Monitoring Urbanization in Latin American Metropolitan Areas (Bogota, Quito and Lima)

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Company facts

- founded in 1961, ~1,000 employees, Ottobrunn/ Germany
- high-level engineering and testing

**Geodata Factory Dresden, Germany**

- **70 employees**, ~30 projects per anno
- **Service provider** in remote sensing, geoinformatics and photogrammetry,
- **Markets**: defense and security, cadastral & surveying, land planning, environmental protection, water management, forestry, telecommunications
- **Customers** are public authorities, enterprises, armed forces
- **Disciplines**: geography, cartography, geo-informatics, geodesy, geo-ecology, geology, forestry, geophysics, chemistry, etc.
Services & References

**Thematic Mapping**
- Interpretation of VHR EO data
- 181 feature types (LandUse/LandCover, infrastructure)
- Implementation of related info (GeoNames, DTM, ...)
- Multi-phase Quality Mngmt.
- 150,000 km²/year, >1,000,000 km road network

**Update of official topographic GIS**
- official Digital Landscape Model of Germany.
  Based on topo ATKIS data of the German Survey 2009
- Multi-temporal & -spectral update with EOdata 2012
- Result: Automatic deduction of CORINE for Germany
- semantic transformation model & object-oriented image-classification
- high quality requirements (97.5% per class)
- 360,000 km² edited in 9 months

... & GIS Analysis
- population density dataset, Germany (day/night, 50m, using statistics classification)
Services & References

Terrain related Analysis

- **Digital Terrain Model** from EOdata ... precise geodetic information: “the goal defines technique & scale”
- 3D calculation (amount of water outflow, water levels, drainage calculation)
- Support for risk prevention & demonstrator of (hazardous) events (potential landslide areas, flood risk)
- Identification of deformation events (ground water extraction, volcanism, ...)

Analysis & Modelling

- Urban development
- Green & Blue aspects (distribution, connectivity)

Consulting, Training & Workshops

... & Software solutions
Background: The World Bank Project
Monitoring Urbanization in Latin American Metropolitan Areas

- **Main WB contact:**
  Felipe Targa, Department for Transport & ICT

- **WB team members:**
  Tatiana Peralta Quiros, Department for Transport & ICT
  Bishwa Raj Pandey, Department for Transport & ICT
  (Catalina Marulanda, Social, Urban, Rural & Resilience)

- **Project users/promoters:**
  applied for internal analysis,
  Daniel Páez (Universidad de los Andes)

- **Project context:**
  fast urban development ⇔ suitable reference data
  for decision making process
  ⇔ Goal: preparing standardized up-to-date Urban Services

- **Bench mark & Schedule:**
  Service definition phase ⇔ Production phase ⇔ Assessment
  start June 2014; delivery June 2015
  Focus on urban structures, large area, high LOD & Quality

© http://www.paxgaea.com/images/Lima.jpg
Background: The World Bank Project
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- **Key requirements (WB/ Scope of Work):**
  - Urban Mapping of 2000 & 2013, Change Layer
  - emphasis on Urban structures & Land Use
    → expanding to administrative units

- **Additional requirements (WB):**
  - transportation network & real footprint
  - higher detail for selected features (Vegetation, informal housing)
  - building heights (VHR analysis)
  - Exceeding time range (back & forth)
  - Larger extent (changing areas are often “outside”)

![Urban Mapping of 2000 & 2013, Change Layer](image1)
![Urban Mapping of 2000 & 2013, Change Layer](image2)
![Land Cover Flows](image3)

[Map of Latin America showing urban areas]
The EO Products: What They Are

- **Transportation network 2013**
  - buffering (>10m, 3m intervals)
  - Fast transit road, Other road; Railroad

- **Urban Service 2013 and 2000**
  - Urban Atlas (minimum mapping unit 0,25/ 1ha)
  - 18 urban classes, 5 other classes
  - geometric reference Google Maps/ ESRI Basemap
  - thematic accuracy > 96 %
  - cities: 71,800 polygons

