June 2013

Issue 2

GEOURBAN Newsletter

Editorial

EO provides new opportunities for different Earth systems modelling. In this context, the monitoring of urbanization, a phenomenon with high impact on human's life, largely benefit from the use of satellite data. As an example, the monitoring of socioeconomic variables (e.g. population density) or climate characteristics (e.g. urban energy, water and carbon exchanges; urban heat island) are applications in which EO data can play a significant role. Urban planners can enhance their planning and management initiatives to design the appropriate framework for sustainable development activities. Here, the contribution of EO is of high importance and becomes more attractive, in the light of the increasing availability of data, advanced processing techniques and analysis tools.

In addition to providing highlights on the overall progress of the GEOURBAN project, this newsletter focuses on the activities of WP4, WP5 and WP6. The newsletter is open to articles, news and opinions.

Geourban partners:

1. FORTH **Foundation for Research and Technology, Greece**
2. GRADI Ltd. **Specializes in complex method of urban planning, Russia**
3. GARD Ltd. – **Specializes in HW/SW system development, Israel**
4. DLR - **The German Remote Sensing Data Center (DFD) of the German Aerospace Center (DLR), Germany**
5. KUZGUN **Specializes in geospatial solutions for urban planning, Turkey**
6. UNIBAS - **University of Basel, Switzerland**

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Primary articles

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Get to know GEOURBAN WP4 activity

WP4 includes the micro-scale applications in GEOURBAN case studies. Although previous research projects already addressed the use of very high spatial resolution (VHR) Earth Observation (EO) data in urban planning and management, WP4 represents a unique attempt to collect and to analyze an integrated EO dataset suitable for the estimation of a subset of the EO-based indicators developed in WP3. The development of EO data analysis techniques is beyond the scope of GEOURBAN, therefore state of the art methods are used to derive specific products from raw EO datasets. VHR (e.g. Ikonos, Quickbird, WorldView, RapidEye, TerraSAR-X type) satellite data is used in the GEOURBAN case studies. The output of this WP4 is a set of products to be used as inputs for indicator evaluation and a report on the techniques used to derive these products from raw EO data.

The VHR EO Data Analysis Protocol

The data obtained by using sensors without contacting the Earth surface is called remote sensing (RS) data. All RS data have four types of resolution namely, spatial, temporal, spectral and radiometric.

Very high resolution (VHR) RS data refers to spatial resolution of 5x5 m or less in GEOURBAN project. When the urban planning indicators are considered spatial resolution of 5x5 m or less is found to be appropriate for extracting related indicators.

The temporal resolution is important for investigating the change in the indicators over a time period.

Spectral resolution determines the extractability of indicators related with urban surface materials. VHR data with higher spectral resolution provides detection of object's material types as well as their geometries.

Most of the VHR data have spectral resolution of four spectral intervals which are also called bands, namely, Blue (B), Green (G), Red (R) and Near infrared (NIR).
Before extracting any indicator form the VHR data images usually gone through three levels of pre-processing:

1. **Geometric and radiometric** correction.
2. **Image enhancement** for better interpretation or information extraction.
3. **Image transformation -** carried out in order to extract specific characteristics like texture, vegetation, *etc.*

VHR Data Interpretation

The VHR data should be interpreted in order to obtain urban planning indicators. **Visual interpretation** constitutes integrated analysis of the specific features related to Earth objects, namely, shape, size, tone, texture, pattern, shadow, association, and site. The image analysis methods use sophisticated algorithms consisting of the following stages:

