Demonstration of Cases from EO4SD

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EO4SD Session Overview

This session is intended to be highly interactive, questions and active involvement are encouraged throughout the session

<table>
<thead>
<tr>
<th>2:00-4:30</th>
<th>Interactive Demonstration of EO4SD-Urban Earth Observation (EO) Products &amp; Tools</th>
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<tbody>
<tr>
<td></td>
<td>• Satellite EO products and the SDG indicator framework</td>
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<td>• Storylines – (1) Global Urban Growth, (2) Urban Green Areas, (3) City Land Assets Dynamics</td>
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<td>• Capacity building activities – intro to webinar series, available on OLC</td>
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<td></td>
<td>• Live demo of ESA urban Thematic Exploitation Platform (uTEP) analytical and visualization capabilities</td>
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<td>• Link to EO4SD-Urban collection on DDH</td>
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</table>
Collaborative Efforts with WB Programmes

- City Planning Labs - Indonesian National Programme (Semarang, Denpasar)
- UrbanScapes Global advisory services and analytics: Neighbourhood Upgrading Project and Neighbourhood Improvement Project (Dhaka and Karachi)
- Water Supply and Sanitation (WSS) Global Solutions Group’s Project: Analytical and Planning Tool for Integrating Multi-dimensional Data in Urban Slums (Dhaka)
- Urban Planning for Tanzania: Impact & Effectiveness of Urban Planning on City Spatial Development (7 Secondary Cities in Tanzania)
- ASA Cambodia (Phnom Penh)
- Development Research Group (DECRG) - Pilot Study for Kigali-Using Satellite Imagery to Improve Tax Maps and Local Revenue Collection (Kigali)
- Metro Mumbai Urban Project: Transit Oriented Development- Phase 2 (Mumbai)
- UrbanScapes Community of Practice & Emergency Operation for Development: Transforming Cities through Public Spaces (Ramadi, Falluja)
- UrbanScapes Community of Practice & Engine of Growth and Service Delivery ASA: Transforming Cities through Public Spaces (Bamako, Lima)
- Global Platform for Sustainable Cities (GPSC) programme (Bhopal, Vijayawada, Campeche, Abidjan, Saint-Louis, Dakar, Lima)
Earth Observation (EO) Data

- Spatial explicit information on earth surface and objects
- Multitemporal and long term archives
- Application specific resolutions
- Repeatable, Unbiased

Spatial explicit information is needed for many administrative processes.

→ Earth Observation (EO) data can support urban planning activities
Need for Geo-Spatial Data

Cities in Developing Countries confronted with several challenges:

- Unplanned urban growth
- Development of informal and unplanned settlements
- Inadequate services for these areas
- Lack of adequate transport infrastructure leading to traffic congestion

Geo-spatial data play a major role in quantitative data that supports evidence based urban planning.

Main challenges for City Authorities in developing countries:

- lack of high quality and validated geo-spatial data,
- lack of technical capacities to use the data for planning
Earth Observation (EO) based Products by EO4SD

Satellite Data: HR, VHR

Preprocessing:
- Geometric Validation
- Atmosphere Correction
- Cloud Masking
- ...

Ancillary Data:
- OSM Data
- User Data

Semi-Automatic/Automatic Classification

Land Use/Land Cover
- With VHR Data:
  - Up to 30 classes
  - Accuracy > 85%
  - MMU = 0.25 ha
- With HR Data:
  - Up to 10 classes
  - Accuracy > 85%
  - MMU = 0.5 to 1 ha

Transport Network

Urban Extent, Imperviousness and Change
Building Footprint and Heights
Elevation Models
Landslide Risk
Flood Risk
Terrain Motion
Urban Green Areas
Informal Settlements
Population Distribution

Advanced Spatial Analytics
Indicators of Sustainable Development Goal 11, Urban Planning Metrics
Utility of remote sensing data via the use of 3D building height data and building footprints to support land property valuation and related updating tax registers
Feature Extraction (Building Heights)

- Optical Stereo Satellite Image Pair
- Digital Surface Model
- Digital Terrain Model
- Vegetation Detection
- Building Footprint
- Building Heights
- nDSM (Object Height)
Building Footprints and Heights

Abidjan, Ivory Coast
DECRG Pilot Study supports the Government of Rwanda to improve methods of land valuation.

Study Objective

To assess methods for using actual land transaction data from the country with the land cadastral map and basic building height data (from EO data) to simulate different property values and related tax rates.
Building Heights in Kigali
Feedback and Conclusion

Data and Computer-Assisted Mass Appraisal (CAMA) model was tested for Kigali and published by the WBin 2018


- EO-derived Building Height data can be used to support property tax evaluation
- EO data can significantly reduce the cost of establishing and updating tax registers

→ high resolution remotely sensed imagery can be used to reliably check the completeness of valuation rolls and if data on land values are available, also run land valuation models at a fraction of the time and resources required by more traditional technologies.