- **Urban Change Layer**
  - detailed
  - LEAC Level2 (higher thematic depth)
  - LEAC Level1

- **Urban Vegetation Layer 2013**
  - low and high vegetation
  - minimum mapping unit 0,1ha
  - significant single trees

- **Statistics, Maps & Presentations**
The EO Products: What They Are

- **EO data used**
  - 2000: SPOT 4/5 (2.5m ... 5m)
  - 2000: Landsat 7 (15m)
  - 2013: SPOT 5/6 (1.5 – 2.5m)
  - 2015: Sentinel 2 (10m resolution)

- **Data – easy to handle**
  - different exchange formats (shp)
  - conform to PUMA platform

- **Google-ready**
  - for a wider audience (kml)
Comparability of Metropolitan regions

**Urban Atlas**
- 1.1.1.1. - Continuous dense urban fabric
- 1.1.1.2. - Continuous medium dense urban fabric
- 1.1.1.3. - Discontinuous dense urban fabric
- 1.1.2.1. - Continuous medium dense urban fabric
- 1.1.2.2. - Discontinuous medium dense urban fabric
- 1.1.2.3. - Discontinuous sparse urban fabric
- 1.1.3. - Informal transition
- 1.1.4. - Informal settlement
- 1.2.1. - Industrial and Commercial
- 1.2.1.1. - Public and Private
- 1.2.2.1. - Fast transit road
- 1.2.2.2. - Other road
- 1.2.2.3. - Railway
- 1.2.3. - Port area
- 1.2.4. - Airport
- 1.3.1. - Mineral extraction and dump site
- 1.3.2. - Construction sites
- 1.4.1. - Green urban areas
- 1.4.2. - Sports and leisure facilities
- 2.1. - Agriculture and natural vegetation
- 2.2. - Bare ground
- 3. - Forest
- 5.1. - Inland water
- 5.2. - Marine water

**Comparable** due to:
- similar dates
- similar nomenclature Urban Atlas (applied standard)
- easy to combine with other sources
- administrative units

**Limitations**
- subset definition → often related to administrative units

**Suggestion:**
core area & buffer approach, considering administrative units
Lima – Urban spreading (“informal transition”)
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Image © 2015 DigitalGlobe
Image U.S. Geological Survey

2002  2009  2013  2015
Lima – Urban spreading ("informal transition")
Lima – Urban spreading ("informal transition")

Image © 2016 DigitalGlobe
Lima – Urban spreading ("informal transition")
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- detecting populated areas and open spaces in-between, density, & avg. size of housing
- fast, comparable and repeatable at reasonable quality
Urban Vegetation Layer

Connectivity & Urban Climate
protection of the Greens
Bogota – Urban Area ↔ Area with significant change
example Bogota

- urban core (up-to-date, draft classification)
- EOworld2 subset for mapping
  - Mapping result 2013 (Urban only)

- calculation of buffer area (relative to absolute size of city):
  \[
  r(\text{buffer}) = 0.25 \sqrt{A(\text{core})}
  \]

+ administrative Units:

map & analyse areas under severe change

overlay with 1984
Summary: The EO Products – What They Bring

**POTENTIAL INPUT**
.. to save World Bank costs

- + World Bank references
  GIS, previous analysis layer

- + auxiliary data
  land use, thematic features

- + in-situ knowledge
  hot-spots, special aspects of the cities

- + local contact

**CONTEXT OF USE?**
providing solutions for simplification & optimization processes

**URBAN SERVICE LAYER RANGE**

**FEEDBACK INFO (BENEFITS)**

- high level of detail
  - urban density classes
  - comparable (date, legend)
  - high accuracy

- back- & up-dating
- geographically extendable
  - Sentinel 2 ?

- downstream services
  - terrain, risk ...

- fast results
  - large area
  - low data & mapping costs: regional mapping level

- independent

- cost aspects can be reduced by automation (reasonable quality)

**GOALS & CHALLENGES OF ANALYSIS?**
IABG mbH

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