1. Classification of the images
2. Change analysis
3. Digital surface and terrain modelling
4. Feature extraction

VHR SAR Data Analysis

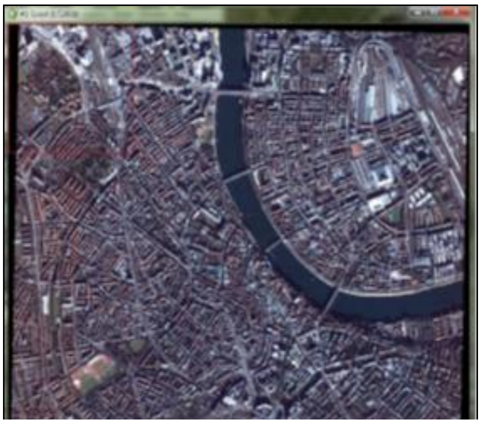
Synthetic Aperture Radar (SAR) works by collecting the echo returns from many radar pulses and processing them into a single radar image. In contrast to passive optical sensors, radar systems are active imaging devices capable of acquiring data both during day and night independently from weather or environmental conditions.
SAR sensors used to have a reputation as being unsuitable for a precise thematic characterization of the urban environment (Dell' Acqua, 2010). Nevertheless, this has changed with the emergence of the latest-generation SAR sensors such as TerraSAR-X, Tan-DEM-X RADARSAT-2, CosmoSkyMed or ALOS-PALSAR and the resulting operational availability of VHR SAR data.

LULC Classification – Basel Case Study

LULC classification for Basel uses one 4 band (R,G,B,NIR) Quickbird Multispectral image with a 2.51 m spatial resolution. In particular, the study area covers a part of the central business district with dense built up and road features.

Following is the LULC algorithm implemented for this case study:

1. Identification of classes
2. Preparation of test data for accuracy assessment
3. Obtaining Gabor filters - add them to the image bands
4. preparation of training Data
5. SVM classification
6. Accuracy Assessment



Quickbird image of Basel study-area

Step I consists in the visual investigation of the image since every LULC classification algorithm requires a reliable identification of the different information classes in the region of interest. Six major classes have then been identified, namely **water, grass, trees, bare land, roads and built-up areas**.

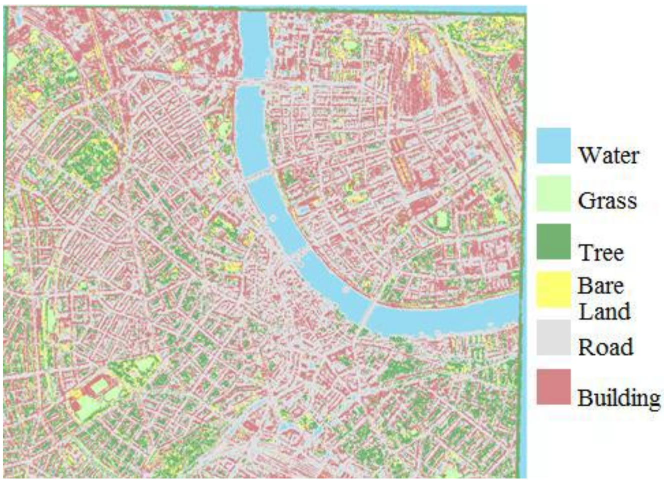
Step II is preparation of a point vector layer to test the classification accuracies by using GIS software. 330 points which are proportional to the each LULC class, are generated manually.

In **Step III** Due to dense build-up area concentration of the study area **Gabor filters** providing good information about man-made linear objects are added as additional image bands to the multispectral data.

In **Step IV**, training data for the LULC classes are obtained to be used in **SVM**. Visual investigation of the VHR data indicates that the study area contains building roofs with various roof material in grey, blue, white color as well as brick roofs. Hence training set is established for **classes of road, water, grass, tree, bare land and four different roof types**.

After collection of the training data **Step V**, classification is performed by using Support Vector Machine (SVM) classification tool of the ENVI.

Collection of the training data is carried out by using region of interest (RoI) tool of the ENVI.



LULC classification for Basel study area

Step VI - the quality of the final LULC classification product is evaluated by using accuracy measures of separation index, producer's accuracy, user's accuracy, overall accuracy and kappa coefficient.

