GLOBAL ESTIMATES OF URBAN SURFACE ALBEDO TIME SERIES WITH THE USE OF CLOUD COMPUTING

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ABSTRACT

The **Land Surface Albedo (LSA)** is a critical physical variable which influences the Earth's climate by affecting the energy transfer and distribution in the Earth-atmosphere system. Its role is highly significant in global and local scales, since LSA measurements provide a quantitative means for better constraining climate modelling efforts. In urban environments, LSA is crucial for the estimation of the local scale radiation and energy budget.

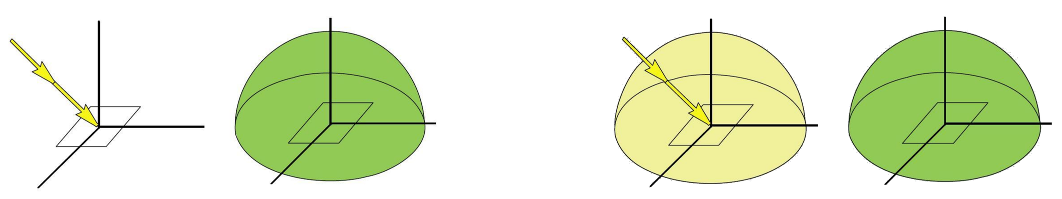
In the present study, LSA was estimated in **large urban areas globally**, at **0.5 km × 0.5 km** spatial resolution and on an 8–day basis, for the period **2001 - 2014**. Products from the Moderate Resolution Imaging Spectroradiometer (**MODIS**), on board NASA's Terra and Aqua satellites were used. Urban areas were masked using the **Global Urban Footprint (GUF)** layer and **LSA changes** during the period examined were assessed using linear regression.

All computations for albedo estimationwere performed using the **Google Earth Engine** (GEE) platform and the data available in its catalog. GEE is a cloud computing system designed to enable **petabyte-scale** scientific analysis and visualization of geospatial datasets, which made possible LSA estimation at global scale for a 14-year period (2000-2014). Albedo products for the urban areas were then processed locally for the statistical analysis.

EARTH OBSERVATION DATA

MODIS data

- Combined Terra and Aqua data, 8-day temporal average, at 0.5 × 0.5 km spatial resolution
- Include kernel weights ($f_{iso}, f_{vol}, f_{geo}$) for the computation of black and white sky albedo:

