# Satellite Earth Observations in support of the SDGs

## Launch of the CEOS EO handbook Special 2018 Edition

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European Space Agency

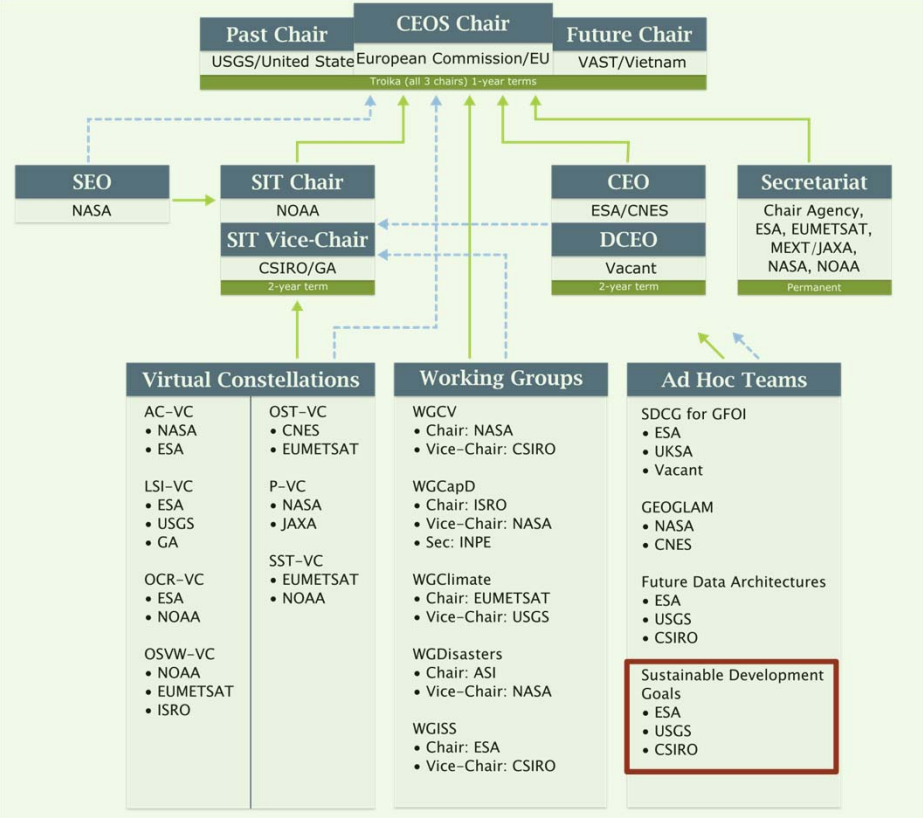
Directorate of Earth Observation Programmes

UNSC 49th Session | Statistical-Geospatial Integration Forum | New York, 5 March 2018

*Integrating Statistical, Geospatial, and other Big Data to leave no one behind*

ESA UNCLASSIFIED - For Official Use

# Ensure international coordination of civil space-based EO programs and promote EO to optimize societal benefit and inform decision making for securing a sustainable future for humankind




- **Optimize benefits of space-based EO** through cooperation of CEOS Agencies in mission planning and in data products, applications and policies.
- Serve as **focal point for international coordination of space-based EO activities**, including GEO and entities related to global change.
- **Encourage complementarity and compatibility among space-based EO systems** currently in service or development.

**32 CEOS Agencies | 28 Associated Members**

# EO Supporting Global Policies

## Climate Action

Paris Agreement

**Monitoring Climate Change & Understanding**

## Sustainable Development

UN SDGs

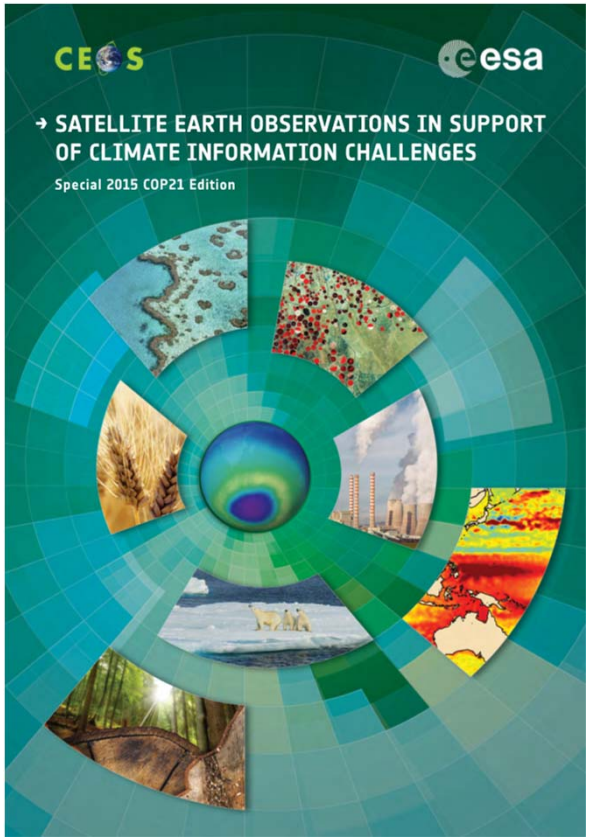
**Measuring Development Status & Progress**

