases 2 and 3 with the input and

1

consultation of the WGGI and then provided to the IAEG-SDGs following a development period of 6-8 months from this 11th meeting.

The IAEG-SDG is invited to review this early draft, propose guiding questions, suggest more in-depth developments on particular ideas, and participate in developing the SDGs Geospatial Roadmap.

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Executive Summary (2 pages)

2020 was intended to be a milestone for global sustainable development. Twenty years on from the inception of the Millennium Development Goals and five years into the SDGs, regardless of the present global situation, the transformational vision and new data requirements called for to realise the 2030 Agenda has only been partially realised. The extent of this challenge has been underestimated and is further amplified by geospatial data, leadership, knowledge, and innovation primarily limited to some countries, the majority being the developed countries. While technologies are evolving at a rapid pace, the commensurate capabilities, skills, and opportunities in the developing countries are not, and countries are being left behind. This is a gap that must be bridged; this **SDGs Geospatial Roadmap** provides simple and actionable guidance to the IAEG-SDGs, Member States and Custodian Agencies to bridge this gap.

This **SDGs Geospatial Roadmap** has been developed as a strategic information and communications mechanism that 'builds the bridge' and understanding between the statistical and geospatial actors working within the global indicator framework. The vision of the SDG Geospatial Roadmap is to see geospatial and location-based information being recognised and accepted as official data for the SDGs and their global indicators. This vision expands on the recommendation of the IAEG-SDG's Working Group on Geospatial Information (WGGI) that, while official statistics are the foundation on which the SDGs are built, the SDGs cannot be fully realised using official statistics alone. In fact, the SDGs are highly dependent on geospatial information, Earth observations and other forms of non-official data.

The WGGI was established by the IAEG-SDGs at its 3rd meeting in Mexico City in April 2016. The primary objectives of the WGGI are to 1) ensure that, from a statistical and geographic location perspective, the key principle of the 2030 Agenda for Sustainable Development, to leave no one behind, is achieved via the global indicator framework, and that everyone can be counted; and 2) provide expertise and advice to the IAEG-SDGs and the larger statistical community as to how geospatial information, Earth observations and other new sources of data can reliably and consistently contribute to the global indicator framework to support the implementation of the SDGs.

In its first three years of work, the WGGI set a number of tasks to achieve, primarily related to providing expertise, advice, and strategic guidance to the IAEG-SDGs and the wider statistical community on how geospatial information, Earth observations and other new data sources can reliably and consistently contribute to the production of indicators.

In July 2019, the IAEG-SDGs updated the Terms of Reference of the WGGI to align to the emerging needs of the IAEG-SDGs, and to achieve a greater working relationship, synergy and coordination between the statistical and geospatial information communities. With a revised membership and updated modalities, the WGGI developed its draft 2020-2021 Work Plan at its 6th meeting in Mexico City in March 2020, a key element being the development of an 'SDGs Geospatial Roadmap'. UN-GGIM, at its tenth session in August 2010, subsequently endorsed the final Work Plan, and further *'welcomed the development and future dissemination of the Geospatial Roadmap for the Sustainable Development Goals as a means to support Member States towards improving the application of geospatial information and Earth observations for the production of indicators.'*

Therefore, this Roadmap is a resource that helps communicate, guide and enhance the awareness of geospatial information, Earth observations, and related data sources, products, and enabling

3

tools and methods, to inform and support the implementation of the SDGs, according to national circumstances. It achieves this through three phases that detail how and why geospatial information is needed, and how it can be applied, to support countries in their national implementations of the SDGs. The Roadmap is guided by a series of questions that detail the unique value proposition and opportunity that geospatial information can provide, what needs to be done, when, why, and by whom.

Introduction (Purpose 1-2 pages)

Guiding Question: What are the overarching mandates?

In July 2017 the General Assembly, in its resolution 71/313, adopted the global indicator framework for the 17 SDGs and 169 targets of the 2030 Agenda for Sustainable Development, as developed by the IAEG-SDGs. The global indicator framework was earlier agreed upon by the Statistical Commission at its forty-eighth session, held in March 2017. The resolution stressed that official statistics and data from national statistical systems constitute the basis needed for the global indicator framework and recommended that national statistical systems explore ways to integrate new data sources into their systems to satisfy new data needs of the 2030 Agenda. In line with the requirements of the 2030 Agenda, the SDG indicators should be disaggregated, where relevant, by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics, following the Fundamental Principles of Official Statistics.

The Cape Town Global Action Plan for Sustainable Development Data, issued on 15 January 2017, recognises the need to facilitate the application of modern technologies and new data sources to mainstream statistical activities to support the implementation of the 2030 Agenda and tracking progress on the SDGs. It calls for the identification and removal of barriers to the use of new data sources, including registries and administrative data, geospatial information systems, and other innovative data sources. To this end, the Action Plan promotes the integration of modern geospatial information management systems within mainstream statistical production programmes, highlighting synergies between the two systems. It also stresses the need to build confidence, trust and capacity through coordinated measures, legal reforms, and better funding, as well as through the development of principles and guidelines, to support the integration of data from traditional and non-traditional data sources.

While official statistics are the foundation on which the SDGs are built, they cannot be fully realised using official statistics alone. The SDGs are highly dependent on geospatial information and Earth observations as the primary data for relating people to their location and place, and to measure 'where' progress is, or is not, being made, particularly at 'disaggregated' sub-national and local levels. The WGGI was established to directly support and complement the ongoing work of the IAEG-SDGs and its implementation of the global indicator framework, where the data acquisition, integration and disaggregation is most needed.

Guiding Question: What is the Mandate and Role of the WGGI?

