EARTH OBSERVATIONS FOR THE
SUSTAINABLE DEVELOPMENT GOALS

GEO GROUP ON
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CEOS
Committee on
Earth Observation Satellites

ZERO**HUNGER**

A Primer on Sustainable Development Goal 2:

End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

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Abstract

One of the significant objectives of the United Nations 2030 Agenda for Sustainable Development and associated Sustainable Development Goals (SDGs) is to end hunger and food insecurity. This means promoting a path towards sustainable food and agricultural production while safeguarding plant and animal genetic resources. It also means ensuring that people who are suffering from hunger and malnutrition have access to nutricious food.

This primer offers an introduction to SDG 2 ("Zero Hunger"); a description of progress since the Millenium Development Goals (MDGs) Agenda; an overview of the enabling environment – key stakeholders, institutions, governance and partnerships; and a summary of the role of data, including Earth observations and geospatial information, in enabling transformation across sectors and contributing to a zero hunger society.

Introduction

The 2030 Agenda for Sustainable Development, spearheaded in 2015 by the United Nations (UN) and agreed upon by its 193 Member States, includes 17 Sustainable Development Goals (SDGs) with 169 associated Targets and a Global Indicator Framework.[1] Each Member State is committed to accomplishing the SDGs via international and domestic resources and collaboration, in order to realize a more resilient and sustainable global society.

As a successor to the Millennium Development Goals (MDGs), initiated by the UN in the year 2000 with a focus on the developing world, the 2030 Agenda is inclusive and universal, acknowledging that improvement is needed in every socioeconomic domain around the world. While the MDG Agenda largely targeted social change, the 2030 Agenda aims for social, economic and environmental progress. With regards to measuring progress, the MDG Agenda included strict requirements concerning the use of Official Statistics and Administrative Data, while the 2030 Agenda allows for a more diverse contribution of datasets, including citizen-generated data, geospatial data and Earth observations (EO).[2]

> **Did you know?** The world's population grew from 6.1 billion in 2000 to 7.2 billion in 2015, and it is projected to increase to 8.5 billion by 2030. Rapid population increase must be accounted for by means of a practical methodology geared towards achieving the 2030 Agenda.[3]

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[1] United Nations
[2] United Nations Development Programme and the World Bank Group
[3] The World Bank DataBank

What is Goal 2?

Sustainable Development Goal 2 calls to "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture".[4] In short, the UN declared "Zero Hunger" a global priority. When the 2030 Agenda was established in 2015, five out of every nine people on our planet suffered from undernourishment, making Goal 2 imperative for global development progress.[5] SDG 2 is composed of eight Targets, each of which represents a specific sub-goal to Goal 2 (see Figure 1). The progress toward each Target is measured by one to two associated Indicators (14 total).

Figure 1. Diagram of SDG 2, *End hunger, achieve food security and improved nutrition, and promote sustainable agriculture*, and its associated Targets and Indicators. "Agr"=agriculture.

SDG 2 Interlinkages

Goal 2 is an integral component of the UN 2030 Agenda, as it is linked to many other SDGs. Ending hunger is a clear prerequisite for eradicating poverty and achieving universal health (Goals 1 and 3). Rural areas tend to be more vulnerable due to their isolation and distance from urban centers, and thus they may be more susceptible to societal ills such as poverty and inadequate access to health care. Promoting a more equitable and stable income for farmers is therefore a major catalyst for much-needed change.[6] Improving agricultural systems correlates highly with women's empowerment and gender equality (Goal 5). Agriculture also provides a major opportunity for women to enter the agrarian workforce, with the potential to help manage a community or nation's food production.[7] Agriculture and food production also have implications for water management, energy use, climate change and ecosystems (Goals 6, 7, 13, and 15). For example, agricultural practices that provide the highest crop yields and help achieve food security may contradict practices that would best conserve water and energy, and protect the environment. Targets 2.4 and 2.5 address this potential challenge by aiming to conserve the environment while developing sustainable agricultural practices. In essence, the successful achievement of Goal 2 may have cross-cutting, and often profound, impacts on the progress of many other SDGs.