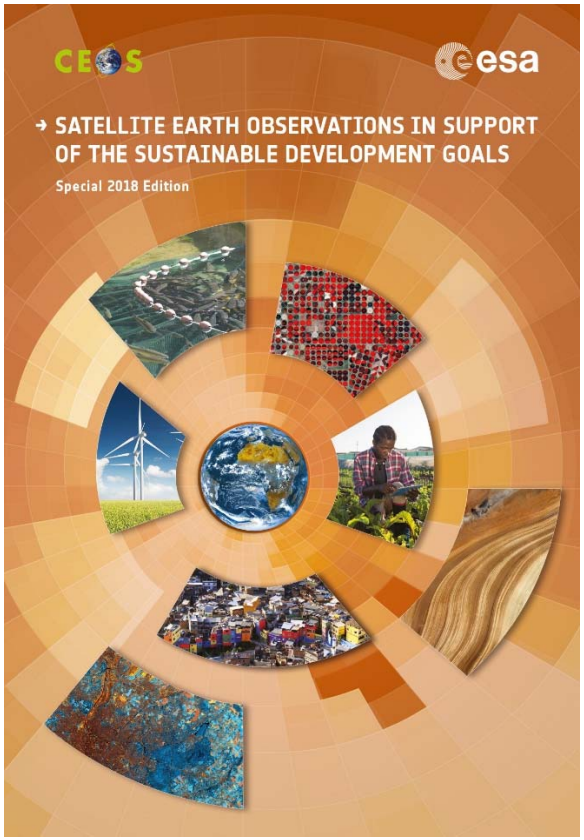
## Disaster Risk Reduction

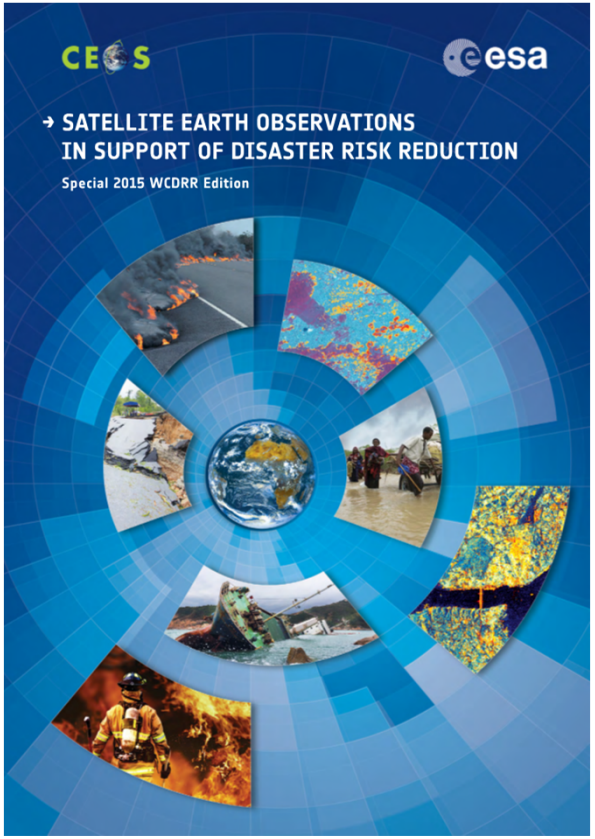
Sendai Framework

**Supporting Disaster Resilient Societies**

www.eohandbook.com



esa
EO for People & the Planet

# Commonly stated obstacles to the scaling-up and operational use of EO in the global sustainable development agenda

Restrictive data access policies (including cost)

