Monitoring Urbanization in Latin American Metropolitan Areas
Understanding the Urban Story

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Background

The use of Earth Observation (EO) services is on the rise, but not yet appropriately applied to the planning & industrial sectors. ESA took the opportunity to finance pilot projects following key aspects of World Bank topics within Value Adding Element EOworld2, designed to set-up EO services, ***following thematic requirements of World Bank staff***. Planning activities, construction, appropriate management of investments & administrative services combined with broader modelling of potential future development requires detailed spatial information. Fast urban growth requires services covering large areas at reasonable costs combined with high thematic depth.

The pilot project was set up to find tailored solutions to support these essential needs by generating up-to-date, detailed urban land use maps & land use change analysis. The services were prepared and optimized in close co-operation with World Bank and local stake holders in order to identify real needs, prepare solutions ready to be implemented in their modeling and evaluation processes. Multi-temporal Copernicus Urban Atlas logic was transferred onto the metropolitan areas of Bogota, Quito and Lima.

http://www.mtritter.org/travel/Bolivia_Paraguay_Uruguay/slides/DSC_3004.JPG

Conclusion

The importance of a wider ***subdivision of urban structures*** became obvious in context with statistic modelling approaches. In general, statistical inquiries refer to administrative units, to previous years or show other broader reference. Resulting average values display distributions independent from real situation on ground (land cover and natural restrictions). This often prepares the ground for misinterpreting the situation on-site.

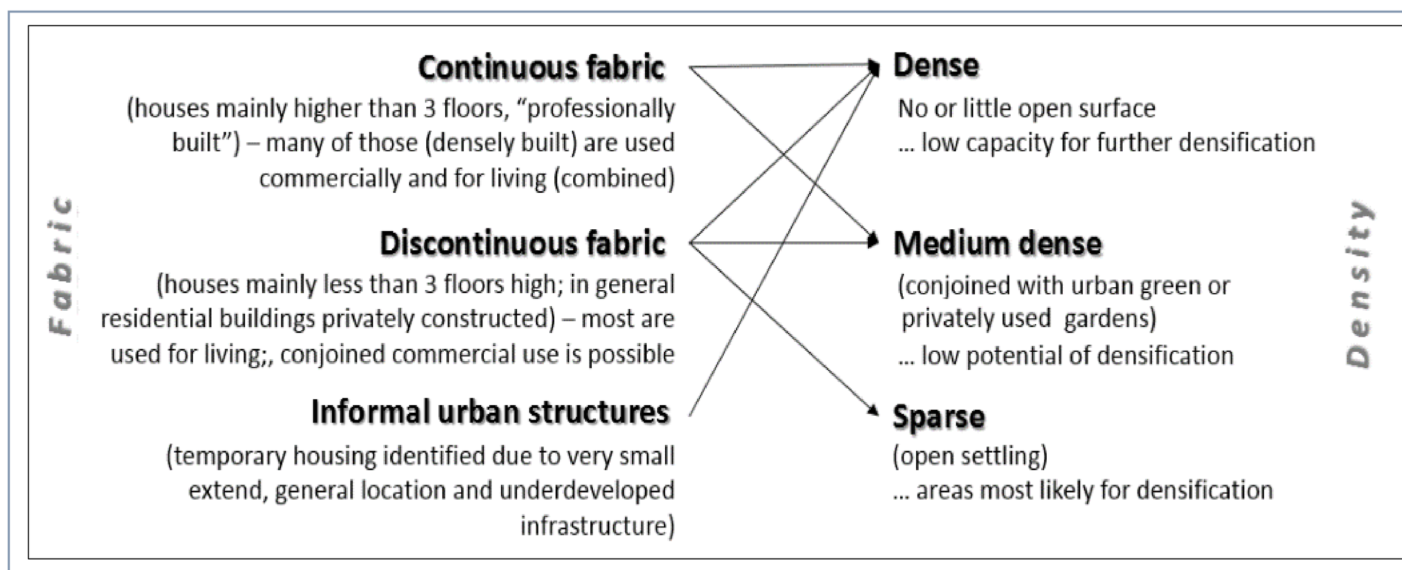
The ***Urban Baseline Services***, prepared within EOworld2 showed, how the analysis process can be supported as a cost effective and suitable basis for derivation of information at suitable reference and of new kind.

