Remote Sensing and Social Sciences

A gallery of applications

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In our album today.....

Mutual Relations between Geospatial Information Technology and Science (GIST) and Social Sciences in Urban Research

What can GIST in general and remote sensing in particular offer to research in social sciences?

What can social sciences offer to remote sensing?

Concerns, opportunities and challenges for education: An open discussion
My story with RS & SS
Luxor Temple
Red Sea

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Cairo and the Nile

The University of Oklahoma CENTER FOR SPATIAL ANALYSIS
But it is not the same Egypt for everyone....
The Rich
The So So

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The Poor
...and the Ugly
Cities represent the locus of a diversity of environmental problems with local and global negative consequences that potentially affect millions of people.

The emergence of the idea that calls for “sustainability science” directs attention to the role of science and technology in helping integrate the three pillars of environmental, social and economic sustainability in cities.

Satellite data provide an important source of information for characterizing and monitoring land cover and land use change in urban areas.

In some cases, they become the only feasible way to provide timely and reliable assessments.
The Question of Urban Morphology

and the varying compositions and spatial configurations of urban places

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The question social variability.....

......as it related to physical variability.
..and the contribution of GI S&T

- Philosophy
- Psychology
- Mathematics
- Statistics
- Computer Science
- Geography
- Landscape Architecture
- Application Domains
  - Agriculture
  - Political Science
  - Public Health
  - Business
  - Planning
  - Social Sciences
  - Logistics/Operation
  - Conservation
  - Archeology
  - Others
- Engineering
- Geospatial Information Science and Technology
- GI Science
- Applications of GI S&T
- Geospatial Technology
- Information Science & Technology
Mutual Relations Between GI S&T and Social Sciences in Urban Research

Socioeconomic/Political Context

Levels of Knowledge

Existing conditions

Universal

Particular

Local
Regional
National
Global

Feedback
Interventions
Resources
Remote Sensing as a Research and Educational Tool for Social Analysis

Help us understand population context by providing additional measures for the built environment that can be incorporated in social processes

Make connections across time and space scales

Establish new ways for the interpretation of remote observations
Spectrum of Applications and Techniques in Urban Settings

- Delimitation of land cover and land use
- Texture measures & contextual classification
- Land cover and land use change
- Energy and moisture flux models
- Analysis of urban heat island effects
- Image classifications, spatial statistics, overlay, fuzzy logic, spectral mixture analysis, agent modeling, etc
- Planning/urban and regional analysis
- Archeology/economics
- Sustainability/environmental policy
- Public health/epidemiology/urban ecology
- Resource management/environmental policy
- Demography/anthropology/criminology

Empirical models to estimate, demographic & socioeconomic variables

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Some application examples of what remote sensing can offer to research & education in social sciences
The Arab Fertility Project

Fertility Transition Theories
- Supply demand
- Culture diffusion

What makes Arab cities different?
- Family structure
- Role of women in society
- Predominant economic activities

Research Questions
- How can we measure the local or environmental context?
- How can we measure the spatial diffusion of reproductive behavior?
Applications of RS/GIS for fertility transition analysis in Rural Egypt
How can RS/GIS help?

- Extract populated areas and transportation networks
- Reconstruct census data
- Generate spatial connectivity index for populated areas
Unclassified IRS image of Menoufia in 1998

Extracted waterways

Extracted residential areas
Reconstruction of census data

CWR for Menoufia on village level

CWR for Menoufia on residential area level
Reconstructing of demographic variables

CWR for Menoufia on village level, 3D representation

CWR for Menoufia on residential area level, 3D representation

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The Euclidean distance grid representing the distance from Nile branches.
Each color represents 3, 54 Km
assigning distance values to residential areas
Research Questions

What extent is variability in the built environment predictive of variability in the social environment?

How could change in the local environmental context be related to processes of social and cultural changes?
How RS/GIS can help?