> ***Did you know?*** Agriculture is the world's largest provider of jobs, making up nearly 40% of the world population's livelihood. Some developing nations employ up to 75% of their population in the agricultural/food production sector.[8]
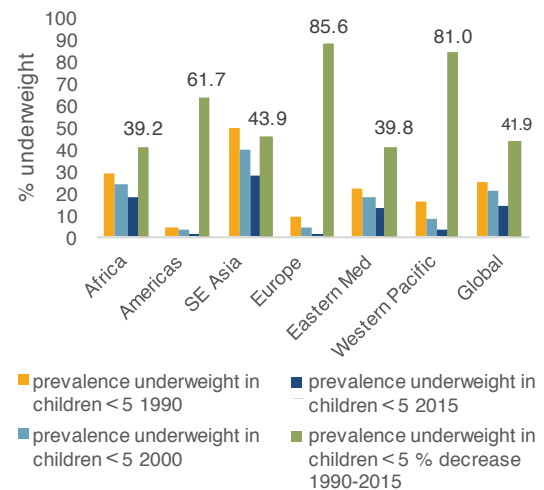
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[6] Mollier, ICSU
[7] Mollier, ICSU
[8] FAO

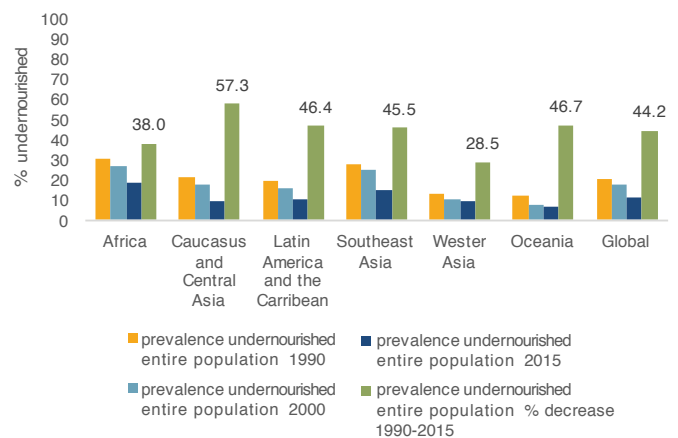# How did we do on MDG 1, and where are we headed with SDG 2?

Goal 1 of the MDG Agenda addressed global poverty and hunger, which corresponds to Goals 1 and 2 of the SDG Agenda. Specifically, MDG Target 1.c focused on food security, stating the aim to "Halve, between 1990 and 2015, the proportion of people who suffer from hunger".[9] Progress around this Target was measured by two Indicators: prevalence of underweight children and the proportion of the population below a minimum level of dietary energy consumption. Significant progress was made on MDG 1: the world came just shy of reaching the 2015 goal of halving hunger. Progress varied significantly by region, however; although the incidence of underweight children aged 5 years or younger in the Western Pacific fell by 81%, the numbers in Africa decreased by only 30%.[10] Within each region there were countries that both surpassed and fell short of Target 1.c according to the World Health Organisation (WHO), which both tracked MDG 1 progress and also continues to collect data for the 2030 Agenda.

The 2030 Agenda extends MDG Target 1.c into an eight-Target plan for Zero Hunger, recognizing that hunger is a universal problem in need of regional and country-specific solutions.

Prevalence of **underweight** among children (under the age of 5)

- prevalence underweight in children < 5 1990
- prevalence underweight in children < 5 2000
- prevalence underweight in children < 5 2015
- prevalence underweight in children < 5 % decrease 1990-2015

Prevalence of **undernourishment** (entire population) in 1990, 2000, 2015

- prevalence undernourished entire population 1990
- prevalence undernourished entire population 2000
- prevalence undernourished entire population 2015
- prevalence undernourished entire population % decrease 1990-2015

[9] United Nations
[10] World Health Organisation

Key players: Who is working toward SDG 2?

Everyone has a role in achieving global food security. Today, collaboration among local, regional and national stakeholders is increasingly important. Interdisciplinary, public-private, socio-economic and environmental partnerships are now at the forefront of international development. On the international scale, many global entities are helping define and populate the data and policy framework for the 2030 Agenda.

The **UN** provides leadership as it encourages other international entities and individual nations to take action. For instance, the **UN Inter-Agency and Expert Group on SDG indicators (IAEG-SDGs)**, a working group of the UN Statistical Commission, assigned a **"Custodian Agency"** to each SDG Indicator.