Get to know GEOURBAN WP5 activity

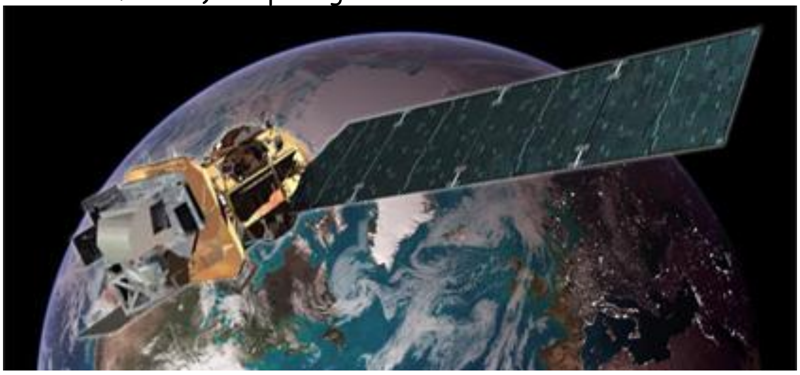
WP5 includes the local and regional applications in GEOURBAN case studies.
WP5 represents a unique attempt to collect and to analyse an integrated EO dataset suitable for the evaluation of a subset of the EO-based indicators developed in WP3. State of the art methods are used to derive specific products from raw EO datasets. In case of regional scale where EO derived products are already available online (i.e. MODIS Level 2 products) these products are directly used. The output of this WP is a set of products to be used as inputs for indicator evaluation and a report on both the techniques used to derive these products from raw EO data and the location of the online available EO-derived products.
WP5 also involves the description of the Earth Observation Products Database for GEOURBAN case studies. The ability to design associated applications is critical to the success of the database.

The HR-LR EO Data Analysis Protocol

HR-LR EO Data Analysis Protocol is used to drive EO-based indicators from high resolution (HR) and low resolution (LR) images. The EO data and related products involve mainly the georeferenced EO satellite images and their processed outputs which are obtained by using various image processing algorithms. The processed images of EO data form the basis of indicators to be used in the GEOURBAN framework. These products are obtained for the case studies Basel, Tyumen and Tel Aviv according to available EO data in various spatial resolutions. Here are some HR-LR EO data sources:

Landsat TM, ETM+

The Landsat satellite series provides an invaluable inventory for monitoring the global land surface and its natural and human-induced landscape changes. The Landsat data archive at the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center holds an unequaled 40-year record of the Earth's surface and is freely available to users via the EarthExplorer or the Global Visualization Viewer (GloVis) web sites.
The Landsat Data Continuity Mission (LDCM) the long time series of LR Landsat data renamed to LANDSAT-8 on April 2013. The captured data is processed within several days and can easily be downloaded from the USGS GloVis Server. LANDSAT-8 provides more spectral bands and a higher radiometric resolution (12-bit instead of 8-bit) comparing to LANDSAT-7.



MODIS

The Moderate Resolution Imaging Spectroradiometer (MODIS) is a sensor on board the NASA Earth Observing System Terra and Aqua satellites. Both satellites are polar orbiting, covering the entire Earth's surface every 1 to 2 days, and crossing the equator at approximately 10:30 (Terra) and 13:30 (Aqua) local time.

Digital Terrain Model (DTM): SRTM

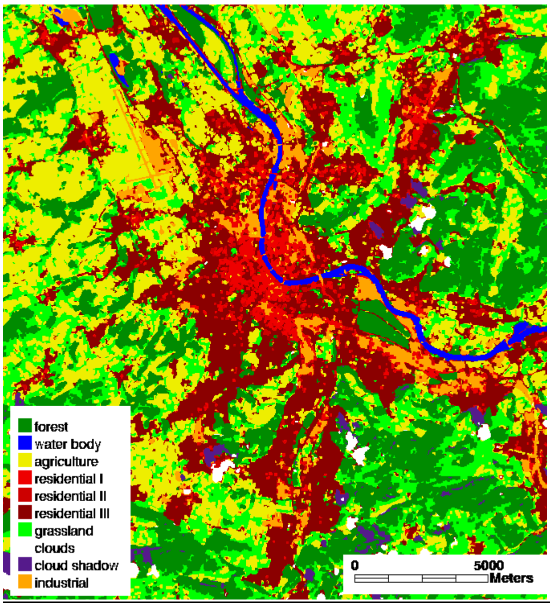
The Shuttle Radar Topography Mission (SRTM) from February 2000 generated the most complete HR- digital topographic database of Earth. The Digital Terrain Model for case studies Basel, Tel Aviv and Tyumen are used in GEOURBAN as provided by NASA's Jet Propulsion Laboratory (JPL) with no further processing.

