The Urban Transition in Ghana and Its Relation to Land Cover and Land Use Change Through Analysis of Multi-scale and Multi-temporal Satellite Image Data

Research Team

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Objectives

1. Identify, map, and quantify land cover and land use change (LCLUC) within an extensive study area in Ghana, particularly for the period 2006 through 2010.
2. Understand the regional impacts of LCLUC associated with rural-to-urban migration in these changing environments.
3. Assess LCLUC and its effect on demographic and quality of life factors, for four major urban centers during this time period.

Research Approach

- Map and quantify LCLUC at two spatial scales: (1) inter-regional scale for the Greater Accra, Central, and Ashanti regions of southern and central Ghana, and (2) intra-urban scale for Accra, Kintampo, Cape Coast, and Kumasi, the five major cities within the study area.
- Inter-regional identification of LCLUC based on moderate spatial resolution, multi-temporal image data from Landsat ETM+, Terra ASTER, and SPOT-2 optical satellite systems, and IRS-2 synthetic aperture radar (SAR).
- Intra-urban identification of LCLUC based on high spatial resolution image data from Quickbird, Worldview, BDMO, and German commercial satellites.
- 2000 through 2010 study period coincides with a period of available demographic and health survey data for Ghana.
- Utilize quantitative spatial analysis techniques to examine relationships between LCLUC and magnitudes and changes of demographic, socioeconomic, and health variables using generalized linear and multi-level regression models, multivariate logit models, regression tree analysis, and agent-based models.
- Emphasis on the effects of LCLUC on quality of life indicators such as child mortality, crime indices, and food security, within four of the major cities of Ghana.

Table 1: Characteristics of commercial high spatial resolution satellite (HSRS) systems and data.

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Spatial Resolution</th>
<th>Data Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quickbird</td>
<td>0.61 m</td>
<td>Global</td>
</tr>
<tr>
<td>Worldview</td>
<td>0.5 m</td>
<td>Global</td>
</tr>
<tr>
<td>BDMO</td>
<td>0.5 m</td>
<td>Global</td>
</tr>
</tbody>
</table>

Table 2: Characteristics of moderate spatial resolution satellite (MSRS) systems and data.

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Spatial Resolution</th>
<th>Data Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat ETM+</td>
<td>30 m</td>
<td>Global</td>
</tr>
<tr>
<td>Terra ASTER</td>
<td>15 m</td>
<td>Global</td>
</tr>
<tr>
<td>SPOT-2 SAR</td>
<td>12 m</td>
<td>Global</td>
</tr>
</tbody>
</table>

Preliminary Results

Figure 6. Preliminary evaluation of LCLUC for greater Accra and its rural environs based on classification of Landsat ETM+ data: "Built" land cover increased substantially, particularly in northern and eastern Kumasi, whereas high spatial resolution satellite image data are available for more detailed layers.

Benefits of Studying Ghana

- Abundant demographic and health data sets relative to rest of sub-Saharan Africa
- Stable and democratic government and reasonably safe environment
- Leader in science and technology for Western Africa
- Research team has about 20 years of experience working there
- Reasonable wages availability relative to other African countries

Challenges Studying Ghana

- President should be keen on maintaining peace and order in the region
- Limited high spatial resolution satellite coverage for early 2000s
- Limited land cover monitoring capability
- Census boundary files require geographic information and substantial editing by Ghana team

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