The contribution of Earth Observations to the realisation of the 2030 Agenda for Sustainable Development.

Marc Paganini, European Space Agency

4th Plenary UN GGIM Europe | 7-8 June 2017 | Brussels, Belgium

European Space Agency

2030 Agenda for Sustainable Development: 17 goals, 169 targets, 230 Indicators
New norms to integrate the principles of sustainable development into country policies and programs

Mobilising the data revolution
Sustained data for sustainable development

- The monitoring of the MDGs taught us that **data are indispensable elements of the development agenda**.

- Despite improvement, **critical data** for informed policy making on development **are still lacking**.

- **New technology** is changing the **way data are collected** and disseminated.

- Data should be **open**, **easily accessible** and **effective for decision--making.**

A World That Counts: **Mobilising the Data Revolution for Sustainable Development**, Nov. 2014
UN SG Independent Expert Advisory Group on data revolution for sustainable development
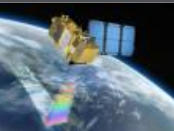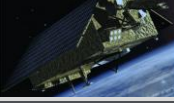
- **Global Action Plan for Sustainable Development Data** launched at UN WDF in Jan 2017 and adopted at UNSC-48 in March 2017.

- **modernizing NSOs** is essential to achieving the 2030 SDGs.

- **Integrating geospatial and statistical data** is a necessity.

First UN World Data Forum on Sustainable Development Data
15-18 January 2017
Cape Town, South Africa.

The Millennium Development Goals Report 2015

United Nations WORLD DATA FORUM

The European Copernicus initiative,
Securing satellite data access on the long term

Copernicus

Sentinel 1 – SAR imaging
All weather, day/night applications, interferometry
2014 / 2016

Sentinel 2 – Multi-spectral imaging
Land applications: urban, forest, agriculture,…
Continuity of Landsat, SPOT
2015 / 2017

Sentinel 3 – Ocean and global land monitoring
Wide-swath ocean color, vegetation, sea/land
surface temperature, altimetry
2017 / 2018

Sentinel 4 – GEO Atmospheric Chemistry
Atmospheric composition monitoring, trans-
boundary pollution
2019

Sentinel 5 & Precursor – LEO Atmospheric Chemistry
Atmospheric composition monitoring
(S5 Precursor launch in 2016)
2017 / 2019

Sentinel 6 Jason-CS – Altimetry Mission
High precision measurements of global sea-level
(continuation of Jason ocean topography missions)
2020

Long term
EO data
to better
monitor
our Planet

(*)

Free and open data policy

* Joint EU/ESA Data Policy Principles adopted by ESA Council and by EU Parliament and Council (Nov 2013)

The Sentinels of the European Copernicus Program

Copernicus

2014   2017   2021   2027   2030

S-1 A/B/C/D
S-1 A/B 2nd Generation
S-2 A/B/C/D
S-2 A/B 2nd Generation
S-3 A/B/C/D
S-3 A/B 2nd Generation
S-4 A/B (on MTG)
S-5 Precursor
S-5 A/B/C (on MetOp-SG)
S-6 (J-CS) A/B

Sentinel-1 Constellation Observation Scenario:
Revisit & Coverage Frequency

sentinel-1

validity start: 10/2016
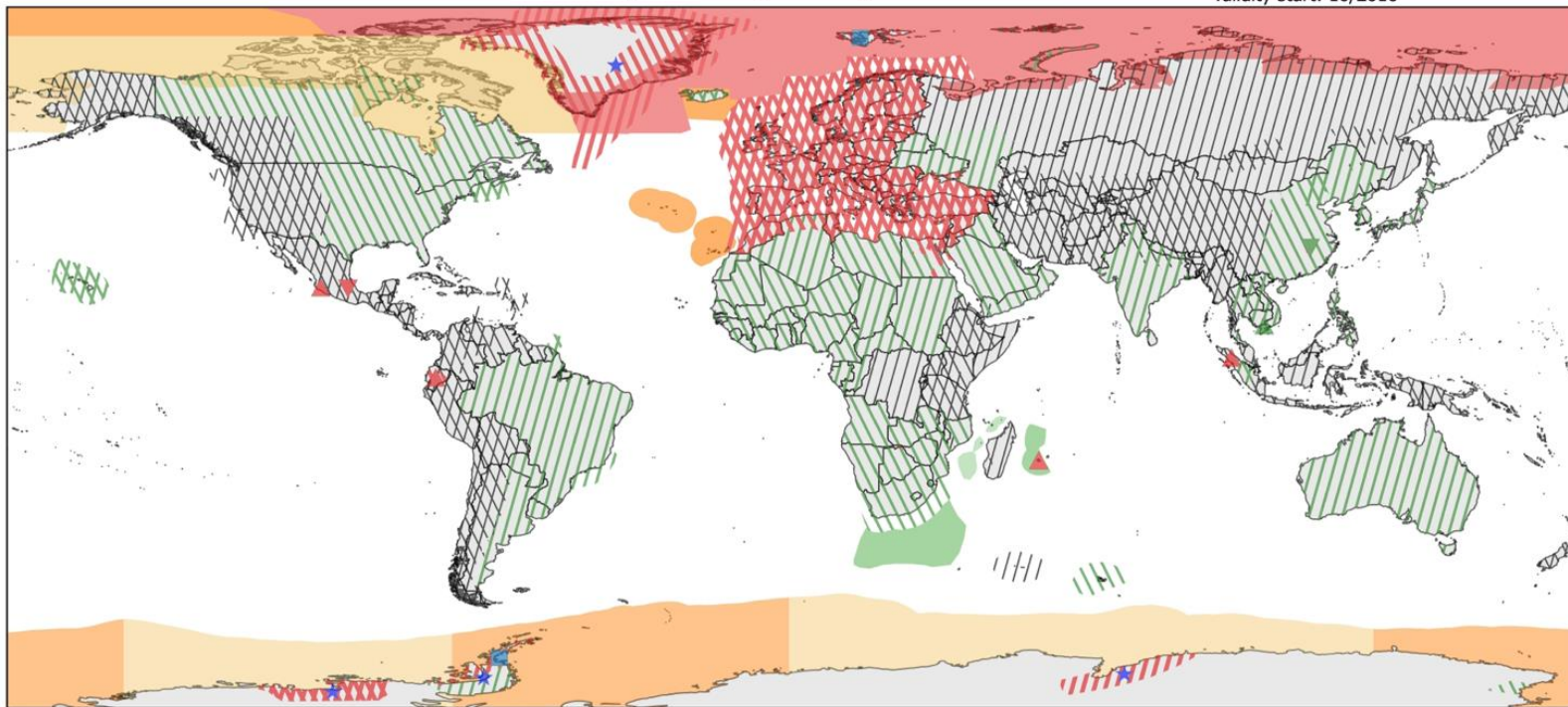
PASS	REVISIT	FREQUENCY *		COVERAGE	FREQUENCY **	REFERENCE DATA SITES (6d repeat)
ASCENDING	6 days	12 days	24 days	1-2 days		▲ Highly active volcanism
DESCENDING				3 days		▼ Fast subsidence
				6 days		▲ Short growth cycle, intensive agriculture
				12 days		▼ Fast changing wetlands
						★ Fast moving outlet glaciers
						■ Permafrost & glaciers