The ASTER Global DEM (GDEM)

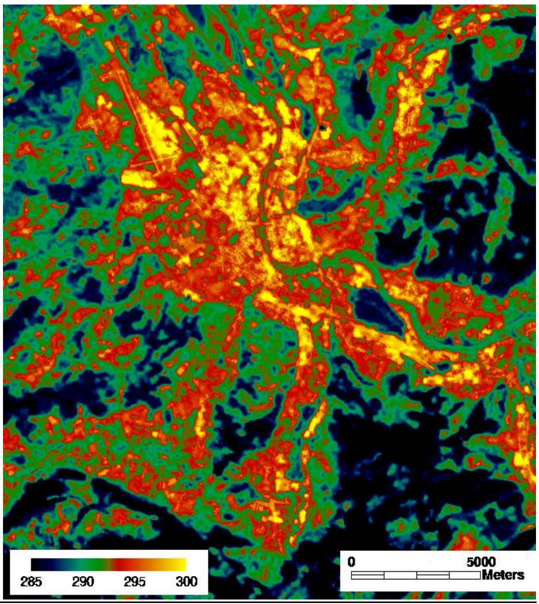
The most recent global DEM source is the **ASTER Global Digital Elevation Model (GDEM)**, released by Japan's Ministry of Economy, Trade and Industry (METI) and United States National Aeronautics and Space Administration (NASA) on June 29, 2009. GDEM is a global DEM generated using ASTER data, with 30 m posting

Landsat TM/ETM+ derived products

Land use/Land cover (LULC) is a key product in GEOURBAN. Several indicators (e.g. fractional land cover, land cover change, built-up density, etc.) rely on derivatives of LULC and thus their quality depends on the quality and accuracy of the LULC classification.



LULC product for the city of Basel



LST product derived from Landsat TM, Basel

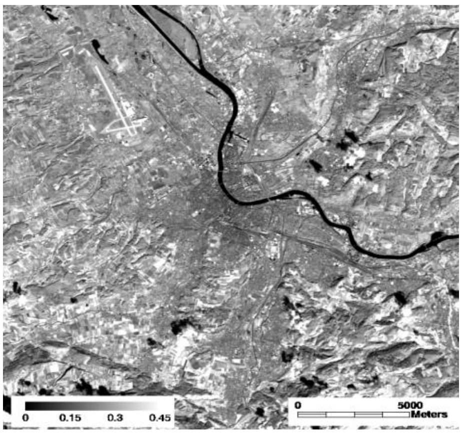
Land surface temperature (LST) and Land surface emissivity (LSE)

To retrieve LST from satellite thermal infrared observations (TIR), three main effects have to be considered and corrected for: angular, emissivity and atmospheric effects. The LST retrieval accuracy varies according to both the satellite view direction, resulting in longer path-lengths through the atmosphere and thus to higher atmospheric absorption.

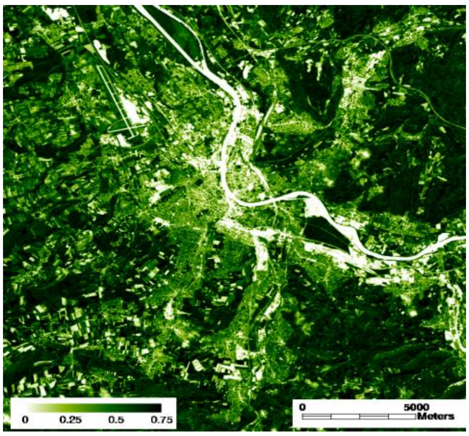
Broadband albedo

The urban land surface broadband albedo is an important variable in the radiation balance and has significant impacts on the urban energy balance. The "Cool Roofs Project" in the frame of the R20 Regions of climate action (www.regions20.org) and the propagation of "Cool Roofs" and "Cool Pavements" technologies by the U.S. Environmental Protection Agency (www.epa.gov) are illustrious examples on how the effect of shortwave broadband albedo is included in urban planning and urban heat island mitigation strategies, amongst many others.