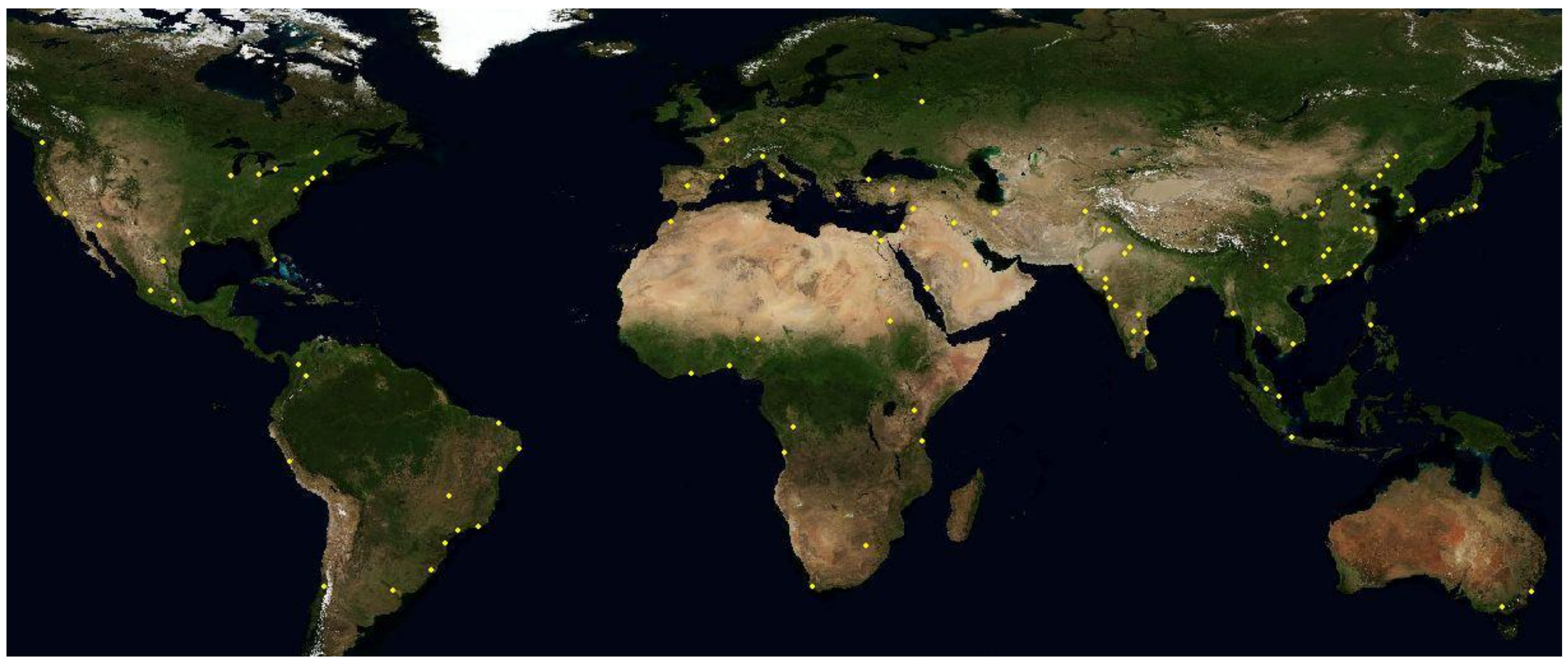


- MODIS Level 3 AOT (550 nm), 8-day temporal average, at 1° × 1° spatial resolution

Global Urban Footprint data (DLR)

- built-up areas derived from TerraSAR-X and TanDEM-X
- Percentage of built-up areas at 100 m × 100 m spatial resolution

URBAN AREAS

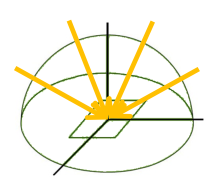


METHODOLOGY

Surface Albedo Estimation

$$\mathrm{LSA}(\theta, L) = \{1 - \mathrm{S}(\theta, \tau(\lambda))\}\, a_{bs}(\theta, \lambda) + \mathrm{S}(\theta, \tau(\lambda))\, a_{ws}(\theta, \lambda)$$

θ: solar zenith angle
λ: wavelength
τ: aerosol optical thickness
S: fraction of diffuse skylight
a_{bs}: black sky albedo
a_{ws}: white sky albedo



LSA averaged over multiple SZAs

Google Earth Engine

LSA annual average estimations performed in GEE | Large computational power allowed hourly SZAs variations