* coverage ensured from same, repetitive relative orbits
** coverage not considering repetitiveness of relative orbits

Sentinel 2 Observation Scenario

Baseline observation scenario in routine phase (S2A + S2B)

Systematically

- **All land surfaces** between 56° South latitude (Cape Horn in South America) and 84 North latitude (north of Greenland)

- **Major islands** (greater than 100 km2 size),

- EU islands and all the other small islands located at less than **20 km from the coastline**

- The **whole Mediterranean Sea** as well as all inland water bodies and closed seas

0 days 00 hours 00 minutes
Sentinel 2 constellation:
summer solstice
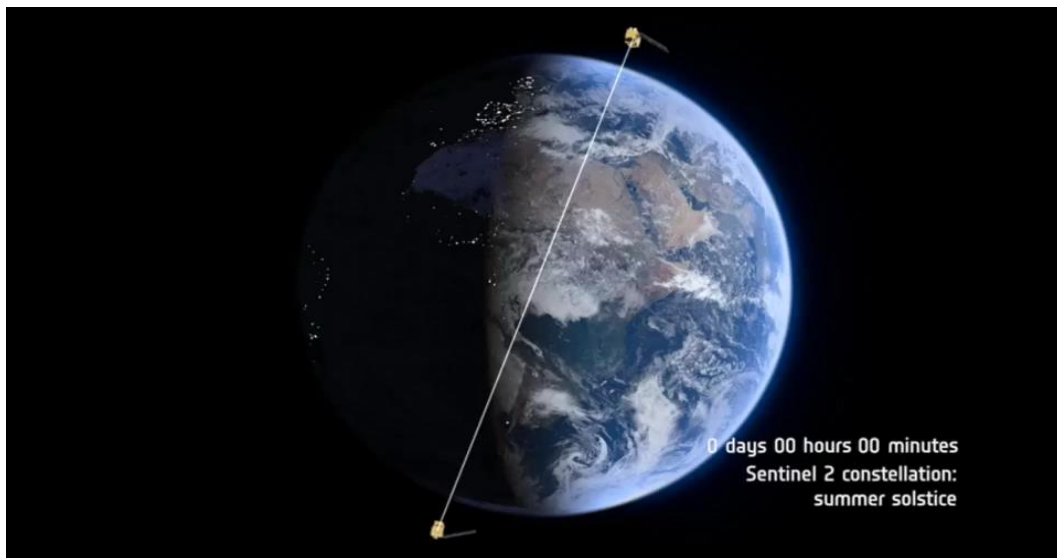
EO importance for the SDG's

Earth Observations potential contribution to the SDG Targets and Indicators

SDGs with most opportunities for EO data

Analysis performed by the GEO EO4SDGs initiative

Target — Contribute to progress on the Target yet not the Indicator per se									Goal	Indicator — Direct measure or indirect support				
						1.4	1.5		1	1.4.2				
						2.3	2.4	2.c	2	2.4.1				
					3.3	3.4	3.9	3.d	3	3.9.1				
									4					
								5.a	5	5.a.1				
	6.1	6.3	6.4	6.5	6.6	6.a	6.b		6	6.3.1	6.3.2	6.4.2	6.5.1	6.6.1
					7.2	7.3	7.a	7.b	7	7.1.1				
								8.4	8					
				9.1	9.4	9.5	9.a		9	9.1.1	9.4.1			
						10.6	10.7	10.a	10					
	11.1	11.3	11.4	11.5	11.6	11.7	11.b	11.c	11	11.1.1	11.2.1	11.3.1	11.6.2	11.7.1
				12.2	12.4	12.8	12.a	12.b	12	12.a.1				
						13.1	13.2	13.3	13.b	13	13.1.1			
		14.1	14.2	14.3	14.4	14.6	14.7	14.a	14	14.3.1	14.4.1	14.5.1		
	15.1	15.2	15.3	15.4	15.5	15.7	15.8	15.9	15	15.1.1	15.2.1	15.3.1	15.4.1	15.4.2
								16.8	16					
17.2	17.3	17.6	17.7	17.8	17.9	17.16	17.17	17.18	17	17.6.1	17.18.1			

The UN governance process on SDG's

HIGH-LEVEL POLITICAL FORUM ON SUSTAINABLE DEVELOPMENT

SG annual report on "Progress towards the Sustainable Development Goals"