Normalized Difference Vegetation Index (NDVI) values are, amongst other, necessary for the retrieval of Land surface emissivity (LSE). NDVI is a well-established index and widely used in numerous applications in the remote sensing community. It is basically calculated from red and near infrared bands, in the case of Landsat this conforms to TM/ETM+ bands 3 and 4, respectively.



Broadband albedo product, ,Basel



NDVI Product, Basel

Surface Temperatures derived from Satellite Imagery - Tel Aviv Case Study

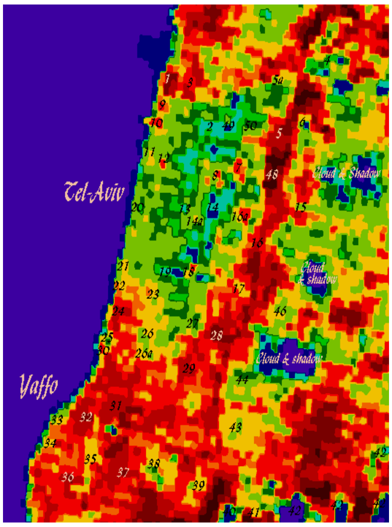
Abraham Tal, from A.TAL Satellite Imagery, has done comparative studies of the Urban Heat Island (UHI) phenomenon that arises from the essence of the process and the characteristics of urban development.

The thermal picture of Tel Aviv-Jaffa, as "seen" by processing the LANDSAT satellites' thermal band, shows some interesting thermal features of cooler and warmer parts of the city, constant in its distribution over 11 years and different seasons. From many studies of the UHI, it is quite clear that surface temperatures are influenced by:

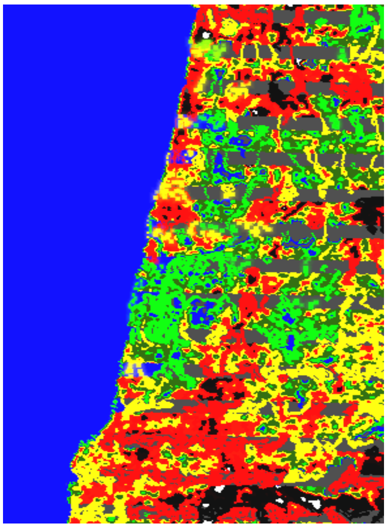
- Building density
- Construction materials
- Inter-building land-use (including parking lots)
- Vegetation, mainly trees
- Direction of main streets with relation to the dominant breeze direction
- Obstacles to the breeze
- Other factors such as human activities - transportation, industry, power production etc.

Based on different combinations and comparisons of different data sets sources, there seems to be little doubt that the dominant feature in lowering surface temperatures is the presence of trees. Even in more dense areas of the city, trees planted in the inter-building spaces are apparently responsible for a considerable reduction of the surface temperatures.

Preliminary Imagery Analyses of Landsat 5 imagery (from 2010) shows that in general, the Tel-Aviv Urban Heat Island layout remains unchanged. The relatively low resolution of the Landsat thermal band (120m on the TH instrument of LS5 and 60m on the ETM of LS7) does not enable to resolve discreet changes in small areas. Tel-Aviv has developed, especially during the past decade, with many high-rise buildings replacing old, dense neighborhoods. Further work is required to study in-depth, the changes in specific areas.



Tel-Aviv UHI - Landsat 5 11/8/1986



Tel-Aviv UHI - Landsat 7 10/08/2012

Third Basel CoP meeting

May 24, 2013, Palmrain, France.