Since 2016, the WGGI has provided expertise and advice to the IAEG-SDGs, custodian agencies and the broader statistical community as to how geospatial data, Earth observations and other new data sources can reliably and consistently contribute to the production and dissemination of the indicators. This Roadmap is now developed to articulate the vision *"to see geospatial, and location-based information being recognised and accepted as official data for the SDGs and includes key*

4

strategic messages and facts" an essential action emanating from the WGGI's 6th meeting in Mexico City[1], noted in decision 10/105 of UN-GGIM and other fora.

Guiding Question: Why is this Roadmap Needed?

At its eighth session in August 2018, UN-GGIM, in making decision 8/110, noted the importance and crucial role of the WGGI in engaging with national Governments, and acknowledged that geospatial information and Earth observations were not yet sufficiently leveraged in statistical production processes. Further, UN-GGIM requested that the WGGI continue to develop and provide expert advice and guidance on the application of geospatial information and its management to achieve national development priorities and the global targets of the SDGs, and that the WGGI do so with a degree of urgency while ensuring the robustness of the advice and guidance provided.

This Roadmap communicates the value of the support already provided to the IAEG-SDGs, UN custodian agencies, and Member States and elaborates on the vision to see geospatial and location-based information being recognised and accepted as official data for the SDGs and their global indicators. Therefore, this Roadmap outlines how to 'build the bridge' between the statistical and geospatial actors working within the global indicator framework, through three phases:

Phase 1: Prepare and Plan
Phase 2: Design, Development and Testing
Phase 3: Measuring, monitoring and reporting geospatially enabled SDG indicators

Guiding Question: Who should be implementing this Roadmap?

This Roadmap recognises the immense contribution and the role of NSOs and NSS' that currently provide a significant contribution to the data needs of the global indicator framework. Primarily, it will be NSOs that will take the recommendations and guidance contained within towards implementing the various frameworks that enable for the integration of data across the national data ecosystem; an ecosystem that extends beyond the NSO, but which the NSO is a key actor. This can include the National Geospatial Information Agency (NGIA), the national (or regional) space agency, custodian agencies of the United Nations System and other stakeholders within the data community. Significantly, innovations within the geospatial information and Earth observations communities, and their enabling technologies, can be leveraged to transform the measurement, monitoring and production of indicators to support the 'leapfrogging' of countries that currently lag behind.

Guiding Question: What has been the development cycle of this Roadmap, *so far*?

The WGGI has developed the general structure of this Roadmap through several dedicated meetings as its work moves to respond to its longer-term activities as defined in its Work Plan, leading to the definition of a series of guiding questions. These questions are informed by the expert perspective and experience of members and aim to resolve common problems and demystify the perceived complexity regarding the use of geospatial information for the SDGs. The WGGI has responded in an organised manner to the propose these guiding questions and reacted to the developments of their peers. This draft represents the culmination of these various contributions so far.

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[1] http://ggim.un.org/documents/WGGI_Workplan_2020-21.pdf

The SDGs Geospatial Roadmap (1-2 pages)

<mark>**Guiding Question: What are the components for Implementing the Roadmap? How can the Roadmap implement geospatially enabling SDG indicators? What are the national mechanisms? Tell the story of why.**</mark>

The Millennium Development Goals, the precursor to the SDGs, highlighted the global nature of data and demonstrated *why* an established data ecosystem is crucial to enabling informed decision making. Simply, without the appropriate data, it is impossible to make the best decisions. Today, developing a functioning data ecosystem is challenging for some, yet easy for others with this inequality impacting least developed and developing nations hardest; this has the effect of leaving those already behind further behind.

The innovations of the geospatial information and Earth observations communities, combined with the development of analytical methods and the widening of access to this data in many forms presents a transformational opportunity that will not only help leave no-one behind but will enable those furthest behind to be reached first.

Guiding questions of this section include:

<mark>**Guiding Question: What is the added value can Earth Observations bring*?***</mark>
Drafted by GEO-EO4SDGs – JAXA
- Earth observation data (from satellite, airborne, and in-situ sensors) at all scales from global, regional, national and local scales, enabling dissagregation of data and information by geographic location and contribution to the principle of "no one left behind"
- Earth observation data in timely and regularly manner which reduce considerable time required to update survey and statistical data
- Earth observation data of consistent quality from suite of sensors calibrated and validated
- A reduction of cost for survey and monitoring

<mark>**Guiding Question: Why is interoperability so important?**</mark>
Drafted by GEO-EO4SDGs – JAXA
- Interoperability enables connecting different systems to talk with each other and exchange data and information seamlessly among them
- Interoperability helps making data and information open and shared across different agencies within and across countries
- Standardisation of system interfaces and data exchange procedure are essential
- Standardisation of data format and data quality through calibration and validation are necessary to enable interoperability (discover, access, analysis and use, decision making support) of Earth observation data. CEOS (Committee on Earth Observation Satellites) are promoting Analysis-Read Data (ARD) so that data ARD product is generated from raw data and processed so that it can be used without the need for further processing to be applied by users.

<mark>**Guiding Question: Why is Disaggregation by Geographic Location so important?**</mark>
Drafted by GEO-EO4SDGs – JAXA

6

- Global changes in our environment, economy and society are ongoing at different geographical scales from global, regional, national and local. To understand, better inform and transform the changes need monitoring and decision making at different scales.

Guiding Question: How does the WGGI continue to best give guidance and clearly articulate the essential value-add to SDG monitoring from the geospatial information and Earth observations community to the IAEG-SDGs?

Drafted by GEO-EO4SDGs – JAXA

- Support UN custodian agencies and NSOs by identifying available data, any data gaps, and developing practical methodologies for the indicator production using geospatial information and Earth observation data.
- Bring together UN custodian agencies, NSOs, NMAs and Earth observation community to identify and respond to needs and gaps in the implementation of the indicators.
- The intergovernmental organisation the Group on Earth Observations (GEO) supports the WGGI with technical expertise to use Earth observation data for monitoring and implementation of the SDG indicators and assists developing countries in increasing their capacity to use Earth observation data and information.