- Add timely and spatially explicit measures of urban morphology

- Establish quantitative ways for the interpretation of morphological patterns

- Link changes in the physical composition of urban morphological patterns to processes of social and cultural changes
Vegetation

Soil

Shade/Water

Impervious

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Texture Analysis

variance  homogeneity  dissimilarity
Decision tree analysis of urban morphology in Cairo

- **greenness**
  - **shade**
    - Soil and Urban B
    - Water
  - **shade**
    - Urban Green And Urban A
    - Roads and Cultivated Greens
Classification Results

Classes:
- Water
- Crop-Green
- Urban-Green
- Urban-A
- Urban-B
- Desert
- Roads

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### Analysis of SMA Fractions

<table>
<thead>
<tr>
<th>Class</th>
<th>SMA Fractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Areas</td>
<td>High Vegetation, Low RMS, All other fractions &lt;10%</td>
</tr>
<tr>
<td>Nile River</td>
<td>High Shade, Low RMS, All other fractions are &lt;5%</td>
</tr>
<tr>
<td>CBD, Roads</td>
<td>High Shade, High Impervious</td>
</tr>
<tr>
<td>Lower Density/Higher Social Status Residential Area</td>
<td>Primarily Vegetation and Impervious -- Some Shade and Low Soil</td>
</tr>
<tr>
<td>Higher Density/Lower Social Status Residential Area</td>
<td>Primarily Impervious– Low Shade and Vegetation – Some Soil</td>
</tr>
<tr>
<td>Desert</td>
<td>High Soil, High RMS (&gt;4%)</td>
</tr>
</tbody>
</table>
The Built Environment as a Representation of Social World is not only a concept for Egypt...
The Ecology of Earthquake Danger in LA

EARTHQUAKE OCCURS

PRIMARY HAZARDS:
Faulting, Shaking, Liquefaction,
Ground Failure, Landslide, Tsunami...

PRIMARY DAMAGE:
Building/Structural,
Nonstructural/Equipment

SECONDARY HAZARD/DAMAGE:
Fire, Hazmat, Flooding...

PRIMARY LOSS:
Life/Injury, Repair Costs, Function,
Communications/Control...

SECONDARY LOSS:
Business/Operations Interruption,
Market Share, Reputation...

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The Question of Urban Vulnerability

Risk = Hazard X Vulnerability

- Exposure
  - Capacity to absorb the impact of the hazard (characteristics of the built environment)
- Coping
  - Capacity to recover from the impact (level of household and community resources)
.. and social vulnerability....

THE PROGRESSION OF VULNERABILITY

1. Root Causes
   - Limited access to
     - Power structures
     - Resources
   - Ideologies
     - Political systems
     - Economic systems

2. Dynamic Pressures
   - Lack of Training
     - Appropriate skills
     - Local investments
     - Press freedom
     - Ethical standards in public life
   - Macro-forces
     - Rapid population growth
     - Rabid urbanization
     - Arms expenditure
     - Deforestation
     - Decline in soil productivity

3. Unsafe Conditions
   - Fragile physical environment
     - Dangerous locations
     - Unprotected buildings and infrastructure
   - Fragile local economy
     - Livelihoods at risk
     - Low income levels
   - Vulnerable Society
     - Special groups at risk
     - Lack of local institutions

Disaster

Hazard

Earthquakes
High winds (cyclone/hurricane/typhoon)
Flooding
Volcanic eruption
Landslides
Droughts

Risk = Hazard X Vulnerability

R = H * V
Studying Vulnerability in LA

Research Questions:

• To what extent do spatial differences in vulnerability levels correspond to variations in the social and physical (both natural and built) parameters of urban neighborhoods within the city?

• How are variations among physical indicators of urban vulnerability manifested in RS images (e.g., land cover as an index of quality of life)? Can they accurately be detected using remote sensing?