The meeting took place at the headquarters of TEB (Trinationale Eurodistrict Basel)

Christine Griebel from the Department of Environmental Sciences Geography/Urban and Regional Studies presented results from a student course that was held during the last fall semester. In this course six LULC maps derived from Landsat-scenes (provided by UNIBAS) spanning the time frame from 1984 to 2011 were analyzed with focus on indicators "land cover change" and "settlement development". The analysis was done using the shape-files of community boundaries in the region under investigation (Upper Rhine Valley from Basel to north of Colmar) and the GIS-software ArcGIS.

An important result with respect to GEOURBAN was that LULC of peri-urban regions is crucial if used in LULC change studies and the boundary of settlements is difficult to define.

Christian Feigenwinter from UNIBAS presented the current version of GEOURBAN-WIS and reported about future implications. The GIS-group of TEB showed heavy interest in the GEOURBAN-WIS. Raised question was if it will be possible to include one's own data into the WIS. TEB will provide feedback to UNIBAS after the next WIS-update.

Get to know GEOURBAN WP6 activity

WP6 includes the investigation of the potential of future missions to support the GEOURBAN indicators and information system.
The characteristics of future missions capable of supporting urban planning and management are examined and their capability to provide inputs for the evaluation of the developed indicators is addressed. WP6 is focused on the following missions:

- **Sentinels 2 and 3** operated by ESA,
- **EnMAP** operated by DLR
- **HyspIRI** operated by NASA.

WP6 provides guidelines on how the EO data from future missions will be used to evaluate GEOURBAN indicators and suggests additional indicators that cannot be provided using current sensors data, but are likely to be evaluated by using future mission observations.

The output of WP6 is a report summarizing the above guidelines and describing any additional indicators.

WP6 continuously interacts with WP3 and provides input to WPs 7 and 9.

Future Missions for Urban-Remote-Sensing

Based on current and past EO-missions a wide variety of methods and applications have been developed to show their capability for urban analysis. The applications for urban mapping, change detection for urban sprawl analysis, risk and vulnerability analysis, energy-relevant questions or urban climate studies are mentioned as examples for the possible scientific directions.
Future missions will enlarge the capability for urban remote sensing to develop and provide relevant geoinformation products for monitoring. Future relevant missions will be the Sentinels 2 and 3 missions to be operated by ESA, EnMAP to be operated by DLR and HyspIRI to be operated by NASA. The following missions are presented which will allow continuing existing approaches or improve significantly the urban remote sensing research.

ESA Sentinel missions

ESA is developing five new missions called Sentinels specifically for the operational needs of the GMES programme.
The Sentinel-1 mission is a polar-orbiting satellite system for the continuation of Synthetic Aperture Radar (SAR) operational applications.
The Sentinel-2 mission is a super-spectral optical mission with a scheduled launch for the first satellite in 2014.

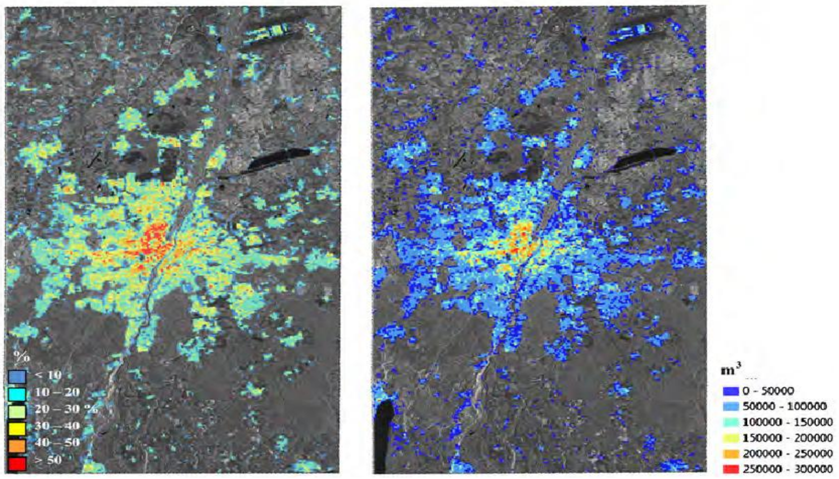
Multispectral missions

ALOS-3 is the follow-on JAXA optical satellite mission of ALOS/Daichi (launch Jan. 24, 2006), to complement the SAR services of the ALOS-2 mission (launch is planned for 2013).
The goal of the ALOS-3 mission is to provide operational support services in the following areas:

