



# TRANSFORMING OUR WORLD

GEOSPATIAL INFORMATION -  
KEY TO ACHIEVING THE 2030 AGENDA  
FOR SUSTAINABLE DEVELOPMENT





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## PREFACE

### **Reaching the ‘furthest behind first’ with geospatial information**

In September 2015, when the United Nations adopted the Sustainable Development Goals (SDGs) to transform our world by 2030, it was termed as a grand plan of action for people, planet and prosperity. With an integrated and indivisible global agenda, the Goals opened up a new coherent way of thought and action on issues as diverse as poverty, education and climate change to achieve sustainable development in its three dimensions – economic, social and environmental.

Learning from the mistakes of MDG implementation, the SDG Agenda laid out meticulous road map to implement, measure and monitor the progress through 230 indicators under the 17 Goals, recognizing earth observation and geospatial data as a prerequisite underpinning the success of the Agenda. This has opened up an immense opportunity and a challenge at the same time to the global geospatial community.

The current study – **Geospatial Information, Key to Achieving the 2030 Agenda for Sustainable Development** - commissioned by DigitalGlobe and produced by Geospatial Media & Communications, makes an overarching assessment of the significance of earth observation and geospatial data in supporting a wide range of indicators and targets of the Agenda 2030. While presenting some of the existing geospatial frameworks available globally, the study points out critical gap areas that need immediate attention to ensure the full potential of geospatial data is realized. The study gives a historic perspective from sustainable development standpoint and makes a keen assessment of the prospective sustainable development sectors in identified countries.

Progressive businesses like DigitalGlobe have been supporting bold societal ambition, partnering with multiple stakeholders in supporting disaster mitigation and relief efforts, fostering development, and reaching out to remote communities, while balancing its commercial interests simultaneously.

The present study will act as a benchmark study for DigitalGlobe in formulating its business development strategies in furthering its vision of seeing a better world by reaching the ‘furthest behind first’ with geospatial information.

Team **Market Intelligence & Business Consulting**  
Geospatial Media & Communications

A composite image of Earth with a city skyline and an airplane, overlaid with a yellow frame containing text. The background is a blue-tinted image of the Earth from space, with a city skyline and an airplane visible. A yellow frame is overlaid on the image, containing the text 'TRANSFORMING OUR WORLD' and '‘TRANSFORMING OUR WORLD’ WITH GEOSPATIAL INFORMATION'.

TRANSFORMING OUR WORLD

‘TRANSFORMING  
OUR WORLD’  
WITH GEOSPATIAL  
INFORMATION



## I. INTRODUCTION

The world today is experiencing a deluge of data. Every time one uses that weather app on their smartphone, every time one checks-in to his/her office using a biometrics device, every time a bar-coded product is moved across an assembly line or every time a satellite orbits imaging or communicating with earth, data is created. Increasingly, this data is being pored over, structured, analyzed and inferred for patterns and insights before a decision is made.

However, this is not a uniform scenario across the world. Developed economies are grappling with an abundance of data while there are parts of globe where data scarcity prevails. This is the paradox of data revolution. The paradox however is symptomatic of a broader disparity. Those countries/societies experiencing data scarcity are also those that tend to be the most vulnerable, particularly with respect to poverty, gender inequality, conflict and extremism, disasters and climate change. At the same time, the world is on the threshold of immense opportunity – an opportunity of development and bridging the divide that exists among the countries. The United Nations' Millennium Development Goals (MDGs) initiated in 2000 have consolidated several disparate sustainable development initiatives into a common framework and set concrete goals. Consequently, significant progress has been made in a number of areas, though the progress remains uneven, particularly in the least developed and developing countries. Also, many of the MDGs were never fully realized, in particular those related to maternal, newborn, child and reproductive health.

To continue the development strides and to fulfill the vision of MDGs, the United Nations announced the 2030 Agenda for Sustainable Development in September 2015 - an ambitious, integrated, indivisible and transformational global agenda to reach the 'furthest behind first'. The 17 Sustainable Development Goals and the 169 associated targets with 230 indicators promise to achieve sustainable development in its three dimensions – economic, social and environmental – making the agenda a new coherent way of thinking about how issues as diverse as poverty, education and climate change fit together as an 'indivisible whole'. While the agenda itself is global, it takes different national realities into consideration and guides and permits governments to incorporate these Goals and targets into their national planning processes and strategies as per their priorities.

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Sustainable  
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## II. CAPITALIZING ON DATA REVOLUTION

A key lesson from MDG implementation is that a lack of reliable data can undermine governments' ability to set goals, optimize investment decisions and measure progress. The SDG Agenda will continue the development work set under MDG Agenda adding the challenges of ensuring more equitable development and environmental sustainability. Crucial to their success will be good governance, informed by strong statistical systems that can measure and incentivize progress across all the goals.<sup>1</sup>

The 2030 Agenda, while defining its goals and targets as aspirational and global, recognized this importance of adequate data for the follow-up and review of the progress made in implementing those goals and targets. The basic objective of the 2030 Agenda – that no one is to be left behind – will require quality, accessible, timely and reliable disaggregated data to help with the measurement of the progress. However, the Agenda acknowledged that baseline data for several of the targets and indicators remain unavailable, indicating that the data paradox is indeed a reality, and calls for increased support for strengthening data collection





and capacity development in Member States, to develop national and global baselines where they do not yet exist.

Today, data have become bigger, faster, more current and detailed than ever before. Advances in sensor technologies, communications and IT are leading to this exponential increase, adding to the volume and types of data, creating unprecedented possibilities for informing and transforming the society (Figure 1). National statistical systems have seen rapid advances over the past ten years; with improved use of national strategies for the development of statistics, and more regular census and survey-based data collection. The next step is to capitalize on the data revolution and turn it into a revolution for sustainable development.<sup>2</sup>

With the right tools, policies and investments, we can move towards better quality, high frequency data on sustainable development in all countries. The adoption of Agenda 2030 indeed presents an opportunity to build on the momentum of data revolution, expanding data-input categories with new technology innovations, and demonstrating the central role of in sustainable development.

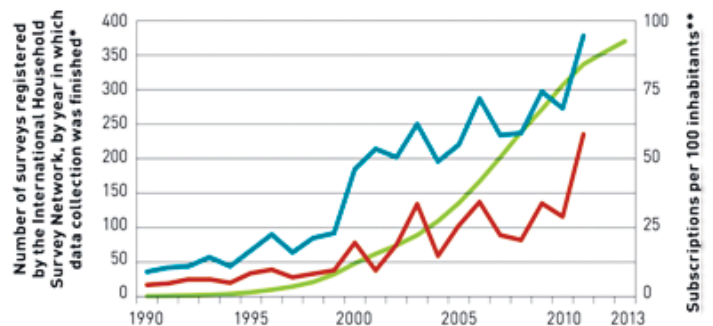
### III. GEOSPATIAL DATA TO MEASURE & MONTIOR SDGs

While recognizing that each country could use different visions, approaches, models and tools available for achieving SDGs based on the national circumstances and priorities, the UN acknowledged the significance and the need for leveraging a wide range of data, including earth observation and geospatial data<sup>4</sup> to measure and monitor the progress of SDG targets. The national statistical offices and census bureaus are wrested with the responsibility of measuring and monitoring the targets and indicators. The Agenda underscored the need to develop capacities of national statistical offices and data systems, especially in developing and least developed countries, to ensure access to timely, reliable and disaggregated data. However, while these organizations are familiar with demographic information and population data, it is often observed that they are unaware of the significance and utility of geospatial data to monitor the progress of the Goals and targets.

The Agenda committed itself to conducting regular and inclusive reviews of progress at sub-national,

#### THE GROWTH OF DATA: TRENDS IN DATA AVAILABILITY, DATA OPENNESS AND MOBILE PHONE USE

- All Surveys
- Open Access Surveys
- Mobile-cellular subscriptions (per 100 inhabitants)



Source: \* International Household Survey Network (<http://catalog.ihns.org/index.php/catalog>). For a detailed analysis of global trends in survey data availability, see, e.g., Demombynes and Sandefur (2014), "Costing a Data Revolution," Center for Global Development, Working Paper 383.