Trends in Surface Albedo

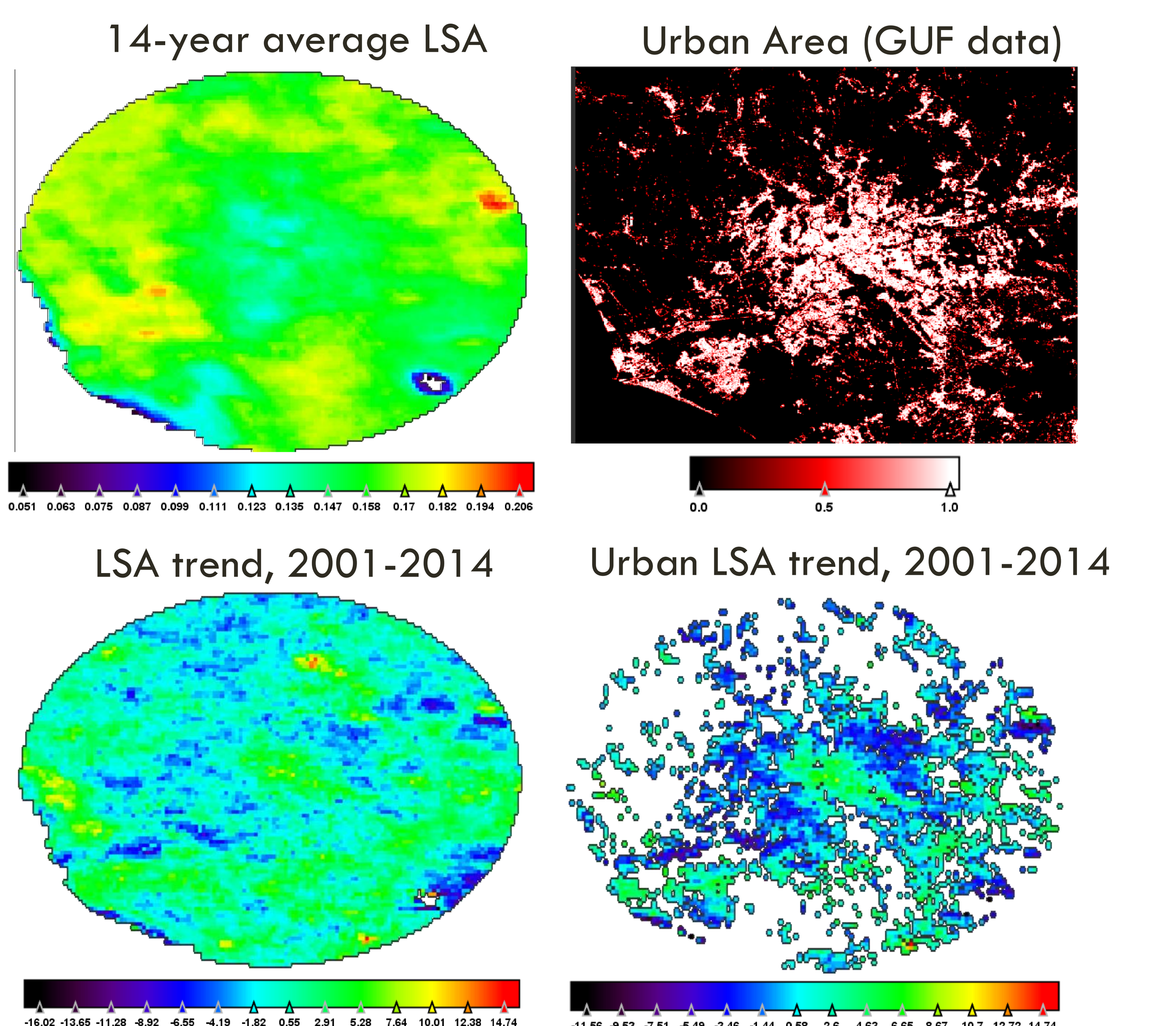
Estimation of annual average LSA based on 8-day values | Linear regression analysis based on annual values during 2001 – 2014 | Assessment of statistically significant LSA trends