Guiding Question: Geospatial data and "disaggregation by geographic location" is now needed. However, we need to understand where is the data, what is its composition, and how are countries using it?

Drafted by GEO-EO4SDGs – JAXA

- Metadata identifies available data sources and how to access and use data.
- Data providers need to make available necessary technical information and guidance as to how to access and use the data.
- Toolkits and platforms can support discovery, access to, analysis and use of data.

Guiding Question: How do we articulate, in SDG indicator implementation and monitoring, the role of geospatial information, Earth observations and other data in national case studies and best practices for disaggregation by geographic location?

Drafted by GEO-EO4SDGs – JAXA

- Regular reporting, survey and sharing mechanisms need to be established to collect national case studies and best practices so that countries can replicate such uses.

Guiding Question: What are the principles and guides?

Drafted by GEO-EO4SDGs – JAXA

- The GEOSS Data Sharing Principles are one such resource. The availability of Earth observation data for all nations is of fundamental importance to their uptake and global impact.

Guiding Question: What are the data supply chain requirements and solutions for certain indicators?

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Drafted by GEO-EO4SDGs – JAXA
- Data requirements for certain indicators need to be identified, and its gap-filling also needs to be coordinated by stakeholders.

Roadmap Phases

Phase 1: Prepare and Plan: Assessing capability and readiness. Identifying data methods, gaps, issues, disaggregation (3 pages)

Through the implementation of Phase 1, the basic data to measure, monitor and produce indicators is established and available to be integrated, disaggregated and disseminated to inform decision making. ***Further observations – Report(s) of the WGGI: E/C.20/2020/27/Add.1***

==Guiding Question: Implementation of the Frameworks – Using the Integrated Geospatial Information Framework as the Starting Point==

Drafted by ECLAC

NSOs and the NSS play a fundamental role as providers of the national data ecosystem to support the framework of sustainable development indicators. However, this data ecosystem transcends the borders of the statistical community, extending to national geospatial agencies, which frequently act as coordinating entities of inter-institutional structures that make up a national geospatial information system or a geospatial data infrastructure. Additionally, it is necessary to consider, from the institutional point of view, the organisations that lead the implementation of the 2030 Agenda, as part of the demand of the data ecosystem.

To achieve the integration and interoperability of this diversity of data, the institutional agreements between the public organisations involved, the partnerships with non-governmental and international organisations, the strengthening of capacities and other relevant components to be considered in this SDG Geospatial Roadmap, is provided by the Integrated Geospatial Information Framework[i] (IGIF) and its nine strategic pathways[2]. The IGIF and its guidance build upon the existing body of work of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) and the World Bank, provides a basis and guide for developing, integrating and strengthening geospatial information management.

The IGIF has a comprehensive implementation guide that defines, describes and offers guidance on the actions that can be taken in each of the mentioned nine strategic pathways. These actions can be conducted as a structured sequence step by step in a roadmap and executed through an action plan at the national level, establishing interrelationships between one and the other to achieve a set of results and deliverables. Additionally, the IGIF Implementation Guide provides a valuable set of support tools, for example, forms for the collection of data inventories, matrices for the analysis of gaps, assessment tools, examples on the formation of working groups, and guidance on

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[2] Governance and Institutions; Policy and Legal, Financing; Data, Innovation; Standards; Partnerships; Capacity and Education; and, Communication and Engagement

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monitoring the progress of action plans. Importantly, it also supports the implementation of the Global Geospatial Statistical Framework (GSGF) - a key enabling framework, adopted by both the Statistical Commission and UN-GGIM that through its five principles and key elements supports the integration of statistical and geospatial information.

In providing the 'anchor' that is the geospatial basis for the implementation of the GSGF, the IGIF offers a practical means for all countries to develop, integrate and strengthen their national geospatial information management and related infrastructure.

To do this, the IGIF provides the framework glue and blueprint for why location is important so that countries are able to take positive action. With the integration of statistical and geospatial information a necessity for the SDGs, the IGIF provides crucial guidance and proposes actions that can inform the statistical and geospatial communities in the development of national policies and laws, standards and many other crucial elements to the national data ecosystem. In sum, the IGIF is a fundamental reference and starting point that enables the implementation of the SDG Geospatial Roadmap and its Phases.

==Guiding Question: What are the baseline needs needed for the production of SDGs Indicators?==
Drafted by Italy
The fundamental geospatial data needs of a country to meet the requirements of the SDGs should be based on the national availability of authoritative geospatial datasets. The 14 Geospatial Data Themes identified by the UN-GGIM Working Group on Global Fundamental Geospatial Data Themes[3] offer a sound basis for national data needs (see Annex One for an expanded overview of the 14 Themes).

Therefore, geospatial datasets related to these data themes, which can be coupled with appropriate metadata and a regular update frequency, can be considered a sound baseline for supporting production and monitoring of several SDGs indicators, as well as for enabling disaggregation by geographic location for improved situational assessment at a local and national level.

The acquisition and maintenance of datasets related to these data themes are often conducted at a national level by differing agencies (mainly NSOs and NGIAs), compiled from a variety of data sources. The challenging nature of this process means that for many countries, the intensive requirements of the SDGs cannot always be achieved due to several reasons: missing data themes, incomplete coverage, inconsistent reference system, inaccurate not authoritative data, and absence of updating policy, among many other issues.

In this context, Earth Observations (EO) offer a significant capacity to transformation national data collection related to several of the 14 Themes. While the Working Group which identified the 14 Themes highlighted the contribution of EO as a data source for two themes (Land Cover and Land Use; and, Ortoimagery), it must be considered that EO data is considered as a reference data source

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[3] https://ggim.un.org/meetings/GGIM-committee/9th- Session/documents/Fundamental_Data_Publication.pdf and E/C.20/2020/14/Add.1

for the generation of datasets related to the other 14 Themes such as Buildings and Settlements, Transport Networks, Water, Elevation and Depth, Geology and Soils, and Land Parcels.