Geodata and change analysis of 2000 / 2013 was prepared and visualized to standardized statistic summaries, visualizing the changes. In correlation to in-house statistical appraisals a number of downstream applications were prepared, considering e.g. socio-economic data and terrain information in order to raise the awareness of potentials that are not obvious at first sight.

The availability of free EO data of the Sentinel fleet in combination with Urban Atlas will provide the opportunity to become an essential segment in the planning and management process towards direct monitoring prior changes and making urban areas more resilient.

Urban Services

The Urban Mapping Service, prepared within the EOworld2 Pilot Project, distinguishes between up to ***18 classes related to urban***. It corresponds to Copernicus ***Urban Atlas*** and is in line with CORINE, focusing on urban and simplifying natural and semi-natural areas.



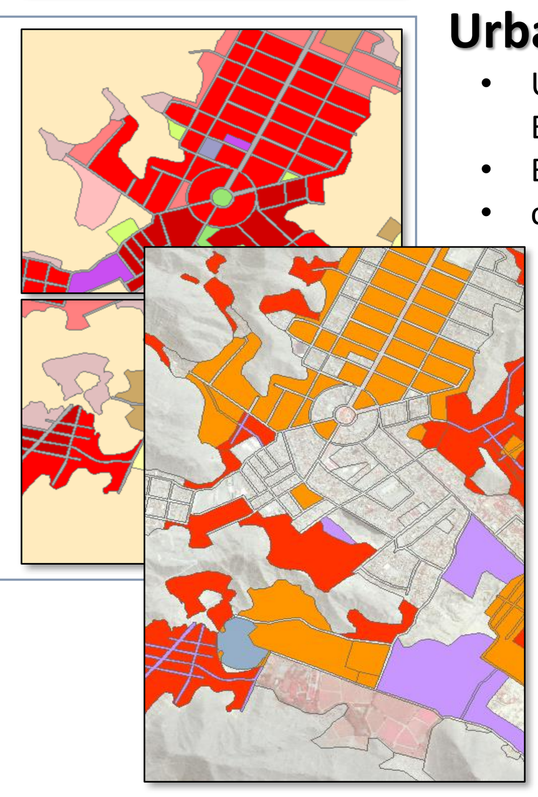
The mapping is comparable to 1:25,000 and better. Urban structures separate by density & building height as basic component for a ***transferable nomenclature applicable worldwide*** suitable for medium scale downstream analysis with different history of development due to geographical, natural and/ or political circumstances. The Urban Service was prepared for 2013 (SPOT6 data/ 1.5m) and transferred towards 2000 (SPOT4/ 5, Landsat/ 2.5-15m) following a (backdating) approach combining manual and automated object-based image analysis (OBIA) reaching ***thematic accuracy of 96%***. Changes were identified, summarized, presented as GIS layers and in statistical context*.

Urban green acts as substantial indicator for climatic aspects or for ***quality of living***. Protecting those and monitoring changes becomes an important issue. Sensibility related to environmental analysis arises (urban climate, water economy). Often quality of related information is rare. A detailed vegetation layer was calculated using advanced technologies, separating low and elevated vegetation ready for downstream GIS analysis or direct usage (identification of ***vegetation corridors***, green hot-spots important for urban climate, protection and/ or further development).

**Reference: EEA Land and Ecosystem Accounting (LEAC) based on CORINE land cover changes database (1990-2000)*
http://www.eea.europa.eu/themes/data-and-maps/data/land-cover-accounts-leac-based-on-corine-land-cover-changes-database-1990-2000

Transportation Network 2013

- Fast transit road, Other roads, Railroad
- Roads MMU 10m (buffering in 3m intervals)
- Focus is set on spatial analysis of the entire metropolitan area, therefore transportation is mapped as area feature