Not enough "fit for purpose" products

Frequency of observations insufficient to track changes at appropriate scales

Needs for continuity of observations and long-term EO programs

Lack of analysis ready data

Capacity building and training

Lack of standardisation of EO data processing methodologies

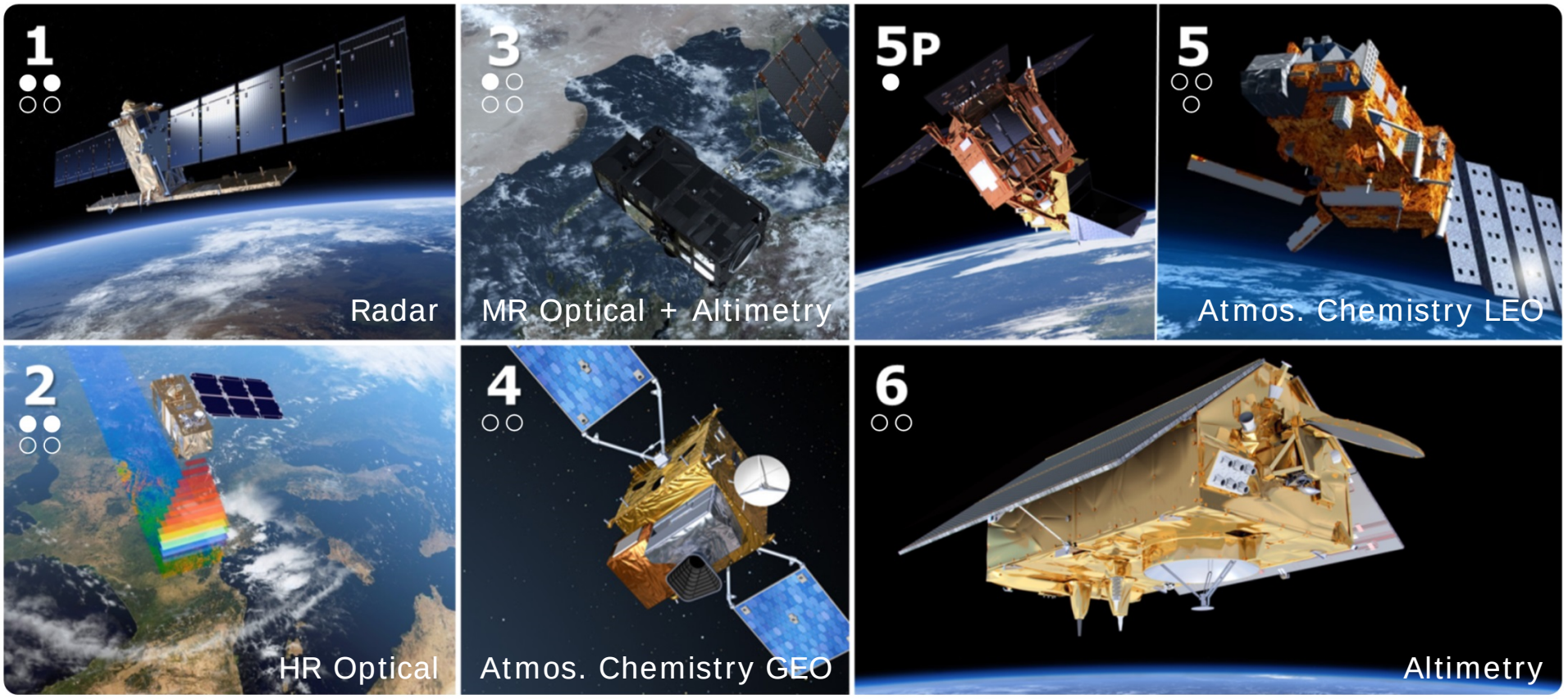
Lack of clear and solid user-oriented methods and guidelines

Difficulties to discover and access EO data

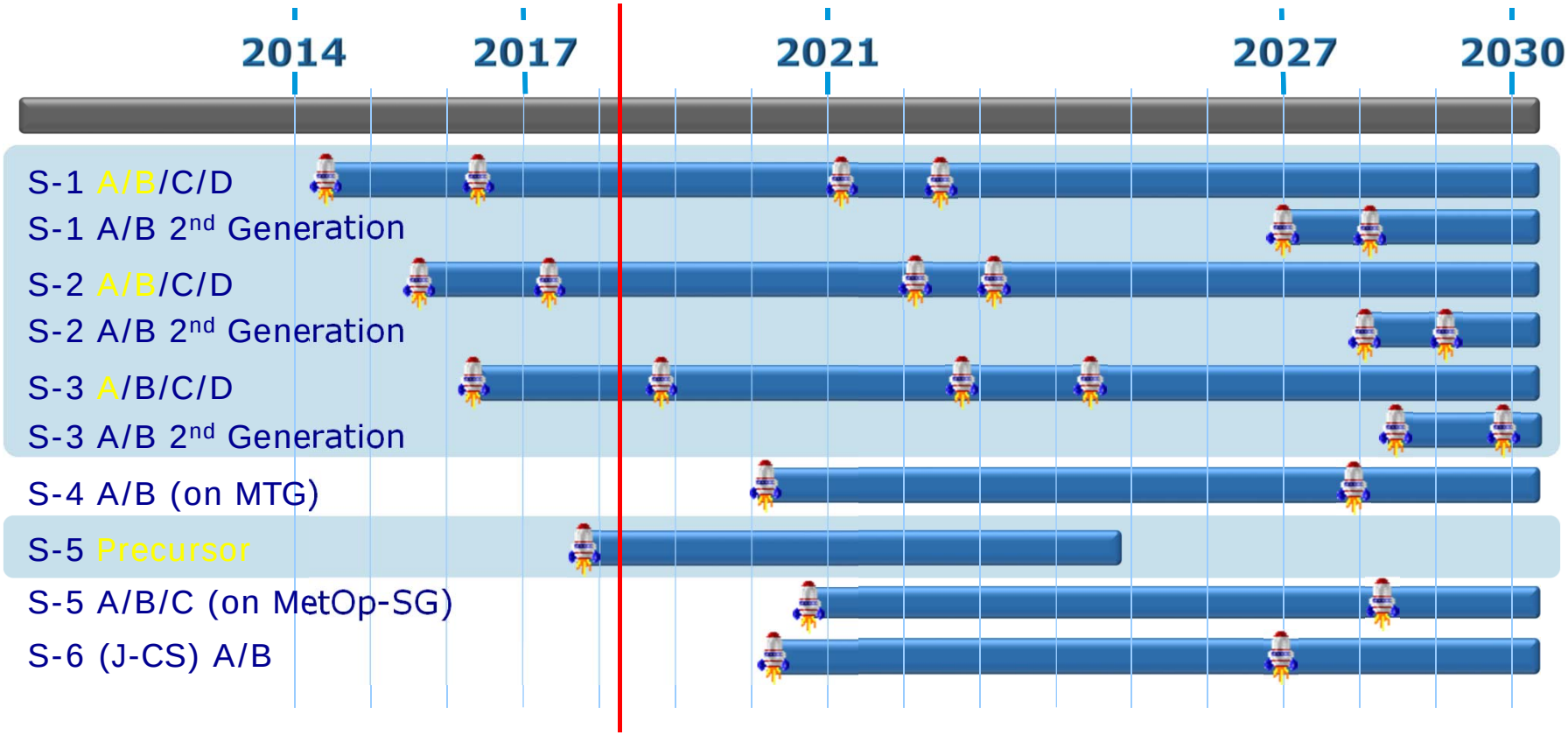
Insufficient solid track records of successful case studies