Therefore, when dealing with the data baseline needed for the production of SDGs indicators, a starting point or a relevant source to be always considered is national coverage of EO images, to derive several geospatial data layers, which can also be used to fulfil data needs for other national development priorities, potentially in other application domains.

The choice of using EO data should be based on the integration of datasets collected by different satellite missions, providing data at different resolution and with different imaging frequency. If possible, the configuration should be based on the integration of commercial VHR (Very High Resolution) imagery with openly licenced and free lower resolution images. VHR images, due to their cost, could be collected with a low temporal acquisition frequency (often in years) to capture detailed territorial elements. In contrast, lower resolution images, can be collected at a high temporal frequency (daily, weekly, or monthly depending on their resolution and on their usage) can monitor the analysis of the evolution of the territory and provide more thematic information. Where possible or convenient from a budget point of view, VHR images should be substituted by aerial photo collected with the same or better spatial resolution. It is recommended that the cost of the commercial data is shared between different national agencies with this data used as a common reference data source. This has the additional benefit of nationally promoting synergy and cooperation, optimising investment cost, and reducing duplication. A similar shared approach should also be exploited for the processing of satellite data. Effectively, the outputs from EO are just a starting point, offering a rich foundation from which geospatial layers of differing content and detail should be extracted. Their effective usage involves the operation of turning images into reliable information with a geospatial component that can be managed within specific workflows for SDGs indicators computation or the generation of information in support of other needs. This operation requires proper infrastructures, tools and skill.

Even if at the beginning can be complex, depending on the information, to manage the extraction of geospatial laters from EO, it is an important issue to consider that the applied workflows can be repeated several times also for future years, as many of the main satellite missions are scheduled to operate for the coming decade. Further, the ever-increasing archive of historical time series imagery enables countries to extend their analysis to consider the historical dimension for a better and more complete understanding of the evolution of their territory.

The SDG Geospatial Roadmap recommends the prioritisation of the 14 Global Fundamental Geospatial Data Themes, starting with the Orthoimagery theme, using this as the basis for supporting the extraction of the other data themes.

Drafted by GEO-EO4SDGs – JAXA
- Data, methodology and responsible organisation (s)
- Coordination of data and information system and services already available
- Institutional arrangements to produce and use the indicators for country development plan

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October 29, 2020 version.

Guiding Question: How to decide on data and actions to implement?

Drafted by Wageningen University

There are four main stages in deciding on the relevant geospatial information and actions: 1. Establish the need to use geospatial information; 2. Determine geospatial information needs; 3. Select appropriate geospatial information; and 4. Identify relevant actions.

Stage 1: Establishing the need to use geospatial information

The need to integrate geospatial information should be evaluated. The List of Indicators developed by the WGGI identifies indicators where geospatial information can be used to produce, measure or monitor indictors, either through direct use of geospatial data itself or through integration with other statistical data. This list builds on the prior work of the WGGI, its Shortlist[ii].

Despite the obvious applications of geospatial information for many indicators, and indeed it is the recommended data type for some indicators, many methodologies propose other data sources; Where possible the methodologies and their proposed data sources should be used. However, there are several reasons why a country might choose to use geospatial information. Firstly, if it is the recommended data source, then all available efforts should be made to use this data. Capacity-building activities might be required for countries to access, and properly utilise geospatial datasets.

Where it is not the recommended data source as per the official methodology, geospatial information may still be used if there is a lack of alternative data. Even where there are plans to follow an official methodology and collect ground data/survey data for example, then this typically takes time, and geospatial data can be a quicker alternative, providing results in the interim. Further, geospatial data can also be selected to complement other data sources, bridge gaps, or add information and coverage.

Additionally, geospatial information enables the possibility to create time series, of both historical and future/predictive dimensions, which can be useful when matching data to reporting timeframes. Historical satellite data, for example, can be very useful for measuring dynamic variables, for which it is otherwise impossible to monitor in the past.

The visualisation of geospatial information can also be a great asset for policy design and implementation. Maps can support decision-makers in the planning interventions, allow for disaggregation by geographical region, support communication activities, and stimulate engagement among multiple stakeholders. Since increasingly satellite-derived geospatial information is free and open, transparency is stimulated, and increasing trust in data outputs can be expected. As an increasing amount of geospatial information is now freely available, it can potentially be a cost-effective data source for monitoring. Analysis of ready data products which do not require processing or complex analysis also exist, which enable quicker assessments.

Stage 2: Determining Selection of geospatial data type: available global data or nationally produced data

There are several types of geospatial data, including nationally produced data, and available global datasets. Where possible, it is preferable to utilise national data, which in many cases suits the national context better, providing greater and more relevant thematic detail (for example in the

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context of many land cover datasets). Also, it allows national ownership of the data, which stimulates progress towards better monitoring of the indicator. National data produced by national experts are also likely to provide better data (e.g. higher resolution, more accurate).

Global datasets can also be selected. Using a global dataset is advantageous as these datasets are globally available and can provide an almost immediate assessment of an indicator's status. Further, existing global datasets often have existing guidance and case studies that can guide its correct use.

Stage 3: Selection of an individual dataset
Several considerations should be made, based on the dataset's fitness for use, including:
- **Thematic match –** whether the classes in the dataset match with what is required according to the indicator methodology;
- **Spatial resolution** – should be neither too high (can create processing complications) nor too coarse (detail is lost);
- **Temporal coverage** – the match of the timestamp of the data to the reporting timeframe
- **Temporal extent**- this includes both historical and future coverage. Data availability should meet the SDG reporting timeframe (to 2030) and maybe a consideration due to expected life expectancy of satellites, and the planned launches of future satellites; and,
- **Availability of accuracy information** – required to assess its suitability

Stage 4: Relevant actions
In all cases, geospatial data should be validated at the geographic level in which it is being used (for example, at the national or sub-national level). For this, local ground data which can be of a higher quality than the dataset itself may be available for use[4].