• Can variations among vulnerability’s social indicators be determined by RS surrogates? To what extent are vulnerability measures affected when RS surrogates are exclusively used in the assessment procedure?
Vulnerability analysis

Derive a measure of social vulnerability by assessing wealth per census tract based on that is weighted by the age and race/ethnicity of householders.

Using HAZUS to “back into” an assessment of vulnerability by place. We use these results to define Vulnerability as a fuzzy set, and test a model that predicts where “high” vulnerability occurs as a function of the physical characteristics of places.

The progression of vulnerability:

1. Root Causes
2. Drivers and Processes
3. Exposure
4. Disaster
5. Risks
6. Vulnerability
7. Hazards
8. Consequences

Equation: Risk = Hazard * Vulnerability

THE PROGRESSION OF VULNERABILITY

- Root Causes
- Drivers and Processes
- Exposure
- Disaster
- Risks
- Vulnerability
- Hazards
- Consequences

Place Vulnerability

Biophysical Vulnerability

Social Vulnerability
Remote Sensing Analysis

Urban land cover and mixed pixels

Landsat TM Pixel
30 X 30m

Linear Mixing

Spectral Mixture Analysis

Ridd's (1995) Vegetation-Impervious surface-Soil (VIS) model urban material compositions
Linking Vulnerability and RS Measures

Vulnerability

Social Vulnerability: an index of wealth weighted by income, race, and age

Biophysical Vulnerability: based on the spatial multicriteria approach applied to HAZUS simulation results

RS measures

Normalized MESMA fractions
Landscape metrics
Results of the Logistic Regression for the Index of Vulnerability (IV)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
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</thead>
<tbody>
<tr>
<td>VEG_CAT</td>
<td>.0000</td>
<td>1.87</td>
</tr>
<tr>
<td>PD_IMP_C</td>
<td>.0000</td>
<td>2.01</td>
</tr>
<tr>
<td>Low wealth</td>
<td>.0000</td>
<td>1.83</td>
</tr>
<tr>
<td>Medium wealth</td>
<td>.0007</td>
<td>1.45</td>
</tr>
<tr>
<td>High wealth</td>
<td>.0180</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Dependent Variable=high vulnerability
What social sciences can offer to research and education in remote sensing
A Little Bit of Context for Urban Spectral Classification

We learn it this way

- Statement of the Problem & Context
- Need for RS
- Identify Suitable Technique
- Identify Suitable Imagery
- Analyze Data
- Present Information

We apply it that way

- Have access to some data
- Have a technique in mind
- Find a problem
- Analyze Data
- Present Information and prove your technique is the best
But.....

Classification methodologies classify the remotely sensed image not reality

Before over-focusing on algorithm sophistication an appreciation and awareness of what exactly the image represents in reality is of paramount importance

At the same time, effective communication of how reality is represented is critically dependent on the scope and detail of the context of the problem
Limitations of current remote sensing approaches to urban change analysis

Measure change in a discrete, crisp way (e.g. change/no change)

Thresholds of change are often surrounded with a considerable degree of uncertainty

Fail to reveal the magnitude of change

Do not address situations when small, sub-pixel conversions of land cover occur within an area covered by a single pixel

Fail to address a range of contemporary issues pertaining to urban policy and sustainability
Anderson’s Scheme

<table>
<thead>
<tr>
<th>Level1</th>
<th>Level2</th>
<th>Level3</th>
<th>Level4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Built up</td>
<td>Building/roofs</td>
<td>Single roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metal roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tile roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tar roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wood roof</td>
</tr>
<tr>
<td>Vegetation</td>
<td></td>
<td></td>
<td>Transportation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Green vegetation</td>
</tr>
<tr>
<td>Water bodies</td>
<td></td>
<td></td>
<td>NPV</td>
</tr>
<tr>
<td>Non-urban bare surface</td>
<td></td>
<td></td>
<td>Natural</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Human-made</td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
<td>Bare soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bare rock</td>
</tr>
</tbody>
</table>

RS Models of urban classifications

Ridd’s VIS Model

Compositional

RS Models of urban classifications

Small’s HLV Model

Compositional


Understanding urban change
How social sciences can help?

