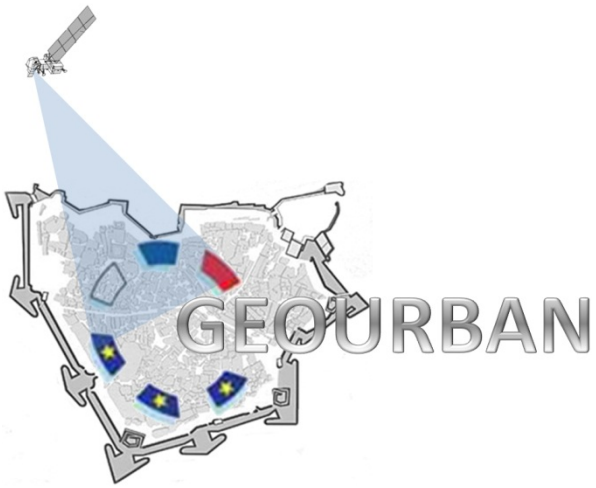
SEVENTH FRAMEWORK PROGRAMME

CAPACITIES - ERA.Net RUS: Linking Russia to the ERA

Contract for: **Innovation Project**

D.8 Demonstration Proceedings



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1. WORKPACKAGE OVERVIEW

WP8 leaded the efforts related to Community Of Practice (CoP) involvement, demonstration of the GEOURBAN results and managing the feedback received from the end-users in regards to the applicability, usefulness and potential impact of the GEOURBAN Web Information System (WIS). The work was focused on organizing In Basel, a major event in terms of an umbrella CoP. During this event the final version of the GEOURBAN WIS prototype was demonstrated. This document discribes the demonstration proceedings, as well as provides urban planning guidelines based on the application of the system in GEOURBAN case study cities.

The project was done in cooperation of the local Authorities in **Tyumen**, **Tel-Aviv** and **Basel** and their respective agencies. Thus the project findings will be shared with local stake holders and integrated into respective urban land management processes. GEOURBAN data analysis methods were translated into **user-friendly guidelines** in order to guarantee the traceability and independent applicability.

The Demonstration event was organized within the framework of **WP8** and thus, it is described in **this document**. Information system's demonstration and hands-on applications has been taken place during this event, providing the means to disseminate the GEOURBAN achievements to the project participants, some of the urban planners and local/regional Authorities.

On the one hand, the results help represent the ecological and socioeconomic constraints based on urban vulnerability profiles which rely on indicator based approaches, consequently allowing the composition of a **monitoring system**. On the other hand, the results should help **to understand the gaps** and **needs** for the development of adequate adaptation strategies within a city. The developed methods and findings, also in regard to the **new EO technologies**, could be transferable to any other region.

The **adaptation** of the system to **future missions** was also addressed in the meetings and it is expected that a fully operational tool can be developed in the future. New services based on the GEOURBAN pre-operational information system could be developed for the urban planning and management community, as this system prototype will be available for GEOURBAN partners' future developments.

1.1. Purpose of the document

The purpose of this document is to describe the WP8 activities and results. The WIS demostreation event is reviewd in addition to reviewing the feedback received from the end-users in regards to the GEOURBAN WIS. The main purpose is to provide sustainable urban planning guidelines in light of the demonstrated WIS indicators as well as the feedback received from Urban Planners and other end-users.

1.2. Document references

- The Web Information System DEVELOPMENT, A. Sazonova (2013)
- EO-based Indicators Development, D. Triantakonstantis (2013)
- Urban planning requirements relative to EO, C. Feigenwinter (2013)
- Exploiting Earth Observation in Sustainable Urban Planning and Management - the GEOURBAN Partners (2013)

2. Sustainable urban planning requirements

2.1. General Planning Requirements

Urbanization is the defining global phenomenon of this century. For the first time in history, more than half the world's population lives in urban areas. Between 2000 and 2030, in developing countries, the urban population is expected to double, and entire built-up areas are projected to triple if current trends continue. This rapid demographic and spatial transformation may prove to be difficult for cities in developing countries, especially small- and medium-sized cities, where capacity is typically inadequate to cope with major urban challenges. These challenges include environmental effects like climate change, resource scarcity, as well as slum growth and increased poverty, and safety and security concerns.

