Geography 403
Lecture 11
Agriculture, Forestry, and Resource Applications

Needs: Lect_403_11.ppt, ndvi_namer_1991.ppt

Key Terms and Concepts
Monitoring Spring and Autumn Plant Phenology (from ground to satellite sensors)
Reed and White techniques to measure start-of-season (SOS) from NDVI
Integrating Satellite, Model, and Native species (ground data): Wisconsin examples
Agricultural Vegetation Identification
Forest Classification and Damage Assessment
Rangeland Applications

A. Monitoring Global Change with Phenology: The Spring Green and Brown "Waves"
(biospheric monitoring is sparse and static compared to atmospheric monitoring)
PP1 1. Phenology--an integration of the biosphere, lithosphere, and atmosphere
a. Well-suited to global change monitoring
i. Data must be generalized from the local to global scale
ii. Biome diversity must be addressed
iii. Physical mechanisms responsible for events must be explored
PP2&3 b. Definition and Research Goals
PP4-8 c. Connections to seasonal air temperature changes
PP9 d. Integrated approach (Satellite-Indicators-Native species)
PP10-11 i. Indicator species (Lilac and Honeysuckle clones)
PP12-13 ii. Native species
PP14-16 iii. Satellite sensor-derived NDVI
2. Cloned Lilac and Honeysuckle data used to develop large-scale phenological models, termed the "Spring Indices"
PP17&18 a. Cloned species data used for model development
PP19 b. "Suite of Measures" associated with Spring Indices models
PP20-27 c. Example output products used for comparison/validation of satellite data
3. Remote Sensing connections
NDVI ppt a. North American NDVI spring changes
PP28 b. Land Cover classification
PP29-30 c. Developing "Landscape Phenology" (Liang et al. 2011)
PP31 d. Contamination problem
4. Start of Season determination
PP32-39 a. Reed Satellite data technique
PP40-45 b. White Satellite data technique
5. Integrating Satellite, Model, and Native species (ground data)
PP46-48 a. Wisconsin example (Zhao & Schwartz 2003)
6. Integrated Phenological Measurements of Spring and Autumn Phenology
PP49-61 a. Downer Woods example (UW-Milwaukee Campus)

PP62-69 b. Park Falls and Willow Creek examples (northern Wisconsin)
PP70 c. USA National Phenology Network

B. Agricultural Vegetation Identification--related to plant structure, soil background, and status
PP71 of plant
1. Leaf structure--reflectance will be related to cell wall-air interface in plant
a. Examinations of variations in leaf structure can be related to differences in reflectance in several bands
b. .5-.75 μm-dominated by pigments (chlorophyll)
c. .75-1.35 μm-internal leaf structure
d. 1.35-2.5 μm-leaf structure and water concentrations
2. Air cell wall changes with age (leaf age)
PP72 a. “spongy” mature leaf will have higher reflectance than the compact young leaf
3. Pigments--reflectance can be related to type, season, and general plant vigor
4. Leaf damage--may affect reflectance
a. Rust infestations can cause a difference in the .75-1.0 μm reflectance
b. .5-1.35 μm range shows many relationships to plant disease by changes in reflectance
PP73 5. Leaf water content--dehydration increase reflectance
6. Senescence--visible light reflectance increases, while NIR reflectance decreases
7. Direct applications of vegetation identification
a. Resource surveys and interpretations
b. Water management and monitoring in agriculture (evapotranspiration, irrigation scheduling, water table monitoring, salinity monitoring)
c. Disease and Pest detection (plant effects, direct detection of flying insects with radar)
d. Erosion documentation and management
e. Yield estimates (satellite and air photo)
f. Phenology (growth stage monitoring and detection, geographic advance)