Applications for 3D Building Information

- Number of floors
- Building height
- Population density
- Building density
- Land value calculation
- Estimation of volume
- Building type
- Urban green ratio
- Degree of Sealing
- Hydrological network

Tri-Stereo DSM Beijing, China © 2017, GAF AG, © CNES (2017) Distribution AIRBUS DS
3D Information based on satellite data

• Supporting information for disaster risk reduction (e.g. vulnerability mapping, flood risk modelling) and in the event of emergency cases
• Elevation models and derived products support urban planning, assessment of property taxes, floor-area-ratio calculation, etc.
• Supporting population estimation and population density calculation
• 3D Change detection and construction simulation

• Reproducible (standardized) + reliable + worldwide applicable
• VHR for urban core areas and HR for regional and trans-national issues
Questions and Answers Slot

• Topics presented
  – Remote Sensing / Earth Observation (EO)
  – EO4SD Product Portfolio
  – 3D Information derived from satellite data
EO for Sustainable Development

Satellite EO products and the SDG indicator framework

How to implement SDG 11 Indicators?
Achieving the objectives of the SDGs:
→ Need to monitor indicators in a harmonised way.

Challenge:
• Too often, existing city data is not adequately detailed, documented, accessible and timely or harmonized.
• Very often no data at all are available

→ Good reliable data is a key element in improving the process in monitoring and reporting
**EO for Sustainable Development**

**SUSTAINABLE DEVELOPMENT GOAL 11:**
Make cities and human settlements inclusive, safe, resilient and sustainable

<table>
<thead>
<tr>
<th>Target 11.1: Access to Housing and upgrading slums</th>
<th>Indicator: 11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing</th>
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<tbody>
<tr>
<td>Target 11.3: Sustainable urbanisation</td>
<td><strong>Indicator 11.3.1:</strong> Ratio of land consumption rate to population growth rate</td>
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<tr>
<td>Target 11.7: Access to green &amp; public spaces</td>
<td><strong>Indicator 11.7.1:</strong> 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</td>
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Selected use cases for demonstration

SDGs with major opportunities for EO data
Analysis by the GEO EO4SDGs initiative
http://www.data4sdgs.org
UN Habitat Methods

Tier Classification Criteria/Definitions:

• Tier 1: Indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.

• Tier 2: Indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries.

• Tier 3: No internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested.
Tiers and status in December 2019

SDG 11, Indicator 11.1.1 Proportion of urban population living in slums, informal settlements or inadequate Housing: Tier I

SDG 11, Indicator 11.3.1 Land Consumption: This indicator is categorized under Tier II, meaning the indicator is conceptually clear and an established methodology exists but data on many countries is not yet available. Data for this indicator, at the global level, is available for all cities and countries (UN DESA - United Nations Department of Economic and Social Affairs population data) and satellite images from open sources.

SDG 11, 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: Tier II
Target 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.

Indicator Definition:
This indicator combines the components of slums, of informal settlements and of inadequate housing to have a universal indicator that can be used to monitor these areas in both developing and developed regions.

The indicator considers three components which are calculated as follows:

a) Slum Households (SH) = \( \frac{100 \times (\text{No. of people living SH})}{\text{City Population}} \)

b) Informal Settlement Households (ISH) = \( \frac{100 \times (\text{No. of people living in ISH})}{\text{City Population}} \)

c) Inadequate Housing Households (IHH) = \( \frac{100 \times (\text{No. of people living in IHH})}{\text{City Population}} \)
11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing.

**Concept:**

**SLUM**
- No improved drinking water
- No improved sanitation facilities
- No sufficient living area
- No housing durability
- No security of tenure

**INFORMAL SETTLEMENTS**
- Lack, or cut off from, formal basic services
- Inhabitants have no security of tenure
- Housing may not comply with current planning and building regulations

**INADEQUATE HOUSING**
- Legal security of tenure
- Availability of services, materials, facilities and infrastructure
- Affordability
- Habitability
- Accessibility
- Location
- Cultural adequacy
11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing.

Required Input Data:

- Built-up area of the urban agglomeration (EO4SD product)
- Extent of informal settlements (Information on the typical pattern of informal settlement in this region is helpful) – EO4SD product
- Population raster data (or Census data) – WorldPop or Landscan
11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing.