GEOURBAN is based on research and publications covering the required modern attitude and tools. According to *the Global Planners Network* (http://www.globalplannersnetwork.org) the principles of New Urban Planning are:

- Promote sustainable development
- Achieve integrated planning
- Integrate plans with budgets
- Plan with partners and stakeholders
- Meet the subsidiary principles
- Promote market responsiveness
- Ensure access to land
- Develop appropriate planning tools
- Be pro-poor and inclusive
- Recognize cultural diversity

Agenda 21, established at the 1992 United Nations Conference on Environment and Development, or "Earth Summit", in Rio de Janeiro, Brazil, is considered to be the blueprint for sustainability in the 21st century. The Rio Summit, with its Agenda 21 Principles for Action, has inspired urban planners and the Local Agenda 21 (LA21) movement. According to the Global Development Research Centre (http://www.gdrc.org) there are six key elements of a LA21:

1. **Managing and improving the local authority's own environmental performance** through corporate commitment, staff training and awareness raising, implementation of environmental management systems and environmental budgeting, and policy integration across sectors.
2. **Integrating sustainable development aims into the local authority's policies and activities** through land use planning, transport policies and programmes, tourism and visitor strategies, health strategies, and welfare, equal opportunities and poverty strategies.
3. **Awareness raising and education**, supporting for environmental education, promoting awareness-raising events, supporting for voluntary groups, publication of local information and press releases, and promoting initiatives to encourage behaviour change and practical action.

4. **Consulting and involving the general public** trough public consultation processes, forums, focus groups and feedback mechanisms.
5. **Partnerships promotion** through meetings, workshops and conferences, working and advisory groups, Rounds Tables, developing partnerships and support.
6. **Measuring monitoring and reporting** on progress towards sustainability through environmental monitoring, local state of the environment reporting, sustainability indicators and targets, Environmental Impact Assessment (EIA), and Strategic Environmental Assessment (SEA)

2.2. Guidelines for sustainable urban planning

Sustainable planning is a dynamic and continuous improvement proces that should be implemented step by step as follows:

1. Definition of a shared vision (long term strategy) for the city, the more this vision is shared by all parties of the urban society, the greater the possibility of implementation;
2. Identification of the current state of the city, main problems and advantages;
3. Establishment of a discussion forum involving inhabitants, stakeholders and institutions in order to define clearly city needs and priorities, the interventions areas and specific strategies to be adopted;
4. Definition of intervention planning alternatives according to specific strategies adopted;
5. Assessment of planning alternatives through the use of an information or support system);
6. Development of an intervention plan focused on the best planning alternative, including objectives, targets, policies and measures, monitoring tools and appropriate evaluation indicators, financial support and time schedule, people and institutions involved, its role and commitment in the process;
7. Implementation of policies and measures;
8. Continuous monitoring and data collection;
9. Evaluation of results through periodic survey, analysis of indicators and update the state of the art on most eco-efficient technology and management tools; the discussion forum should be involved in this process;
10. Review of the intervention plan.