C. Classification of Forest land
PP74 1. Images can be used to complement, improve, and reduce fieldwork, but unlikely to ever replace it completely
PP75 2. Photo interpretation keys--training the human interpreter to recognize the expected species in the study area and their characteristics
a. A reasonably simple code and classification system must be developed to fit all possible categories
PP76 b. Basic diagrams may help in making identification from stereo air photos
3. B/W panchromatic air photos can be used for many applications, but color (esp. CIR) contains much more information
a. Large scale photos most common (1:24,000), but some accurate ids. may require much larger scale (1:2000)
b. Smaller scale color or CIR may be able to replace larger scale B/W panchromatic

   c. Panoramic (non-vertical component) photos allow quick identification where planimetric considerations are not as important
   d. SLAR most useful in tropics--delimit burn patterns, determine elevation-vegetation zones, find timber line, and help regional interpretation
   e. Satellite-large areas and broad differences can be detected, and computer classification techniques can be employed

D. Forest volume inventory-can be estimated from air photos almost as accurately as on the ground by skilled analysts
   1. Tables and keys are developed to aid interpretation and estimate

E. Damage assessment
   1. Fire
      a. Control--rapid information on wild fire size, extent, and movement
      b. Planning controlled burns-part of management program
         i. Inventory of existing facilities and features
         ii. Knowledge of special hazards
         iii. A record of topographic features important to fire control
      c. Airborne IR systems (use 3-4 µm and 8.5-11 µm bands)
         i. Can quickly identify fires and hot spots
         ii. Some systems can detect fires as small as 1/10 m^2 from an altitude of 600 m
      d. Post fire evaluation
         i. Extent of fire, cleanup, and assessment procedures
         ii. Damage and life state of remaining trees and stress
   2. Insects--often many trees are attacked at one time and begin to show signs of stress by changing “color” which can be detected in pattern variations
      a. Changes in groups of 4-10 trees (13 m) can be detected in
PP77 1:32,000 scale images with 70% accuracy
      b. Only very large infestations can be detected from 80m res. satellite images
   3. Disease--similar effect as insects on tree health, but since symptoms are often less uniform, and sometimes only in single trees, more difficult to detect
      a. Some success using CIR to detect Dutch elm disease
   4. Air pollution injury-can be detected on color film by general discoloration, leaf loss or tree death
      a. May be very species dependent, as two trees next to each other may be quite differently affected
   5. Storm damage--quick assessment of the size, extent, and location of damage
      a. Often difficult to assess on ground
      b. Economics of salvage often require quick response

F. Timber management
   1. Set up procedures and determine best strategies for harvest

2. Monitor logging procedures for problems such as erosion, or improper techniques
3. Monitor reforestation implementation and subsequent growth
4. Monitoring of camping, trails, ski areas, and potential use problems

G. Rangeland applications--state of the range as a resource for grazing

PP78 1. Wish to know kind, amount, condition, and location of vegetation as well as various soil and animal resource features
2. Remote sensing data gathering is faster and possibly more cost effective than surface observations
3. Same general application of techniques as in forest inventories, but much more difficult to identify individual species (plants too small)
4. LANDSAT data and computer classification can be used to assign large regions to particular vegetation associations

PP79 a. Accuracy of results varies greatly by cover type, but not highly accurate overall

5. Effects of range management techniques
    a. Erosion control
    b. “chaining”
6. Ecological range condition assessment-determine the dynamic state of the range
    a. Plants will be classed as invaders, decreasers, or increasers, and relative proportions will determine range condition (poor to excellent)
    b. Changes in range condition over time can quickly be compared for the same area, particularly if coupled with surface observations
    c. Seasonal changes in range condition can be monitored and related to ground based measurements of nutrient value
        i. Effect animal movement considerations
    d. Identify areas subject to desertification
        i. Assessment of range conditions related to desertification
        ii. Monitoring changes in land use and land cover state over time
7. Wildlife habitat assessment
    a. Relationship to vegetation patterns with airphotos
    b. LANDSAT large area assessments (when snow leaves geese nesting areas)
8. Animal census
    a. Large scale air photos can be used to actually count wild or domestic animals
        i. Background critical-most do not want to be observed
        ii. Forested areas can significantly hinder accuracy
        iii. As for vegetation, must develop interpretive keys
    b. Thermal IR-use detectable temperature difference between animal and its background
        i. Problem-not always a lot of difference, especially with lower TIR resolution
        ii. Counting can be difficult in closely spaced groups
        iii. Radio telemetry can be used to tack movement and monitor condition of tagged animals