The **Custodian Agencies** are charged with producing a methodology for collecting data from national data sources and tracking progress, as well as contributing towards statistical capacity building. The **UN High Level Political Forum (HLPF)** produces an annual report on progress toward the SDGs; custodian agencies contribute towards the storyline for this global report.

Further, the IAEG-SDGs has formed three working groups to address areas relevant to SDG indicator implementation, including a **Working Group on Geospatial Information (WGGI)**, which aims to ensure from a statistical and geospatial perspective that the principle of 'leaving no one behind' is reflected in the Global Indicator Framework.

Did you know? In addition to assigning a Custodian Agency for each Indicator, the UN assesses the level of existing methodologies for measuring each Indicator:[11]

- Tier I includes Indicators for which standards are clearly established, and countries regularly collect the data. There are seven Tier I Indicators for SDG 2.

- Tier II includes Indicators for which the standard methodology is available, but data are not commonly collected, which is the case for two SDG 2 Indicators.

- Tier III includes Indicators that have little to no previously established methodology or identified data sources. There are five Tier III SDG 2 Indicators.

The UN is comprised of several specialized agencies that play key roles in achieving SDG 2:[12]

- The **Food and Agriculture Organization (FAO)** is charged with the eradication of hunger and the guarantee of safe food and water for all. The FAO is the Custodian Agency for eight of the 14 SDG 2 Indicators.

- The **The United Nations (UN) Environment** creates the UN's environmental agenda and develops instruments for eco-friendly global management. UN is the Custodian Agency for three SDG 2 Indicators.

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[11] United Nations
[12] United Nations

- The **Word Health Organization (WHO)** provides treatment in cases of acute malnutrition and, as Custodian Agency, provides valuable data for two of the SDG 2 Indicators.

- The **United Nations International Children's Emergency Fund (UNICEF)** fights for the rights and well-being of children across the world through proper education, health, and other measures. UNICEF is the Custodian Agency for two SDG 2 Indicators.

- The **World Food Programme (WFP)** both delivers food aid in short-term emergencies and works with communities to improve long-term nutrition.

- The **International Fund for Agricultural Development (IFAD)** aims to develop rural communities by working with and financing agricultural development projects.

The **World Bank** and the **International Monetary Fund (IMF)** provide loans to developing countries in order to invest in social welfare programs, with the goal of eradicating poverty and hunger. The extent of World Bank, IMF, and individual community involvement varies on a case-by-case basis.

The **Group on Earth Observations (GEO)**, a partnership between over 100 national governments and over 100 participating organizations that envision a future where decisions and actions are informed by coordinated and sustained EO, leads various initiatives that are relevant to SDG 2. This includes the **GEO Global Agricultural Monitoring (GEOGLAM)** Flagship activity. GEOGLAM provides coordinated EO from satellites and integrates these with ground-based and other *in-situ* (ground/on-site) measurements to help generate reliable, accurate, timely and sustained crop monitoring information and yield forecasts.

GEO and the **Committee on Earth Observation Satellites (CEOS)**, which is made up of space agencies from around the world and is often referred to as "the space arm" of GEO, have both launched dedicated initiatives geared specifically toward achieving the 2030 Agenda, including the **GEO Earth Observations for the Sustainable Development Goals (EO4SDG)** Initiative and the **CEOS Ad-Hoc Team on SDGs (AHT SDG)**.

Other global initiatives and partnerships, such as the **Global Partnership for Sustainable Devleopment Data (GPSDD)** and the **Sustainable Development Solutions Network (SDSN)**, work to bridge diverse actors and mobilize resources, while enabling the development of data ecosystems for achievement of the SDGs.

There are many **Non-Governmental Organizations (NGOs)**, including Oxfam International, Action against Hunger, and the Hunger Project, among others, that work toward food security all over the world at both regional and national levels. There are various approaches to NGO involvement: emergency aid, community building, technology implementation, awareness raising, and more.

Additionally, various **think tanks** provide expert guidance, research, analysis and data on food security worldwide. Think tanks work with countries, universities, NGOs, international organizations, and other actors.