2.3. GEOURBAN Indicators - contribution to sustainable urban planning requirements

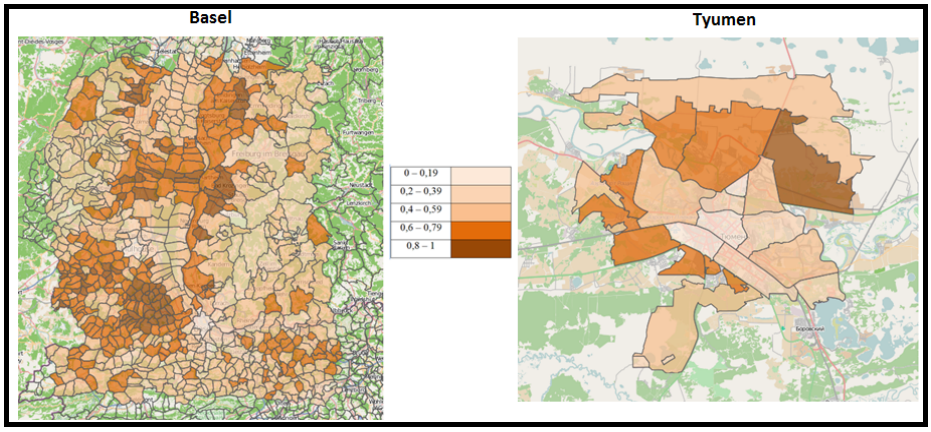
GEOURBAN EO based urban indicators are powerful tools in describing urbanization process. They belong to a wider category, the Urban Sustainability Indicators that enable to learn and understand the urban sustainability performance within the environmental, social and economic framework.
The great importance of EO urban indicators is based on the ability of easy and quick retrieval by EO data. Therefore, Remote Sensing becomes a unique source of information and methods.

Urban management and planning requires tools for decision making support. Indicators become valuable means in planners' hands, because of their contribution to analyse and characterize urban form and shape, urban dynamics and urban microclimate.
The method of generating indicators within the GEOURBAN framework of is based on EO data –> products –> indicators schema. Thus, for example, raw satellite observations to generate Land Cover maps are used. Land Cover is the respective EO-derived product, which is further used to generate indicators. For example, the WIS indicator Building Density is derived from Land Cover, by calculating the proportion of the built up areas compared to the total area within specific administrative boundaries. The GEOURBAN Indicators are categorized as follows:

Surface Structure Indicators - extracted from EO products using administrative political community boundaries, or user-defined boundaries (polygons). The value of each indicator is estimated using a dedicated formula within each polygon. The Indicators in this category are:

Density indicators

The **Built-up density** is the proportion of built-up areas within the polygon boundary. **Open Space Density (OSD)** is calculated as the ratio between the pixels of open spaces and the total number of pixels within the political community boundaries. **Green Space Density (GSD)** is the ratio between the number of pixels of green spaces (forest and grassland) and the total number of pixels within the political community boundary.



Open Space Density (OSD) for Basel and Tyumen

Diversity indicators

The **Class Richness Density (CRD)** is a measure of richness of different land cover classes within administrative boundaries. The **Ecological Effectiveness Ratio (EER)** is the ratio of the ecologically effective surface area to the total land area. The ecologically effective surface area is the result of combining the areas of different ecological parts of the study area, where for each part a weight is suitably assigned.

Area / Edge indicators

The Edge Density of a class within administrative boundaries is calculated as the total length of the edge of patches divided by total area of administrative boundaries.

Ratio indicators

Imperviousness Open space Ratio (IOR) is an urban indicator which combines the built up density indicator with open space density indicator. The **Imperviousness Green space Ratio (IGR)** is a comparison of impervious and green areas exist within an administrative boundary.

Surface Type Indicators - consist of the following indicators:

- Land Cover
- Imperviousness
- Fractional Land Cover
- Surface Albedo and Surface emissivity

Urban Sprawl Indicators - Urbanization usually leads to an undesirable growth, called urban sprawl. The reduction of urban sprawl not necessarily implies reduction of urban expansion, but rather becomes more functional.