Urban neighborhoods, as Pacione (2001, 196) asserts, “are in a constant state of flux”. Such flux can be conceptualized as a continuum in which neighborhoods at any stage can be stable, improving or declining.

Bourne (1976) suggested a model for “western” cities in which this continuum is divided into five temporal stages: new growth, in-filling, stability, downgrading and thinning out, and renewal.

The length of each temporal stage depends on a complex web of interactive factors and processes.

Each of the temporal stages in Bourne’s model is further characterized with some physical transformations (e.g., construction, densification, demolition of exiting units, cluster or scattered development) that may occur in part of in full in a given urban neighborhood.

Physical transformations constantly occur across all the stages, including the “stability” stage, but the magnitude and speed of a transformation vary by stage and the physical factor under consideration. change
Two Dynamics of urban neighborhood change

Urban fabric added

Time 1

Time 2

Urban fabric modified

Time 1

Time 2
Patterns of changes

From-To Class Change
Rapid, Full transformation of land cover

Within-Class Change:
Slow, Internal modification in the composition of land cover
Expanding Strahler’s Remote Sensing Model for Urban Classification**

Urban Change Analysis

**Date 1**

- Satellite Image
  - Fraction Validation
  - Multiple Endmembers Spectral Mixture Analysis
  - Land Cover Fractions

**Date 2**

- Satellite Image
  - Fraction Validation
  - Multiple Endmembers Spectral Mixture Analysis
  - Land Cover Fractions

- Fuzzy Linguistic Membership Functions of Change

- Fuzzified Layers Representing Different Magnitudes of Changes in Each Land Cover Class

- Aggregate by Census Tracts Coverage and Calculate Landscape Metrics
Multiple Endmember Spectral Mixture Analysis (MESMA)

Social Variability.....

..and evidence of physical variability
Learning from social science

An alternative hypothesis is that the correspondence between land cover and social changes within urban place is, in fact, not concurrent.

Rather, the paper suggests the existence of a temporal lag between change in the social environment and the corresponding change that may occur in the land cover of the urban environment, with the former occurring first.

- Individual moving decisions and processes
- Neighborhoods change and individual decisions
- Urban impacts of neighborhood change
- Housing abandonment
- Gentrification
# Factors Underlying Neighborhood Decline and Revitalization

## Revitalization Factors
- High-income households
- New buildings with good design
- Distant from low-income neighborhoods
- High-class owner occupancy
- Close to strong institutions
- Strong, active community organization
- Low vacancy rates in homes and rental apartments
- Low turnover among residents
- Little vehicle traffic

## Decline Factors
- Low income households
- Old buildings with poor design and no historic value
- Close to very low-income neighborhoods
- Low income occupancy
- Far from strong institutions and desirable amenities
- No strong community organization
- High crime rates
- Heavy traffic, especially trucks on residential streets
The Case of Los Angeles

Los Angeles County: Population Density 1960

- low density
- high density

Pacific Ocean

SPACE

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The Case of Los Angeles

Los Angeles County: Population Density 1970

- Low density
- High density

Pacific Ocean

San Fernando Valley

Hollywood

Beverly Hills

Santa Monica

Inglewood

El Segundo

Watts

Compton

Long Beach

Orange County

Whittier

East L.A.