# The European Copernicus initiative

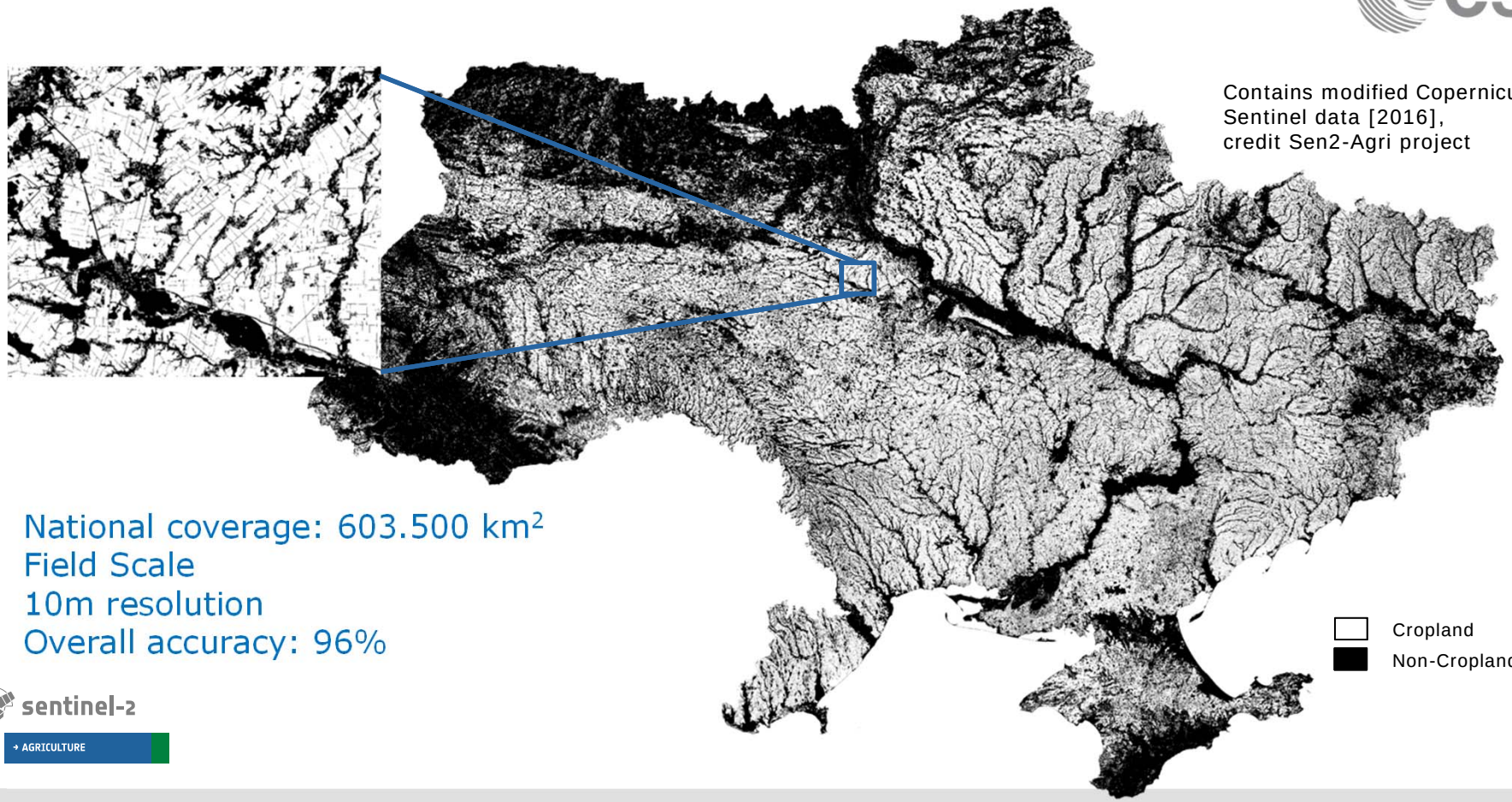
*Securing satellite data access in the long term*