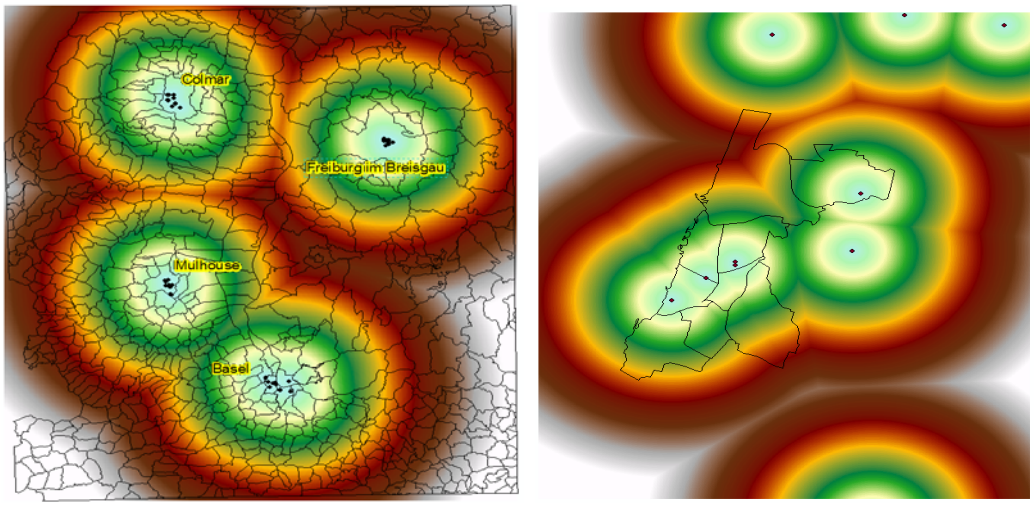
The GEOURBAN urban sprawl indicators are:

- **Urban Fringe** - is defined as 30-50% built up neighbourhoods.
- **Scatter Development** - less than 30% built up neighbourhoods.
- **Change Detection** - the process of identify the differences of a phenomenon is taken place within a time interval.

Urban Environmental Quality Indicators:

- **Surface Urban Heat Island (SUHI) intensity** - describes the difference in surface temperature between a conurbation and the surrounding rural area.
- **Aerosol Optical Thickness (AOT)** - is an important aerosol parameter estimated using low spatial resolution satellite observation (MODIS). Within GEOURBAN framework we use the MODIS AOT product daily available at 10 km × 10 km.

Vulnerability to Natural Hazards Indicators - The vulnerability to natural hazards should be carefully assessed. Droughts, floods, earthquakes and other natural hazards have become frequent and therefore, **disaster response** plays an important role in case of emergency. **Distance to critical services** is vulnerability indicator that was used in GEOURBAN.



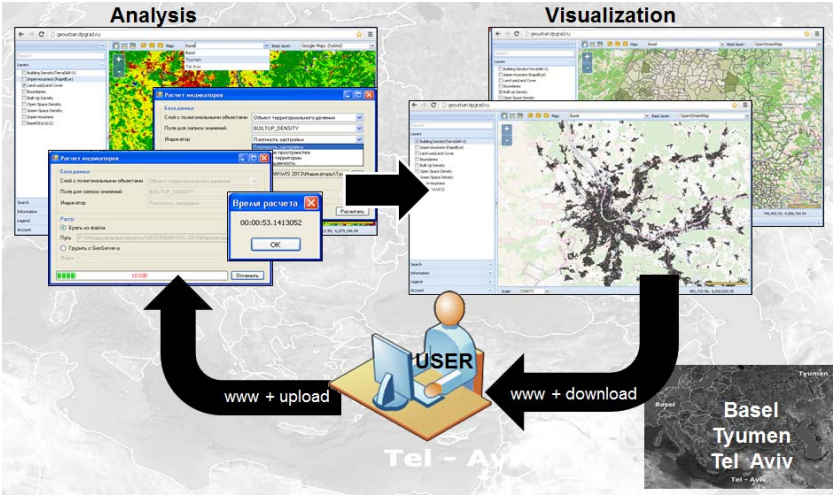
Distance to Critical Services(hospitals) in Basel and Tel Aviv.

3. The GEOURBAN Web Information System (WIS)

The GEOURBAN WIS reflects multidimensional nature of urban planning and management, as operationalized in intelligible indicators which are easily understood and applicable by the non-experts. It was developed in the framework of WP7 activities with support of all GEOURBAN consortia partners. The WIS is a fully dynamic system exploiting all internet capabilities and the “open layers” availability. The user solely needs a web-browser and internet connection to access the WIS.