\*\* World Bank (<http://data.worldbank.org/indicator/IT.CEL.SETS.P2>), based on data from the International Telecommunication Union (ITU), World Telecommunication/ICT Indicators database

Figure 1: The Growth of Data: Trends in Data Availability, Data Openness and Mobile Phone Use<sup>3</sup>

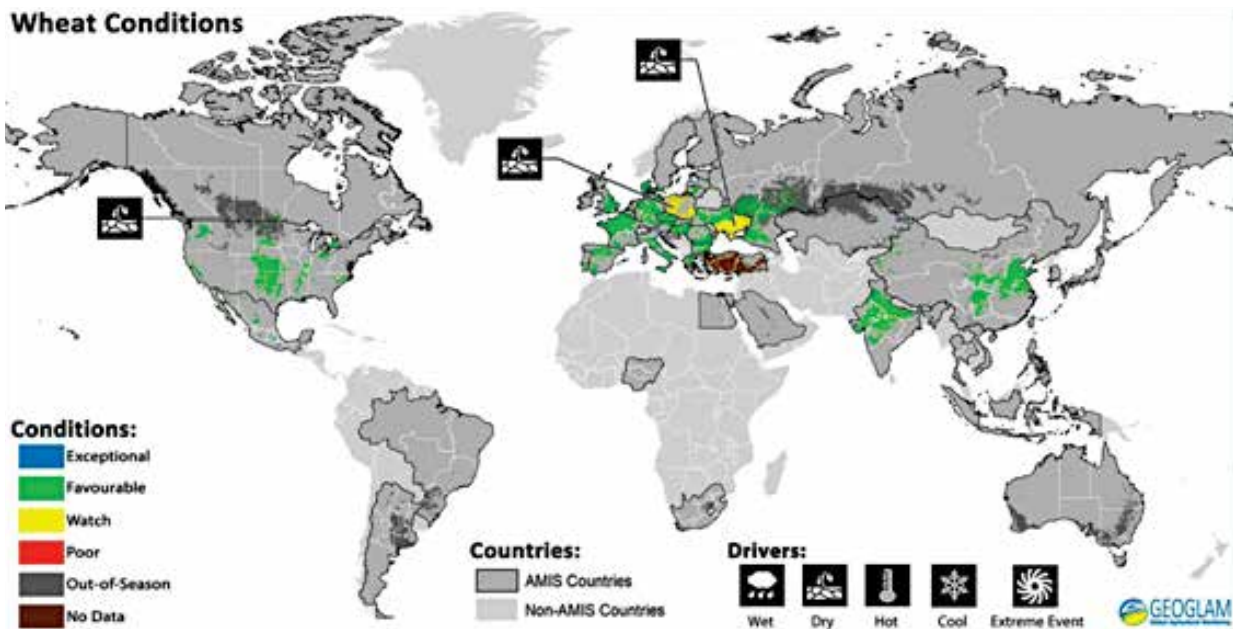


| Goal   | Target   | EO Application   |
|--|--|--|
| Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture | <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production...</p> <p>2.3 Adopt measures to ensure the proper functioning of food commodity markets and their derivatives, and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.</p> | <p>Global earth observations allow crop monitoring and provide early insights on anomalies in crop condition aiding food supply and production forecasts (Figure 2) facilitating monitoring as prescribed by indicators under this target.</p> <p>The Agricultural Market Information System (AMIS) provides monthly crop health estimates through its Market Monitor<sup>6</sup> supporting the indicators under this target.</p> |

Table 1: Targets under Goal 2 and EO application

national, regional and global levels. It encourages nations to identify and create most suitable mechanisms to build on existing follow-up and review mechanisms at these levels. The Inter-Agency and Expert Group (IAEG) on SDG Indicators developed a list of indicators for the monitoring of the Goals and targets at the global level.

For achieving Goal 2.4 (Table 1), the indicator framework<sup>5</sup> mandates countries to periodically monitor and estimate the proportion of agricultural land under resilient practices. Until recently, in many developing and least developed countries, monitoring and evaluation was commonly done by manual surveys, which were expensive, logistically



Courtesy: GEGLAM

Figure 2: Crop conditions as in June 2016 over the main growing areas for wheat, maize, rice, and soybean are based on a combination of national and regional crop analyst inputs along with earth observation data. Crops that are in other than favourable conditions are displayed on the map with their crop symbol




|  |   | Population distribution | Cities and infrastructure mapping | Elevation and topography | Land cover and use mapping | Oceanographic observations | Hydrological and water quality observations | Atmospheric and air quality monitoring | Biodiversity and ecosystem observations | Agricultural monitoring | Hazards, disasters and environmental impact monitoring |
|---|---|-------------------------|-----------------------------------|--------------------------|----------------------------|----------------------------|---|--|---|-------------------------|--|
| 1   | No poverty                              |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 2   | Zero hunger                             |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 3   | Good health and well-being              |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 4   | Quality education                       |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 5   | Gender equality                         |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 6   | Clean water and sanitation              |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 7   | Affordable and clean energy             |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 8   | Decent work and economic growth         |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 9   | Industry, innovation and infrastructure |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 10  | Reduced inequalities                    |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 11  | Sustainable cities and communities      |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 12  | Responsible consumption and production  |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 13  | Climate action                          |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 14  | Life below water                        |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 15  | Life on land                            |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 16  | Peace, justice and strong institutions  |                         |                                   |                          |                            |                            |   |  |   |                         |  |
| 17  | Partnerships for the goals              |                         |                                   |                          |                            |                            |   |  |   |                         |  |

Figure 3: Earth Observation and geospatial information resources for SDG monitoring. Courtesy: Group on Earth Observations (GEO)



challenging and extremely time consuming. Also, these estimates were not very accurate and not reliable in countries where statistical infrastructures are weak.

Comprehensive and accurate location-based information drawn from high-resolution satellite- and aerial-earth observation data could be used, to support such measuring and monitoring outcomes. The Group on Earth Observations (GEO)'s Global Agricultural Monitoring (GEOGLAM) initiative is worth citing here. It sends out periodic crop monitor reports, strengthens the international community's capacity to produce and disseminate relevant, timely and accurate forecasts of agricultural production at national, regional and global scales using earth observations, including satellite and ground-based observations<sup>7</sup>.

**When combined with demographic and statistical data, EO data and analyses can enable nations monitor change over a period of time in a standard format and make decisions and mid-term corrections.**

The crop monitor reports provide global crop condition assessments in support of the Agricultural Market Information System (AMIS) market monitoring activities (Figure 2). Both GEOGLAM and AMIS were endorsed by G20 countries and were tasked to "coordinate satellite monitoring observation systems to enhance crop production projects and weather forecasting data." These report support Targets 2.4 & 2.3 effectively.

