Space for Sustainable Urban Development

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European Space Agency

Source: Medsea Night’s Sky, Astronaut photograph ISS025-E-9858 acquired October 28, 2010, on board the International Space Station.
The ESA Earth Observation Satellite Fleet

Meteorological Missions

Copernicus: "Sentinel" Missions

"Earth Explorer" Missions
Global impact of human enterprise on our planet

Growth

Demography

Global Changes

Source: adapted from Johan Rockstrom, by PPM
Global Risks as seen by WEF

Top 5 Global Risks in Terms of Impact

2007 - 2014:
- **Asset price collapse**
- **Retrenchment from globalization**
- **Slowing Chinese economy (<6%)**
- **Oil and gas price spike**
- **Pandemics**
- **Fiscal crises**
- **Oil price spikes**
- **Chronic disease**
- **Pandemics**
- **Oil price shock**
- **Major systemic financial failure**
- **Water supply crises**
- **Water shortages**
- **Climate change**
- **Geopolitical conflict**
- **Global energy price volatility**
- **Extreme energy price volatility**
- **Food shortage crises**
- **Water crises**
- **Food crises**
- **Global information infrastructure breakdown**
- **Extreme volatility in energy and agriculture prices**

Integrated Observing System

Multi variate, multi sensors, multi purposes, observing system for climate

Source: Adrian Simmons (Global Climate Observing System), 2013
Obs - Foundation of Science & Services

Climate House
WITH Observations

Guidance / Knowledge
Information services
Science Assessment
In-situ & Space data

Adapted from
DiploFoundation
Climate Change Building
Climate House
WITHOUT
Observations

If you cannot **measure** it,
You cannot **improve** it, ..

Lord Kelvin (1824-1907)

Courtesy Marco, ESA
The Great Geophysical Experiment

Source: Michael Buchwitz, IUP, University of Bremen, Schneising et al., 2011
Global Sea Level Rise from altimetry
Monitoring Ice Thickness with ESA Cryosat

Source: Planetary Visions/CPOM/UCL/ESA
Growing EO use in Numerical Weather Prediction

Source: ECMWF
Superstorm Sandy

Probability of a wind storm 9.5 days before landfall

Track forecasts 6.5 days before landfall

Observed track of Sandy

Two days before Sandy formed (9.5 days before landfall in New Jersey) there was already a significant probability (25%) of a severe wind storm affecting the North-Eastern USA.

Source: ECMWF
Human Footprint of Agriculture

“Already, we have cleared or converted more than 35 percent of the earth’s ice-free land surface for agriculture, whether for croplands, pastures or rangelands…. Since the last ice age, nothing has been more disruptive to the planet’s ecosystems than agriculture.” Jonathan Foley, Uni Minnessota
Global Framework for Monitoring Agriculture

Global Framework for monitoring of agriculture and limit volatility. EO from space has a key role to play. ESA is developing EO products to quantify food insecurity risks.

Source: G-20, GEO-GLAM
Global food prices are increasingly volatile due to climate extremes, which alter global production patterns and exacerbate hunger in poorer countries. About 44M people driven into poverty by rising food prices in the second half of 2010 (World Bank).
Soil Moisture & water-induced food insecurity

Improved Soil Moisture monitoring from space enables identification of **dry** conditions to support appropriate **actions** to avoid **food insecurity**.

Source: Maxime Trompier (ESA)
From local to regional and global impact

Source: Envisat/SCHIAMACHY NO2 concentration, courtesy IUP.
Mega-Cities, Mega-Pollution

NO$_2$ reductions detected from space during the 2008 Beijing Olympic Games


Source: Global Urban Footprint, DLR, based on TerraSAR-X; ESA / DLR, Source: ESA Dragon, NASCC.
EO based NO$_2$ emissions South Africa

OMI, 2009

Mijling and van der A KNMI, 2012

Matimba power plant

vanadium mine

Sasol company oil from coal

Majuba power plant

Source: Prof. dr. P.F. Levelt, KNMI & TUD, 2013
Dynamic Picture of Urban environment & stress

Las Vegas Urban Growth, 1986-2012
Urban Mapping: EC DG-Regio *Urban Atlas*

- Part of the local component of the Copernicus land monitoring services
- 305 cities for the reference year 2006
- 22 thematic classes (CLC)
- MMU: 0.25 ha urban, 1.00 ha other

**Corine Land Cover vs Urban Atlas**
Mega-Cities

Source: Global Urban Footprint, DLR, based on TerraSAR-X; ESA / DLR, Source: ESA Dragon, NASCC.
Population Distribution:
Disaggregating Population Data

- EO-STAT service:
  - "Sharpening" of census data using LU/LC information
Urban Risk: Land Motion Due to Water Extraction

Jakarta, Indonesia
ALOS PALSAR 2007–2009


Annual Displacement Rate
- more than -75.0 mm/yr
- from -75.0 to -60.0 mm/yr
- from -60.0 to -45.0 mm/yr
- from -45.0 to -30.0 mm/yr
- from -30.0 to -15.0 mm/yr
- from -15.0 to 15.0 mm/yr
- from 15.0 to 30.0 mm/yr
- from 30.0 to 45.0 mm/yr
- from 45.0 to 60.0 mm/yr
- from 60.0 to 75.0 mm/yr
- more than 75.0 mm/yr
Urban Risk: Land Motion Due to Metro Line Construction

Jubilee Line, London
1997–2005
Copernicus – an user-driven operational Integrated Observing System for our planet
Sentinel-1 - Copernicus

- Spectral bands: C-Band Synthetic Aperture Radar (at 5.405 GHz)
- Life time: 7 years design life time
- Orbit: Near-Polar sun-synchronous (dawn-dusk) orbit 698 km.
- Repeat Cycle: $12 \, d$ repeat cycle (1 sat), $6 \, d$ for constellation
Sentinel-1 – First image Antarctica
Sentinel-1 – First image Namibia
Target readiness for launch: 2014
Sentinel-2

S-2 workhorse for agriculture
Making the most of Big Data

..of large volume, variety, complexity of EO data.

“The most common purpose of big data is to produce small data”
data informed 10 sep 2013
Exploitation Platforms

Moving the Calculations to the data

USERS

RESEARCHERS

APP ENGINE
e.g. CDO operators

CLOUD
HPC

runmycode Agency
EO Service: Soil Sealing / Soil Loss

New Delhi 1991

New Delhi 2003

New Delhi 2011

Continuous Urban Fabric, Soil Sealing > 80% in % of total artificial area

- 2003
- 2010(2011)

EOWORLD, ESA/World Bank (2011)
Exploitation Platform

- Platform for Urban Monitoring and Analysis (PUMA), World Bank
Thank You

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