Harmonising data will also be required where geospatial data is replacing or complementing another data source; however, extensive methodological guidance is available. In the case of Land Cover, the WGGI has already developed extensive methodological guidance[5]. Effectively, where national geospatial data is planned to be collected, then a campaign to acquire the data, process it, and analysis is required. Still, there is a wealth of guidance that can be leveraged.

Drafted by GEO-EO4SDGs – JAXA
- Start with the indicator metadata to identify data and methodology.
- With available data and methodologies, including toolkits and platforms, establish a data supply chain and partnership to process, analyse, disseminate the data and report the indicators.
- Identify national needs and data gaps and fill the data gaps through a partnership with stakeholders.

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[4] For example, there is existing comprehensive guidance on the methods for evaluating the local accuracy of satellite maps for example in the case of biomass data in the Methods and Guidance Documentation of the REDD+ National Forest Monitoring System https://www.reddcompass.org/download-the-mgd

[5] http://ggim.un.org/documents/Report_Global_and_Complementary_Geospatial_Data_for_SDGs.pdf

Guiding Question: How to prioritise data needs in-line with national circumstances?

Drafted by FAO

The 2030 Agenda, of its Goals, Targets and the actual Global Indicator Framework are built upon the recognition that future sustainable development strategies shall be evidence-based and data-driven. It is within this context that alternative data sources, among which EO data and more in general geospatial data, come into the picture to complement the existing national data ecosystems maintained by the NSO to suffice the requirements for the SDG measuring and reporting.

The reporting requirements of the 2030 Agenda add an extra layer of work to NSOs, at a time when many are already facing ever higher pressures caused by national and global reporting frameworks. Data from Earth observations (EO) can alleviate the burden on NSO's in providing the means for rapid and cost-efficient monitoring of selected SDG indicators as well as on aspects of land cover, agriculture, climate and socio-economic indicators.

The versatility of EO data is often not fully understood. EO data can be used for the direct measure of selected SDG indicators, for the production of proxies of SDG indicators, and for disaggregation by geographic location to the subnational geographic level (e.g. at Administrative level 2) and by thematic level (e.g. by land cover type, by hydrographic basin, etc.).

However, NSOs have diverse EO data needs, as the data they produce primarily serves National Development Plans and the overarching commitments to the various Regional and Global development agendas. Subsequently, a country-specific strategy is required to prioritise the EO data needs of NSOs, to maximise benefits and reduce complexity in an already stressed NSS.

Furthermore, to the primary requirement for data of the National Development Plans, there are other circumstances from which to prioritise EO data needs. The identification of the most critical areas of the current SDG reporting capacity of NSOs could be a good initial step. Based on such analysis a list of SDG indicators that require support can be produced and further actions be taken:

1. Prioritise those SDG indicators that have already a consolidated EO methodology developed and used in other countries, to rapidly reduce the overall reporting burden on NSOs, and to timely start reporting on the given indicator;
2. Prioritise EO based monitoring of specific variables that are critical for multiple SDG indicators. This is exemplified in the case of land cover and crop types which feed directly in a series of indicators such as 2.4.1, 6.4.1, 6.4.2, 15.4.2, 12.3.2; and,
3. Address the SDG indicators that are complex (e.g. 2.4.1) and evaluate hybrid approaches, where EO data are used to calculate one or more components of the indicators. At the same time, the rest is measured through other data sources (e.g. survey).

Drafted by GEO-EO4SDGs – JAXA

- Optimise the use of national data, and if national data is not available, consider the use of a global dataset.
- When prioritising data needs, user requirements, quality of data, availability of calibration and validation data, available resources and capacities to use data also need to be examined.

13

Draft Outline of the SDGs Geospatial Roadmap provided to the 11th meeting of the IAEG-SDGs
3 – 5 November 2020.
October 29, 2020 version.

- Data needs and priorities need to be examined from a viewpoint that if it fits for the purpose.

Phase 2: Design, Development and Testing [Implementing the Guidance (3 pages) Deciding on data and actions to implement.

Phase 2 of the Roadmap entails designing, developing, and testing that enables the implementation of the Roadmap. Developing a training program is crucial for providing technical training and support and for building organisational support and buy-in at all levels of Member States, the IAEG-SDGs and custodian agencies. Ie. Ensure that the foundation established in Phase 1 is fully utilised, and further, able to integrate future, innovative data streams, as and when, they are available.

Key Guiding Questions:

Guiding Question: What are the outcomes of implementing frameworks?
Drafted by GEO-EO4SDGs – JAXA

- Most importantly, the provision of reliable and consistent data for the use of producing SDG indicators.

Guiding Question: How can regional cooperation be used to implement high-level frameworks, standards and tools?
Drafted by GEO-EO4SDGs – JAXA

- Regional organisations can lead and promote regional cooperation to support countries in the region to implement high-level frameworks, standards and tools in response to country and regional requirements.

Guiding Question: How can countries prioritise and optimise their resources for the maximum benefit? What is nice to have – what is essential?
Drafted by GEO-EO4SDGs – JAXA

- National coordination by NSO and institutional arrangements to prioritise and optimise their resources are essential.
- Nice to have a dedicated national (and institutional) budget for funding national activities to develop, promote the production and use of the indicators.

