Time Series Analysis of Urban Land Cover Change and Densification in and around Merida, Yucatan, Mexico

Urban development context
The region of the dry tropical karst plain on which the city of Merida (Yucatan, Mexico) is situated has been a hotbed of urbanisation for about 2,500 years. Merida itself has been a major settlement centre for over two millennia. Until the Spanish conquest in the sixteenth century, urbanism was determined by the local Maya civilisation. Urban landscapes were characterised by patterns of monumental civic-ceremonial centres, surrounded by a relatively dispersed patterns of ‘urban farmsteads’: groups of buildings housing extended family households surrounded by ample multipurpose horticultural plots (referred to as solares). The Spanish re-established various settlements, displaced populations, and introduced the typical colonial pattern of the regular urban grid. Within grids the shapes of house lots became regularised (rectangular) and houses became increasingly oriented towards the streets, mimicking European examples. In towns which grew gradually, the local preference for large horticultural plots and open spaces associated with the household resulted in grid patterns maintaining large amounts of green space. In the city of Merida itself, and outside of the colonial centre, population pressures, changing urban lifestyle expectations, cultural suppression and land grabbing, spurred on by globalisation and the liberalisation of the land market, increasingly generated large urban expansions (low rise, so maintaining relatively low population densities). In the 21st century, with the acceleration of urban migration and urban land cover expansion, these expansion neighbourhoods (fraccionamientos) have become more uniform and repetitive, plot sizes and green space are further reduced, and the zonation has become more piecemeal. The expansions and changing expectations of urban life are threatening the remnants of urban horticultural practices in the wider region, including vernacular architecture, and are recognised to lead to inefficient land use, unsustainable practices, poor service provisions, and damages to the environment.

This project focuses on mapping and analysing spatial and temporal patterns of the loss of urban green and open (soil) space in the urbanising region of and around Merida in the 21st century. While mapping regional urban expansion would be a first step, of particular interest is to recognise the changes in urban land cover vis-à-vis open and green space within already established neighbourhoods and population centres, to better understand the wider and diverse regional impact of urban land cover growth resulting from rapid urbanisation. The results will be used to enrich and contextualise detailed studies of the changing morphology of urban house lots and block densification in the long-term.

This study is envisioned to be organised as multiscale. A first master thesis subject would aim at a regional visualisation of green/open space loss and urban expansion patterns at a coarse resolution (High resolution Open imagery such as Landsat TM/ETM+ and Sentinel2). A second master thesis would select and focus on specific zones, such as specific (small) town, neighbourhoods, or (historically) developed areas for further study at higher resolutions (with Google Earth data). A common part to both thesis would connected to qualitative assessments of the changing opportunities to access and spatial (morphological/topological) relations between built/paved space and green/open space.
Time-scale, and seasonality
Because it has been observed that the rate of urbanisation has been accelerating (again) since 2005, the project focuses on a period starting from 2000 to present. But, the time frame could also start in 1990 because of a new law edicted in 1992. The latter made it possible to sell ‘ejido’ (communally held agricultural) land, creating opportunities for different urban and peri-urban development. Depending on data availability, we would seek to establish a rhythm of time-slices, for example at three to five year intervals, which would allow the identification of temporal patterns (changes of pace) as well as spatial patterns of land cover change.

For reasons of (free) data availability, it may be necessary to permit later start and end dates for the time series analyses in the more detailed study of zones. Ultimately, at the smallest scale, the assessment of change in urban land cover within blocks and the relationship between built volumes and open space could remain qualitative.

One note on seasonality, it is probably necessary to ensure internal consistency between time slices to source imagery captured in the same (dry or wet) season. This would ensure that at least similar vegetation vivacity can be expected from time-slice to time-slice.

Research question/objective:
Process High Resolution Earth Observation data and perform analyses in GIS to identify, map, and characterise spatial and temporal patterns in urban expansions and land cover change (in particular paved/build space vs green/open (soil) space) in Merida, Yucatan, Mexico, and its surrounding region, distinguishing temporal rhythms and multisclar spatial patterns (zones/areas) of transformation in terms of urban development, urban densification, and green/open space loss.

In answering this question consider:
1. Visualise the urban expansion pattern over this time period, e.g.: assessing general patterns of green/open space loss; recognising different types of change (from classification to classification); “heat maps” of accumulated change over time; “heat maps” of relatively rapid/slow change; diversification of change from one stage to the next.

2. Identify zones with similar patterns/characteristics of urban green/open space loss, from major urban areas and small towns to neighbourhoods.

3. Can we confirm the acceleration of urbanisation as a process and what are the proportional characteristics of this acceleration?

4. Is the acceleration more the result of urban expansions or is it also expressed as densification in pre-existing areas and how do these two aspects relate?

5. How do patterns of change result in different zones across the urban landscape and are there notable differences between smaller towns around Merida?

6. Is there evidence for densification and/or intensification of urban land cover in pre-existing neighbourhoods: comparing historic urban fabrics (colonial centre, historic neighbourhoods, expansion neighbourhoods of different decades, small towns around Merida (comparing those experiencing expansion, neighbouring expansion, or not experiencing expansion)). What happens to informal settlement along the fringes?