Collected at local, national and global levels, and supported by IT tools and other best available technologies, earth observation data have the potential to play a critical and insightful role in monitoring the targets, tracking the progress and helping countries make mid-term corrections to several of the Sustainable Development Goals (Figure 3). When combined with demographic and statistical data, these

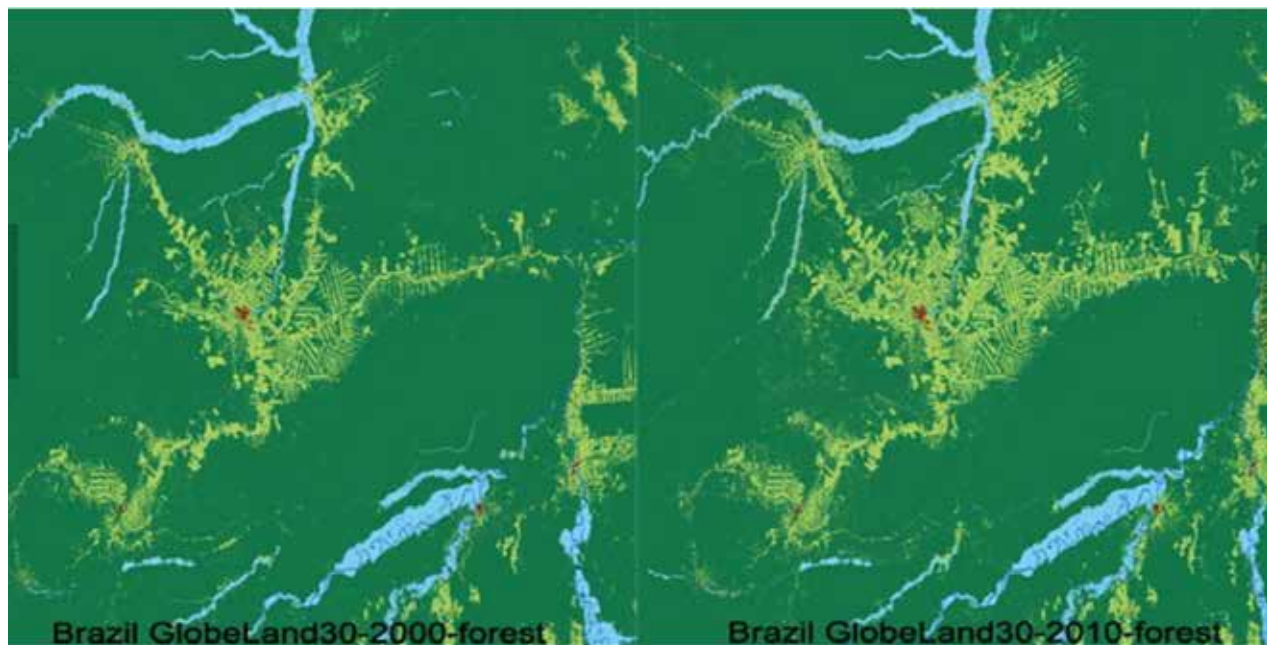


Figure 4: Forest cover image for Brazil-2000-2010. Courtesy: GlobeLand 30



data and analyses can enable nations monitor change over a period of time in a standard format and make decisions.

Another example is the effective use of EO data to observe land use and land cover changes. Apart from providing a general view of land cover, such data can be used to predict the onset of drought, flooded areas and can best serve as a pre-planning as well as a monitoring and evaluation. Consider the example of GlobeLand 30, a global land cover dataset at 30m resolution for the years 2000 and 2010, developed by the National Administration of Surveying, Mapping and GeoInformation (NASG). The datasets, drawn from Landsat – 4, 5 and 7, MODIS, and Chinese HJ scenes, are organized by ten major land cover classes and provide essential high-resolution land cover and change information freely available for climate change studies, environment monitoring, resource

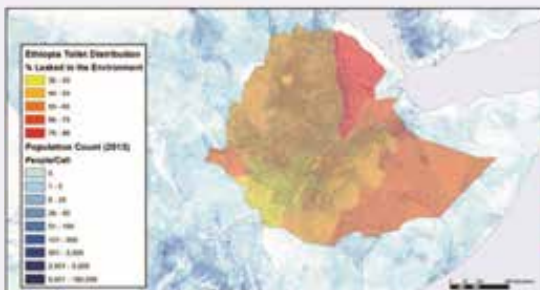
management and support several targets under Goal 2, Goal 3, Goal 11, Goal 13 and Goal 15 (Figure 4).

The Rio+20 outcome document ‘The Future We Want’<sup>8</sup>, which renewed the commitment of heads of State and government to sustainable development, specifically recognizes the importance of “reliable geospatial information” in the areas of national disaster risk reduction strategies and plans (including comprehensive hazard and risk assessments), and for sustainable development, policymaking, programming and project operations<sup>9</sup>. The efforts of United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) is promoting the use of earth observation to monitor and track the efforts put in by countries towards the sustainable development goal of climate action (SDG13). In the area of disaster risk reduction and



**Target 6.3** By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing the least hazardous chemicals and materials, halving the proportion of untreated waste water and substantially increasing recycling and safe reuse globally.

**POPULATION DENSITY OVERLAID ON UNTREATED WASTEWATER LEAKING TO THE ENVIRONMENT, ETHIOPIA SUB NATIONAL**



WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation

Integrating data from Earth observations and geospatial information with national surveys to monitor the impact of untreated wastewater on the population. The map on the left shows the extent of leakage of wastewater, excreta and grey water, with areas in red denoting extensive pollution. The map on the right integrates all data and shows where there is high impact i.e. high leakage in densely populated areas.

Courtesy: Group on Earth Observations (GEO)

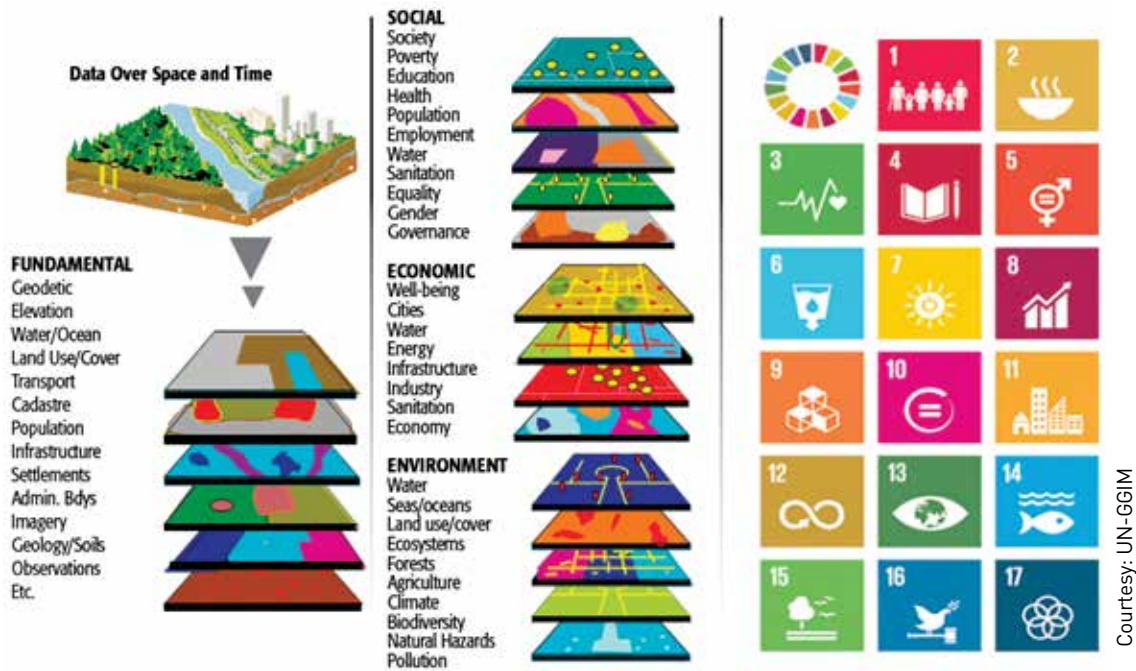


Figure 5: Extending national fundamental data themes to the 17 SDGs and targets by means of the global indicator framework

emergency response, UN-SPIDER contributes to the charter laid down in COP21<sup>10</sup>, the historic 2015 Paris Climate Conference, taking note of the launch of the Climate Risk Early Warning Systems (CREWS). CREWS is expected to contribute to one of the seven targets of the Sendai Framework for Disaster Risk Reduction<sup>11</sup> and focuses on increasing the availability of and access to multi-hazard early warning systems.

Geospatial professionals, for many years, both individually and collectively, have articulated and stressed the role, need and value of geospatial information, technology and services to the governments and decision makers. But now is the moment in time where they can, and must, elevate and demonstrate our ‘geospatial value proposition’. The global geospatial community, particularly through national geospatial information agencies, has a unique opportunity to integrate geospatial information into the global development agenda in a more holistic and sustainable manner, specifically in measuring and monitoring the targets and indicators of the SDGs

(Figure 5). However, the opportunity brings with it substantial expectation to deliver!<sup>12</sup>

This is not an easy task as very little is understood regarding the role of geography in sustainable development processes at the inter-governmental level, including how geospatial information can be applied to sustainable development, and how policies can be implemented to bring geospatial and statistical data together in a coherent and integrated manner. A few common threads could however be identified in line with the SDG Goals and targets that could potentially be useful in many developing countries. The subsequent sections will discuss a few of these.