Guiding Question: How can developed capacity and skills be sustained?
Drafted by GEO-EO4SDGs – JAXA

- Continue to improve information system and services, data supply chain, institutional arrangements to sustain the reporting and implementing the indicators.
- Institutionalise the production and implementation of the SDG indicators in the national development plan

Guiding Question: What are the different institutional arrangements and relationships that exist and support the creation of statistical, geospatial and other data that can be used for the production, measurement and monitoring of Indictors?

14

Draft Outline of the SDGs Geospatial Roadmap provided to the 11th meeting of the IAEG-SDGs
3 – 5 November 2020.
October 29, 2020 version.

Drafted by GEO-EO4SDGs – JAXA

- Intergovernmental GEO coordinates and promotes the use of Earth observations for supporting the SDG reporting and implementation

This section is to be completed will present an integrated development of the topic through the guiding questions mentioned above.

Phase 3: Measuring, monitoring and reporting geospatially enabled SDG indicators

Phase 3 of the Roadmap demonstrates how and why the measurement, monitoring and reporting of geospatially enabled SDG indicators can be achieved. This will be done by highlighting examples of good practices and available tools. I*ncludes a 'vision' of what the future may hold.*

Key Guiding Questions:
==**Guiding Question: How can the measurement, monitoring and reporting of geospatially enabled SDG Indicators be achieved?**==

Drafted by Mexico

Decision-making in many countries is not sufficiently based on findings resulting from analysis of data, public data or transparent methods. Many countries do not have sufficient data to address the development problems of their territory. Among the reasons are the lack of budgets or the lack of development of appropriate strategies to make budgetary decisions in this direction. The lack of technical capacities for the development of replicable methodologies that allow the best use of data and their comparability between locations and periods, but also the lack of capabilities to analyse existing data appropriately, are other reasons for the low input from long-term strategies. Discontinuous administrative cycles without effective mechanisms to ensure the maintenance of these capacities is a definite break.

The existence of high-quality, precise, current data, with a sufficient level of disaggregation, allowing analysis over time is a *sine qua non* for the construction of measurement and monitoring systems. On it depends on the observation of the territories. The improvement of data accessibility seems to lie in the construction of lasting partnerships between actors whose capacities and skills make it possible to produce and centralise, manage, distribute data, but also with experts in territorial policy, coming from various sectors such as academics, private, social. In a virtuous circle, strong partnerships facilitate budgetary consolidation and frameworks sustainability. Supported by the cohesion of actors that transcend the administrative periods, long-term strategies can be developed and followed. In this context, groups of experts and local institutions are the path for the creation of local and global monitoring systems adapted to specific objectives as proposed by Agenda 2030, and to Individual national conditions.

It is this construction of open governance, which enables the development and maintenance of a production strategy, data accessibility, development of long-term methodologies, applications and monitoring, that allows to a system of indicators to function and prosper. Its impact on development programs is linked to the same governance scheme in place, as long as all the institutions involved participate, from the development of the strategy to monitoring and reporting.

Finally, the international collaboration around the 2030 Agenda, the public reporting on methods, on data used as well as on the evolution of the indicators, is an instrument for the support of other countries in this collective effort, this promoting an impact in less developed countries.

Thus, the measurement, monitoring and reporting of geospatial information not only can allow the achievement of SDG Indicators, but they are a central condition for them.

Drafted by GEO-EO4SDGs – JAXA
- There is a disparity between huge expectations for Earth observation data and limited use of the data by the statistical community. There is a desire to increase the use of EO data by NSOs to report on SDGs, but there are technological and methodological challenges that need addressing before this can be done more frequently. SDGs provide opportunities for EO community to focus on filling known data gaps in SDG reporting. While having access to the data is an important aspect, having detailed guidance on how to handle and process the data (for different levels of geospatial expertise) also needs to be considered an essential part of the process.
- Increasing reliability and confidence level for Earth observation data to be used for statistics, including the SDG indicators, is the core issue to be addressed by the EO community in close association with the statistical community. Use cases of EO for SDG indicators need to be collected and shared for other countries to replicate or adapt the process in countries, which will help more countries understand better and improve trust on use of EO data for SDGs. GEO works with its member countries to collect use case of EO for SDGs and its indicators in particular which are available at EO4SDG website[6].

Drafted by Colombia
The measurement of the SDG indicators with a geospatial emphasis can be achieved through the definition of standardized methodologies that involve all available sources of geospatial information, including satellite images and base and thematic cartographic information. Said methodologies must start from the implicit and explicit use, management, processing and exploitation of geospatial information.

Based on the foregoing, the monitoring and notification of these SDG indicators is based on having updated geospatial information, which allows temporary reports to be made in different periods, guaranteeing comparability and monitoring of progress and projections focused on the 2030 Agenda.

Guiding Question: How can mandated tools, such as the FIS4SDGs – be leveraged to empower and accelerate digital transformation?
Drafted by Colombia
Tools such as the Federated System for the SDGs, as well as the SDG Data Hub, are essential, not only for the dissemination of results associated with the SDGs, but also to guarantee the standardized management of their results. Likewise, the potential to reflect information at different levels of disaggregation, global and local, means that these tools and platforms are oriented to

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[6] https://eo4sdg.org/get-more-information/country-use-cases

different types of users and facilitate both decision-making and focused actions that guarantee compliance with the Goals and targets of the 2030 Agenda.

However, it is essential, for the massification of these tools, that open licenses and training are available for the countries, in order to promote the use of these technologies, both in statistical offices and in geographic institutions, seeking to accelerate the digital transformation.

Drafted by GEO-EO4SDGs – JAXA

- UN Global Platform for SDGs (GIS4SDGs) is being developed in cooperation with volunteer countries[7] The Task Team on Satellite Imagery and Geo-Spatial Data released a handbook on creating official statistics using satellite imagery[8]. The UN Global Platform is available to all National Statistical Offices (NSOs) and their partners.
- GEO EO4SDG is developing SDG11 toolkit in cooperation with UN-Habitat and Human Planet to integrate Earth observation data and geospatial information into the urban monitoring and reporting processes on SDG targets and indicators.