The Sustainable Development Goals Report 2016

ECOSOC United Nations

Statistical Commission — ECONOMY · ENVIRONMENT · POPULATION · SOCIETY · TRADE
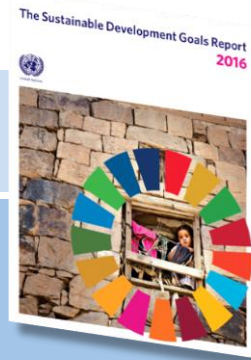
BETTER DATA BETTER LIVES
unstats.un.org
@UNStats

UN-GGIM
UNITED NATIONS INITIATIVE ON GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

UNDESA - UN Statistics Division (UNSD)

IAEG-SDGs
Inter-agency Expert Group on SDG Indicators

National Statistical Offices

National governments and agencies

UN Specialised Agencies (Custodians)

Working Group on Geo-spatial Information (WGGI)

Working Group on Inter-linkages of SDGs

Working Group on SDMX

UNEP

UN Habitat

FAO

WHO

UNISDR

UNCCD

UNICEF

UNSD

WB

OECD
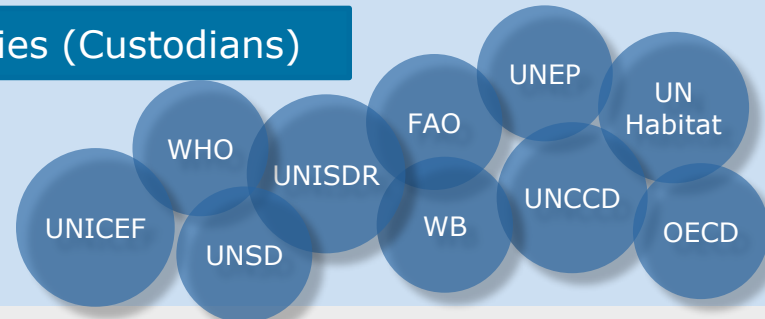
The Global Indicator Framework

- Limited in number and **globally harmonized**
- Simple, single-variable indicators, with **straightforward policy implications**
- Allow for **high frequency monitoring**
- **Consensus based**, in line with international standards and system-based information
- Constructed from **well-established data sources**
- Can be **disaggregated**
- **Universal**
- Mainly **outcome-focused**
- **Science-based** and forward-looking
- A proxy for **broader issues** or conditions

IAEG-SDGs
Inter-agency Expert Group on SDG Indicators

NSOs

Custodian Agencies

WG on Geo-spatial Information (WGGI)

WG on Inter-linkages of SDGs

WG on SDMX

IAEG-SDGs ToR
- Develop a list of indicators for monitoring targets.
- Provide technical support for the implementation by countries.
- Regularly review methodological developments.
- review CB activities in NSOs.

WGGI ToR
- Advice IAEG-SDGs how geo-spatial and EO can contribute.
- Identify existing geospatial data gaps & methodological issues.
- Provide GEO/EO best practices
- Propose strategies for methodological work on specific areas

To monitor progress, inform policy and ensure accountability of all stakeholders

GEO-CEOS-ESA engagement in the SDG's

GEO Initiative on SDGs (EO4SDGs)

Leads: US (NASA), Japan (JAXA), Mexico (INEGI),

GEO Sec, GEO WP elements, UN-GGIM, GPSDD, WHO, UNOOSA, CEOS, ESA, CSA, CSIRO, NOAA, US EPA, EARSC, …

CEOS Ad-hoc team on SDGs

Leads: CSIRO, NOAA, ESA

CEOS SEO, NASA, USGS, CSA, ISRO, JAXA, SANSA, DLR
GEO Sec …

ESA

Lead: EO Science, Application and Future Technologies Department

EOEP-5 Program (2017-2021)
- Expanding Public Sector Benefits
- EO for Sustainable Development

UN Statistical Division
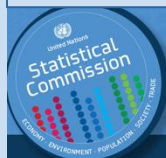
BETTER DATA BETTER LIVES

unstats.un.org
@UNStats

IAEG-SDGs
Inter-agency Expert Group on SDG Indicators

WG on Geo-spatial Information (WGGI)

UN Habitat | UNCCD | UNEP

UN Custodian Agencies

National Statistical Offices

GEO EO4SDGs initiative

Realize the potential of EO and geospatial information to **advance the *2030 Agenda*** and enable societal benefits through achievement of the Sustainable Development Goals.

GOAL I: **Demonstrate** how EO and geospatial information, with socio-economic and other data contribute in novel and practical ways to support achievement of the SDGs.

GOAL II: **Increase** skills and capabilities in use of EO for SDG activities and their broader benefits.

GOAL III: **Broaden interest and awareness** of EO support to the SDGs and contribution to social, environmental, and economic benefits.

CEOS Ad-Hoc Team on SDGs

In the complex and evolving SDG environment,

the new **CEOS AHT SDG** will

- **take stock of the UN processes** in place for the SDG implementation and of the existing participants and stakeholders,

- focus its activities around the **unique role that CEOS** should play **as coordination body of the Space community efforts** to support the integration of satellite EO in support to the full realisation of the SDG's.

CEOS AHT will **align its engagement with the UN SDG agenda** in the context of **GEO** (GEO Programme Board, GEO Engagement Strategy, GEO initiative EO4SDGs) and **build on established relationships** the CEOS Agencies have with the **custodian agencies** and **individual countries**.