## IV. NEED OF THE HOUR – QUALITY GEOSPATIAL DATA IN SPACE & TIME

### A. New Data to Address Data Scarcity & Data Gaps

The 2030 Agenda specifically stresses the need for new data acquisition and integration approaches to



improve the availability, quality, timeliness and disaggregation of data to support the implementation of the new development agenda at all levels. This would also include data that is potentially available but needs to be repurposed for new needs.

The IEAG highlights new data collection and monitoring technologies that are

becoming rapidly available. These technologies have the capability to dramatically advance national statistical offices' and the international community's ability to monitor the impacts of development programs, in addition to informing the way they are designed and implemented. High-resolution satellite imagery, mobile devices, biometric data, and crowdsourced citizen reporting will change official data collection processes and the design of the programs they monitor. For example, the cost of high-resolution image acquisition is falling while the availability of imagery and capacity for automated processing are increasing. The increasing use of drones and the feasibility of conducting surveys on digital mobile platforms greatly reduces the time and cost of data collection, while improving accuracy, simplifying collection of GIS and image data, streamlining integration with other data/information streams.

As the geospatial community works through the SDGs and the associated 169 targets and 230 indicators, the community is realizing that amongst the existing datasets, there are a number of data gaps and some of them considerable data gaps, not so much in their

**One solution to address the data gaps is to adopt open data policies that facilitate broad and open access to existing data. Open data policies need to be supported with mechanisms for easy access and easy discovery of data**

spatial resolution but in their temporal resolution. For example, a few of the indicators require more current data, while the data available at this point to measure these indicators is 3-4 years out of date. So, data production needs to become more agile and adaptable in data uses. This however is a challenge for the professional community and requires

partnerships with other organizations and private sector, who often have a more responsive ability to bring, particularly EO data, to the discussion rather than some of the traditional means.

One solution to address the data gaps is to adopt open data policies that facilitate broad and open access to existing data. Open data policies need to be supported with mechanisms for easy access and easy discovery of data. This is because a major part of the data gap in many developing countries is in fact a discovery gap. Bridging providers and their data with facilitating mechanisms to increase discovery and usage is the key. This makes standardization and metadata availability very important to ensure high-quality data. Another priority is to promote the integration of space-based data with *in situ* data. Many countries are operating *in situ* data collection systems that are not up to today's requirements. Efforts to develop complementariness between available *in situ* data and remote data must be made, including developing adapted modeling approaches. This again requires institutional strengthening.



### Geospatial data and SDG11, the study of South Korean UIS<sup>13</sup>

The following study analyses the existing urban data repositories in South Korea vis-à-vis SDG 11 indicators and evaluates the gaps in the data systems.

SDG 11 (Make cities inclusive, safe, resilient and sustainable) is quite crosscutting, and can potentially strengthen other SDGs as well. An urban information system (UIS) serves as a data provider, analytic engine, and information-sharing platform for the measurement and monitoring of the SDGs.

However, the success of a national UIS in the context of SDGs depends on four factors - whether the UIS is able to provide data at the geographical units (and not statistical or administrative units) necessary to measure the SDG indicators; whether the data is open and discoverable; whether the UIS can support spatial analysis functions; and whether data from

multiple sources is provided in an easily accessible, interoperable, and combinable manner.

South Korea developed four systems - the Korea Planning Support System (KOPSS), Urban Planning Information System (UPIS), U-City project, and Spatial Big Data System (SBDS) - and together they are collecting information, providing analytics and solutions for regional planning, urban policies, and big data activities. Junyoung Choi et al<sup>14</sup> evaluated these organizations with respect to the above parameters.

The study showed that SDG 11 indicators need to be measured in the geographical units of nodes/ links, administrative or statistical boundaries, user-defined aggregation units, points, radii, and parcels as described in Table 2. The analysis showed that certain indicators are measurable through spatial analyses while others are statistically measurable.

**Table 2**

The objects of measurement and geographic units for SDG 11 indicators

| SDG 11 indicators   | Objects of measurement   | Geographic unit | Measurement |
|---|--|-----------------|-------------|
| 11.1. Number of street intersections per square kilometre.  | Street density, street safety, and public space in cities.   | Node/Link       | SA          |
| 11.2. Existence and implementation of a national urban and human settlement policy framework.   | Government's commitment to sustainable urban development and safe and sustainable human development.     | A               | Sta         |
| 11.3. Percentage of cities with more than 100,000 inhabitants that are implementing risk reduction and resilience strategies informed by accepted international frameworks. | Disaster and climate preparedness of the city, to be updated in accordance with the new Hyogo framework. | A               | Sta         |
| 11.4. Presence of urban building codes stipulating either the use of local materials and/or new energy efficient technologies or with incentives for the same.              | Sustainable local production and consumption of raw materials and low-carbon development.                | A               | Sta         |





| SDG 11 indicators  | Objects of measurement  | Geographic unit              | Measurement |
|--|---|------------------------------|-------------|
| 11.5. City biodiversity index (Singapore index): Green space and biodiversity are crucial for a healthy urban environment.                           | Protection of endemic species as well as the environmental health of the city.                                | D                            | SA          |
| 11.6. Percentage of consumption of food and raw materials within urban areas that are produced and delivered in/from rural areas within the country. | Linkages between rural and urban areas, and the health of their co-dependency vis-a-vis the national economy. | D                            | Sta         |
| Indicator 6 cross-reference: Losses from natural disasters caused by climate and non-climate related events (in US\$ and in lives lost)              |   | Point                        | Sta/SA      |
| Indicator 66: Percentage of the urban population living in slums or informal settlements   |   | A                            | SA          |
| Indicator 67: Percentage of people within 0.5 km of public transit running at least every 20 min.  |   | Radius                       | SA          |
| Indicator 68: Ratio of the land consumption rate to population growth rate at comparable scales.   |   | A                            | SA          |
| Indicator 69: Mean urban air pollution level for particulate matter (PM10 and PM2.5).  |   | A/Point                      | SA          |
| Indicator 70: Area of public and green space as a proportion of total city space.  |   | Parcel, statistical boundary | Sta         |
| Indicator 71: Percentage of urban solid waste regularly collected and well managed.  |   | D                            | Sta         |

<sup>a</sup>A: Administrative boundary, D: Defined aggregation unit

<sup>b</sup>Sta: Statistically measurable, SA: Spatial analysis

With respect to data openness and availability of spatial analysis functions for SDG 11 indicators, the analysis rated Korean UIS as below:

| SDG 11 indicators | Data openness     | Availability of spatial analysis functions |      |        |      |
|-------------------|-------------------|--|------|--------|------|
|                   |                   | KOPSS                                      | UPIS | U-City | SBDS |
| 11.1              | Limited open data | 0  | X    | 0      | X    |
| 11.2              | Not available     | 0  | X    | X      | 0    |
| 11.3              | Not available     | 0  | 0    | X      | X    |
| 11.4              | Open data         | X  | X    | X      | X    |
| 11.5              | Limited open data | 0  | 0    | X      | 0    |
| 11.6              | Not available     | X  | X    | X      | X    |



| SDG 11 indicators | Data openness       | Availability of spatial analysis functions |      |        |      |
|-------------------|---------------------|--|------|--------|------|
|                   |                     | KOPSS                                      | UPIS | U-City | SBDS |
| 6                 | Limited open data   | X  | X    | X      | 0    |
| 66                | Permitted open data | 0  | 0    | X      | X    |
| 67                | Open data           | 0  | 0    | -      | 0    |
| 68                | Available data      | 0  | 0    | 0      | 0    |
| 69                | Open data           | X  | X    | 0      | X    |
| 70                | Open data           | 0  | 0    | 0      | X    |
| 71                | Limited open data   | X  | X    | 0      | X    |

<sup>a</sup>0: Available, X: Not Available

With respect to geospatial standards, the study revealed that the standards adopted by the UIS are mostly concerned with geospatial services, while the standards related to geospatial data construction are few. Also, Korean standards of geospatial data construction and quality management remain abstract-level standards and have limits when applied to the development of geospatial information systems.