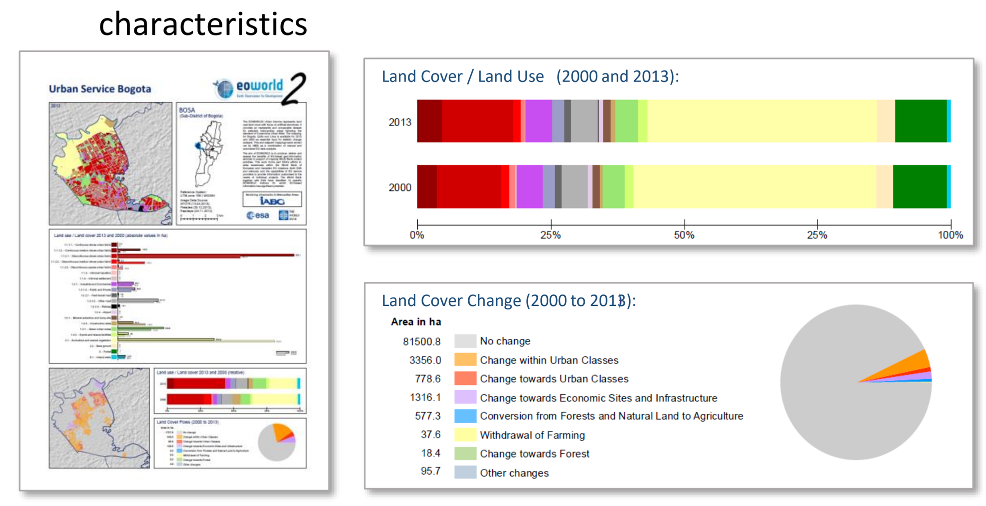


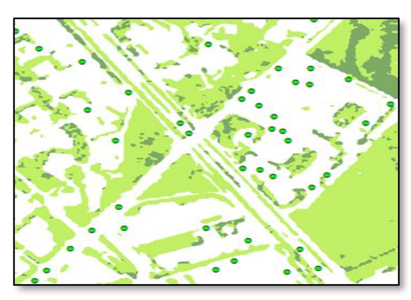
Urban Service 2013 and 2000

- Urban Atlas Standard (MMU 0.25/ 1ha), geometry compatible to Google Maps/ ESRI Basemap, thematic accuracy > 96%, 71,800 polygons
- Backdating approach: (1) mapping 2013, (2) mapping 2000 (considering 2013)
- containing 18 urban and five non-urban classes

⇨ Urban Change Layer & Statistics

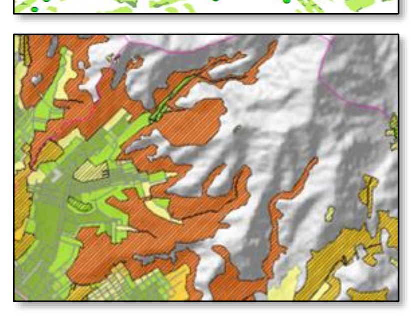
- Detailed change types as well as grouped into main change characteristics





Urban Vegetation Layer

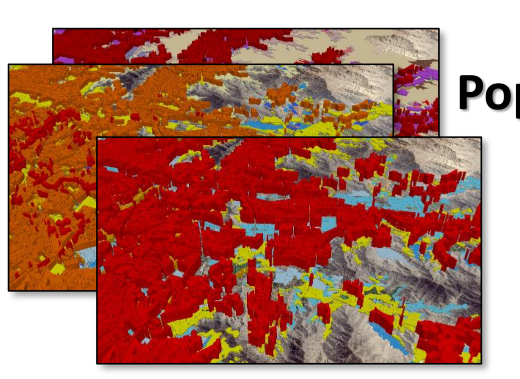
- Low and high vegetation (MMU 0.1ha), significant single trees
- Automatic analysis, also applicable to other features (e.g. informal, construction)
- Input for regional analysis (vegetation corridors for climate issues, change analysis of urban green to identify socio-economic conversion or commercial activities, …)