Results for Dhaka (Bangladesh) and Lima (Peru):

SDG Indicator 11.1.1: Proportion of Urban Population living in Slums and Informal Settlements

- **Dhaka** (Bangladesh):
  - In 2000: 20%
  - In 2015: 18%

- **Lima** (Peru):
  - In 2000: 8%
  - In 2015: 11%
11.3.1: Ratio of land consumption rate to population growth rate

**Indicator Definition:**

**Land Consumption rate** = the annual rate at which cities uptake land for urbanised uses (both built-up and open space demand)

**Population Growth rate** = the change in population in a given area over a unit period of time; expressed as percentage of the number of individuals in the population at the beginning of that period.

Land consumption rate = Annual population growth rate
11.3.1: Ratio of land consumption rate to population growth rate

Bhopal
Urban Growth
1990 - 2015

Population Density by WorldPop
11.3.1: Ratio of land consumption rate to population growth rate

SDG Indicator 11.3.1: Ratio of Land Consumption Rate to Population Growth Rate

- **Indicator**
  - $> 1$ = Urban Sprawl
  - $< 1$ = Urban Densification

<table>
<thead>
<tr>
<th>City</th>
<th>Ratio</th>
</tr>
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<tbody>
<tr>
<td>Bhopal</td>
<td>1.1</td>
</tr>
<tr>
<td>Vijayawada</td>
<td>1.0</td>
</tr>
<tr>
<td>Saint-Louis</td>
<td>1.5</td>
</tr>
<tr>
<td>Dakar</td>
<td>0.7</td>
</tr>
<tr>
<td>Abidjan</td>
<td>1.1</td>
</tr>
<tr>
<td>Campeche</td>
<td>0.6</td>
</tr>
<tr>
<td>Lima</td>
<td>0.2</td>
</tr>
</tbody>
</table>
SDG Indicator 11.7.1

- **Definition:** “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”

- **Aim:** Monitoring the amount of land that is dedicated by cities for public space, which includes open spaces and streets and should be accessible by all (according to the UN-Habitat Methodological Guidance document)

- **Computation formula**

\[
\text{% of land that is dedicated by cities for public space (open spaces and streets) = }
\]

\[
\frac{\text{(Total surface of open public space + Total surface of land allocated to streets)}}{\text{Total surface of built up area of the urban agglomeration}}
\]
SDG Indicator 11.7.1 implementation

- **Limitation**: The share of land in public open spaces cannot be obtained directly from the use of high-resolution satellite imagery, because it is not possible to determine the ownership or use of open spaces by remote sensing without any additional data.

- **Total surface of open public spaces**: Selection of the classes *Urban Green Areas* and *Sports and Leisure Facilities* from the LU/LC product, assuming that these places are public and accessible by all.

- **Total surface of land allocated to streets**: Use of the road network derived from OSM and refined by the service provider (taking into account the different road categories).

- **Total surface of built-up area**: Selection of the classes related to artificial areas from the LU/LC product.
SDG Indicator 11.7.1 results

Results related to all GPSC cities covered by EO4SD-Urban (except Lima)

Basic comparative analysis

- For Indian cities and Campeche, around 28% of the built-up area is open space for public use in 2005 but the trend is downwards with respect to the share in 2015.
- On the other hand, for African cities, the share in 2005 was much lower (especially in Abidjan) but it slightly increased during the decade (except in Saint-Louis).
SAINT-LOUIS: Visual confirmation of the trend

Analysis (northeast part): Very few green, sports and leisure related areas within the new built-up areas
Earth Observation for SDGs Summary

- SDG Indicator calculation can be supported with EO data in a harmonised way on national or international level
- EO data is more cost efficient than traditional in situ techniques
- Historic EO is archived and used for multi-temporal analyses

- Calculation of these indicators with EO data is an estimation/modelling of the indicator.

→ EO data can be used to support some of the SDG 11 indicators
Questions and Answers Slot

• Topics presented
  – EO data for SDGs
  – Informal Settlements
  – Land Consumption
Storylines

- Urban Growth
- Green Areas
- Land Structure

https://urban-tep.eu/visat/scudeoStories19/greenAreas

Webinars available at EO4SD homepage

http://eo4sd.esa.int/
EO4SD Data Exploration Tools

Data Catalog

https://datacatalog.worldbank.org/

Organized by:
Rochelle Glenene O'Hagan

Open Learning Campus

https://olc.worldbank.org/content/webinar-series-earth-observation-sustainable-development-eo4sd

Organized by:
Sheila Jagannathan and Apoorva Reddy Neelapu

EO4SD Data Exploration Tools

https://datacatalog.worldbank.org/search?search_api_views_fulltext_op=AND&f%5B0%5D=field_collection_field%3A1696

Organized by:
Rochelle Glenene O'Hagan

https://urban-tep.eu/puma/tool/?id=743433804&lang=en#
Thank you for your attention

Contact: info@gaf.de