In terms of spatial analysis functions, KOPSS and UPIS can be used to measure the indicators, while U-City has advantages in terms of measuring environment-related indicators but disadvantages in terms of statistical measurements. The SBDS is weak for statistical and environment-related measurements. The evaluation showed that Korean UIS are applicable to measuring and

monitoring SDG 11 indicators to some extent. Geospatial data of the evaluated systems support various geographic units of data collection and analysis, a key requirement for SDG measurements. Some of the systems are also equipped with functions capable of analyzing SDG 11 indicators, and they provide open geospatial data and comply with standards for geospatial services.

A detailed examination and analysis of the information systems existing at national and local levels on the above parameters is crucial to assess the current state of data availability and reliability. This will facilitate a thorough understanding of the gap areas that need to be addressed by the administration to meet the specific SDG indicators related to the information system.



## B. Open Geospatial Data, a conduit to SDG success

In the context of heightened significance of data and its availability for measuring and monitoring SDG progress, the discussion around open data gains a lot of attention. It is common knowledge that organizations, especially those in the government sector, produce variety of geospatial data periodically to perform their tasks, amassing huge repositories of archived data over a period of time, often locking them up and restricting/limiting its re-use and redistribution. The Open Data Handbook defines 'open data' as data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and share alike<sup>15</sup>. Geospatial data has a cost attached to it and expanding the scope of its usability (re-usability) by opening them up as per this definition only increases the Rol on the data, while benefiting the society in more ways than originally imagined.

As government data is public data by law, the argument of open data enthusiasts is to make data open and make them available for other departments/organizations (public and private) and individuals. Successful examples point to a large number of areas where open government data is creating value, increasing transparency and democratic control, facilitating new products and services, improving efficiency and effectiveness of services, improving innovation and empowerment, creating new knowledge from combined data sources and patterns in large data volumes. Open

**A Danish investment of US\$125 million in spatial data infrastructure between 2012 and 2016 brought returns of an estimated US\$33 million net benefit per annum for the public sector and US\$ 66 million net benefit per annum for the private sector**

geospatial data is not only related to increasing democracy and transparency in governance, but is also a means to promote economic and social opportunities. Studies found that central investment in core open-access spatial data brings significant financial returns. For example, a Danish investment of US\$125 million in spatial data infrastructure between 2012 and 2016 brought returns of an estimated US\$33 million net benefit per annum for the public sector and US\$ 66 million net benefit per

annum for the private sector<sup>16</sup>. A similar Finnish study showed that business growth is 15 percent higher in countries where public-sector geographic data is freely available<sup>17</sup>.

While it is impossible to predict precisely how and where the value is created, the argument for opening up data gains more meaning and relevance in the context where geospatial data is either sparse or not readily discoverable. GEO has long played an important role in promoting open

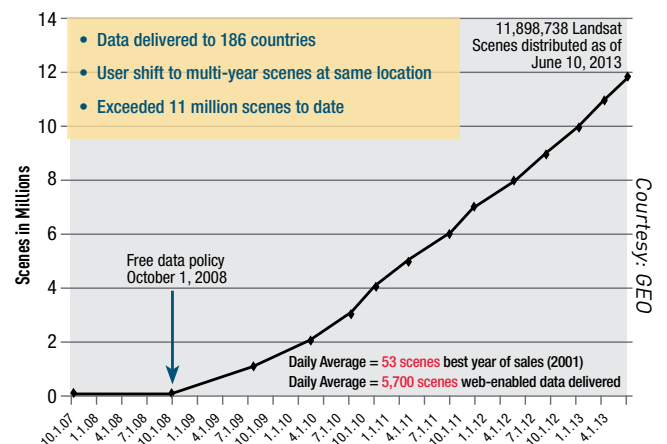


Figure 6: Increasing downloads of free Landsat Data.



data access to unleash the power of earth observations. In fact, one of the first accomplishments of GEO was the acceptance of a set of high-level data sharing principles as a foundation for setting up Group on Earth Observation System of Systems (GEOSS). The 10-Year Implementation Plan and the 2016-2025 Strategic Plan of GEO emphasize on the full and open exchange of data, metadata and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.

**Data needs to be complemented by innovative approaches to data dissemination and usage. Re-purposing available data, evolving solution-orientated approaches to harness existing data and measuring progress on the SDGs and to strengthen the cross-sectoral and multi-scalar analysis of data for SDG monitoring are quite important.**

### C. Harnessing Data for SDG Monitoring:

While data instruments form the bedrock of an effective national monitoring system, experts opine that data/open data is only a starting point. It is an enabler but not sufficient for SDG implementation and monitoring. Data needs to be complemented by innovative approaches to data dissemination and usage. Re-purposing available data, evolving solution-orientated approaches to harness existing data and measuring progress on

the SDGs and to strengthen the cross-sectoral and multi-scalar analysis of data for SDG monitoring are quite important.

About 36 years into the launch and successful operation, the United States Geological Survey (USGS) opened its Landsat archive in 2008. The availability of free and open data resulted in explosive data distribution growth and an expansion in data application. As per a USGS analysis released in 2013, the daily average scene downloads jumped from 53 in 2001 to more than 5700 in 2013, an exponential jump in data access (Figure 6).

Decision makers on SDG implementation are normally far away from data on the value chain and are more interested in information or knowledge. Stakeholders need to create tools, services and solutions that enable the transition from data to information & knowledge and also tools that provide access to knowledge. This will help decision makers make evidence-based analyses and decisions and also customize the solutions to their need.



Several weeks of heavy rain triggered landslides and flooding in Madagascar, causing a loss of life and displacing 36,000 people. WorldView-3 captured this image of flooding in Antananarivo, Madagascar on February 9, 2015.



One approach to achieve this is to create an environment of innovation and creativity. Innovation in creating data, in visualization and in using data is most needed in the context of SDG monitoring. Data has no value until it is used, and the more data is used, the more value they create. Activities to improve data literacy will act to increase the demand for and use of data. Monetary incentives, increasing awareness

of researchers about the importance of sustainable development issues, and promoting knowledge sharing across the stakeholders and experimental approaches are a few suggestions. It is important not to view efforts to spur innovation as costs/ expenditure, but rather as long-term investments in producing credible data and increasing the efficiency of data production, and utilization over time.

Another way to improve data collection and use for sustainable development is to create active linkages between service delivery and data collection and processing. For example, in remote villages of developing countries, everyday, community health workers help patients fight diseases (such as malaria), get them to clinics for check-ups, to receive immunizations, to obtain diagnoses, and to access emergency aid for their infants and young children. But the data from such visits is usually not collected, and even if it is put on paper, is never used again. If community health workers are supported by smartphone applications, which they can use to log patient data at each visit, that data can go directly onto public-health dashboards, which health managers can use to

**UN-GGIM and GEO are working closely with the Inter-Agency and Expert Group on SDG Indicators in providing expertise and advice and the statistical community on how geospatial information, earth observations and other new data sources can reliably contribute to the indicators**

spot disease outbreaks, failures in supply chains, or the need to bolster technical staff in near real time. The information can be used at future visits to the doctor or to remind patients about follow-up visits or medical interventions<sup>18</sup>.

Further, a clear dialogue and clear collaboration between data providers, solution providers and data users in co-designing the tools is

required to enhance the value and utility of open data to monitor the targeted SDGs.

