Land Cover/Land Use Change

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Outline

• Land cover classification
• Land cover change detection
  – Fire
  – Desertification
  – Deforestation
• Land use change detection
  – Rural/Urban transitions
Why it is important to map land cover and land use change?

• NASA key science questions for land cover/land use:
  – *Where are land cover and land use changing, what is the extent and over what time scale?*
  – *What are the causes and what are the consequences of LCLUC?*
  – *What are the projected changes of land use and land cover and their potential impacts?*
  – *What are the impacts of climate variability and changes on LCLUC and what is the potential feedback?*
What is Land Cover?

- “Land cover” often designates only the surface vegetation
- May also include non-vegetated surfaces (snow/ice, urban areas)
What is “Land Use”?  

- The “use of land by humans”
- Typically has a functional/economic designation
- Land use is not always directly observable
Land Cover Classification

Land Cover Classification Schemes:
- International Geosphere-Biosphere Programme (IGBP)
  - 17 classes of land cover
- Modified IGBP
  - 24 classes of land cover
- Vegetation Lifeforms
  - 8 classes of land cover
- Vegetation Continuous Fields
- Normalized Difference Vegetation Index (NDVI)
  - proxy for “greenness”
IGBP Land Cover Classes

- Evergreen Needleleaf Forest
- Evergreen Broadleaf Forest
- Deciduous Needleleaf Forest
- Deciduous Broadleaf Forest
- Mixed Forests
- Closed Shrublands
- Open Shrublands
- Woody Savannas
- Savannas
- Grasslands
- Permanent Wetlands
- Croplands
- Urban and Built-Up
- Cropland/Natural Vegetation Mosaic
- Snow and Ice
- Barren or Sparsely Vegetated
- Water Bodies
Satellite Land Cover Mapping

• Global scale:
  – AVHRR
  – MODIS

• Local and regional scale:
  – Landsat TM or ETM+
  – Synthetic Aperture Radar (especially for cloudy areas)
AVHRR Global Land Cover Products

• 1 km grid resolution
• IGBP land cover classes, modified IGBP, vegetation lifeforms
• Based on data collected from April 1992 - March 1993
• Available for free from http://edcdaac.usgs.gov/glcc/glcc.html
MODIS Global Land Cover Product

- 1 km spatial resolution
- IGBP land cover classes (other classifications schemes are also included)
- Produced every 96 days
- Available for free from http://edcdaac.usgs.gov/modis/mod12q1.htm
MODIS Vegetation Continuous Fields (VCF) Product

- Describes tree cover, leaf type, leaf longevity
  - %treecover
  - %broadleaf
  - %needleleaf
  - %evergreen
  - %deciduous
MODIS VCF

- 500m spatial resolution
- Available for free from http://modis.umiacs.umd.edu
USGS Land Cover Product

• Based on aerial photographs from 1970s and 1980s
• Variable spatial resolution (30m to 4 hectares)
• Covers coterminus U.S. and Hawaii
• Created using data acquired 199 - 199
Land Cover Change

- Fire mapping
- Desertification
- Deforestation
- Changes in growing season/vegetation greenness
Fire Mapping

• Important for:
  – fire monitoring and post-burn management
  – estimating biomass burning emissions (tropospheric ozone, carbon monoxide, formaldehyde, carbon dioxide, etc.

• Fire properties from thermal remote sensing:
  – active fire detection
  – fire characterization
  – burned area mapping

• MODIS fire products
• ATSR World Fire Atlas
MODIS Fire Products

- 8-day and monthly temporal composites
  - 1 km spatial resolution
  - fire occurrences
  - strength of fire
  - total burned area
- Daily fire product
  - 5-km spatial resolution
- Active fire detection
  - daily fire maps
  - each detection is the center of a 1km pixel
  - Available for free from http://rapidfire.sci.gsfc.nasa.gov
MODIS Fire Product

- Comparison of MODIS fire detection in 1 km pixels with ASTER 90m pixels
Along Track Scanning Radiometer (ATSR) World Fire Atlas

- ATSR nighttime data
- Monthly fire occurrences
Desertification

• AVHRR data show changes in area of Sahara Desert from 1984 - 1990
• Between 1980 and 1984 the desert grew steadily larger (moving southward by about 240km)
• Fluctuations in later years but overall trend is towards increasing desertification
High Plains Sand Dunes

- Reactivation of sand dunes in the High Plains region of the U.S.
- Climate change implications
High Plains Sand Dunes

- Mapping and monitoring of areas thought to be at risk for reactivation of sand dune migration
- Using Landsat TM and ETM+ imagery

Sand dunes outside of Sterling, CO
Deforestation

• Implications for:
  – carbon cycle
  – biodiversity
  – hydrology
  – sustainability

• Remote sensing is useful for mapping global changes in forest cover
  – multispectral and synthetic aperture radar
  – multi-temporal mapping for change detection
Forest Clearcutting in Alberta, Canada

Multi-spectral imagery

SAR imagery
Amazonian Deforestation Mapping

- Uses JERS-1 Synthetic Aperture Radar
- Penetrates through cloud cover
- 30m spatial resolution
Landsat TM

- Multispectral mapping of vegetation
  - Change in NDVI
  - Change in albedo

Rondonia, Brazil

British Columbia, Canada
Synthetic Aperture Radar

- Backscattering properties vary with vegetation cover
- Useful for regions with persistent cloud cover

Red areas indicate tropical deforestation

SAR images from 2 dates show increase in deforestation over 15 months
MODIS Vegetation Cover Conversion (VCC) Product

- Uses MODIS 250m data -- combines spectral and textural methods to detect change
- Available monthly -- intended to monitor rapid land cover conversion
- Data available for free from http://modis.umiacs.umd.edu/vcc.htm

Flood recession in Thailand
Changes in Growing Season

• Using NDVI data from 1981 to 1999, researchers have found that spring has advanced by about 8 days (±4 days) in North America, 11 days (±3 days) in Eurasia and that autumn was also delayed.
Changes in “Greenness” Level

- NDVI data show that average greenness level has increased since 1981
Land Use Change

- Forest to agricultural (Amazon and other regions)
- Rural to Urban
Land Use Change

- Urban sprawl infringes on agricultural or naturally vegetated land
- City growth is an indicator of industrialization
- Remote sensing provides multi-temporal analysis capability
  - Typically need high spatial resolution
  - Multispectral data needed to distinguish between land cover classes
  - SAR data show change in backscatter properties
Land Use Change

• Urban growth mapping:
  – Green areas were urban in 1973
  – Pink areas were newly urbanized as of 1985
Gap Analysis Program

- Goal is to identify gaps in biodiversity
- Administered on a state-by-state basis
- GAP combines land cover maps, vertebrate species distribution data, stewardship info
- Land cover is mapped using Landsat TM data