The **Organization for Economic Cooperation and Development (OECD)** and the **World Trade Organization (WTO)** have resources and governing power that impact policy on agriculture, aid, and other SDG 2-relevant factors. These two groups are also custodian agencies for two of the SDG 2 Indicators.

Finally, various **Multinational and Transnational Corporations (MNC/TNCs)** have an undeniable role in the flow of money and crops around the world.

When it comes to achieving the SDGs, much of the needed change must happen at the level of individual countries, in accordance with the principle of national ownership. Engagement in the SDG process by socioeconomic policy decision-makers and welfare program implementers is crucial for making progress, as is multi-stakeholder approaches where civil society and the private sector are engaged in addressing the SDGs. Reliable data are equally critical for tracking and reporting on progress, and in the context of the data

revolution, as is the use of new sources of data that provide more dynamic, real-time and disaggregated information for decision-making and action.

National governments, who have contributed to the design of the SDGs and have committed to their achievement, typically rely on a variety of public and private resources in order to contribute to SDG 2, including:

• A National Office of Statistics

• Ministries/Departments of Food, Agriculture, Water, Fisheries, Forestry

• Governing bodies that enact agricultural policy

• Farmers and citizens who are affected by national policies

> *Did you know?* National Statistical Offices (NSOs) hold a coordinating and leading role in national SDG reporting to the global UN IAEG-SDGs Group. For this reason, it is critical that the Earth observation community develop and/or strengthen engagement with National Statistical Offices.[13]

Country SDG Implementation

Countries are at the center of the SDG implementation process and organize their monitoring efforts via national government coordination mechanisms. These coordination mechanisms help systemize efforts from national entities that are officially mandated or informally tasked with coordinating country-level efforts on the SDGs.

National Statistical Offices (NSOS)

NSOs are primarily responsible for coordinating the country-level SDG process, including coordinating the entire statistical system in relation to the SDGs, mapping data sources and gaps, and organizing country-level inputs for global reporting purposes.

Ministries of National Planning/ Economic Development

Ministries of Planning or Economic Development usually host and/or lead SDG coordination committees and are also responsible for administering national development plans.

Line Ministries

Line Ministries are involved in the country-level tracking, monitoring, and reporting process of SDGs that are of relevance to their thematic focus and expertise.

City/municipal or local governments

City/municipal and local governments are primarily responsible for localizing the SDGs, i.e. providing subnational contexts in the achievement of the SDGs, and supporting a bottom-up approach for SDG implementation.

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[13] Group on Earth Observations
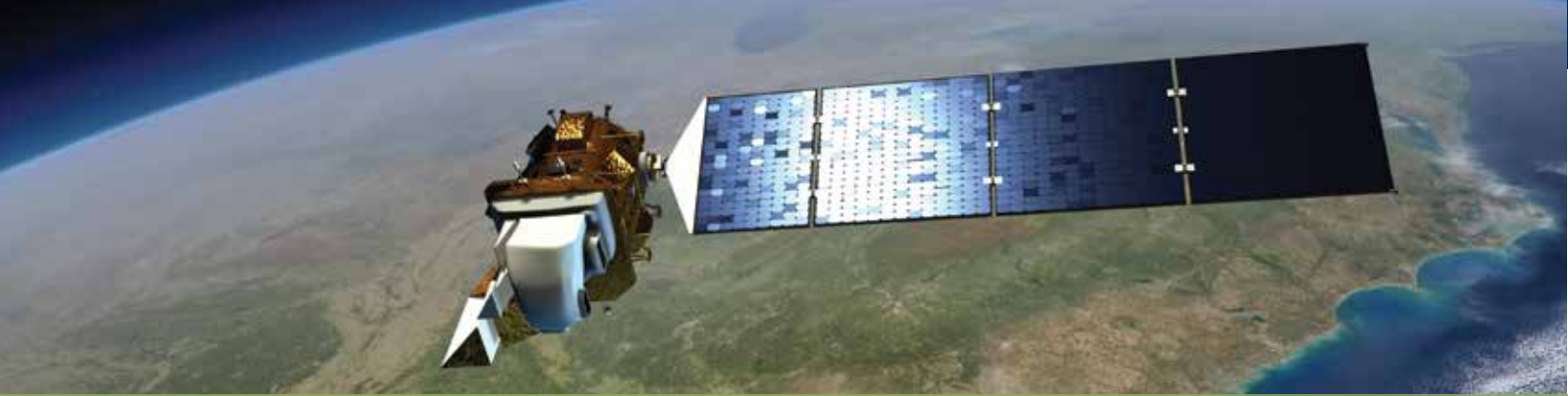
What can Earth observations contribute towards achieving SDG 2 on a global scale?