Guiding Question: What are the examples and stories of "measuring, monitoring and reporting"?

Drafted by Colombia

DANE's Geostatistics Directorate is compiling different indicators, generated through statistical operations and by methodologies that involve geospatial information, in order to provide the results in a centralized geo-visualization platform for this purpose, in an Esri Hub.

Now, for the geospatial dissemination of census and sample statistical operations in DANE, geo-viewers have been developed through story map templates, which allow the geographic visualization of different themes, some of them associated with SDG indicators, such as the poverty, education, gross domestic product, among others, which are available for consultation and viewing on the DANE geoportal[9].

Drafted by GEO-EO4SDGs – JAXA

- FAO's Green Mountain Index is a very good model for Custodian agency to work with NSOs to collect and report the global indicator. FAO produced Moutain Green Cover Index (MGCI) for each country using a global land cover classification data and a global mountain classification data based on digital elevation model data, and request countries to validate the estimation results. FAO recommends using national land cover classification data if national data is available.
- Custodian agency's support and guidance for country production of the SDG indicator are essential. For preparing the indicator, NSOs are encouraged to work with Earth observation agencies to use and validate satellite land cover data.

Guiding Question: How geospatial data can inform the production, measurement and monitoring of progress on the overarching principle of the SDGs: 'leave no one behind'?

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[7] https://unstats.un.org/bigdata/taskteams/globalplatform/

[8] https://unstats.un.org/bigdata/taskteams/satellite/UNGWG_Satellite_Task_Team_Report_WhiteCover.pdf

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

17

Draft Outline of the SDGs Geospatial Roadmap provided to the 11th meeting of the IAEG-SDGs
3 – 5 November 2020.
October 29, 2020 version.

Drafted by Mexico

The relationship between people and their environment involves a great diversity of situations. The central aspect of the "Leave no one behind" proposal for the 2030 Agenda, makes understanding the nuances that determine the conditions of all people and space, a particular challenge in measuring SDGs. Aggregation of data is a central problem in statistics and can lead to a partial or even biased understanding and message.

The choice of the administrative spatial scale in the data production method constitutes, in fact, an element in the discourse of the authorities on this territory, which often complicates or exaggerates problems or trends.

The integration of geospatial data reveals new phenomena and trends that statistics alone can hardly discern. The role of indicators in decision-making and equitable development in all countries justifies the search for methods which help to achieve the finest possible perception on all levels: social, cultural, demographic, economic, etc. which all have a spatial and territorial projection. In addition to the use of geospatial information, the analysis of spatial relationships between localised elements is also a contribution of new knowledge: such as proximity or remoteness, agglomeration or isolation, continuity or discontinuity, of human groups and phenomena. Not all indicators require geospatial processing, but any indicator aimed at decision making would provide better understanding if it is geospatially enabled.

The communicative aspect of geospatial information is also a key dimension regarding the role of awareness-raising towards a large audience and decision-makers. This type of information is highly illustrative and allows a message to be instantly understood if the analysis is well conducted and the method transparent. In this sense, its integration requires an effort to empower the technical teams in charge of their development, construction of indicators and monitoring and reporting methods.

Drafted by GEO-EO4SDGs – JAXA

- Geospatial data can visualise and inform where the data are collected and used for decision making support to ensure "leave no one behind". Earth observation has demonstrated its capability to cover the globe with required scale and frequency to enable the principle, through data integration of different EO missions and sensors.
- Intergovernmental coordination and arrangements are essential to avoid duplication and optimise the use of limited resources. Open and free data policy for data integration and production of the SDG indicators need to be strongly encouraged. GEO advocates the GEOSS Data Sharing Principles for countries to make EO data open and shared for SDGs.

Drafted by Colombia

"Everything that happens, happens somewhere." In this way, the integration of statistical and geospatial information is not a future objective, but a required need to have information available to everyone, being this a fundamental asset for informed decision making. In this way, the production, measurement and monitoring of the 2030 Agenda and the fundamental principle of the SDGs, is linked to the constant and recurring production of geospatial information, whose context, combined with thematic or statistical information, becomes the required support to guarantee results, their dissemination, analysis and monitoring, in the different geographic scales required.

18

Draft Outline of the SDGs Geospatial Roadmap provided to the 11th meeting of the IAEG-SDGs
3 – 5 November 2020.
October 29, 2020 version.

Guiding Question: What are the requirements for implementing an architecture that enables the provision of data for the SDGs?

Drafted by GEO-EO4SDGs – JAXA

- Partnership and institutional arrangements are key for such implementation architecture and clear national (and institutional) policy and leadership to commit to and implement SDGs is needed.
- GEO is developing the Global Earth Observation System of Systems (GEOSS) and federated approach to harness and align its activities to SDGs. Earth observation community makes available analysis-ready data (ARD) to facilitate uptake and use of the Earth observation data by countries. CEOS (Committee on Earth Observation Satellites) Data Cube supports countries to establish its national satellite data infrastructure to enable monitoring and implementation of SDGs. Space agencies recognise that long-term series and continuity of data, which require strong government support, is essential for monitoring and implementation of SDGs.
- Still, many developing countries are confronting the lack of computing resources and data infrastructure. Cloud computing resources need to be made available and shared among countries for the production of the SDG indicators. GEO works with Google Earth Engine and Amazon Web Service to make available such cloud computing resources. There is a need for high-resolution satellite data for addressing urban issues such as delineating slums and informal settlements (SDG 11.1.1) where commercial satellite operators a role in which to make a contribution.
- Implementing an architecture that enables the provision of data for the SDGs can be started with coordinating existing national information systems and services since the framework on how they use their data to measure the indicators will largely depend on institutional and architectural arrangements that already exist.