1. Disaster monitoring of stricken regions.
2. Continuous updating of national geographic information, including topographic maps, land use, and vegetation
3. Survey of crops and coastal fishing conditions
4. Environmental monitoring

Radar missions

The three-satellite configuration will provide complete coverage of Canada's land and oceans offering an average daily revisit, as well as daily access to 95% of the world to Canadian and International users. satellite launches planned for 2018

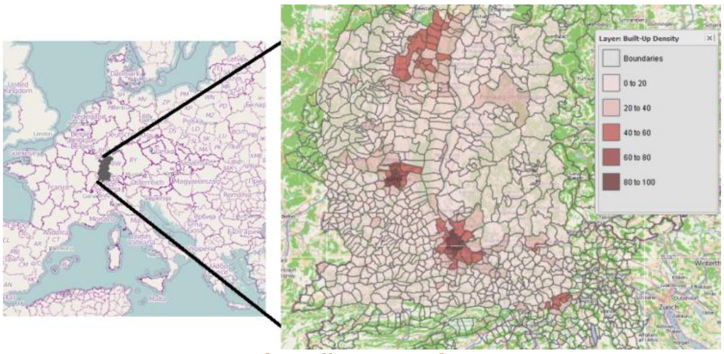


Building density and volume derived from TSX-stripmap data

The GEOURBAN EO-based Indicators

Urban indicators are powerful tools in describing urbanization process. Their great importance is based on the ability of easy and quick retrieval by earth observation data. Therefore, Remote Sensing becomes a unique source of information and methods. Urban management and planning requires tools for decision making support. Urban indicators become valuable means in planners' hands, because of their contribution to analyse and characterize urban form and shape, urban dynamics and microclimate.

An example of the urban indicators is the built-up density indicator that calculates the density of built-up areas including residential (high density-medium density-low density) and commercial/industrial. The required data for built-up density indicator is a LULC map and the political community boundaries.



Basel - Built-up Density map

The WIS brings new impressive capabilities

The Web-based Information System (WIS) reflects multidimensional nature of urban planning and management, as operationalized in intelligible indicators which are easily understood and applicable by a non-scientific public.

Thus, the main WIS's objective is to provide spatial data for end-users such as urban planners, architects and engineers by using web services. The first prototype of the GEOURBAN WIS was released at the beginning of 2013. A standard set of tools, enabling the user to manage map layers, changing scale and displaying object's attributes were included. The 1st WIS prototype provided three indicators layers of Built-Up Density, Open Space Density and Green Space Density that were evaluated for the Basel and Tyumen case studies.
The 2nd prototype was released on April. It includes additional data and capabilities such as raster Land Use\Land Cover (LULC) map, TerraSAR-X and RapidEye layers with Building Density and Imperviousness indicators as well as the use of Google satellite and Google hybrid.
The final WIS version is expected by the end of June. It will provide enhanced capabilities as well as integration spatial data required for the Tel Aviv case study.

About Air pollution and public health

The air pollution and the public health depend on emissions of industry, as well as traffic and domestic heating. Mitigation activities should be adopted for a sustainable management. Examples of related indicators:

Atmospheric Optical Thickness

AOT can be used to derive spatial distribution which in combination with population distribution and buildings structure is an estimation of exposure.

Surface Topography(DTM) and Buildings Structure(DSM)

DTM can represent terrain surface, while **DSM** takes into account terrain discontinuities, where man-made structures can be distinguished.