San Gabriel Valley

San Gabriel Valley

Pasadena

El Monte

Covina

Ventura County
The Case of Los Angeles

Los Angeles County: Population Density 1980

low density
high density

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The Case of Los Angeles

Los Angeles County: Population Density 1990

- low density
- high density

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SPACE
Data

Study Area: LA County, CA

RS Imagery

1990 Landsat TM image
2000 Landsat ETM+ image
Arial Photos for 1995


Census tract is the unit of analysis
## Assessing the Accuracy of MESMA Fractions

<table>
<thead>
<tr>
<th>Vegetation</th>
<th>1990</th>
<th>2000</th>
<th>Average Difference</th>
<th>1990</th>
<th>2000</th>
<th>Average Difference</th>
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<tr>
<td>Site1</td>
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<td>235,889</td>
<td>0.052</td>
<td>238,624</td>
<td>0.051</td>
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<tr>
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<td>211,250</td>
<td>222,629</td>
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<td>234,688</td>
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<tr>
<td>Site3</td>
<td>325,000</td>
<td>310,365</td>
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<td>322,179</td>
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<tr>
<td>Site4</td>
<td>1,034,375</td>
<td>1,120,759</td>
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<td>1,117,548</td>
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<table>
<thead>
<tr>
<th>Impervious Surface</th>
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<th>101,934</th>
<th>0.063</th>
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<tbody>
<tr>
<td>Site1</td>
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<td>103,411</td>
<td>0.088</td>
<td>101,934</td>
<td>0.063</td>
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<td>Site2</td>
<td>1,743,125</td>
<td>1,829,180</td>
<td>1,815,604</td>
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<tr>
<td>Site3</td>
<td>25,000</td>
<td>28,539</td>
<td>27,037</td>
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<tr>
<td>Site4</td>
<td>718,750</td>
<td>822,654</td>
<td>835,140</td>
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</table>

<table>
<thead>
<tr>
<th>Soil</th>
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<th></th>
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<th>142,694</th>
<th>0.054</th>
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<tbody>
<tr>
<td>Site1</td>
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<td>137,078</td>
<td>0.046</td>
<td>142,694</td>
<td>0.054</td>
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<tr>
<td>Site2</td>
<td>125,000</td>
<td>132,115</td>
<td>136,527</td>
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<tr>
<td>Site3</td>
<td>302,500</td>
<td>312,708</td>
<td>308,142</td>
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<tr>
<td>Site4</td>
<td>1,321,250</td>
<td>1,288,430</td>
<td>1,315,549</td>
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<table>
<thead>
<tr>
<th>Shade</th>
<th></th>
<th></th>
<th></th>
<th>326,800</th>
<th>0.077</th>
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<tbody>
<tr>
<td>Site1</td>
<td>310,625</td>
<td>258,210</td>
<td>0.100</td>
<td>326,800</td>
<td>0.077</td>
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<tr>
<td>Site2</td>
<td>298,125</td>
<td>325,682</td>
<td>314,758</td>
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<tr>
<td>Site3</td>
<td>279,375</td>
<td>268,226</td>
<td>296,121</td>
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<tr>
<td>Site4</td>
<td>450,000</td>
<td>495,366</td>
<td>514,364</td>
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</tbody>
</table>
Change in MESMA Fractions Calculated through Fuzzy Logic

<table>
<thead>
<tr>
<th>Change In fraction</th>
<th>Magnitude of change with 0.7 degree of membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher increase</td>
<td>65% &lt;100%</td>
</tr>
<tr>
<td>Lower increase</td>
<td>35% 55%</td>
</tr>
<tr>
<td>No change</td>
<td>-10% 10%</td>
</tr>
<tr>
<td>Lower decrease</td>
<td>-55% -35%</td>
</tr>
<tr>
<td>Higher decrease</td>
<td>&gt;-100% -65%</td>
</tr>
</tbody>
</table>
Aggregating Change by Census Tract

Veg

Imp

Soil

Shd

- High Decrease
- Low Decrease
- No Change
- Low Increase
- High Increase
Socioeconomic Variables

%Black for 1980, 1990, 2000
%Hispanic for 1980, 1990, 2000
Testing the Hypothesis

Logistic regression models to

Test the linkage among 1990 land cover fractions** and 1980 census variables vs. 1990 census variables

Test the linkage among 2000 land cover fractions and 1990 census variables vs. 2000 census variables

