Fertility and Urban Context: A case study from West Africa using remotely sensed imagery and GIS

Extended abstract

1. Background

In the coming decades most of the world's land cover and land use change (LCLUC) is predicted to take place in the tropics, where population is growing the fastest (DeFries, Asner and Foley 2006). United Nations projections estimate that virtually all of the world's population between now and the middle of this century will emerge in cities of the developing world (United Nations Population Division 2011), driven by natural increase along with continued migration from rural to urban areas as people search for economic opportunity (Lee 2007). Urbanization plays a major role in shaping landscapes in and around cities through densification and sprawl but also far removed from them as increased interactions with cities are stimulating diversification of rural livelihoods (Lambin et al. 2001).

Literature on urbanization of the developing world is mostly focused on large cities and their prevailing slums, while largely ignoring the magnitude of urban growth that is taking place in small and mid-size cities (Montgomery 2008). However, most urban dwellers in Asia, Africa and Latin America live in urban settlements with less than one million people (Satterthwaite 2000), and it is in those intermediate cities and market towns that we can expect the most rapid rates of population growth and thus of land cover land use change (Cohen 2006). The expansion of social networks that is brought by urban growth is not only changing landscapes it is also reshaping traditional ways of thinking in areas such as family strategies (Newson and Richerson 2009). Studies in Sub Saharan Africa have found that urbanization is linked to decreasing fertility levels (Brockerhoff and Yang 1994, White et al. 2005), however little is known about how that association varies with heterogeneous urban contexts. Rapid urban growth combined with rising urban poverty is generating diverse urban environments inhabited by people with a wide variety of lifestyles and different reproductive preferences.

This research studies how the characteristics of urban landscape correlate through space with different living arrangements and with varying fertility levels in Southern Ghana. Testing the hypothesis that urban context is associated with a variety of household structures which in turn have an impact on attitudes towards family planning. Traditional living arrangements such as extended family and foster households are expected to be more prevalent in smaller towns and intermediate cities where fertility levels are higher while nuclear and woman headed households are expected to be more common in larger cities where fertilities are lower in comparison.

Study area

In Ghana urbanization is spreading at fast pace, in 2010 the UN estimated that more than half of the country's population resided in urban areas, a figure that is projected to reach three quarters by 2050. Ghana Statistical Service estimates that population in Greater Accra increased from under 1.5 million in 1984 to almost 3 million in 2000. This rapid growth in urban population translates into dramatic changes in land use land cover. The study area for this research is located in southern Ghana, composed of 17 districts covering Greater Accra and 13 adjacent districts in the Central, Eastern and Volta regions. The coastal region of Ghana has seen a steady increase in population growth and urbanization because of the predominance of Accra's metropolitan area, but also because of growing intermediate cities such as Cape Coast, Takoradi, and Tema. The study site includes Greater Accra, the metropolitan fringe, periphery and hinterland. The districts selected for this study stretch over Accra's neighboring regions defined here as the capital's extended area of influence composed by a diverse urban landscape.

2. Methodology

The physical characteristics of urban places generate spatial and spectral signatures that are readily identified with remotely sensed data (Elvidge et al. 2004) and, as a result, detection and monitoring of urban growth at global, regional and local scales is increasingly relying on the use of such data (Potere et al. 2009, Small 2005, Ward and Phinn 2000, Lu and Weng 2006). In developing countries, where urbanization is taking place at the fastest rate (Miller and Small 2003), the geographic comprehensiveness of satellite imagery has turned it into a useful tool for quantifying and monitoring the distribution of human settlements (Harris and Longley 2002, Small 2003, Weeks 2004). While different urban land uses are composed of different combinations of land cover, a common denominator of cities throughout the world is the predominance of the built environment. This is why in remote sensing research urban landscapes are generally defined as impervious surfaces or built environments (Arnold and Gibbons 1996). The built environment corresponds to artificial structures such as buildings, paved roads, parking lots and sidewalks where cement or asphalt prevail (Weeks 2003, Lu and Weng 2008).

In this study the degree of urbanization is estimated for a uniform grid cell unit of analysis using satellite imagery and a combination of remote sensing and geographic information system (GIS) techniques. Moderate resolution optical and radar imagery from Southern Ghana for 2000 are combined into a decision tree classifier that categorizes the landscape into an urban scale. Optical imagery is classified using spectral mixture analysis into impervious and vegetation patches. Landscape and patch metrics are calculated on the resulting impervious and vegetation patches in order to evaluate land cover fragmentation. The resulting measures of fragmentation are then combined with the classified patches and an additional measure of texture extracted from radar imagery into the decision tree classifier. This approach incorporates morphology into the classifier and proposes a nuanced definition of urban scale describing sparsely populated areas, small settlements, fragmented satellite cities, suburban fringe, sprawl and compact urban core.

Variables measuring population characteristics, fertility levels and household composition from the 2000 census are aggregated to the cell level in order to model the association between household composition, fertility and urban context. Fertility levels are modeled through ordinary least squares (OLS) regression using urban context and household composition variables as explanatory variables of interest while controlling for age, education and parity. The two sets of independent variables of interest in the regression analysis correspond to urban form and to household composition. Living arrangement variables are created at the household level based on individual responses to the 2000 census aggregated to the cell unit. In order to identify different types of living arrangements, household members are assigned to different generations based on age thresholds and relationship to the head, allowing us to identify households with inter-generational co-residence. In addition we identify households headed by women and households where member's usual residence is in a different region. The resulting residuals are then analyzed for spatial autocorrelation in order to identify whether there is a spatial component unaccounted for in the regression analysis. A spatial autoregressive (SAR) model is finally used to specify the spatial component within the regression analysis in order to identify the magnitude of spatial effects.

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