Selection of Urban Areas

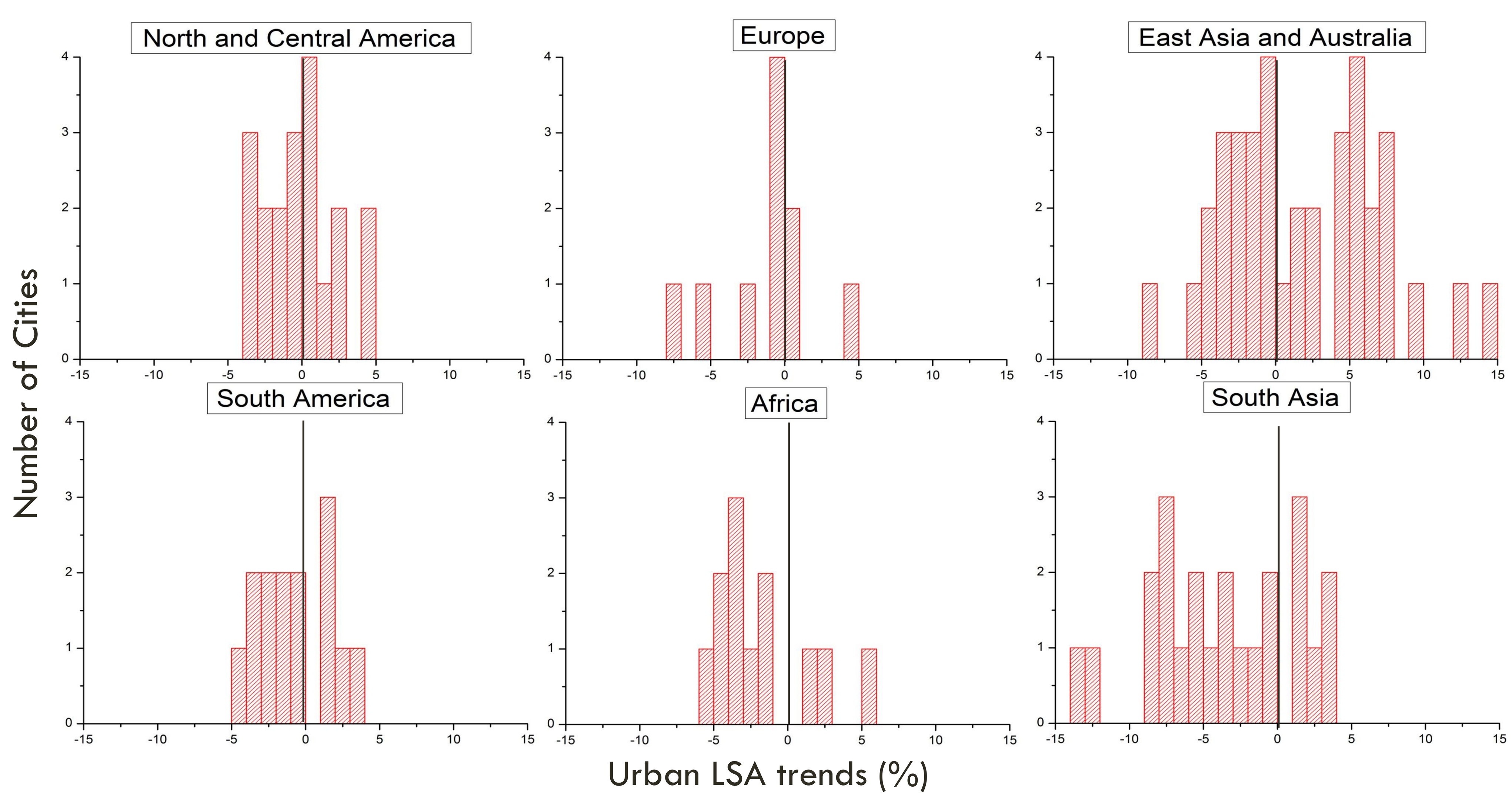
Population criteria (> 4 million in 2010) | Selection of circular areas (25 km radius) based on city center s coordinates | GUF upscaled at 0.5 × 0.5 km → Urban pixels: GUF ≠ 0

RESULTS

Case study: Rome



Global trends in Urban Surface Albedo



REFERENCES

- Benas, N. and Chrysoulakis, N., 2015. Estimation of the land surface albedo changes in the broader Mediterranean area, based on 12 years satellite observations. *Remote Sensing* (in press).
- Esch, T., Marconcini, M., Felbier, A., Roth, A., Heldens, W., Huber, M., Schwinger, M., Taubenbock, H., Muller, A. and Dech, S., 2013. Urban Footprint Processor – Fully Automated Processing Chain Generating Settlement Masks from Global Data of the TanDEM-X Mission. *IEEE Geoscience and Remote Sensing Letters*, 10, 1617 - 1621.
- Schaepman-Strub, G., Schaepman, M. E., Painter, T. H., Dangel, S. and Martonchik, J. V., 2013. Reflectance quantities in optical remote sensing-definitions and case studies. *Remote Sensing of Environment*, 103, 27 - 42.

CONCLUSIONS

- Global estimates of blue-sky albedo for 2000 - 20015 of 0.5 km × 0.5 km spatial resolution
- Varying urban LSA trends in different world regions and cities
- Potential causing factors, including NDVI changes and urban sprawl, are under investigation
- Earth Observation data in combination with the power of cloud computing can support studies of urban climate and energy budget