Test the linkage of change in 1990-2000 land cover fractions and change in census variables between 1990 and 2000

** Only Vegetation and Impervious surface fractions were used in the testing
## Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Hispanic in 1980</td>
<td>0.0000</td>
<td>0.519</td>
<td>%Hispanic in 1990</td>
<td>0.0000</td>
<td>0.559</td>
</tr>
<tr>
<td>Pop density in 1980</td>
<td>0.206</td>
<td>1.123</td>
<td>Pop density in 1990</td>
<td>0.119</td>
<td>1.145</td>
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<tr>
<td>%Household poverty in 1980</td>
<td>0.0000</td>
<td>0.357</td>
<td>%Household poverty in 1990</td>
<td>0.0000</td>
<td>0.322</td>
</tr>
<tr>
<td>%Black in 1980</td>
<td>0.0007</td>
<td>0.701</td>
<td>%Black in 1990</td>
<td>0.0007</td>
<td>0.701</td>
</tr>
<tr>
<td>Overall Prediction: 81.1%</td>
<td></td>
<td></td>
<td>Overall Prediction: 77.7%</td>
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<td></td>
</tr>
<tr>
<td>Dependent Variable=Vegetation in 1990</td>
<td></td>
<td></td>
<td>Dependent Variable=Vegetation in 1990</td>
<td></td>
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</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Hispanic in 1990</td>
<td>0.0000</td>
<td>0.618</td>
<td>%Hispanic in 2000</td>
<td>0.0000</td>
<td>0.705</td>
</tr>
<tr>
<td>Pop density in 1990</td>
<td>0.728</td>
<td>0.970</td>
<td>Pop density in 2000</td>
<td>0.279</td>
<td>1.095</td>
</tr>
<tr>
<td>%Household poverty in 1990</td>
<td>0.000</td>
<td>0.712</td>
<td>%Household poverty in 2000</td>
<td>0.0000</td>
<td>0.271</td>
</tr>
<tr>
<td>%Black in 1990</td>
<td>0.0000</td>
<td>0.205</td>
<td>%Black in 2000</td>
<td>0.0000</td>
<td>0.729</td>
</tr>
<tr>
<td>Overall Prediction: 83.6%</td>
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<td></td>
<td>Overall Prediction: 79.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent Variable=Vegetation in 2000</td>
<td></td>
<td></td>
<td>Dependent Variable=Vegetation in 2000</td>
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</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Hispanic in 1980</td>
<td>0.0000</td>
<td>1.930</td>
</tr>
<tr>
<td>Pop density in 1980</td>
<td>0.0000</td>
<td>1.690</td>
</tr>
<tr>
<td>%Household poverty in 1980</td>
<td>0.173</td>
<td>1.296</td>
</tr>
<tr>
<td>%Black in 1980</td>
<td>0.0000</td>
<td>1.493</td>
</tr>
<tr>
<td>Overall Prediction</td>
<td>77.9%</td>
<td></td>
</tr>
<tr>
<td>Dependent Variable=Impervious surface in 1990</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Hispanic in 1990</td>
<td>0.0000</td>
<td>1.752</td>
</tr>
<tr>
<td>Pop density in 1990</td>
<td>0.0000</td>
<td>1.506</td>
</tr>
<tr>
<td>%Household poverty in 1990</td>
<td>0.0000</td>
<td>1.987</td>
</tr>
<tr>
<td>%Black in 1990</td>
<td>0.0000</td>
<td>1.439</td>
</tr>
<tr>
<td>Overall Prediction</td>
<td>75.3%</td>
<td></td>
</tr>
<tr>
<td>Dependent Variable=Impervious surface in 1990</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Results