## V. ENABLING FRAMEWORKS FOR SDG MONITORING

### A. Global Geospatial Frameworks

Several frameworks already exist at global level either facilitating data access and/or providing advisories to nations in creating frameworks and infrastructure for facilitating geospatial information. The United Nations initiative on Global Geospatial Information Management (UN-GGIM) is playing a leading role in setting the agenda for the development of global geospatial information and to promote its use to address key global challenges. UN-GGIM's Committee of Experts provides a platform for the development of effective strategies to build and strengthen national capacities in geospatial information, as well as disseminating best practices and experiences of national, regional and international bodies on geospatial information related to legal instruments, management models and technical standards<sup>19</sup>.



GEO, a voluntary partnership of governments and organizations, envisions “a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained earth observations and information<sup>20</sup>.” With 102 governments, European Commission and 95 participating organisations, GEO is committed to create a Global Earth Observation System of Systems (GEOSS) and promote the use of earth observation resources across multiple societal benefit areas and make those resources available for informed decision-making. GEO is working at the global level, at the regional level and at the national level to make sure all entities across that spectrum that are collecting and using earth observations are working together.

Several other global and regional frameworks - including The Committee on Earth Observation Satellites (CEOS), Global Spatial Data Infrastructure (GSDI), The UN Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), European Environment Agency and International Centre for



Integrated Mountain Development (ICIMOD) – are developing and facilitating access to geospatial information and knowledge. As part of the Working Group on Geospatial Information, UN-GGIM and GEO among others, have been working closely with the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs) in

providing expertise and advice to IAEG-SDGs and the larger statistical community on how geospatial information, earth observations and other new data sources can reliably and consistently support the indicators. The Working Group also reviews options and provides guidance to the IAEG-SDGs, on the role of national statistical offices (NSOs) in considering geospatial information and earth observations, as well as other

Big Data, as a means to contribute to and validate datasets as part of official statistics for SDG indicators; Reviews the agreed indicators and metadata through a ‘geographic location’ lens and identify existing geospatial data gaps, methodological and measurements issues; Consider how geospatial information can contribute to the indicators and metadata; Communicates and visualises the geographic dimensions and context of the indicators where appropriate; provides national and regional level experiences and best practices in geospatial data



production to measure, leaving no one behind; Propose strategies for undertaking methodological work on specific areas for improving disaggregation by geographic location concepts for national and sub-national reporting, including to the HLG and to the Statistical Commission<sup>21</sup>.

GEO's initiative GI-18 envisions the organization and realization of the potential of earth observations to advance the 2030 Agenda along with the participating organizations. The initiative aims to enable countries and organizations to leverage earth observations to support the implementation, planning, monitoring, reporting and evaluation of the SDGs and their normative societal benefits. The initiative also serves to advance GEO's strategic engagement with entities at national to international levels<sup>22</sup>. GEO will launch 4-6 pilot projects 2016 in specific countries in a collaboration mode to highlight the use of earth observations as a proof of concept in measuring and monitoring the SDG targets and indicators.

## B. National Geospatial Frameworks

To complement this top-down approach, a bottom-up approach at the national level is recommended to evolve mechanisms to effectively use geospatial information for monitoring the indicators of Agenda 2030. Several institutional and architectural arrangements unique to individual countries are already in place. In countries, these arrangements are officially within national statistics offices (which are mandated with monitoring the progress of SDGs) and in many countries, located in other government agencies. Regardless of where the structures are within the government, there is an imminent need to harmonize their processes, build capacities and

evolve strategies suitable to monitor the indicators under various SDGs. While this is an easy consideration in developed countries in terms of modifying the existing spatial data infrastructures or the equivalent mechanisms, it is important to evolve suitable and customized mechanisms in developing countries, small island states and least developed countries. This is certainly within UN-GGIM's mandate and it is working to strengthen the existing national frameworks worldwide and make them relevant to meet the needs of the SDGs.

Considering that the availability of core geospatial data is a pre-requisite for calculating the SDG indicators, there is also a need to build a consensus on the need to integrate the NSDIs into the national government's development plans. An NSDI strategy that is anchored in sustainable development, as an overarching theme, would provide an 'information' approach to national policy and implementation. It would also bring the analysis and evidence-base to the process, and thereby a consistent monitoring and reporting framework, that would benefit all areas of government. Based on existing national-scale costing studies and expert opinion, it is estimated that on average, IDA countries should budget at least US\$ 3,000,000 to build geospatial data infrastructures and should plan for a re-occurring operating budgets of between US\$ 600,000 and US\$ 850,000 per year<sup>23</sup>. These costs include data management, technology, data policy support, and a limited amount of annual data analysis and assume that the country has no current spatial data infrastructure.

As geospatial community understands, core data layers are fundamental features that serve as a reference, or the common denominator, for all GIS data layers. They are required for calculating all



other spatial data SDG indicators. Once these core datasets are developed and shared between data users through the facilitating mechanism like NSDI, several users working on SDG indicators can avoid duplicating the efforts of core data development. This exercise not only fulfills the SDG indicator requirements, but also is a critical component for multiple governance programs including e-governance map platforms and strategic development plans. It would also benefit to task

the NSDIs to work closely with and support the national statistical offices in evolving SDG targets and indicators at the national level and also in measuring and monitoring the progress of SDGs.

### C. Collaborating Frameworks

While several global, regional and national frameworks – government, not-for-profit, multilateral and private - are individually and specifically tasked with promoting the use of geospatial information for sustainable development, an increasing need is felt for them to fully develop and employ, join forces and support each other. Now is the time for better coordination of these initiatives so that data and information are translated into the development and provision of adapted solutions, both to measure and monitor the progress and to equip governments with planning tools they need to successfully implement the SDGs. This does not necessarily imply that an over-arching structure is required but instead, close inter-agency collaboration to properly integrate end-user requirements and

**On average, IDA countries should budget at least US\$ 3,000,000 to build geospatial data infrastructures and should plan for a re-occurring operating budgets of between US\$ 600,000 and US\$ 850,000 per year**

expectations is the need of the hour. GEO'S initiative to expand its partnership with UN-GGIM to build processes, mechanisms and capacity will benefit the SDG community integrate earth observations with geospatial and statistical information to improve the measuring, monitoring and achievement of the SDGs.

GEO could use its convening power to bring together the groups that can achieve the identification of all relevant Essential Variables (EVs)

for both the current and a future updated monitoring framework and the integration of socioeconomic and environmental data. As GEO has sufficient involvement of S&T communities to support the implementation of the SDGs, an important task for GEO is to establish a working relationship with the IAEG-SDG to participate in the review of the current monitoring framework. It is also important that GEO organizes its Work Programme more visibly around the SDGs, and have more GEO Initiatives and GEO Community Activities directly related to the SDGs.

Specifically for space-based information generated from EO, global navigation satellite systems and satellite telecommunications, the United Nations Office for Outer Space Affairs (UNOOSA) has the unique mandate to promote international cooperation. To celebrate 50 years of UNISPACE conferences, UNOOSA and the Committee on the Peaceful Uses of Outer Space (COPUOS) are developing a new global framework to collaborate and support nations in reaching their SDG targets. There is a lot of work in progress at various levels and there is an imminent need to evolve more such partnerships for creating



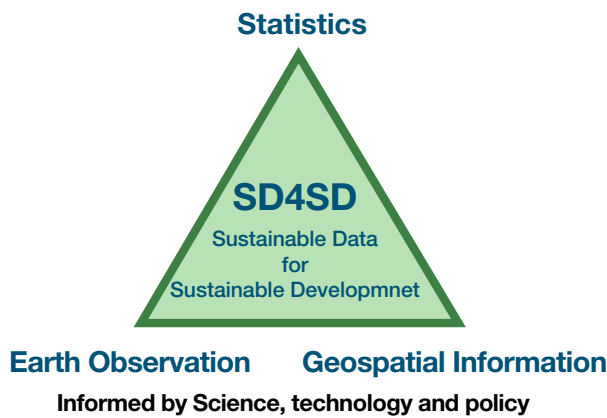


Figure 7: Key areas of data contribution to the global indicator framework. Courtesy: UN-GGIM

common frameworks that directly and indirectly contribute to the success of SDGs.