Population-Distribution is another urban indicator which influences air pollution. As the census interval is usually inadequate for urban planning the **integration of satellite images with census data** can improve the population estimation.

GEOURBAN meetings and demonstration events

Biannual GEOURBAN progress meetings are held to secure the highest level of information exchange among beneficiaries. Minutes of these meeting are prepared by the coordinator, sent to all beneficiaries by email and published on the GEOURBAN website. In addition, regular Skype meetings are organized among partners (or among Management Board or Steering Committee members) to discuss a particular subject or to exchange related information.

GEOURBAN demonstration events are organized in the framework of WP8. WEB-BASED INFORMATION SYSTEM demonstration and hands-on applications are taken place during these meetings,Pproviding the means to disseminate the GEOURBAN achievements to urban

Current Status and Upcoming events

Plenary Meetings:

The GEOURBAN Mid-term Meeting was held in Ankara on December 13-14, 2012.

The 2nd GEOURBAN Progress Meeting was held in Tel Aviv on June 27-28, 2013

Management Board (MB) Meetings

The 6th MB Meeting was held in Ankara, December 14, 2012.

The 7th MB Meeting was held on Skype, March 1, 2013.

The 8th MB Meeting was held on Skype, May 17, 2013.

The 9th MB Meeting was held in Tel Aviv, June 28, 2013.

Community of Practice (CoP) Meetings:

Basel CoP Meeting was held in Basel on April 25, 2012.

Tel-Aviv CoP Meeting was held in Tel-Aviv on May 16, 2012.

Tyumen CoP Meeting was held in Tyumen on July 23, 2012.

The 3rd Basel CoP meeting was held in Palmrain, France on May 24, 2013.

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New Publications

N. Chrysoulakis, T. Esch, E. Parlow, S. H. Duzgun, A. Tal, A. Sazonova, C. Feigenwinter, D. Triantakonstantis, M. Marconcini and M. Cavour, 2013. "The role of Earth Observation in sustainable urban planning and management: the GEOURBAN project". 1st International Conference on Remote Sensing and Geoinformation of Environment. RSCy 2013, Pafos, Cyprus, 8-10 April.

Esch, T., Taubenbock, H., Chrysoulakis, N., Duzgun, H. S., Tal, A., Feigenwinter, C. and Parlow, E., 2013. Exploiting Earth Observation in Sustainable Urban Planning and Management - the GEOURBAN Project. Joint Urban Remote Sensing Event JURSE 2013, Sao Paulo, Brazil, 21-23 April.

Nektarios Chrysoulakis, Dimitrios Triantakonstantis, Thomas Esch, Mattia Marconcini, Eberhard Parlow, Christian Feigenwinter, Sebnem H. Düzgün, Mahmut Kavour, Abraham Tal, Anna Sazonova, 2013. " The role of Earth Observation in sustainable urban planning and management: the GEOURBAN approach ". Urban planning management Journal, Issue 1 (quarterly in Russia, Thematically for state and municipality specialists in urban planning and GIS)

Marconcini, M., Thomas, E., Chrysoulakis, N., Düzgün, H. S., Tal, A., Feigenwinter, C. and Parlow, E., 2013. Towards EO-based sustainable urban planning and management. In Proceeding of IEEE International Geosciences and Remote Sensing Symposium (IGARSS 2013), to be held in Melbourne on 21 - 26 July 2013.

N. Benas, N. Chrysoulakis, G. Giannakopoulou., 2013 Validation of MERIS/AATSR synergy algorithm for aerosol retrieval against globally distributed AERONET observations and comparison with MODIS aerosol product. Atmospheric Research 132-133, pp. 103-113.

N. Chrysoulakis, C. Feigenwinter, D. Triantakonstantis, I. Penyevskiy, A. Tal, E. Parlow, G. Fleishman, S. Düzgün and Th. Esch, 2013. "A conceptual framework of urban indicators based on earth observation". Submitted in Habitat International Journal.

http://geourban-fp7-eranet.com/

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