It provides analysis and visualization capabilities of GEOURBAN indicators, such as Built-Up Density, Open Space Density, Green Space Density, Building Density and Imperviousness which are evaluated for Basel, Tel Aviv and Tyumen case studies.

The indicators evaluation algorithms implemented as a fixed set of base mathematical operation with raster input data such as Land Cover. OpenStreetMap was used as basic layer.
Following is a WIS Operational Schema:



Major WIS Functionality Includes:

- Objects searching
- View object’s attributes
- Manage map’s (layer) scale and displayed area
- Hide/Show layers
- Distance Measure
- Area size evaluation
- Create objects like point, line or polygon
- Layers Management (Admin. Only)
- Raster / Vector downloading and uploading (Admin. Only)
- Online Indicators evaluation

All WIS data is based on Mercator map projection. Interactive web maps are using "Spherical Mercator" system based on Mercator projection over a sphere.

The WIS vector-based indicators are evaluated using administrative political community boundaries. The value of each indicator is estimated using an appropriate formula within each polygon of political community boundaries. Following maps and indicators are currently available for Basel, Tyumen, Tel-Aviv Maps (Datasets):

Map / Indicator	Basel	Tyumen	Tel-Aviv
Building Density (TerraSAR-X)	✓	✓	✓
Imperviousness (Rapid Eye)	✓	✓	✓
Land Cover (Landsat)	✓	✓	
Distance to critical services	✓		✓
Built-Up Density	✓	✓	✓
Open Space Density	✓	✓	✓
Green Space Density	✓	✓	✓
Fractional Vegetation Cover		✓	
Fractional Imperviousness		✓	
Change Detection		✓	
Urban Surface Heat Island			✓

The WIS provides two methods of generating Indicators

1. Using fixed layer with boundaries.
2. User-defined Areas of Interest using polygons.

WIS can be easily transferable to any city and thus, the WIS Administrator is equipped with a set of tools to define new layers, boundaries and add raw EO data maps.

The WIS is accessible at the URL: www.geourban-fp7-eranet.com/links/GEOURBAN WIS

4. WIS demonstration event and feedback

The demonstration event provided the means to disseminate the GEOURBAN achievements to urban planners and local/regional authorities. The application of the WIS prototype for different case study cities demonstrated as well as hands-on operation tested during this event.
Users' feedback is important to address the requirements for adapting the system in future missions. Thus, the goal was to get feedback from the end-users regarding the applicability, usefulness and potential impact of the GEOURBAN WIS.

Demonstration of the GEOURBAN WIS system prototype functionality was presented by GRADI. Following indicators delivered by the WIS were demonstrated:

- Urban Surface Structure Indicators
- Urban Surface Type Indicators
- Urban Sprawl Indicators
- Urban Environmental Quality Indicators
- Surface Urban Heat Island intensity
- Vulnerability to Natural Hazards Indicators
- Distance to critical services

Among others, SIGRS - GISOR (Geographic Information System of the Upper Rhine) provided important feedback for further development of the WIS. In addition users' needs and valuable comments regarding the functionality were introduced by TEB, describing the following main needs:

- Additional city districts, not just Basel.
- Additional political administrative boundaries.
- Use of high resolution based on required accuracy. Additional data input (e.g. census data), which is then displayed for community level, user layers.

The most important comments agreed to be implemented in WIS by GRADI. Additional comments and user needs will be addressed by the consortium in the framework of future projects.

5. Demonstration event summary and guidelines

The **main project achievements** were summarized as:

- User requirements capture.
- Urban environmental indicators selection.
- VHR methodology specification and data processing.
- HR/LH methodology specification and data processing.
- Web-site, Newsletters.
- GEORBAN WIS release
- Presentation in conferences, journal articles submission.

The main **EO products evaluated**: DEM/DSM, Land use and cover, Fractional land cover Buildings height and density, Albedo, Emissivity, LST, AOT

The vision: towards an operational tool
GEOURBAN WIS has the potential to lead to new services since it will be easily transferable to any city. Beyond the GEOURBAN project, the consortium may further exploit the prototype by updating it with new processing modules and by adapting it to future missions (i.e. Sentinels, EnMAP, HyspIRI, etc.). A fully operational tool can be therefore developed, provided that EO data at the requested spatial and temporal scales are available.

