Earth Observation & GeoSpatial Big Data for Monitoring SDG Indicators

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UNWGIC, 19-21 Nov., 2019, Deqing, Zhejiang, China
Environmental Consequences

High concentrations of aerosols, exhaust gases, pollution and dust
- Hazardous to health
- Increased smog, haze, fog, clouds

Source: The Associated Press
Source: Suicup via Wikimedia
Source: zmescience.com

Environmental Consequences

- **Paved surfaces -> rainfall water -> flooding**
  - Urbanization results in more impervious surfaces, thus reducing the area where infiltration to ground water can occur. Thus, more storm water runoff occurs.
  - 79 people died in July 2012 Beijing flooding

Source: BBC News
Source: www.theatlanticities.com
Sentinel Big Data: Free
Volunteered Geographic Information

Mobility Data: GeoLife Beijing
Mobility Data: Cycling footprint of Madrid

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
UN Urban SGD Indicators

Goal 11: Make cities inclusive, safe, resilient & sustainable

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 – Land use efficiency

Target 11.7: is providing universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

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

EO4Urban

The overall objective is to evaluate multi-temporal multi-resolution Sentinel-1A SAR and Sentinel-2A MSI data for developing a pilot global urban services based on user requirements to support smart and sustainable urban development.

Team
KTH Royal Institute of Technology, Sweden
University of Pavia, Italy

Users
Stockholm County Administrative Board, Sweden
National Geomatics Center, China
**User Requirements: Urban Extent Maps**

- 2015 and 2016 Urban extent maps for Stockholm and Beijing
- Minimum Mapping Unit at 30m x 30m.
- Historical urban extent maps from 1995, 2005 and 2010 if possible.

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**User Requirements: Urban Green Structure & Change Maps**

- Maps of urban green structure changes in 2015 and updated yearly
- Minimum Mapping Unit at 30m x 30m.
Sentinel-2A MSI & -1A SAR Data

Urban Extractor

- Sentinel-2A SAR images or stack of images
- SAR Preprocessing (orbit, terrain, co-register)
- Stack Averaging
- Conversion to 8bit Linear Scale with Histogram Clipping
- SRTM 30m DEM Image
- Slope Image
- Slope Threshold (15%)
- Mountain Mask
- Removed filling operation
- Introduced effective minimum mapping unit
- Replaced Internal Data Scaling
- Increased internal quantization from 6 to 8 bit
- GLCM MASK
- LISA MASK
- Moran, Getis, Geary, Getis
- LISA AND GLCM
- Morphological filtering DENSITY ANALYSIS
- Builtup Mask
- Logical Operators (AND, OR)
- Urban Area Mask
- Corrected Urban Mask
Sentinel Big Data for Urban Extent Extraction

- SRTM Digital Elevation Data
  - Mountain & non-Mountain areas delineation
    - Foreshortening Mask generation

- S1 ASC & DESC Time Series
  - ASC & DESC Multi-temporal image generation
    - Local Min/Max Algorithm & image statistics analysis
    - Automatic Thresholding & ASC+DESC Urban Masks fusion
    - Initial S1 Urban mask generation

- S2 Multi-Spectral Time Series
  - S2 Cloud Mask Generation
    - Spectral indexes trends analysis (i.e. min/max/NDVI)
    - Vegetation & Water masks automatic generation
    - S1 Urban Mask refinement using S2 masks
    - Final Urban mask Generation

Sentinel Big Data for Urban Change Detection

- Imagery Pre-processing and Data Cube Ingestion
  - Multi-temporal Sentinel data
    - Orthorectification & Atmospheric correction (SNAP software)
      - ASC & DESC atmospheric correction (e.g. aerosol index)
    - ASC & DESC multi-temporal data cube
      - Data fusion techniques (e.g. temporal pyramid)
      - MDA (Multi-Source Data Fusion)
  - S1 images & Sentinel-2 data cube
  - S2 images & Sentinel-2 data cube

- S1 changes detection
  - Change detection (e.g. NDVI in-place)
    - Change detection algorithm (e.g. thresholding, entropy)
    - Change detection map
    - Change detection process (e.g. change detection using S1)

- S2 changes detection
  - Change detection (e.g. NDVI in-place)
    - Change detection map
    - Change detection process (e.g. change detection using S2)

- Intervention
  - Collection of the reference data
  - 3D Change Detection
    - 3D Change Detection (e.g. stereoscopic)
    - 3D Change Detection (e.g. multi-temporal)
  - Multi-temporal 3D changes
    - Multi-temporal 3D changes
    - Multi-temporal 3D changes
Stockholm Urban Extraction Using KTH-Pavia Urban Extractor

Urban Extraction: Beijing
Urban Expansion in Beijing

Urban Green Structure
Goal 13. Take urgent action to combat climate change and its impacts

Climate Impact

- 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
Introduction

For active wildfire monitoring
• Moderate Resolution Imaging Spectroradiometer (MODIS) Active Fire maps are often used for contextual awareness

• Landsat data are often deployed for post-wildfire boundary determination and burn severity mapping
Limitation of Optical Images

Sentinel-1 SAR Time Series
FireNet: A Deep Learning Framework

Validations
Results

Conclusions

- EO and geospatial big data and analytics can play a significant role in measuring and monitoring SDG indicators.