Factsheet # 12
Land use/land cover (LULC) from high-resolution near infrared aerial imagery: costs and applications

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UW | **R**emote **S**ensing & **G**eospatial **A**nalysis **L**aboratory

Understanding multiscale dynamics of landscape change through the application of remote sensing & GIS

What is a LULC?

Land cover describes natural and built objects covering the land surface, while land use documents human uses of the landscape. Remote sensing imagery captures characteristics of the Earth's surface, but it takes an interpreter's knowledge about shape, texture, patterns, and site context to derive information about land use activities from information about land cover. LULC classifications typically utilize some modification of the Anderson hierarchical system, with generalized LULC classes described at Levels I & II and more detailed classifications for Levels III & beyond.

Level I	Level II	Level III
1 Urban or Built-up Land	11 Residential	111. Single-family Units
	12 Commercial and Services	112. Multi-family Units
	13 Industrial	113. Group Quarters
	14 Transportation, Communications, and Utilities	114. Residential Hotels
	15 Industrial and Commercial Complexes	115. Mobile Home Parks
	16 Mixed Urban or Built-up Land	116. Transient Lodging
	17 Other Urban or Built-up Land	117. Other
2 Agricultural Land	21 Cropland and Pasture	
	22 Orchards, Groves, Vineyards, Nurseries, and Ornamental	
Horticultural		
	23 Confined Feeding Operations	
	24 Other Agricultural Land	

What are the traditional methods of LULC Mapping?

Traditional classification methods have used Landsat satellite imagery (Fig. 1a) to produce LULC maps (e.g., 2001 National Land Cover Database) by assigning individual pixels to a specific class based on spectral signature (Fig. 1c). The spatial resolution of this imagery is 30m, meaning that anything on the ground less than 30m in size, or 900m^2 (9,688ft^2) will be generalized to the main class represented in that pixel. 9,688ft^2 is larger than most parcels in Seattle so detail beyond Anderson Level I or II cannot be obtained. It is now a well-accepted principle that this moderate resolution is not appropriate for LULC mapping in urban areas.

What are the new methods of LULC Mapping?

A new classification method called Object Based Image Analysis (OBIA) appears to work best on high-resolution satellite and aerial imagery as well as LiDAR data (e.g., 1m NAIP; Figs. 1b & 2). This form of feature extraction allows for use of additional variables such as shape, texture, and contextual relationships to classify features (Fig 1d). This method can be used on free publicly-available high-resolution nationwide NAIP imagery, which can be classified at Anderson Level III and higher to achieve very detailed LULC maps for urban-based planning, management, and scientific research.

What are the traditional applications of LULC ?
- Natural resource management
- Urban planning
- Water quality protection
- Public health studies
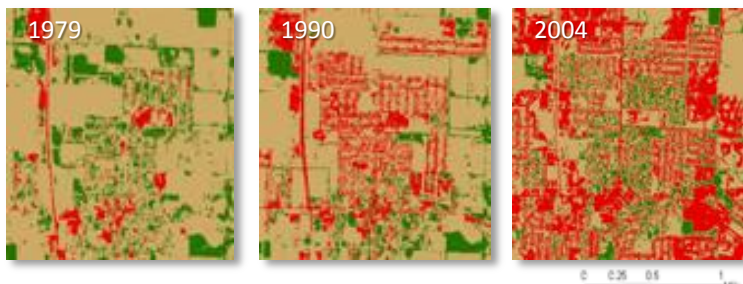- Natural hazard assessments
- Military/Law enforcement use

