



Characterizing Urbanization Processes in West Africa using Multi-temporal Earth Observation Data

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Introduction – Ouagadougou, Burkina Faso





www.naturalearthdata.com



Introduction – Ouagadougou, Burkina Faso



- Burkina Faso's capital Ouagadougou is one of the fastest growing cities in West Africa
- Urbanization driven by: Natural growth rates, rural-to-urban migration, and the restructuring of land zones from rural to urban
- Urbanization follows irregular patterns including formal and informal processes
- Lack of reliable information on population development





Old town Ouagadougou 2015 (*source: Google Earth*)

120-12

City limits, 2011 (source: Google Earth)

City limits, 2015 (source: Google Earth)

Informal development 2011 (source: Google Earth)

14

10

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Informal development 2012 (source: Google Earth)

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Informal development 2015 (source: Google Earth)



Objectives



Understand social, demographic and policy drivers of urban growth

Map the time and type of urban expansion

Methodology to map urban composition in semi-arid area over time

- Strong difference between wet and dry season (intra-annual)
- Inter-annual changes in rainfall
- Soil can be attributed to different land uses
- Land cover: urban, vegetation, soil, seasonal vegetation
- Relatively low frequent coverage of area in USGS archive



Methods – Multi-seasonal unmixing



- Linear spectral unmixing of bi-temporal stacks of Landsat data
- Seasonal variation of wet and dry season included in model
- Soil and constant vegetation shall be separated from seasonal vegetation (extensive agriculture, natural vegetation)





0.1

Methods – Exploring the full Archive



- Full USGS Landsat 4-8 archive
- 9 "end of wet/dry season" pairs identified based on NDVI







Results: Soil – Seasonal Vegetation - Urban



1988

Land cover fractions

seas. Vegetation



urban

van der Linden et al., MUAS 2015



Results: Soil – Seasonal Vegetation - Urban





Land cover fractions seas. Vegetation



urban

14

van der Linden et al., MUAS 2015



Results: Soil – Seasonal Vegetation - Urban



2009

Land cover fractions seas. Vegetation

soil

urban

van der Linden et al., MUAS 2015



Results: Soil – Seasonal Vegetation - Urban













Results: Spatial Patterns of Growth



Planned vs. informal urbanization patterns





Results – Temporal patterns of growth





Year

19

1.2

Vegetation

Results – Temporal patterns of growth

Land cover composition varies with neighborhood type

Photography: J. Hauer

Results – Temporal patterns of growth

Summary

- Mapping patterns of urban growth in fast growing urban areas in semi-arid regions is especially challenging
- Multi-seasonal analysis of time series of Landsat data delivers accurate maps on key bio-physical components
- The composition of relevant components allows insights on seddlement structures and urbanization processes
- Time series of multispectral data contribute to better understanding formal and informal development of urban areas

Conclusions and Outlook

- With Sentinel-2 and Landsat-8 in orbit, dense time series of high resolution multi-spectral data become available
- Bi-seasonal image pairs will become available on annual basis and on ideal dates
- Increased spectral and spatial detail and higher radiometric accuracy will further improve results

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