# Long-term (decadal) continuous & consistent data



# ***National crop mask*** *(Ukraine 2016)*

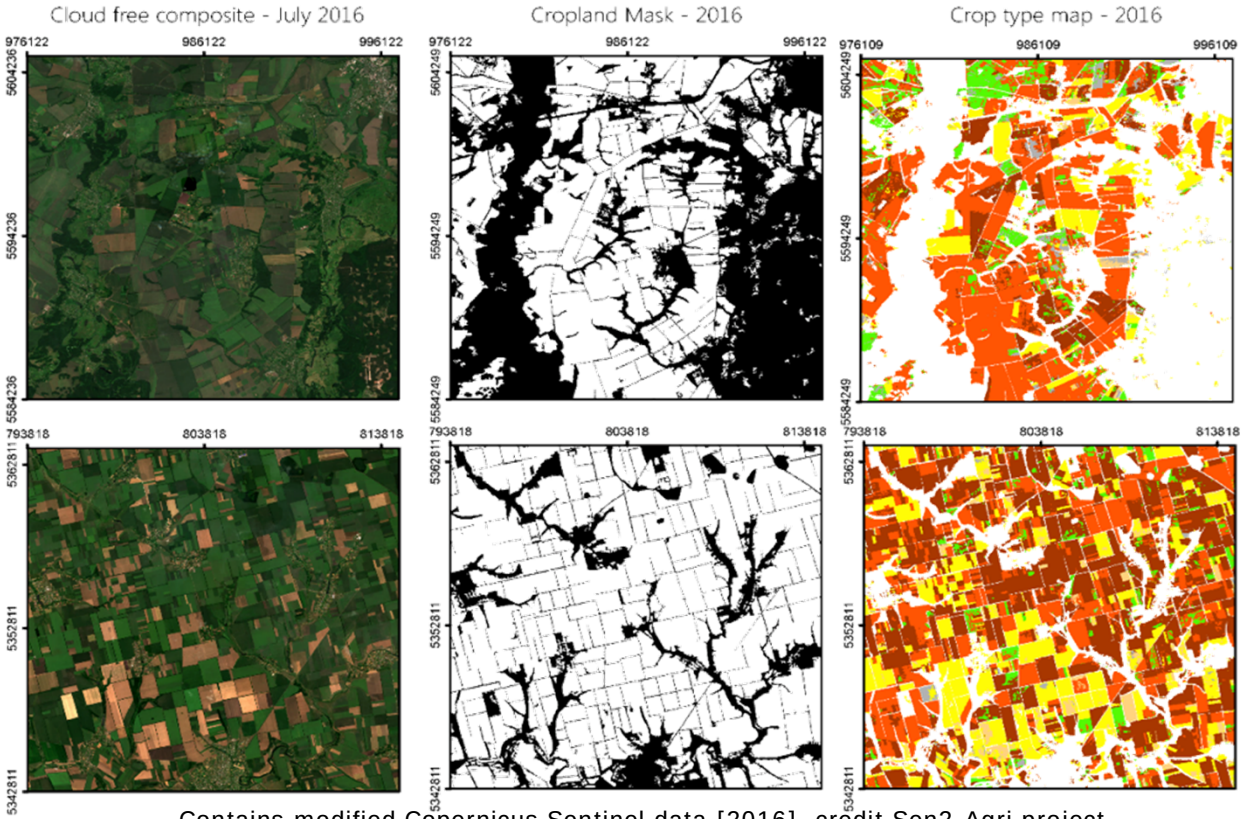



sentinel-2

→ AGRICULTURE

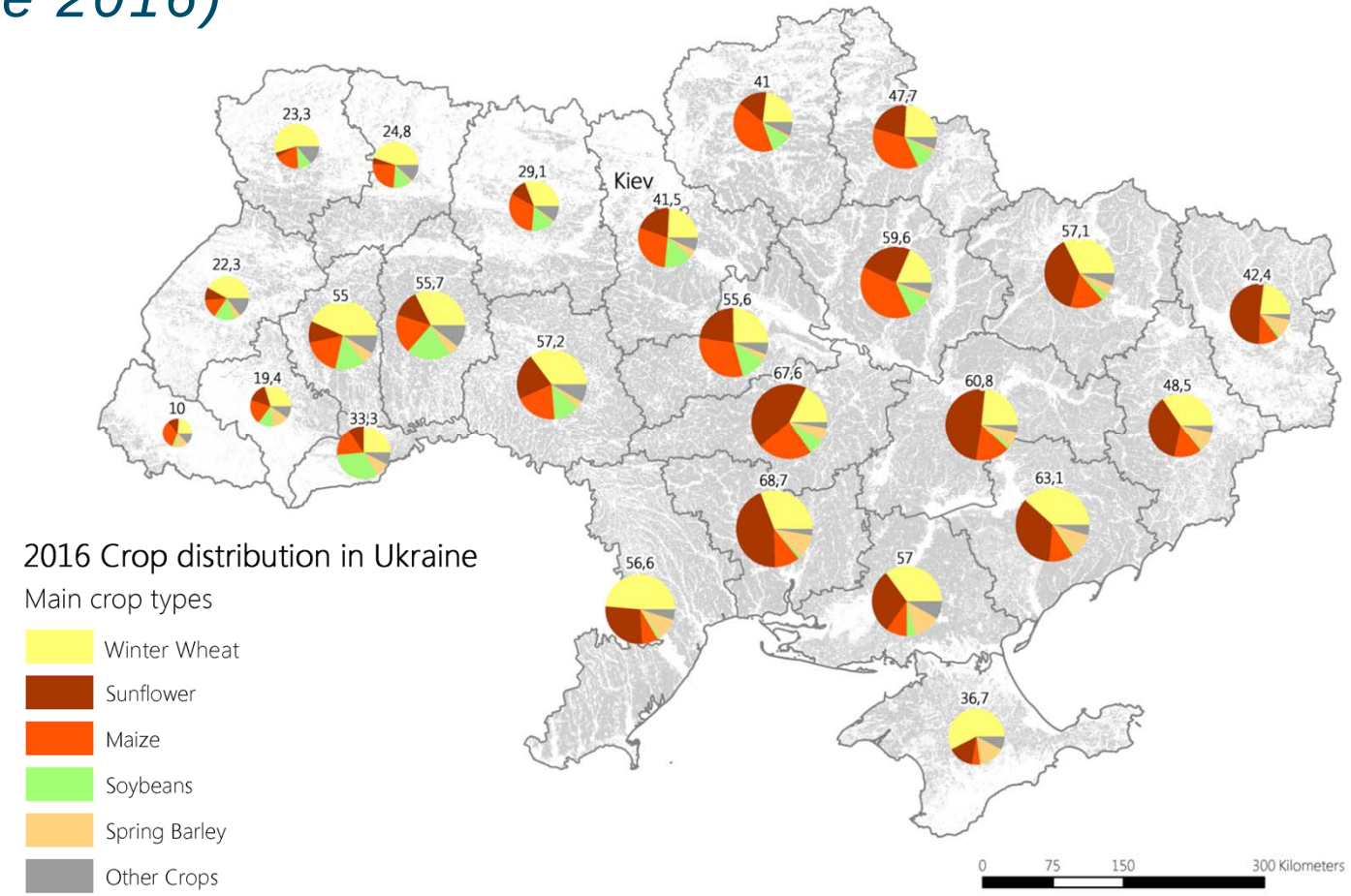
European Space Agency

# *National crop type mapping at field scale*
*(Ukraine 2016)*



Contains modified Copernicus Sentinel data [2016], credit Sen2-Agri project

# *National crop statistics by admin. units*
*(Ukraine 2016)*




sentinel-2
→ AGRICULTURE

# Part I

Satellite Data Supporting the SDGs

# Part II

Perspectives on EO for the SDGs

# Part III

Exploring Contributions from Satellites in Support of SDG Targets and Indicators

# CEOS EO Handbook on SDGs

## UN-GGIM Foreword

*The integration of statistics, geospatial information, Earth observations, and other sources of Big Data, combined with new emerging technologies, analytics and processes, are becoming a fundamental requirement for countries to measure and monitor local to global sustainable development policies and programs. Today a large proportion of the global community have an entirely different set of Earth observations and geospatial information uses, needs and expectations than they did 10 years ago. But more is needed.*

## CEOS Message

*The Committee on Earth Observation Satellites (CEOS) – established under the aegis of the G7 Economic Summit of Industrial Nations in 1984 – ensures international coordination of the civil Earth-observing programmes of more than 30 of the world's leading space agencies. These agencies are collectively investing billions of dollars in space infrastructure with the capability to provide precise, continuous and sustained observations of the entire planet. Recognising that no single country can satisfy all of the observational requirements necessary for monitoring of the Earth system, governments are taking steps through CEOS to harmonise and integrate their observing network.*

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# Part II: perspectives on EO for the SDGs

Stand-alone narratives from different organisations on the role of EO for the SDGs.

- **UN System** and its role in ensuring optimal application of EO for different aspects of the SDGs.
- **NSOs** and their inspiring efforts to apply EO in their national statistics.
- **Custodian Agencies** promoting the use of EO in the methodological guidelines of the indicators.
- **EO data & service providers and coordination bodies** stimulating uptake of EO in the SDGs.
- **NGOs** that have recognised the importance of EO and its potential for the SDGs.
- **IFIs/MDBs** seeking to ensure that development aid projects get the full benefit of EO.