Drafted by Colombia

Indeed, for the implementation of methodologies and capacities in the management and processing of geospatial information, it is necessary to have a robust and efficient architecture that allows the performance of methodological processes in accordance with the large volumes of data that are currently produced. However, the current provision of servers, data clouds, and platforms in the network, has allowed to reduce the costs associated with the installation of physical infrastructures, guaranteeing efficiency in the technical processes of geospatial information. Currently, various alternatives are offered for storing and processing information in the cloud, including Google Earth Engine, with its catalogue of satellite images and open access for the classification operations to be carried out on said images.

This section to be completed will present an integrated development of the topic through the guiding questions mentioned above.

Draft Outline of the SDGs Geospatial Roadmap provided to the 11th meeting of the IAEG-SDGs
3 – 5 November 2020.
October 29, 2020 version.

Summary and Call to Action

Implementing the SDGs Geospatial Roadmap will enable countries to better harness geospatial information for the measurement, monitoring and reporting of geospatially related indicators. Further, this will help countries disaggregate indicators by geographic location and combine with data disaggregated by income, gender, age and others to help inform the measurement, monitoring and production of indicators, which in turn will assist countries with making decisions informed by data. While it is already recognised that integration of these forms of data is a critical driver that enables the implementation of the SDGs, this cannot be achieved through statistics alone in part due to the interconnected and interrelated nature of the SDGs.

Unfortunately, the call of Goal 17 to *"enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts"* by 2020 will not be met. However, we collectively have the tools and mechanisms that will enable the production and dissemination high-quality, timely and reliable data within our grasp.

At the foundation of this is geospatial information; from adding value to all other disaggregation to providing the key mechanism which will enable the full realisation of the overarching principle of the 2030 Agenda for Sustainable Development, namely to leave no-one behind and to reach those furthest behind first. Geographic information is the key (and broadly missing) component that can highlight groups which are currently behind left behind, whether through disaggregation of income, gender, age, race, ethnicity, migratory status, disability or other characteristics relevant in national contexts. In sum, geospatial information provides the basis to integrate and analyse these forms of data, inform decision-making, and enable the 'where' needed for action and this Roadmap is the starting point to enable the IAEG-SDGs, custodian agencies and member states to fully harness geospatial information for the SDGs, and in turn, this Roadmap calls for geospatial and location-based information to now be recognised and accepted as official data for the SDGs alongside official statistics.

Annexe 1: Guidance on Frameworks, Toolkits and Standards

- ***Are there assumptions on the production of statistical data? GSBPM/GASMO, etc.?***

- ***The Global Fundamental Geospatial Data Themes were developed for the SDGs, what needs to change within the Statistical System to 'implement' this?***

The Global Fundamental Geospatial Data Themes
What are the initial building blocks, the fundamental data that is needed?

The Global Fundamental Geospatial Data Themes are 14 themes considered fundamental to strengthening a country's geospatial information infrastructure[10]. They range from Addresses to Physical Infrastructure and are "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". Significantly, the 14 Themes were developed in direct response to the data needs of the SDGs.

Implementing the 14 Themes is a first step towards realising the data ecosystem and help provide a framework for integrating different forms of data. This data can come from a variety of stakeholders, commonly the NSO and NGIA, but there will be others, especially if using Earth observations. In effect, to enable the integration of data, a bridge must first be built between the NSO and the NGIA, this sets the stage for providing high-quality, timely and reliable data for the measurement, monitoring and production of indictors.

The Global Statistical Geospatial Framework
How to build a bridge to the Statistical Domain?

'Building the bridge' is a well-used statement between the statistical and geospatial communities and one whose usage predates the indicator framework. The Statistical Commission, through its decision 44/101 of February 2013, "recognised the importance of the integration of geospatial information and statistics in supporting social, economic and environmental policy decision making, including at the subnational level, and welcomed the proposal to develop an international statistical geospatial framework, taking into account existing national and international efforts. In August 2019, through its decision 9/106, the Committee of Experts on Global Geospatial Information Management (UN-GGIM) adopted the "Global Statistical Geospatial Framework" (GSGF) as the realisation of this mandate. The decision of UN-GGIM was subsequently endorsed by the Statistical Commission through its decision 51/123 of March 2020.

The GSGF[11] is a high-level principles-based framework that enables a range of data to be integrated from both the geospatial and statistical communities and that, through the application of its five principles and supporting key elements, permits the production of harmonised, standardised and integrated, geospatially enabled statistical data to facilitate data-driven decision-making. 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.

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[10] http://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/Fundamental_Data_Publication.pdf
[11] http://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/The_GSGF.pdf

The Integrated Geospatial Information Framework
How to build a bridge to the Geospatial Domain

Detail geospatial information and its integrative ability

The IGIF[12] 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 IGIF sets the context of 'why' geospatial information management needs to be strengthened and why it is a critical element of national social, economic and environmental development. It focusses on the role of geospatial information in the digital age and how that information is integral to government functions at all levels. This vision is communicated via vision and mission statements, seven (7) underpinning principles, eight (8) goals and nine (9) strategic pathways. Part 2, the Implementation Guide describes the 'what' needs to be done to implement and strengthen a national geospatial infrastructure. It translates the high-level principles into actions that can be undertaken at the national level. These are augmented by Country-level Action Plan(s) (CAP) that are specific to each country and detail 'how' the guiding principles, options, and actions specified in the Implementation Guide will be carried out, when and by whom.

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[i] https://ggim.un.org/IGIF
[ii] Shortlist: results of the analysis of the Global Indicator Framework with a "geographic location" lens http://ggim.un.org/meetings/2017-4th_Mtg_IAEG-SDG-NY/documents/WG's_Initial_Shortlist-Table_A_B.pdf

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[12] http://igif.un.org