Basel regional GIS and planning institutions objectives and the different working experts groups work process and needs were presented and explained by ***SIGRS - GISOR***. Following are some important feedbacks for further possible customers' needs to influence WIS development decisions:

- Environmental damages
- pollution
- high risk chemical or other industrial companies
- community scale parameters
- connection to census data

EO potential in urban planning and possible future needs were introduced by DLR. The future potential needs estimated as:
Regional focus - Mapping of settlement pattern, Urban land consumption, Soil sealing, Climate-relevant variables, Land Surface Temperature, Built-up extent
Local focus - Land Use/Land Cover, Estimation of population distribution, Change mapping, Urban micro-climate analysis, Modelling of district heating potential

Following are some conclusions based on GEOURBAN studies:
Remote sensing to meet Urban Planning needs

- Common understanding, vision of goals and implementation strategies required.
- Diversity of end-users, user requirements, data availabilities, legal frame conditions and local planning systems.

- Applicable concepts and instruments like WIS indicator on line extraction.
- Multi-disciplinary, synchronized approaches.
- Simple and user-oriented tools (as WIS user interface).

Role of Remote Sensing as input for WIS indicators extraction

- Provision of digital geo-information (on-demand, GIS-ready).
- Flexible and harmonic data source (independent; spatially, temporally and thematically adaptive).
- Automated procedure ensures cost-efficiency.

Micro-scale applications with VHR (e.g. Ikonos/Quickbird/WorldView, RapidEye Terrasar-X) satellite data in GEOURBAN case studies were discussed by KUZGUN:

- EO products from VHR (e.g. Ikonos/Quickbird/WorldView type) satellite data for GEOURBAN case studies for Basel, Tel-Aviv and Tyumen are used in WIS.
- Case Studies include also development EO Data Analysis Protocol and EO (VHR) Product Database

The results of VHR EO Data analyses for GEOURBAN case studies form one of the main WIS inputs. The results indicate that there is a high potential of these products to be used for LULC maps as well as urban impervious layer maps. The new EO data types to be available in near future will provide opportunities to derive more indicators

Demonstration of the GEOURBAN WIS functionality was presented by GRADI.
Following indicators maps delivery by the WIS were demonstrated:

- **Urban Surface Structure Indicators**
  - Density indicators (Built-up Density, TerraSAR-X building density, Green Space Density, Open Space Density)
- **Urban Surface Type Indicators**
  - Land Cover
  - Imperviousness
  - Fractional Land Cover
- **Urban Sprawl Indicators**
  - Change Detection
- **Urban Environmental Quality Indicators**
  - Surface Urban Heat Island (SUHI)
- **Vulnerability to Natural Hazards Indicators**
  - Vulnerability to Natural Hazards
  - Accessibility to critical services (hospitals) in Basel and Tel Aviv

Some additional futures proposed for WIS development directions:

- moving objects detection like patterns of common illegal car parking areas
- cadastral data registered for property monitoring
- illegal building changes detection
- illegal unregistered heat pipes

- agriculture analysis corps monitoring
- property and the cost of land

GEOURBAN results implementation plan issues were discussed between the Industrial partners GARD, KUZGUN and GRADI. Initial proposal for implementation and exploitation of GEOURBAN project results was introduced to consortium by KUZGUN. The future explotation was further discussed between Industrial /Comercial partners. GARD and GRADI will add their inputs to the Technology implementation plan document.

It was agreed that GRADI will send the sources to GARD and KUZGUN for language translation and local implementation in their countries. The WIS prototype software code possible future local adaptations and translations discussed between partners.

Finally, a GEOURBAN follow-up in the framework of ERA.Net-RUS Plus was discussed. Each of the partners expressed his opinions about possibilities of the future projects directions. Real requests from users-customers are important thus, it is recommended to strongly involve end-users, in future projects, from the beginning.