## VI. INTEGRATING STATISTICAL & GEOSPATIAL INFORMATION

While, all the above-mentioned efforts/initiatives have played and/or continue to play a key role in developing the geospatial data and inputs for the indicator framework, effective linkages need to be developed from the ground up. At the national level, planning and monitoring of the SDGs are the responsibility of statistics agencies. More often than not, statistical data of a country are not integrated with geospatial data, which is essential for SDG monitoring (Figure 7). However, developing these linkages is an urgent need for every country and is central for SDG Agenda.

The third session of the Committee of Experts of UN-GGIM, held in July 2013, acknowledged the importance of integrating geospatial information with statistics and agreed to develop a statistical geospatial framework as a global high level framework for the integration of statistical and geospatial information. The setting up of the UN

Expert Group on the Integration of Statistical and Geospatial Information (UN EG-ISGI) paved way for Member Countries accepting that integrating statistical and geospatial information is critical for – local, sub-national, national, regional, and global decision making processes; measuring and monitoring the targets and global indicator framework for the SDGs; Supporting data sharing between institutions and enhancing the interoperability of geospatial and statistical information; Unlocking new insights and data relationships that would not have been possible by analysing socio-economic, environmental or geospatial data in isolation of each other; Promoting investment and capability building in geospatial and statistical information and building institutional collaboration between geospatial and statistical communities<sup>24</sup>.

The challenge however is to understand how best to achieve this integration in an effective and consistent way. The Expert Group considers the best way to achieve consistent integration is through having a common method of geospatially enabling statistical and administrative data and integrating this with geospatial information through an internationally agreed framework (Figure 8). This is expected to

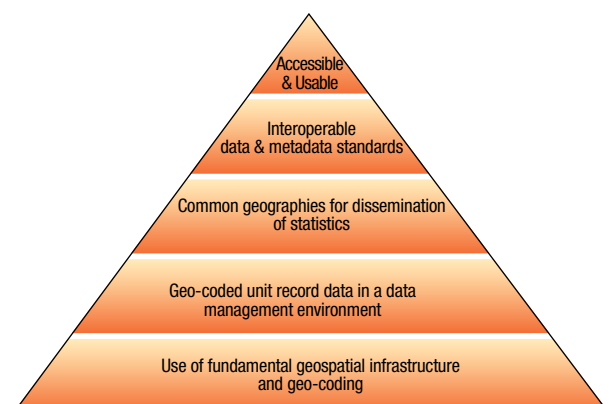
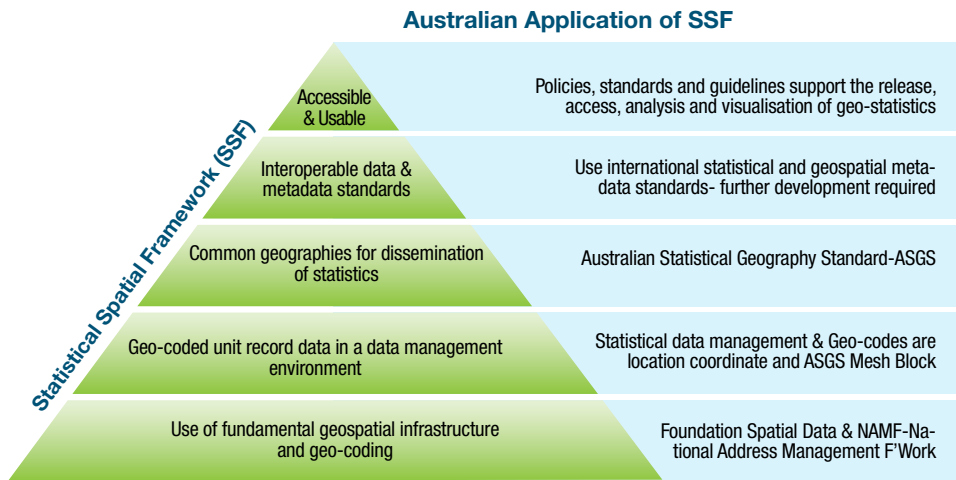


Figure 8: Global Statistical Geospatial Framework<sup>26</sup>  
Courtesy: UN-GGIM



Courtesy: Australian Bureau of Statistics (ABS)

Figure 9: Australian Application of Statistical Spatial Framework<sup>29</sup>

enable new, better and more integrated information for analysis and decision-making process and enable comparisons within and between countries. The UN EG-ISGI is tasked with developing such a framework<sup>25</sup>. This will serve as a tool and a platform to communicate and understand the geospatial capability requirements for statistical information.

and National Mapping and Cadastral Authorities (NMCA). Over the past few years, GISCO has facilitated geo-referencing of official registers and administrative data used for statistics to allow better linkage and integration of statistics and geographic information and evaluated big data and linked data for statistical production<sup>27</sup>.

While several countries are just opening up to the idea and the need to integrate geospatial and statistical information, a few countries have been working evolving mechanisms for integration for the past few years, while others have established and well-defined systems. The Geographic Information System of the Commission (GISCO) promotes the use of geographical information and GIS within the European Statistical System (ESS) and the European Commission. GISCO chairs the working group on the integration of statistical and geospatial information, which includes representatives of National Statistical Institutes (NSI)

Responding to the need, the Australian Bureau of Statistics (ABS) developed a Statistical Spatial Framework (SSF)<sup>28</sup>. The general Statistical Spatial Framework developed by the ABS consists of five

**The best way to achieve consistent integration is through having a common method of geospatially enabling statistical and administrative data and integrating this with geospatial information through an internationally agreed framework**

elements that are considered essential to integrating geospatial and socioeconomic information. The Statistical Spatial Framework for Australia details the Australian implementation of this general Framework as shown in Figure 9.

## VII. TRAINING & CAPACITY DEVELOPMENT

The monitoring of MDGs taught the world that data are an indispensable



Table 3: Goal 17's emphasis on developing capacities and partnerships

| Goal & Target  | Indicators   |
|--|--|
| <p><b>Data Monitoring and accountability:</b></p> <p>17.18 By 2020, enhance capacity building 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</p> | <p>17.18.1 Proportion of sustainable development indicators produced at the national level with full disaggregation when relevant to the target, in accordance with the Fundamental Principles of Official Statistics.</p> <p>17.18.2 Number of countries that have national statistical legislation that complies with the Fundamental Principles of Official Statistics.</p> |

### Multi-stakeholder partnerships

17.16 Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievements of the SDGs in all countries, in particular developing countries.

17.17 Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.

17.16.1 Number of countries reporting progress in multi-stakeholder development effectiveness monitoring frameworks that support the achievement of the SDGs.

17.17.1 Amount of United States dollars committed to public-private and civil society partnerships.

element of Sustainable Development Agenda. Despite improvement, critical data, especially geospatial data, for development policymaking are still inadequate. Understanding that quality, accessible, timely and reliable disaggregated data will be needed for the success of SDG Agenda, the United Nations agreed to intensify efforts to strengthen statistical capacities in developing countries and least developed countries. Goal 17 explicitly discusses the need to build capacities and strengthen the means of implementation and revitalize the global partnership for sustainable development as shown in Table 3<sup>30</sup>.

Experts feel that the biggest challenge for the 2030 Agenda is around capacity development and knowledge transfer and how they can take enabling

technologies and capabilities from data-rich countries to data-poor countries. The UN-GGIM along with the whole UN system is conscious about capacity development. GEO's GI-18 is strongly focusing on developing training and capacity building programs directly related to the use of EO for the monitoring of SDGs. The implementation plan of GI-18 includes a number of tangible goals to be achieved by 2020. The global nature of GEO allows for actions that lead to capacity building on a global scale.