Together with strengthening statistical measures for assessing hunger, the 2030 Agenda seeks to enhance capacity in the use and integration of alternative data sources, including EO and geospatial information, to help countries track progress towards achieving zero hunger. The Agenda also seeks to ensure that data are comparable and are aggregated or broken down at sub-regional, regional and global levels.

EO can add context and provide linkages to any set of statistics by means of:

• **Scale:** EO can provide data on all scales, from local to national, regional, and even global.

• **Reduced Cost:** Thanks to the increasing open and free access policy in the United States and Europe, satellite and in-situ data are becoming more broadly accessible.

• **Long time series and continuity:** The continuous acquisition of data by satellites systematically produces real-time data. With some mission series dating back to the 1970s, data collected over long periods of time are especially valuable for analysis and tool creation.

• **Consistency and comparability:** Satellites provide means for the effective comparison of results between neighboring as well as remote countries.

• **Creating new solutions:** While national statistical data are often used to mark progress towards sustainable agriculture systems, EO data can also be used to further stimulate progress; for example, EO can help identify environments that can produce food at a higher capacity for the global population. The CEOS Open Data Cube is an example of such a new solution, by providing an innovative data architecture to compile multiple time series from sources of data in one location quickly and efficiently.[14]

GEO aims to encourage the use of EO globally, especially in developing countries, in order to inform and improve decision-making at national, regional, and global scales. GEO's EO4SDG Initiative targets the integration of EO and geospatial information into the global SDG effort. The initiative aims to boost effective reporting of SDG progress by incorporating multiple types of data—including both conventional sources, such as national statistics, household surveys and routine administrative data, as well as new forms of data, notably, EO and geospatial information.[15] GEO also ensures that Earth observation data are made open and accessible through its Global Earth Observation System of Systems (GEOSS) Common Infrastructure (GCI).

GEO's EO4SDG has identified various targets and specific Indicators whose evaluation can be supplemented by EO. Targets 2.3, 2.4, 2.c and 2.4.1 have been selected as areas for prime EO utility in the fight against global hunger.[16]

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[14] Group on Earth Observations
[15] Group on Earth Observations
[16] Group on Earth Observations

Where can all these data be found?

Today, volumes of data can be found relatively easily, but it can be difficult to identify which data are high quality, accurate and timely, and where data overlaps occur. However, various platforms exist that combine multiple streams of data into one streamlined and accessible place for users.

Here are some useful resources when searching for EO data:

• The GEOSS Common Infrastructure (GCI), which brokers 400,000,000 open Earth observation datasets and information resources

• The CEOS Missions, Instruments and Measurements Database (MIM)

• The Earthdata Search, which provides easy-to-use access to the Earth Observing System Data and Information System (EOSDIS), a core capability in NASA's Earth Science Data Systems (ESDS) Program. Earthdata.nasa.gov provides services for Earth science data discovery, filtering, visualization, and access.

• GEOGLAM's Crop Monitor for the Agricultural Market Information System (AMIS)

• NASA Giovanni, a web-based application developed to support seasonal forecasting research, as a simple way to visualize, analyze, and access/download vast amounts of Earth science remote-sensing data

• The Worldview tool from NASA's Earth Observing System Data and Information System (EOSDIS), which provides the capability to interactively browse global, full-resolution satellite imagery and download the underlying data.

• The Copernicus Open Access Hub (previously known as Sentinels Scientific Data Hub), which provides complete, free and open access to the Copernicus Sentinel -1, Sentinel-2, and Sentinel-3 user products processed by the European Space Agency (ESA).