| Variable                               | Significance | Log Odds | | Variable                               | Significance | Log Odds |
|----------------------------------------|--------------|----------| |----------------------------------------|--------------|----------|
| %Hispanic in 1990                      | 0.0000       | 1.469    | | %Hispanic in 2000                      | 0.0000       | 1.527    |
| Pop density in 1990                    | 0.000        | 1.390    | | Pop density in 2000                    | 0.000        | 1.279    |
| %Household poverty in 1990             | 0.147        | 1.257    | | %Household poverty in 2000             | 0.875        | 1.020    |
| %Black in 1990                         | 0.0000       | 1.768    | | %Black in 2000                         | 0.0000       | 1.889    |
| Overall Prediction: 72.5%              |              |          | | Overall Prediction: 67.5%              |              |          |
| Dependent Variable= Impervious surface in 2000 |              |          | | Dependent Variable= Impervious surface in 2000 |              |          |
## Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Pop density 1990-2000</td>
<td>0.161</td>
<td>1.050</td>
</tr>
<tr>
<td>Δ Poverty 1990-2000</td>
<td>0.019</td>
<td>1.215</td>
</tr>
<tr>
<td>Overall Prediction: 33.6%</td>
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</tr>
<tr>
<td>Dependent Variable= Δ Impervious surface 1990-2000</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Significance</th>
<th>Log Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Pop density 1990-2000</td>
<td>0.378</td>
<td>0.966</td>
</tr>
<tr>
<td>Δ Poverty 1990-2000</td>
<td>0.000</td>
<td>1.350</td>
</tr>
<tr>
<td>Overall Prediction: 91.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent Variable= Δ Vegetation 1990-2000</td>
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</tbody>
</table>
Interpretation of the Results

The results of the models show that the remotely sensed measures from the 1990 and 2000 RS images were predicted better by the 1980 and 1990 socioeconomic variables respectively than those of 1990 and 2000 respectively.

The results of the models also show that demographic variables are more predictive of vegetation (in a negative sense) while socioeconomic variables are more predictive of impervious surface fractions (in a positive sense).

The results of the last two models show that the change of socioeconomic attributes as measured by poverty between 1990 and 2000 emerged as significant predictors of change in vegetation and impervious surface fractions between 1990 and 2000.

Taken all together, the models confirm the existence of a temporal lag between sociodemographic change and corresponding land cover change in LA County.
Interpretation of the Results

Socioeconomic and demographic variables represent aspects of the social environment that will be reflected in the physical structure of urban places.

The built environment, represented by the arrangement of land cover classes, then interacts with the socioeconomic environment to produce the urban morphology.

The urban environment then influences the volume and intensity of social interaction that in turn has an implication on the opportunities that exist for different social groups to access resources.

This process takes time and does not occur simultaneously.
Moving forward.....
Some Reflections and Concluding Remarks

The emerging picture of remote sensing as a pivotal tool for planning and decision making in urban settings is evident with an ever increasing attention to urban remote sensing applications.

Despite all welcomed developments, it remains uncommon for urban planners, social scientists or public health practitioners to make use of satellite imagery in their way of doing business.

One factor that appears frequently to be of significance influence is the technical “ivory tower” that many remote sensing scientists have isolated themselves in.

The result, as seen by Longley (2002, 237) is that although “the [remote sensing] field already offers detailed urban classifications, [it] too often remains blind to pattern, doggedly reductionist in classification and largely oblivious to urban function.”

There is a need to change what Geoghegan et al. (1998, 54) refer to as “a business-as-usual approach in the remote sensing community” if remote sensing is sought to provide more serious contribution to such complex, multi-actor, multi-dimensional process as sustainable development in cities than what is currently the case.
Implementation and action
Linking knowledge to action
Implementation and action

Spatial Scales of Activity

1. Identifying drivers, need and priorities
2. Integrating science and technology
   - Research in urban physical phenomena
   - Research in urban social processes
   - Innovation and technology development
3. Linking knowledge to action
4. Implementation and action

Feedbacks

Building educational and research capacities

The University of Oklahoma
Center for Spatial Analysis
.. And we have just started the journey!!