The UN-SPIDER allocates financial and human resources to capacity building and institutional strengthening in a wide range of thematic areas, including the use of space-based technology and applications for disaster management,

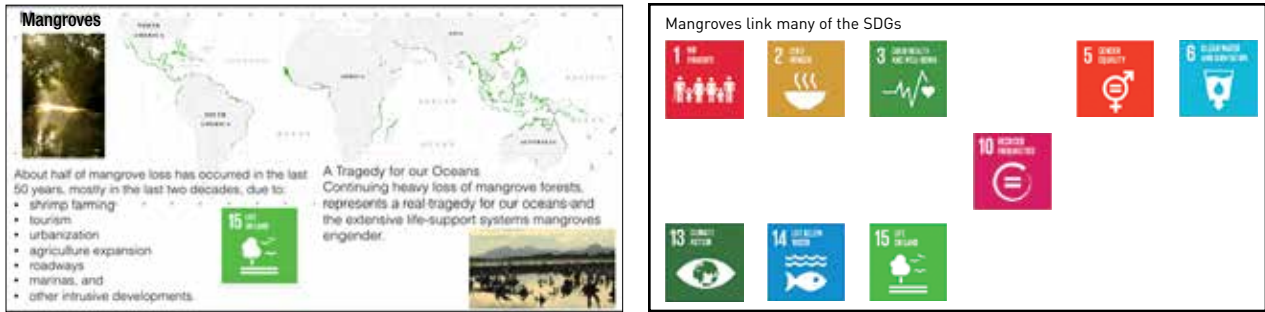


Figure 10: This example of mangroves shows that restoring ecosystems could negatively impact food security or increase inequality or help to reach targets under SDG 14. Modified from Jules-Plag and Plag (2016).

environmental monitoring, climate change, and global health. UNOOSA assists the COPUOS, which has 83 Member States, to coordinate its actions in support of the 2030 Agenda. These actions aim to further bring the benefits of space technology and applications to nations implementing the 2030 Agenda. UNISPACE+50 is actually prioritizing building the capacities of nations in accessing and using space-based technology and applications for better planning and monitoring of SDGs at the national, regional and global levels.

While a lot of training and capacity building efforts are going on globally, challenges remain to make sure that they are just not one-off events but are sustainable and that true capacity is getting built in countries. To be able to ensure this, GEO is downscaling what it is doing globally to the regional level. The AmeriGEOSS, AfriGEOSS and HimalayanGEOSS initiatives bring respective governments and participating organizations together to integrate their capacity building efforts and training opportunities.

An important aspect of the SDGs that is often overlooked is the

interdependency of the SDGs. Many of the individual SDGs depend on actions focusing on other SDGs, and capacity building needs to take this into account. For example, restoring ecosystems under several Targets of SDG 15 may be in conflict with SDG1 and SDG2. The example of mangroves cited in Figure 10 shows that they are connected to several SDGs.

Significant technology innovation and intellectual capacities developed within the private sector often either do not percolate or see delayed adoption by government entities leading sustainable development activities. Considering that geospatial and earth observation industry is taking-off rapidly in private

**To make progress on action climate change (SDG 13), the UNEP Global Adaptation Gap Report says the world will need to invest up to \$500 billion annually by 2050, even if the target of no more than 2°C global temperature rise is achieved.**

space with cost-effective innovations in sensor technologies, small satellites and drones supported by advancements in IT and data analytics, it is prudent to make private industry an equal stakeholder and partner in capacity development, in policy making and in implementing projects pertaining to SDGs. For example, the Global Partnership for Sustainable Development Data supports data-driven decision-making by initiating more open, new and usable data. It also helps to develop and build support for international



principles tying together the data, including sharing and leveraging current, privately held data.

What enables countries develop capacities are resources and it is common knowledge that resources are quite finite. The Addis Ababa Agenda provided a broad framework for the international community to finance sustainable development. Financing the SDGs will require at least \$1.5 trillion extra annually over what was required for the MDGs (\$120 billion annually). To make progress on action climate change (SDG 13), the UNEP Global Adaptation Gap Report says the world will need to invest up to \$500 billion annually by 2050, even if the target of no more than 2°C global temperature rise is achieved. Therefore, innovative approaches, including

private funding, are clearly needed to bridge the funding gaps.

With respect to satellite-based EO imagery, one estimate puts the investment required at US\$ 150,000,000 for start-up costs and US\$ 5,000,000 in annual costs covering all 77 IDA countries. One of the cost-effective ways suggested to achieve higher resolution imagery acquisition for the 77 IDA countries is to create a new non-profit organization charged with operating a satellite network and making available imagery at no cost to IDA recipient countries. Such a model would have estimated start-up costs of approximately US\$ 150 million and operating costs of approximately US\$ 5 million per year. The goal would be to provide a minimum of five-





meter resolution imagery with up to five bands at a frequency of 5-10 images per year. Within this model, countries and global monitoring agencies would use both free 30-metre resolution data (from Landsat, MODIS etc.) and have the option of purchasing even higher resolution commercial imagery for specific priority areas<sup>31</sup>.

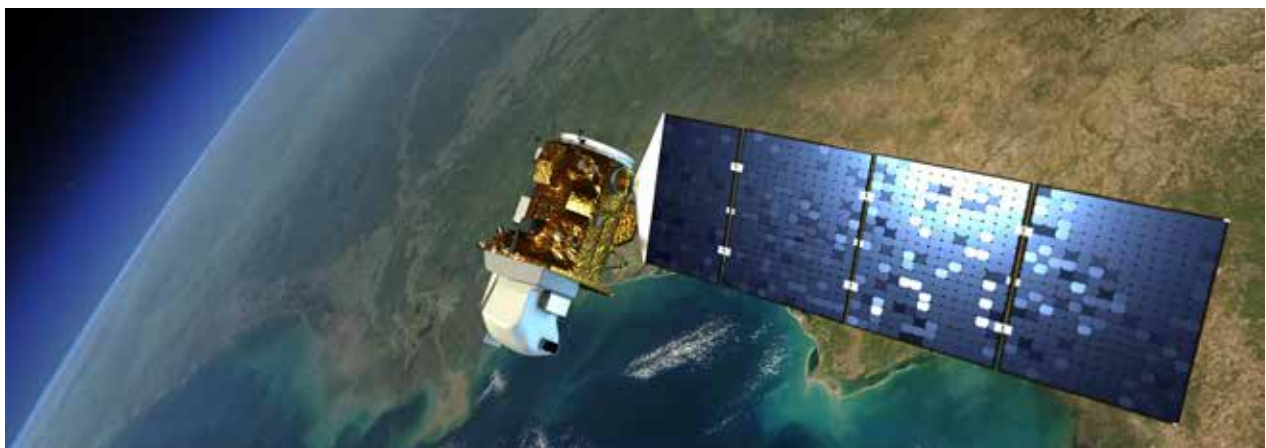
## VIII. CONCLUSION

Data, especially geospatial data, is the basis for evidence-based decision-making, monitoring and accountability. The geospatial community recognizes that location and geography are significantly linked to many, if not all, elements of SDGs. The task before the world geospatial community now is to push the 'geospatial value proposition' envelope to the governments and decision-makers at every level.

The first progress report on Sustainable Development Goals released recently acknowledged that several national statistical systems across the globe face serious challenges with respect to availability of good quality, disaggregated data. As a result, accurate and timely information about certain aspects of people's lives are unknown, numerous groups and individuals remain invisible, and many development challenges are still poorly understood.

In this background, the success of Agenda 2030 hinges heavily on the vision, motivation and commitment of the decision-making fraternity. It also depends on a close interaction between those who are in positions to make policies in support of the Agenda 2030 and decisions on actions for the implementation of the SDGs with those who provide the knowledge about progress towards the SDG targets and the impacts of policies and actions. Methodologies and infrastructure are needed to facilitate a co-design of the research agenda and a co-creation of the knowledge for the implementation and monitoring of the SDGs. To achieve this, it is important to sensitize and encourage local political centers and senior administrators to 'own' and 'lead' the geospatial efforts in their respective countries. Without their involvement much of the data and information derived will remain in the ivory tower of 'space research'.

In the final analysis, the success of the Agenda 2030 will require capacity-building efforts, while simultaneously exploring new and cost-effective technologies for data collection and mechanisms to integrate geospatial and statistical data. Partnerships with civil society, the private sector and academia will play a defining role in the success of the Agenda.





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