Geography 403
Lecture 13
Urban-Land Use-Archaeology Applications

Needs: Lec_403_13.ppt, sample air photos

Key Terms and Concepts
Urban Land Cover Analysis and Land Classification Techniques
Tracking Temporal Urban Land Use Changes
Urban Change Assessment Techniques
Archaeology History and Basic Site Detection Elements

A. Urban land cover analysis with different bands

PP1 1. Visible and NIR from vertical air photography is still the primary remote sensing medium for urban applications
   a. IKONOS and other new satellites will change this (show MKE IKONOS image)
   b. B/W panchromatic--basic discrimination of concrete, water, and plant materials with the usual interpretation factors
   c. Single band B/W--use to distinguish certain features
   d. Color film--not widely used as most of city is "grey"
   e. CIR film--useful for distinguishing vegetation from other materials, but many complex color patterns may develop due to the wide variety of surfaces
   f. Noon is the best time, but "smog" may be thick then too
   g. Scanner data (MSS, TM) doesn't have the resolution of above, but can be used in computer classification techniques
   h. Land cover types in urban areas may not stay constant (identifiable in different cities)

2. Thermal IR
   a. Variable emissivity considerations
   b. Discernment of features such as roads, trees, residential areas, and wet/dry surfaces can be enhanced with day/night TIR imagery
   c. Scale distortions must be rectified

3. RADAR imagery--sense different roughness and dielectric constants
   a. Metallic reflectors or corner reflectors can confuse the return information
   b. Angle of viewing can cause great problems with tall buildings
   c. On large scale; population, vegetation, and settlement location in the range direction affects visibility on SLAR
   d. 1000+ cities can be detected on 1:400,000 with 90% accuracy
   e. <1000 cities could not be consistently detected even at 1:200,000
   f. Radar success in identifying land cover categories
      i. Single family residential best 72% accuracy
      ii. Commercial and services in the CBD only
      iii. Heavy industrial only, light-no
      iv. Transportation inferred only, not directly
      v. Other areas--golf course can be confused with cemeteries, etc.

B. Land Use and Land Cover Classification system with R.S. data

PP2 1. Consists of four levels of successively finer levels of detail (I, II, III, IV)

PP3 2. Level I can be detected with original LANDSAT 80m res. data

3. Level II (2m res. suggested, but perhaps can do with 15m)
4. Level III (1m res. available from air photos only)
5. Level IV (low level air photos with .5m res. only)
6. Objects must be several times larger than the resolution in order to be reliably identified
7. Different environments may require finer detail for a particular level (Asia finer detail necessary than in USA)

C. Temporal Urban Land Use Changes--city "processes" are time scale dependent

PP4 1. Land use change—5-year cycle depending on category

2. Critical environmental areas—2-10-year cycle
3. City infrastructure--basic building features, 5–10-year cycle
    a. Highway conditions (6 mo. interval)
    b. Traffic and parking (hourly)
4. Socioeconomic characteristics--population, gross "quality of life" assessment every 10-20 years
    a. Use in developing countries where ground surveys not feasible
5. Energy Utilization and Conservation
    a. Heat loss and waste generation (1–3-year cycle)
6. Public Works base maps
    a. Civil (10-20 years)
    b. Taxes (1-2 years)
7. Hourly meteorology (air pollution) supplement with R.S. data

D. Techniques for Land Use classification and change assessment

1. Change detection--LANDSAT images obtained on two different dates yield differences in reflectivity used to detect changes in cover type
    a. Spatial registration critical, as other image attributes (show two SPOT images of MKE)
    b. Threshold for change an issue—"how much is enough"
    c. Changes can result from other process besides land use changes--agricultural, reservoir level fluctuations
2. Thematic mapper data provided improved ability to "get at" many features, but IKONOS and other new satellites will do more (most still air photos)
3. Population estimation
    a. Dwelling unit technique, Pop.= #houses*av. family size
        i. Need highly accurate classification of housing type
        ii. Works better in rural areas (lower density)
        iii. Only as accurate as av. family size data

b. Land use / area density--determine land use types and multiply by average population density for each type
i. Need detailed land use information
ii. 5% underestimation is common
c. Built-up area technique--correlation of size of city (built-up area) and population
i. Is size the best indicator of population?
ii. Applicable only to very large cities

4. Housing Quality
a. Examination of individual houses for clues
b. Neighborhood/environment quality
-on street parking
-street grade, width
-traffic hazards, swimming pools
c. Density considerations related to:
-rent, value, income, number of rooms
5. Thermal IR detection of heat loss
a. Can give good qualitative data on sources of heat loss in buildings
b. Needs to be used in conjunction with ground observations and maps to establish location and true temperature
6. Regional use of electricity
a. Relationship between brightness of city area and amount of energy used (as well as population size)
b. Solar energy potential (measure rooftop area, available solar, regional demand
c. Current demand--relate type of building to energy use
d. Locate and assess solid waste resources in same way as for solar--determine feasibility of collection for power generation
7. Assessment of risk factors in locating hazardous or potentially hazardous industries in relation to population
a. Develop a plan of action in emergencies
b. Assessment of possible problems and outcomes
8. Industrial identification, inventory, and analysis
a. Storage tanks volume = (π diameter^2 / 4) height
b. Material piles inventory

E. History of archaeology from R.S. in U.S.
1. 1921--Cahokia mound in Madison County, IL
a. Air photos were used to map and study American Indian burial sites
2. Extensive WWI & II reconnaissance photos also disclosed prehistoric and historic cultural features
a. Several wartime photographers were archaeologists
b. Rapid growth in field began in about 1970
c. Hypotheses are being tested concerning spatial relationships, the exploitation of natural resources and social organization of early cultures

3. Allows use of different parts of the spectrum, temporal coverage, and ecological information to give a more comprehensive perspective

F. Archaeology site detection elements
1. Basic elements of size, shape, pattern, etc.
2. Additional detection elements
a. Shadow marks--at low sun angles--show wall structure remnants or residual depressions of an irrigation canal
b. Soil marks--surface soil color, texture, or moisture
-results of former roads, excavations, and other disturbances
c. Crop or plant marks--may be helpful if only subsurface anomalies are left
-positive marks--due to fertilization effect from lime
-negative marks--due to limited soil moisture over walls
3. Thermal IR applications
a. Detect underground chambers by different surface temperature (pyramid exploration in Egypt)
b. Patterns of abandoned agriculture still show up by materials different thermal "signature"
c. USA Civil War burial investigations
4. RADAR applications
a. Use like sonar to send burst of energy into ground and map returns to look for new sites
b. Use SLAR to search for sites in thick vegetation, like tropical Mexico--develop initial maps of sites--some may be difficult to find and see from the ground

G. Engineering Applications
1. Construction materials survey
2. Highway route planning
3. Dam site investigations and monitoring
4. Landslide investigations
a. Post disaster damage surveys
5. Pollution investigation and monitoring
a. Water
b. Surface mines