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11 SUSTAINABLE CITIES AND COMMUNITIES

***Make cities inclusive, safe, resilient and sustainable***

# Goal 11: Sustainable Cities and Communities

Increasingly satellite monitoring is possible at spatial and temporal resolutions suitable for urban applications. Data can be accessed on a free and open basis, enabling products specifically derived for urban planners, and with supporting tools and platforms that greatly increase the accessibility and usability of observations. Two important urban management topics where satellites are making a growing contribution are urban growth and air quality.

## Mapping urban growth

**11.3.1: Ratio of land consumption rate to population growth rate.** **Custodian Agency: UN-Habitat**

A number of global urban extent datasets derived from satellite observations have been developed such as the Global Human Settlement Layer (GHSL) and the World Settlement Footprint 2015 (WSF2015).

The GHSL provides global spatial information about human settlements over time (1975, 1990, 2000 and 2014), generated from Landsat data, including built-up area, population density, and settlement maps.

The WSF 2015 will be available at the start of 2018 and will be the first global layer generated at 10m spatial resolution based on both optical and radar imagery (i.e., Landsat-8 and Sentinel 1). It will allow the precise delineation of human settlements in urban, peri-urban and rural areas over the entire globe. The WSF evolution dataset estimating the global settlement growth from 1985 and generated from Landsat-5/7 imagery will follow.

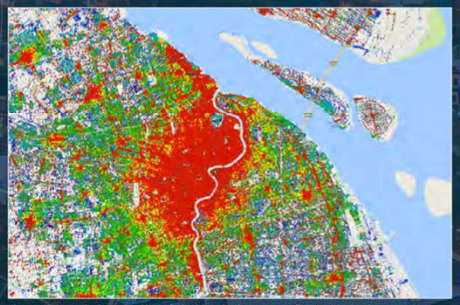

Figure: WSF Evolution over Shanghai, China. Red corresponding to 1985 urban extent, yellow-green-blue growth to 2015. *Credit: DLR*

The WSF suite is freely and openly released for exploitation via the Urban Thematic Exploitation Platform (U-TEP), a Big Data infrastructure offering online processing and analytics services for urban applications. The U-TEP seeks to provide an end-to-end analysis platform for a broad spectrum of users – both expert and non-expert – to produce and extract urban information (e.g., indicators) needed for sustainable urban management.

These global datasets of urban extent, thanks to the use of Big Data analytics platforms like the U-TEP, enable the production of evidence-based knowledge on the properties of human settlements such as area, shape, imperviousness, greenness, pattern and network of settlements and in the future even volumes of building. When combined with information on population they constitute a major source of data to inform the SDG indicator 11.3.1 on land consumption rate.

## World Health Organization Data Integration Model for Air Quality Monitoring

**11.6.2 Annual mean levels of fine particulate matter (e.g., PM2.5 and PM10) in cities (population weighted).** **Custodian Agency: WHO**

Air pollution represents a significant environmental risk to health, and is also linked to climate change and ecosystem damage (e.g., via acid rain) through the release of $CO_2$, black carbon (soot), sulphur dioxide, nitrogen oxides, and other greenhouse gasses. Monitoring the release of this pollution and its impact on air quality in the urban environment are keys to better-informed policies and assessment of the sustainability of development decisions.

The World Health Organization (WHO) is the custodian agency for SDG Indicator 11.6.2, using a variety of observations, including ground and satellite measurements, as inputs to models to estimate human exposure to harmful particulate matter of a diameter less than 2.5 micrometres, known as PM2.5. The WHO maintains an air quality database to support reporting and has recently developed the Data Integration Model for Air Quality (DIMAQ) that incorporates data from a variety of sources in order to provide estimates of exposures to PM2.5 at 0.1° × 0.1° globally.

At the country level, the United States' AirNow system provides the public with real-time air quality observations, forecasts and health information. The system started in 1998, when air quality data was not easily accessed and a national real-time dataset was unavailable, and has since encouraged and supported air quality monitoring efforts around the world. The system makes operational use of data from multiple satellite instruments to supplement measurements from ground-based monitors, which increases the accuracy of PM2.5 air quality forecasts.

