Mapping Urban Footprint from SAR Imagery - example from South Africa -

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Global Perspective on Human Settlements

- 180,000 additional urban inhabitants per day;
- Number of megacities from currently 25 to more than 100 within the next 30 years;
- China: 30 new cities with >1 million inhabitants in next two decades;
- India: 26 new cities with >1 million inhabitants in next two decades.
For an effective planning it is necessary to reliably know **which is the current extent of urban areas.**

In **developed countries** cadastral data are generally available [however, it might be sometimes difficult to get all the necessary information when regional (or national planning) has to be investigated];

In **developing or under-developed countries** often no official or heavy informal settlement regularly occurs (and the population growth here is 6 times faster). In the last few years satellite Earth Observation (EO) has proved being an effective tool for providing global geo-information on the location, spatial extent and distribution of urban areas.
In the last decade several EO-based and EO-supported Global Human Settlements Datasets (GHSD) have been produced to map human settlements worldwide.

NASA MODIS 500 (493 m spatial resolution) and ESA GlobCover 2009 (309 m spatial resolution)

The limited spatial resolution does NOT allow a precise characterization of urban settlements, especially in rural and peri-urban areas (characterized by small and scattered villages and towns).
Currently available Global Human Settlements Datasets

Google Earth
- Accra: 30 km
- Dar es Salaam: 15 km
- Baghdad: 10 km
- Amsterdam: 3 km

GlobCover 2009
- Maps showing different urban areas
The objective of the GUF initiative is to generate a global high-resolution binary mask of urban areas (i.e., built-up) from VHR SAR data acquired in the framework of the TanDEM-X Mission.

**TanDEM-X Mission (TDM):**

- the primary goal is to derive a consistent global DEM at the unprecedented spatial resolution of ~0.4 arcsec (~12 m);
- data are acquired by the TerraSAR-X (TSX) and TanDEM-X (TDX) satellites orbiting in a helix formation with a typical distance of 250 - 500 m;
- Two global coverages are acquired, i.e. 2011/2012 and 2012/2013.

The GUF will serve as a basis for the analysis of human settlements worldwide.
• Input of UFP are single look slant range complex (SSC) Strimap TDX/TSX images acquired at 3 m spatial resolution;
• A total number of more than ~180,000 TDX/TSX images [each one with size ~55000 x 35000 pixels (~165 x 105 km)] compose the first global TDM coverage (adding up to a final data volume of ~300 TB)
• To reduce the amount of data (due to technical restrictions) a multi-looking is performed for rescaling parameters to a spatial resolution of ~0.4 arcsec (~12 m); that is the concurrently the highest resolution in which the global DEM produced in the context of the TanDEM-X mission will be made available
• To overcome overestimation due to topography effects in hilly and mountainous areas, we implemented a dedicated mask derived from the analysis of the ASTER Global DEM.
Global Urban Footprint vs. GlobCover 2009

Accra  
Dar es Salaam  
Baghdad  
Amsterdam

Google Earth

Backscattering amplitude

30 km  
15 km  
10 km  
3 km
Global Urban Footprint vs. GlobCover 2009

Google Earth

Accra

Dar es Salaam

Baghdad

Amsterdam

30 km

15 km

10 km

3 km

speckle divergence
Global Urban Footprint vs. GlobCover 2009

Accra
Dar es Salaam
Baghdad
Amsterdam
Urban Mapping of Witbank
Urban Mapping of Witbank
Urban spatio-temporal development based on historical optical (Landsat MSS, TM and ETM+) and SAR (ERS, ASAR) data + Global Urban Footprint.

What’s next? – Global Urban Growth

Manila

2010
2000
1990
1975
What’s next? – Building Structure Characterization

Munich

Estimated Building Structure (GUF postprocessing)  True Building Structure
The presented GUF has already been produced for different areas worldwide and preliminary validation results assess its great potential to:

- support the research into global urbanization patterns;
- investigate spatiotemporal aspects of (peri-) urbanization;
- support transdisciplinary and structural analyses.

Extensive quantitative validation of the GUF based on in situ ground-truth information is ongoing;

The production of the first GUF layer from the first TDM data coverage is envisaged for 2014 (a public domain version will be made available at ~ 3.0 arcsec, i.e. ~50-75 m);

For research purposes it will be possible to access the full-resolution product at 12 m resolution;

A dedicated website will be online soon