Contents

SDG 15.3 Land Degradation Neutrality (LDN)

Target 15.3 By 2030, combat desertification, restore degraded land & soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

Indicator 15.3.1 "Percentage of land that is degraded over total land area"

Legend:
- Cropland, rainfed
- Cropland irrigated / post-flooding
- Mosaic cropland / vegetation
- Mosaic vegetation / cropland
- Tree broadleaved evergreen
- Tree broadleaved deciduous
- Tree needleleaved evergreen
- Tree needleleaved deciduous
- Tree mixed leaf type
- Mosaic tree, shrub / HC
- Mosaic HC / tree, shrub
- Shrubland
- Grassland
- Lichens and mosses
- Sparse vegetation
- Tree flooded, fresh water
- Tree flooded, saline water
- Shrub or herbaceous flooded
- Urban areas
- Bare areas
- Water bodies
- Permanent snow and ice
- No data

Land Cover

GLOBAL LAND COVER MAP, EPOCH 2010

ENVISAT MERIS FRS, 300m

ESA Land Cover CCI

Legend:
- decreasing productivity
- early signs of decline
- stable, but stressed
- stable, not stressed
- increasing productivity

Land Productivity Dynamics

LPD derived from 1999-2013 NDVI phenological analyses

SPOT VEGETATION, 1km

EC Joint Research Center (JRC)

Custodian Agency:

- UNCCD (secretariat and Global Mechanism)

Other Involved Agencies

- FAO, UNEP/WCMC, CBD, UNFCCC

TIER III

Monitoring 15.3.1. on the status & trends in land degradation is based on sub-indicators:
(1) **Land Cover and Land Cover Changes** (2) **Land Productivity** (3) **Soil Organic Carbon**

EO integration into SDG implementation

| Global & Regional Datasets | Methodological Guidelines | Country Support | Capacity Building | EO Software Toolboxes | Knowledge Hub & Platforms |

| Custodian Agencies | | National Statistical Offices Governments / Agencies | | Key Stakeholders | |

Custodian Agencies

- Access to global / regional datasets.
- in the absence of or to complement and enhance, national data sources.
- countries which face major difficulties in collecting national data

- Support custodian agencies to develop method. guidelines to countries.
- EO Best Practices.
- Scientifically sound approaches.
- Product validation.
- Show Cases.

National Statistical Offices Governments / Agencies

- Targeted activities to support NSOs and governmental ministries to report on SDG indicators.
- Support country level efforts to apply EO to track, monitor and achieve SDGs.

- Build capacity to exploit EO
- Training courses
- Training material on EO best practices
- Mainly in developing and emerging economies
- Critical mass of technical centers

Key Stakeholders

- Free of charge
- Open source
- Easy to use
- EO Processing Toolboxes (SNAP)
- Thematic Toolboxes (WOIS, GWA, S2Agri)

- Knowledge sharing
- Facilitate access to Sentinel data
- Access to global / regional datasets
- EO best practices
- Method. guidelines
- Visualisation and Analsysis
- On-line processing
- Toolboxes (e.g Data cube)

SDG 6.6 Water-related Ecosystems

Tier 3 | Tier 2 | Tier 1

| Global Datasets | Methodological Guidelines | Country Support | Capacity Building | Software Toolboxes | Knowledge Hub & Platforms |

6.6 Expert Workshop, Switzerland, Sept 2015

UNEP Custodian Agency SDG 6.6.1 Target Team

Ramsar, IWMI, UN WATER, CBD, WCMC, UNEP DHI, **ESA**, IUCN
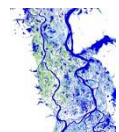
- Global Mangrove Watch (JAXA)
- Global Surface Waters (JRC)
- *Global Wetland Extent (**ESA** GW Africa with GEO-Wetlands)*

Step-by-Step Monitoring Methodology for SDG indicator 6.6.1

GPSDD funded "EO support for SDG 6.6. monitoring and reporting on wetlands", **Uganda**

GW Africa

water resources management
eo4sd

- GW Africa Regional Trainings
- TIGER Capacity Building Facility (TIGER BRIDGE)
- GEO-Wetlands CB Working Group

Ramsar STRP

GLOBWETLAND AFRICA

Toolbox

GEO WETLANDS

SWOS
Satellite-based Wetland Observation Service

- Knowledge sharing Hub
- EO Best Practices
- Mapping Standards
- Monitor. Guidelines
- Benefit Showcases
- Toolboxes
- On-line processing

EO for SDG 11 on sustainable cities and communitie

Tier 1: established methodology and data available

Tier 2: established methodology but data not regularly produced by countries

Tier 3: no established methodology and standards or being developed/tested.

https://unstats.un.org/sdgs/metadata/

SDG #	Urban Indicators	Custodians	Tier
11.1.1	Slums and informal settlements	UN-Habitat	I
11.2.1	Access to public transport	UN-Habitat	II
11.3.1	Sustainable urbanisation	UN-Habitat	II
11.6.2	Urban air pollution	WHO	I
11.7.1	Urban green public areas	UN-Habitat	II

Search

Enter Text

Goal 11

Select Target

Filter | Clear | Back

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Target 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

- **Indicator 11.1.1**: Proportion of urban population living in slums, informal settlements or inadequate housing

See metadata

Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

- **Indicator 11.2.1**: Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities

See metadata

Target 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

- **Indicator 11.3.1**: Ratio of land consumption rate to population growth rate

See metadata

Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

- **Indicator 11.5.1**: Number of deaths, missing persons and persons affected by disaster per 100,000 people [a]

See metadata

- **Indicator 11.5.2**: Direct disaster economic loss in relation to global GDP, including disaster damage to critical infrastructure and disruption of basic services [a]

See metadata

Target 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

- **Indicator 11.6.1**: Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities

See metadata

- **Indicator 11.6.2**: Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)

See metadata

Target 11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

- **Indicator 11.7.1**: Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities

See metadata

Target 11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

Indicator 11.1.1 *"Proportion of urban population living in slums, informal settlements or inadequate housing"*

- Population Distribution and Density
- **Extent and Type of Informal Settlement**