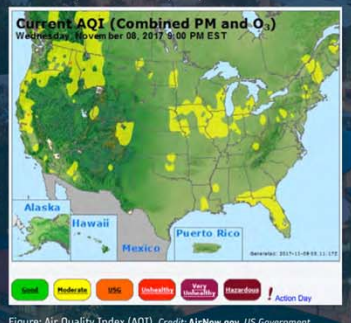


Figure: Air Quality Today (AQI). *Credit:* **AirNow.gov**, US Government

**Further information, datasets, and methodologies**

Goal 11 Description:
http://sustainabledevelopment.un.org/sdg11

ESA Urban TEP (U-TEP):
https://urban-tep.eo.esa.int

JRC GHSL:
http://ghsl.jrc.ec.europa.eu/how.php

GEO Human Planet Initiative:
http://ghsl.jrc.ec.europa.eu/HPI.php
*Observations for a comprehensive understanding of the human presence in support global policy processes*

WHO Interactive Air Pollution Maps:
http://maps.who.int/airpollution

WHO Global Urban Ambient Air Pollution Database:
www.who.int/phe/health_topics/outdoorair/databases/cities/en

AirNow:
https://airnow.gov

***Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss***

## Goal 15: Life on Land

Satellite Earth observations (EO) are unique in their ability to provide consistent and comparable information on global land cover. Imagery may be used to measure the extent of land cover types and their change over time. This is complemented by radar imagers that can provide further information on vegetation type, soil moisture and biomass and can measure day-and-night, in all weather conditions, and 'through' some forest canopies.

Satellite EO is a fundamental tool for deriving statistics on deforestation and land use change and is critical to monitoring the Indicators of SDG Targets 15.2, 15.3 and 15.b from local to national, regional and even global scales – in some cases allowing the assessment of trends over long historical archives.

### Land degradation

**15.3.1: Proportion of land that is degraded over total land area.**
**Custodian Agency: UNCCD**

Land degradation is a process of change over time in vegetation cover, water resources, soil erosion and salinity. Time series of coarse to moderate resolution EO data can be applied globally to reveal environmental changes and target hot spots, and is used by national, state, and municipal governments to manage their land use. Standardised methods are being developed to allow consistent derivation of three sub-Indicators for Indicator 15.3.1:

- land cover and land cover change (see ESA Landcover CCI);

- land productivity; and,

- carbon stocks above and below ground.

The UN Convention to Combat Desertification (UNCCD) commissioned a series of Good Practice Guidance reports to help countries select, process and analyse datasets to report against these sub-Indicators, with EO closely integrated into the recommended methods.

Figure: Land Productivity Dynamics (LPD) map 1999 to 2013 showing 5 classes of persistent land productivity trajectories during the observation period. *Credit: JRC*

### Forests

**15.2.1 Progress towards sustainable forest management.**
**Custodian Agency: FAO**

**15.b.1 Official development assistance and public expenditure on conservation and sustainable use of biodiversity and ecosystems.**
**Custodian Agency: UN Environment**

At the global level, FAO has been carrying out its Forest Resources Assessments (FRA) at 5–10 year intervals since 1946. From 1990, information collected through country reporting has been complemented by remotely-sensed data, supported by a growing archive of satellite imagery and new software for image processing and interpretation.

The World Resources Institute's Global Forest Watch (GFW) uses wall-to-wall national coverage satellite EO data (Landsat) to provide spatially explicit information at the pixel level (30m). Information is presented via an online forest monitoring and alert system empowering forest management stakeholders to create custom maps, analyse forest trends, subscribe to alerts or download data for their local area or the entire world.

The REDD+ initiative of the UN Framework Convention on Climate Change (UNFCCC) looks to provide financial incentives for countries to maintain and sustain forests in an effort to reduce emissions from deforestation and forest degradation, foster conservation and management of forests, and enhance forest carbon stocks.

In support of REDD+, the Global Forest Observations Initiative (GFOI) aims to guarantee availability of wall-to-wall national coverages of satellite data and to provide countries with Methods and Guidance Documentation (MGD) that will facilitate reporting consistent with the relevant IPCC Good Practice Guidelines. GFOI's MGD advice is available in English, Spanish and French (www.gfoi.org/methods-guidance/) and via a new online tool – REDDCompass – that guides users through the core themes, concepts and actions involved in the development of National Forest Monitoring Systems.

Figure: Forest Change in the Congo from Global Forest Watch. *Credit: www.globalforestwatch.org*

**Further information, datasets and methodologies**

Goal 15 Description:
http://sustainabledevelopment.un.org/sdg15

FAO FRA:
www.fao.org/forest-resources-assessment/en

Global Forest Watch:
www.globalforestwatch.org

GFOI MGD:
www.gfoi.org/methods-guidance

REDDcompass:
www.reddcompass.org

GFOI Space Data Portal:
www.gfoi.org/space-data/space-data-portal

Refer also to the ABS/CSIRO article in Part II of this Handbook for details of their work with the Australian Dynamic Land Cover Data and its use for the production of official statistics in Australia.

ESA LandCover CCI Project:
www.esa-landcover-cci.org
http://maps.elie.ucl.ac.be/CCI/viewer/index.php

ESA Forestry TEP (F-TEP):
https://forestry-tep.eo.esa.int

ISRIC Database:
www.isric.org
*World Soil information*

Global Soil Partnership:
www.fao.org/global-soil-partnership/en

FAO site on SDGs:
www.fao.org/sustainable-development-goals/indicators/1521

esa
The Future is Now

# Earth Observation: A Necessity for achieving the Sustainable Development Goals

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