Forest Cover
Urban
Grass

Forest Cover
Urban
Grass
Paved
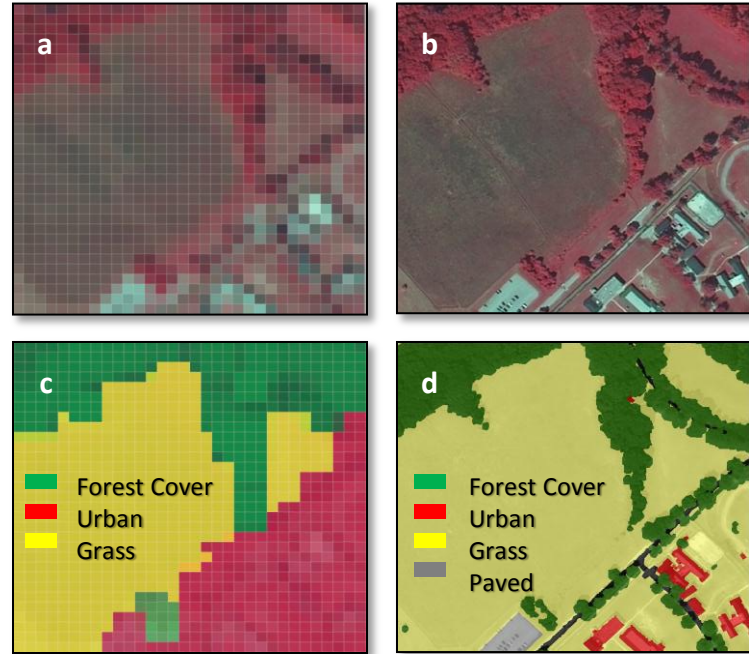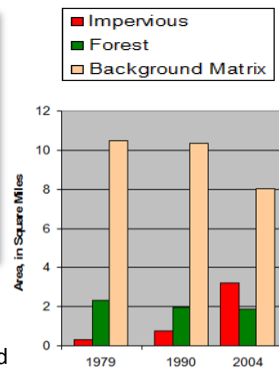
Figure 1. Comparison between a Landsat 30m pixel resolution image (a) classified using per-pixel method (c), and a National Agricultural Imagery Program (NAIP) 1m pixel resolution image (b) classified using Object Based Image Analysis method (d). Note the higher image detail in the OBIA classification and the greater number of classes possible. The forest cover in (c) is 31.74 % or 9.75 km^2 as compared to (d) where forest cover is estimated at 23.54 %, or 7.23 km^2. However, also note that (c) estimates 0% forest cover in or near urban areas versus (d) attributes 13.91 km^2 of forest cover in or near urban areas, thus, the OBIA method captures finer details in area and spatial distribution of canopy cover., in non contiguous, heterogeneous canopies such as urban forests.

Opportunities:

Urban forestry applications of high-resolution LULC:
- Urban tree canopy assessment
- Urban green infrastructure planning
- Change detection analysis over time (Fig. 2) for future acquisition dates
- Standardized protocol allows city to city/area to area comparisons
- Can be implemented state & nationwide for broad-scale analysis and use
- Target planting projects
- Tree protection guidelines

Partnerships:

Partnerships entail sharing scientific-based methods and products that are useful to land conservation, management, and planning agencies in the PNW. For example, we are currently providing analysis and support to Cascade Land Conservancy (CLC) in a county-wide, ground-based forest assessment project. As part of this collaboration, a LULC mapping project as described here is underway. Access to CLC's field and other data strengthens our classification validation and accuracy assessment. Following this pilot project, training materials could be developed for a standardized protocol that can be applied statewide using NAIP imagery. RSGAL aims to engage in efforts that promote technical interchange.

Figure 2. Historical aerial photos classified using OBIA methods. Landscape metrics were used to quantify spatial and temporal changes in two classes from a LULC classification: 1) forest canopy cover and 2) impervious surface areas are presented in the bar graph.

THE KEY ISSUE:

Washington State and Seattle lack current, high-resolution, land use/land cover maps.

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COSTS: Estimated cost is $100/mi^2. This cost is based on an initial investment of algorithm development for a 100mi^2 area. There are no remote sensing data costs associated with the project as WA state has current (2009) high-resolution multispectral imagery collected through the federal NAIP program. Field work or high-resolution oblique photography is required to validate the accuracy of the LULC maps. Costs will increase as areas to be mapped grow larger in extent and as transportation to assess sites increases in distance.

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