Metro Manila, 2014

Legend:
- High dense
- Linear
- Linear along railway
- Linear along river
- Low dense
- Mixed
- Pocket
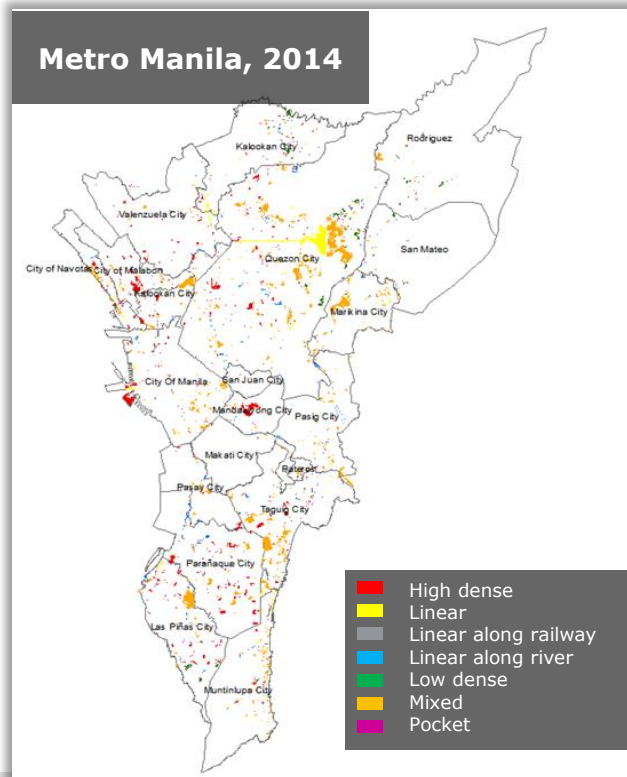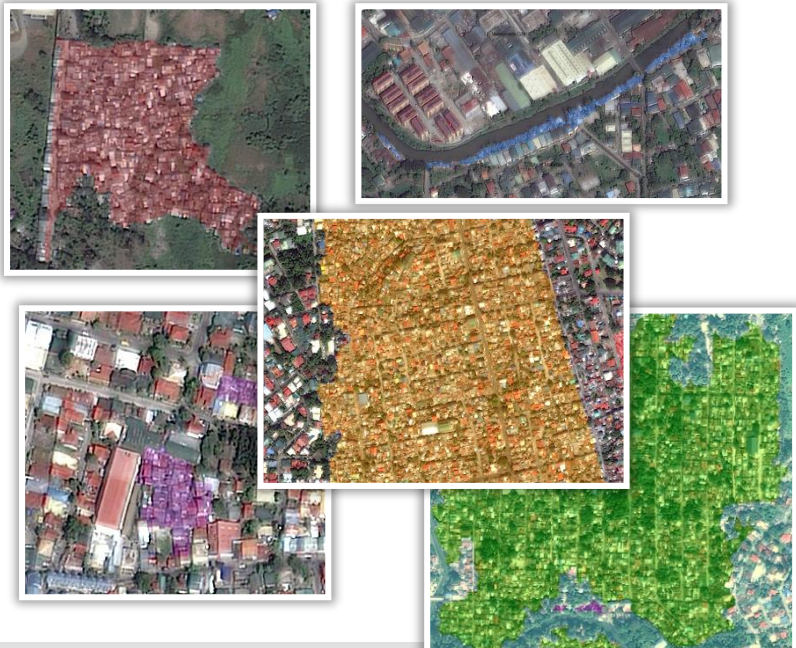
Extracted from very high resolution imagery. Often using advanced semi-automated Object-Based Image Analysis (OBIA) techniques.

Analysis and classification based on attributes reveals typology.

WORLD BANK GROUP

Data: Pléiades 1A.
Processing: GIM.

Manila, Philippines

Detecting and characterising Informal Settlements using very high resolution imagery

Target 11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, …

Indicator 11.2.1 *"Proportion of population that has convenient access to public transport, by age, sex and persons with disabilities"*

- Population Distribution and Density
- Transport Infrastructure
- **Urban Built-up Extent**
- **Urban and Peri-Urban Land Cover/Use**
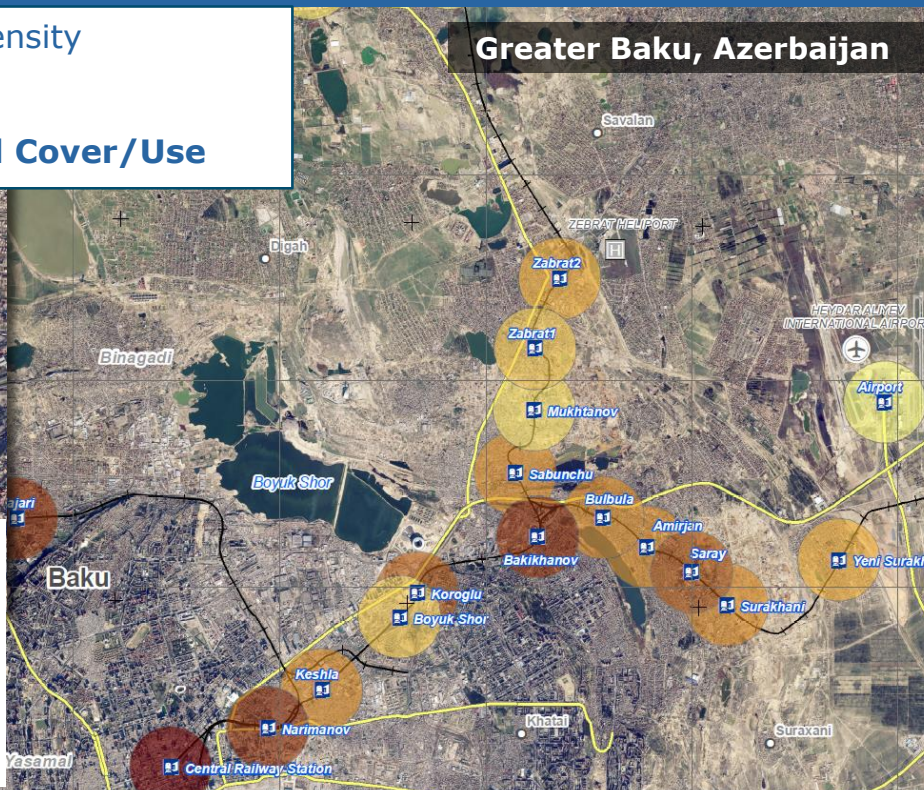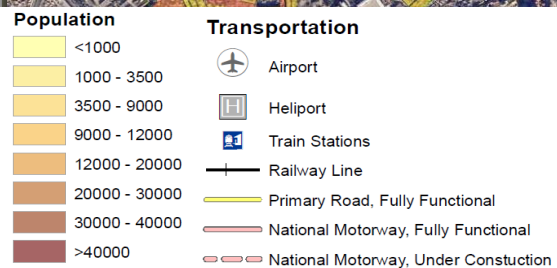
Greater Baku, Azerbaijan