Terrain Analysis

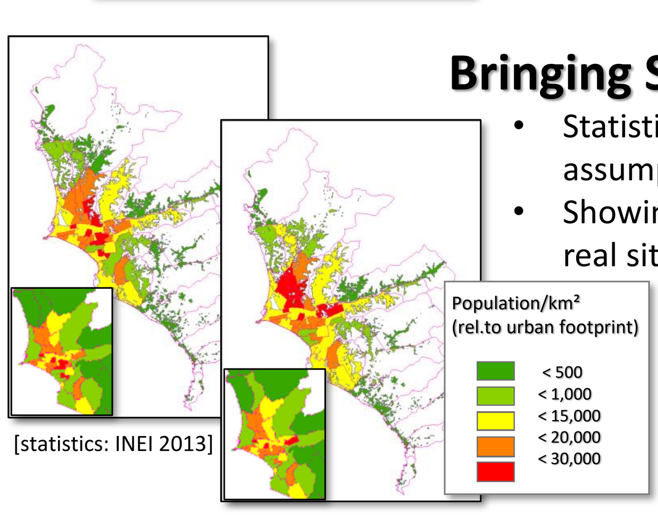
- Considering Urban Mapping Service(s)
- Identification of areas under prior changes for risk identification issues (land slides), natural protection issues (destructive competition), or calculation of natural drainage flow (risk prevention), urban climate issues (emission/ air pollution/ urban heat islands …)

Combining EO Services with Statistics



Population Distribution (day/ night)

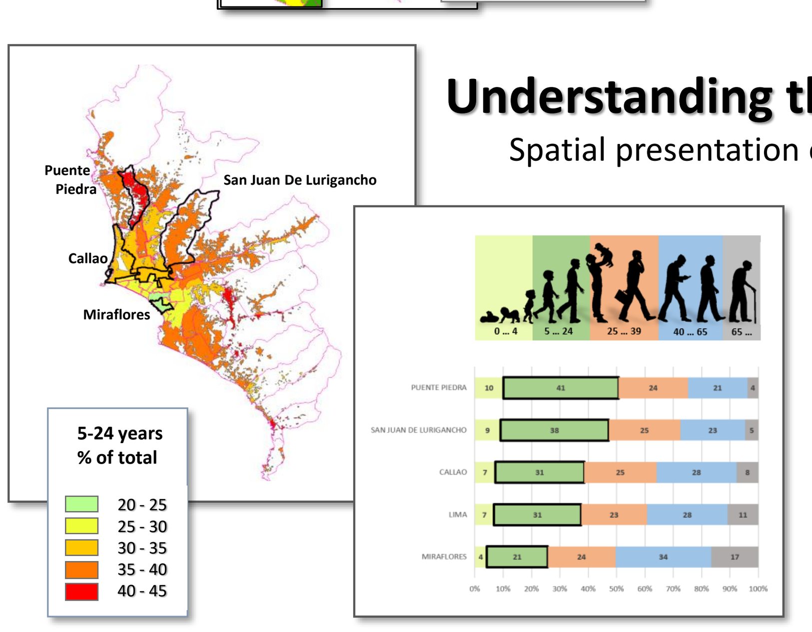
- Combination of Urban Service 2013 and population values (administrative units and/ or building blocks)
- As support for optimization and planning processes for infrastructure and supply issues (public transport, goods, health and security, risk prevention and management, …)



[statistics: INEI 2013]

Bringing Statistics to the Urban Footprint

- Statistics are often related to administrative units or correspond to general assumptions (e.g. average space for living per person, …)
- Showing these statistics related to administrative units often falsifies the real situation
  - → Extrapolating out-of-date statistics onto new situation (land cover)
  - → Representing and valuing the statistics and changes with regard to real situation
  - → Extrapolating future scenarios and numbers