• The World Resources Institute (WRI) Resource Watch, an open platform for everyone to explore accurate, up-to-date insights about our planet

• The GEO-WIKI by the International Institute for Applied Systems Analysis (IIASA), a platform for engaging citizens in environmental monitoring
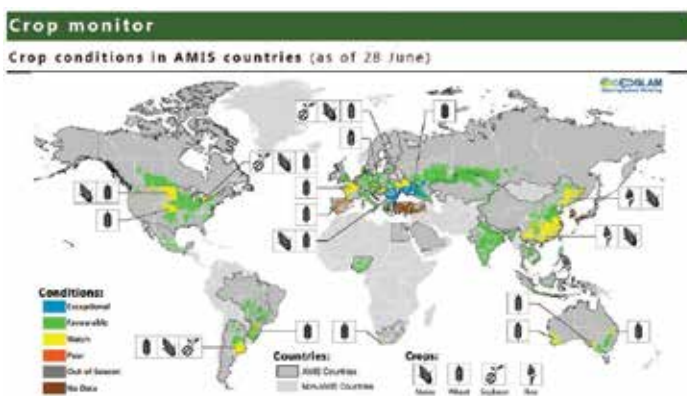
Examples of SDG 2-relevant initiatives and tools informed by Earth observations

Prime examples of tools and initiatives for enhanced decision-making derived from EO data in relation to Goal 2 are listed below:

- **Global Agricultural Monitoring (GEOGLAM):** GEOGLAM's **Crop Monitor for the Agricultural Market Information System (AMIS)** is part of the Group of Twenty (G20) Action Plan on Food Price Volatility, launched in 2011 with the objective to "enhance the community's capacity to produce and disseminate timely, accurate, reliable and actionable information on food production by improving the use of remote sensing tools for crop production projections and weather forecasting". The AMIS tool combines reports by national, regional and international partners in order to summarize global crop conditions. The initiative includes various components, such as the

Crop condition map synthesizing information for all four AMIS crops as of 28 June. Crop conditions over the main growing areas for wheat, maize, rice, and soybean are based on a combination of national and regional crop anyalyst inputs along with earth observation data. *Only crops that are in other-than-favorable conditions are displayed on the map with their crop symbol.*

Joint Experiment of Crop Assessment and Monitoring (JECAM) research network, the Asian Rice Crop Estimation & Monitoring (Asia-RiCE) component, and the Rangeland and Pasture Productivity (RAPP) initiative and its global rangelands monitoring system. More recently, GEOGLAM developed the **Crop Monitor for Early Warning**, which measures crop conditions in 83 countries at risk of food insecurity.

- **Famine Early Warning Systems Network (FEWS-NET):** FEWS-NET is a tool for early warning and analysis on food security, developed by USAID in 1985 to help decision-makers plan for humanitarian crises. The tool integrates a combination of socioeconomic and environmental data to anticipate severity of acute food insecurity. FEWS-NET is a great example of partnerships among various governmental agencies, as well as the private sector.

- **Global Satellite Mapping of Precipitation (GSMaP):** GSMaP is a tool for mapping satellite-based global precipitation data. It can be combined with *in-situ* observations (groundwater, rain gauges, river gauges, lake-level gauges) and river-runoff models, as has been done in the Asia-Pacific region, in order to generate accurate predictions of extreme weather events. Predictions of precipitation and flooding are crucial for successful decision-making about agriculture.

- **Integrated Multi-Satellite Retrievals for Global Precipitation Mission (GPM) (IMERG):** IMERG retrieves precipitation data from NASA/JAXA GPM satellite mission and produces maps on extreme weather conditions.

COUNTRY CASE STUDY: Using Earth observations in support of SDG 2: Agriculture digitization in Senegal

Senegal serves as an example of a developing nation that made significant progress with the MDG Agenda, yet still struggles with food insecurity. The coastal nation in West Africa employs 60% of its 15 million people through agriculture, most of whom are small-scale farmers.[17] The Senegal Emerging Plan (SEP) has identified agriculture as a key sector driving development in support of the ambition for Senegal to reach emerging country status by 2035. The SEP plans to use EO to help the country make progress toward SDG 2.