Estimates of population within a given distance from a point of interest (e.g. planned/existing mass transit stations), based on the controlled disaggregation of national official census data.

Level of detail: usually building blocks, but also down to individual buildings, depending on input data resolution.

ADB ASIAN DEVELOPMENT BANK

Data: SPOT 7 / Azersky. Processing: e-GEOS.

Baku, Azerbaija

Population
- <1000
- 1000 - 3500
- 3500 - 9000
- 9000 - 12000
- 12000 - 20000
- 20000 - 30000
- 30000 - 40000
- >40000

Transportation
- ✈ Airport
- Ⓗ Heliport
- 🚉 Train Stations
- ┼┼ Railway Line
- ── Primary Road, Fully Functional
- ── National Motorway, Fully Functional
- ┉┉ National Motorway, Under Constuction

Population Distribution Mapping based on controlled disaggregation of national census data

Target 11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management…

Indicator 11.3.1 *"Ratio of land consumption rate to population growth rate"*

- Population Distribution and Density
- **Urban Built-up Extent**

Global Human Settlement Layer

- **Fine-scale** and **global**
- **open and free-access** data policy
- **Fully automated** classification engine
- **integration** with environmental, socio-economical and census data
- Evidence-based **analytics**
- Information supporting **policies**
- **Indicators** for international frameworks
- Currently based on **Landsat legacy**
- **S1/S2 methodology** under development

- **Public release of Landsat GHSL Oct 2016**
- **Public release of Sentinels 1+2 GHSL Oct 2018**

http://ghslsys.jrc.ec.europa.eu

Global Dataset: GHSL (JRC)

GHSL (JRC) - *Landsat* – epoch 1979-1990-2000-**2015**

Exploitation of the dense temporal series of freely available HR optical and radar observations (Landsat, Sentinel 1 and Sentinel 2) for global urban mapping

Target 11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management…

Indicator 11.3.1 *"Ratio of land consumption rate to population growth rate"*

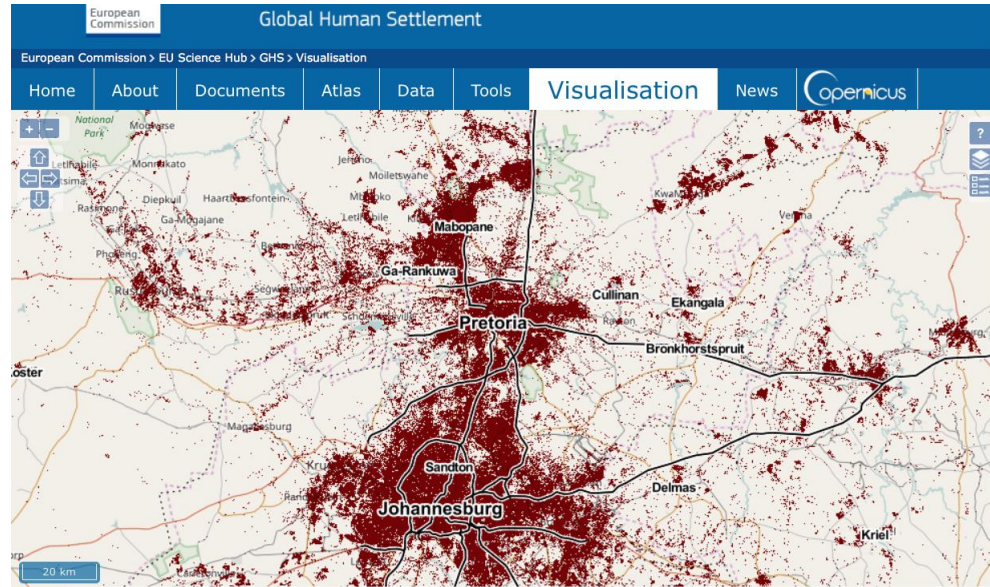- Population Distribution and Density
- **Urban Built-up Extent**

Global Dataset: GUF+ 2015 (DLR)

temporal statistics of S1 backscattering (+ texture)