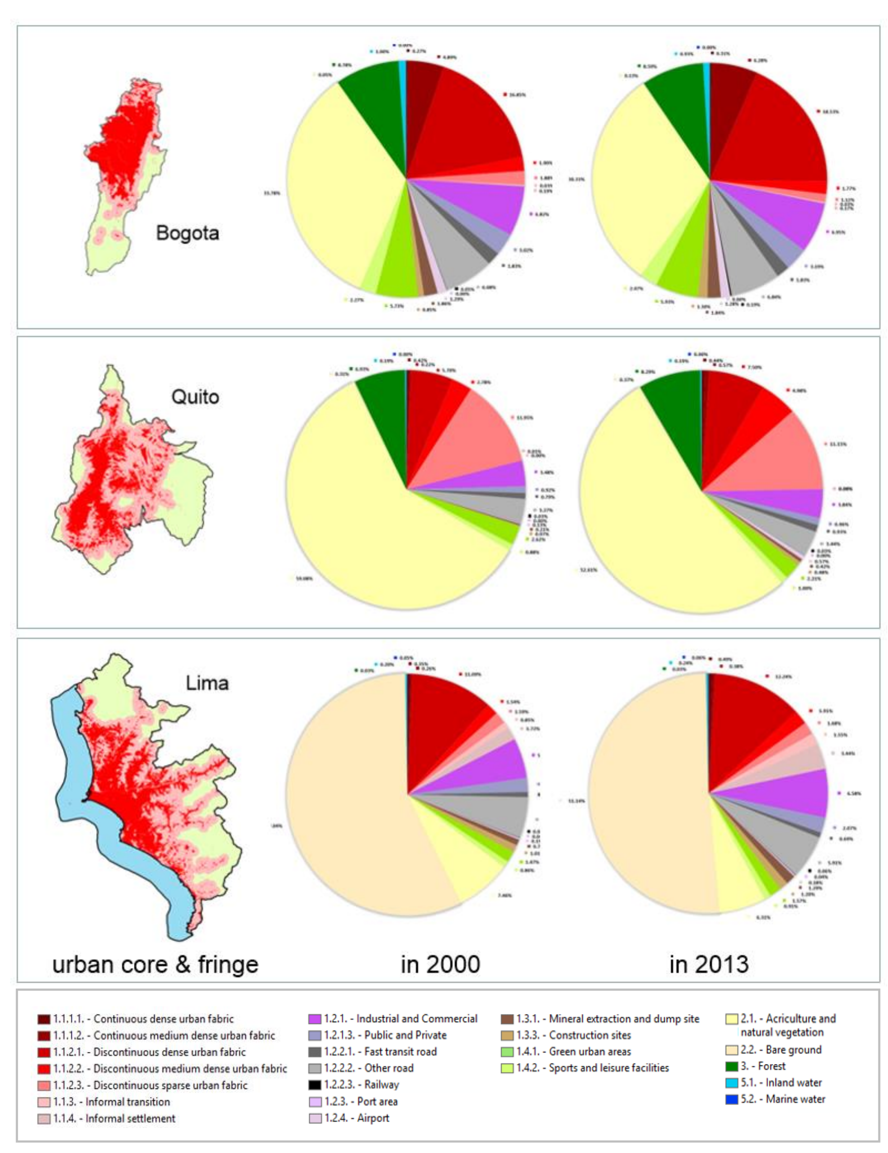
Understanding the Spatial Story

Spatial presentation of statistical values can support the understanding of complex structures and developments of urban agglomerations.

The example shows the age structure of Lima citizens and its interrelation to urban growth: The historic inner-city centre is half populated by people older than 40 years whereas the outskirts are significantly younger. This is related to financial leeway and age of people moving into the city and starting to raise their families there.

This information could directly affect the urban planning process dealing with social infrastructure issues.

Structure Analysis and Comparison



Applying a unique nomenclature, and – like in this case – even similar dates, makes the cities comparable. Various circumstances cause different development. However, class distribution can provide essential information on the character of a city, potential imbalances as well as potentials for future policies.

The Diagrams show class distribution of the metropolitan regions and its close urban surroundings (pink) within the area under investigation. It identifies ***Bogota*** as city a with very compact urban structures, exceeding its boundaries, whereas ***Quito*** grows and densifies within its administrative units at the expense of agriculture. ***Lima***s growth is limited to natural conditions (ocean, mountains). Newly built artificial structures are placed along hillsides due to the fact that inner city regions are already densely populated or occupied by industry.

The cities also show exemplarily that referring to administrative units as only reference reaches its limits. In reality, many urban agglomerations exceed them and the real change and impact on the environment occurs outside the area under focus. It is important to consider the real urban area into analysis which should be related to the actual size of the metropolitan area as well as consider natural circumstances. This will significantly support understanding the cities and their development as well as sustainable planning activities.

eoworld 2 – Earth Observation for Development

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