As in many developing nations, there is a dire need for accurate agricultural statistics to inform policy and socioeconomic decisions. However, in Senegal, there is no means of measuring the number of farmers in the country, and there is very little agricultural data on irrigation/fertilizer patterns. This lack of digital information creates two large problems:

1) There is little incentive for private companies to invest in Senegal and its agricultural practices without proper knowledge of existing infrastructure. Foreign Direct Investment (FDI) generally boosts Gross Domestic Product (GDP) significantly, so partnering with the private sector is critical for nation-wide development.[18]

2) Farmers do not have access to information that would facilitate better decision-making. Since agricultural practices cannot be easily shared across the country, productivity and efficiency are not maximized.[20]

Following the adoption of the 2030 Agenda, the Senegalese government announced that the SEP would focus on efforts to solve these problems. Three key organizations have partnered to create a platform for agricultural digitization in Senegal:[19]

1) Agence Nationale de la Statistique et de la Démographie (ANSD), Senegal's national statistics agency

2) Direction Générale de la Planification et des Politiques Economiques (DGPPE), Senegal's directorate in charge of planning and economic policy

3) Initiative Prospective Agricole et Rurale (IPAR), a private think tank that focuses on agricultural and rural policy in West Africa

The anticipated digital agricultural statistics system will help improve the availability, accessibility and timeliness of basic agricultural data in Senegal for stakeholders at all scales: policy-makers, private sector investors and farmers.

ANSD, DGPPE and IPAR envision a product in the form of an application where data could be crowdsourced from farmers across the country. Each farm household will be able to contribute information on socio-demographics, equipment, type of crops, use of fertilizers, water supply, electricity supply and more. Once data is aggregated and sorted, it will be openly available free of charge. The project will also aim to

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[17] ANSD, DGPPE, IPAR
[18] ANSD, DGPPE, IPAR
[19] ANSD, DGPPE, IPAR
[20] ANSD, DGPPE, IPAR

combine EO data relevant to Senegal, such as satellite-gathered measurements of environmental variables, into a user-friendly platform.[21]

There will also be an emphasis on forging partnerships with relevant non-official data producers, i.e. NGOs, projects and programs, the private sector, satellite imagery companies and all actors involved in agriculture development.

Already, various national and international organizations have taken an interest in propelling the project into action:

• National level: ANSD, DGPPE, Ministry of Agriculture, IPAR, Conseil National de Concertation et de Coopération des Ruraux (CNCR; a farmer organization), Agricultural Projects/Programs, the private sector

• International level: the GPSDD is supporting Senegal on its data roadmap for sustainable development process, through which it is developing the necessary partnerships and fostering cross-institutional collaboration to develop an integrated data ecosystem in support of this effort.

A major challenge the project will face is the relative lack of internet connectivity in Senegal and many other developing nations. However, technology is rapidly progressing by "leapfrogging"existing technology to 4G cables and smartphone use, so there is hope that digitization of the agriculture sector could be achieved. A pilot phase in three selected regions in Northern Senegal is ready for implementation in 2017/2018.

[21] ANSD, DGPPE, IPAR Report

Glossary

ANSD – Agence Nationale de la Statistique et de la Démographie
CEOS – Committee on Earth Observation Satellites
CEPEI – Centro de Pensamiento Estratégico Internacional
CNCR – Conseil National de Concertation et de Coopération des Ruraux
DGPPE – Direction Générale de la Planification et des Politiques Economiques
EO – Earth Observations
EO4SDG – Earth Observations for Sustainable Development Goals
FAO – Food and Agriculture Organization
FDI – Foreign Direct Investment
FEWS-NET – Famine Early Warning Systems Network
GDP – Gross Domestic Product
GEO – Group on Earth Observations
GEOGLAM – GEO Global Agricultural Monitoring
GEOSS – Global Earth Observation System of Systems
GPSDD – Global Partnership for Sustainable Devleopment Data
GSMaP – Global Satellite Mapping of Precipitation
IFAD – International Fund for Agriucltural Development
IISD – International Institute for Sustainable Development
IMRG – Integrated Multi-Satellite Retrievals for GPM
IMF – International Monetary Fund
IPAR – Initiative Prospective Agricole et Rurale
MDG – Millenium Develoment Goal
MNC – Multinational Corporation
OECD – Organization for Economic Cooperation and Development
SDG – Sustainable Development Goal
SDSN – Sustainable Development Solutions Network
SEP – Senegal Emerging Plan
TNC – Transational Corporation
UN – United Nations
UNEP – United Nations Environmental Programme
UNICEF – United Nations International Children's Emergency Fund
WHO – Word Health Organization
WFP – World Food Programme
WTO – World Trade Organization

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