- **GUF+2015 L8+S1 will be available in June 2017**
- **S1+S2 methodology under development**
- **Historical Epochs 1990, 2000, 2010 under production**

innovators
sarforurban

automatic extraction of training areas (urban / non-urban)

classification based on Support Vector Machines (SVM)

classification based on Support Vector Machines (SVM)

combination & post-classification enhancement ruleset

urban / non-urban classification map

temporal statistics of LS8-based spectral indices (+ texture)

https://urban-tep.eo.esa.int/

GUF+ **2015 (DLR)** - *Landsat+Sentinel 1* - Uganda, Kenya

Exploitation of the dense temporal series of freely available HR optical and radar observations (Landsat, Sentinel 1 and Sentinel 2) for global urban mapping
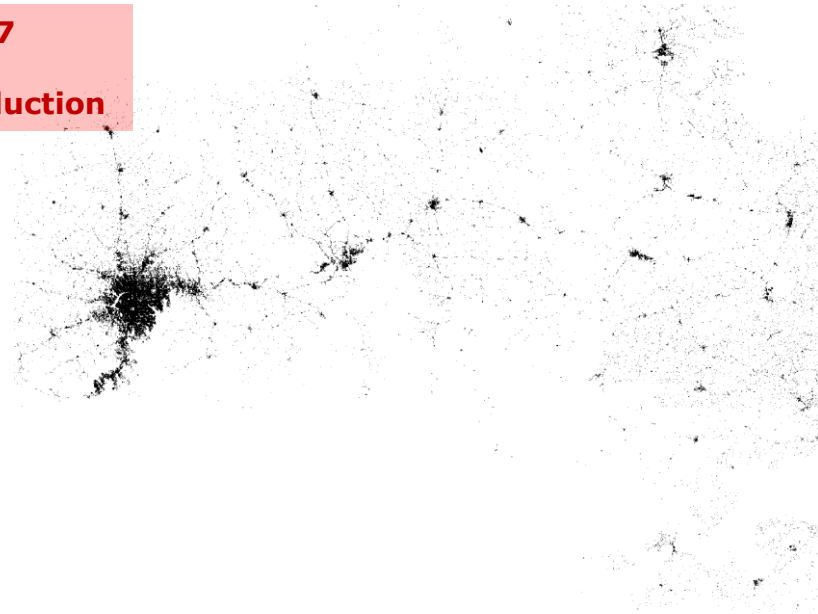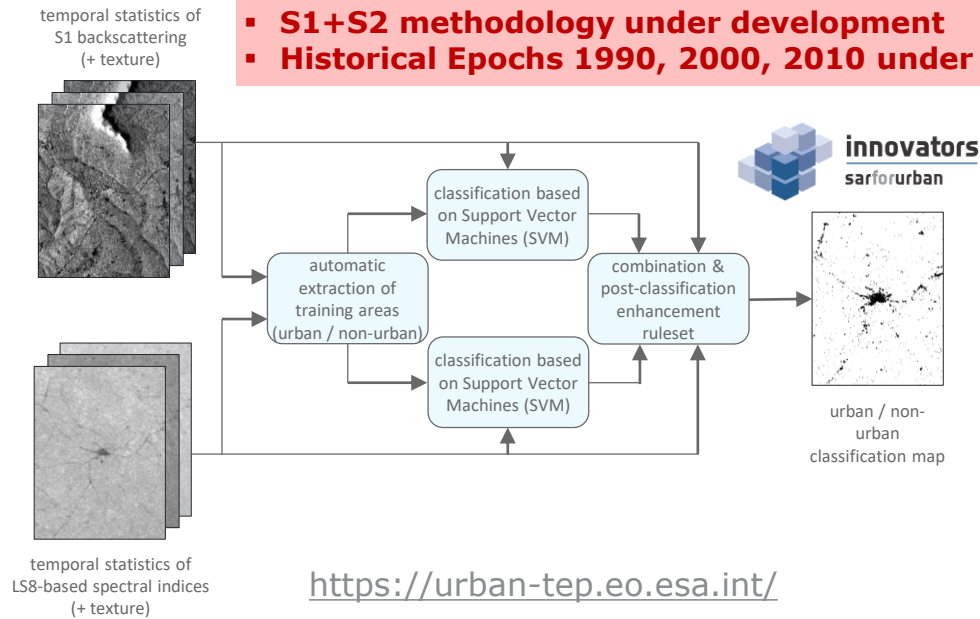
Target 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
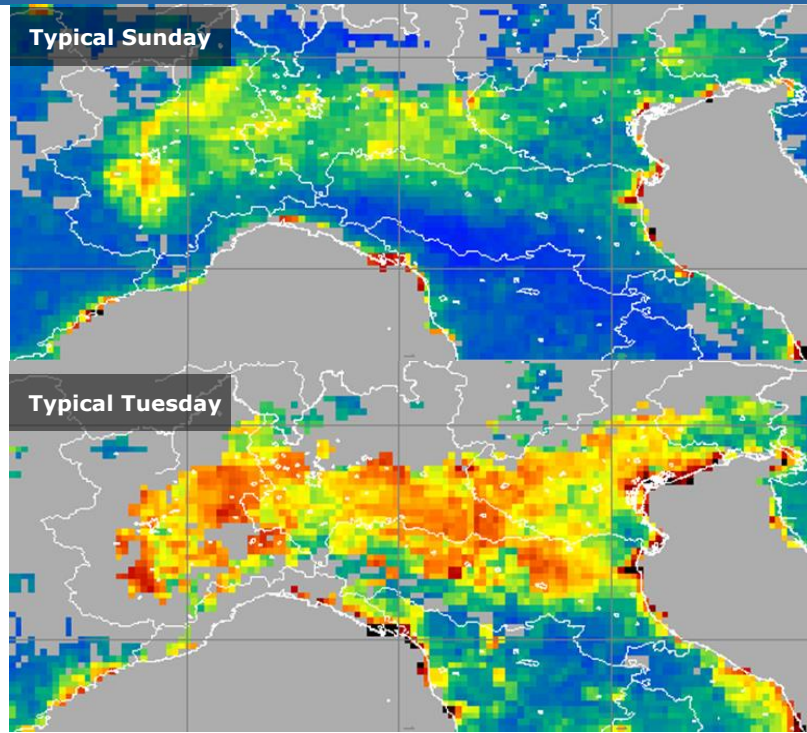
Indicator 11.6.2 *"Annual mean levels of fine particulate matter (e.g. PM2.5 and PM 10) in cities (population weighted)"*

EO-derived parameters

- Annual mean levels of coarse particulate matter (PM10)

- Annual mean levels of fine particulate matter (PM2.5)

Typical Sunday

Typical Tuesday

Particulate matter PM2.5

0   50 µg/m³

Aerosol thickness, e.g. optical depth of PM10 and PM2.5 (an indicator of the overall pollution).

Typical spatial resolutions: 1–10 km on a daily basis, with local improvements down to street level when adequate in-situ information and/or modelling is available

Data: MODIS/Aqua. Processing: Carlo Gavazzi Space / ISAC-CNR.

Northern Italy

Fine particulate matter concentrations (2.5 and 10) over cities are estimated through numerical modelling, integrating satellite data (LEO/GEO through AOT assimilation) and in-situ data
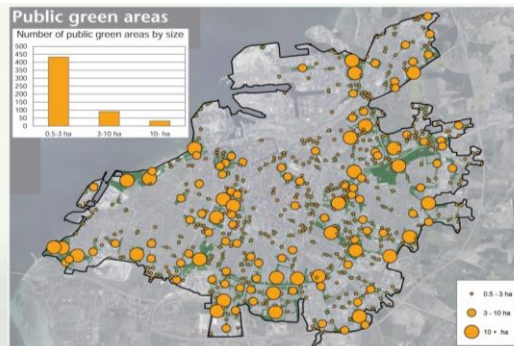
Target 11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

Indicator 11.7.1 *"The average share of the built-up area of cities that is open space in public use for all disaggregated by sex, age and persons with disabilities"*
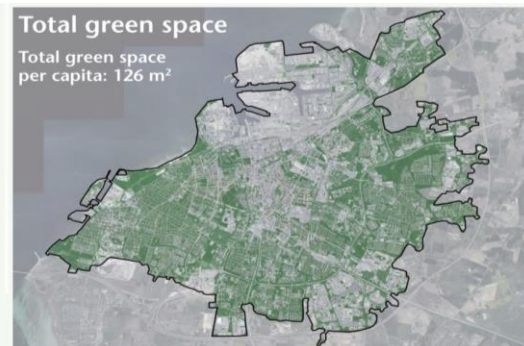
- Population Distribution and Density
- Transport Infrastructure
- **Urban Green Areas**
- **Urban Built-up Extent**
- **Urban and Peri-Urban Land Cover/Use**
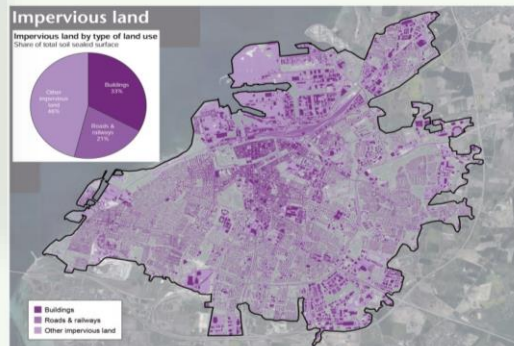

Linköping

Växjö

Accessibility to green areas
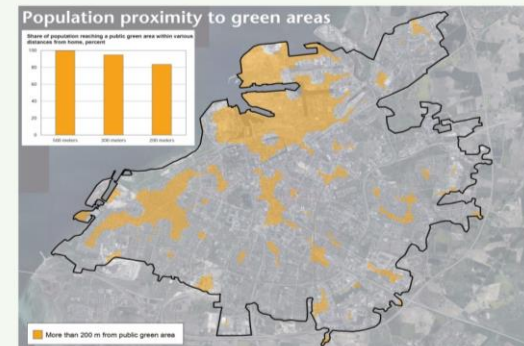Swedish pilot study
Statistics Sweden and Landmäteriet

Access to public green areas based on mapping of urban green areas areas and controlled disaggregation of national census data

New ESA project on "EO for SDGs"

Support GEO, CEOS, ESA/EC and their Member States
and the EO community to play a leading role
in the full realisation of Earth Observations in the 2030 agenda for SD

- Analyse in depth the **Metadata Repository** of all SDG indicators (169 targets, 230 indicators) and assess the **current and potential contribution of EO/Copernicus** to the SDG Global Indicator Framework.

- Review the **Tier 2 and 3 monitoring/reporting guidelines** produced by the custodian agencies for a number of key SDG indicators and propose areas of EO improvements.

- Perform **a country demonstration**, by partnering with the NSO and the relevant national governmental authorities (for the indicators selected) to support implementation of a number of SDG indicators (**at least two**)

- Study how the **GEO/CEOS/EC/ESA/MSs developed EO collaborative platforms and big data initiatives (Datacube)** can serve the EO data and information needs of the large community of SDG stakeholders (UN-GGIM, Custodian Agencies, National Statistical Offices, etc.).

EOEP-5, 400 KEUR, 18 months, ITT in 2017 Q3

Take Home messages

- EO can deliver **key environmental information that can inform the SDGs** and **support** the definition, planning, implementation, monitoring and assessment of **development projects** in particular in developing countries.

- GEO & CEOS have initiated a number of activities to **showcase the value of EO and Copernicus** for achieving the SDG Targets and monitoring Indicators.

- ESA is **engaged in the SDGs mostly through GEO and CEOS** and on a case by case directly with the UN specialised agencies and countries.

- **Discussions are taking place with the EC and its MSs** to have a joint strategy to promote Copernicus data and services in the Global SDG framework.

- The UN has set up a **flexible Global Indicator Framework** with annual refinements and comprehensive reviews (2020 and 2025) and consequently place for higher EO integration.

- Considering the vast amount of EO data to be used by SDG stakeholders at all level, the development of **collaborative platforms and knowledge hub** is a necessity.