Landcover and Water Quality in the Southern Appalachian Mountains, Part II: Methods and Quantifying Change

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Landcover and Water Quality

Efforts to measure and predict the large-area impacts of changing landcover on water quality are limited by a poor historical and current record, perceived lack of spatial detail in previous high-resolution systems, difficulties in accurately measuring current landcover and landcover change at the requisite detail across large areas.

Specific objectives in part 2 of this research include:

Developing a temporally and spatially detailed record of landcover for the Southern Appalachian Mountains. Because of in-stream transport and deposition, current water quality depends on past sediment inputs as well as current sediment inputs.

Develop methods for rapid landcover classification and change detection based on thresholds in spectral variance, change transition probabilities, and automated spectral class winnowing. This "minimum-input" classifier automates spectral-to-landcover class mapping through a number of techniques, including spectral reflectance properties for single and time-series images, previous landcover, thematic data sorting, and cross-class confusion.

Test these new classification methods across the range of mid- to high-resolution satellite data available (30 m to 2.5 m). Sensor/platform versus image resolution is being parsed via successive coarsening of the highest-resolution inputs and within and cross-platform comparisons.

Evaluate data from current high-resolution satellite systems as landcover inputs for spatially-explicit water quality models and identify the effects of source and grain on predictions of water quality.

Figure 4: Landuse Change, Betty Creek

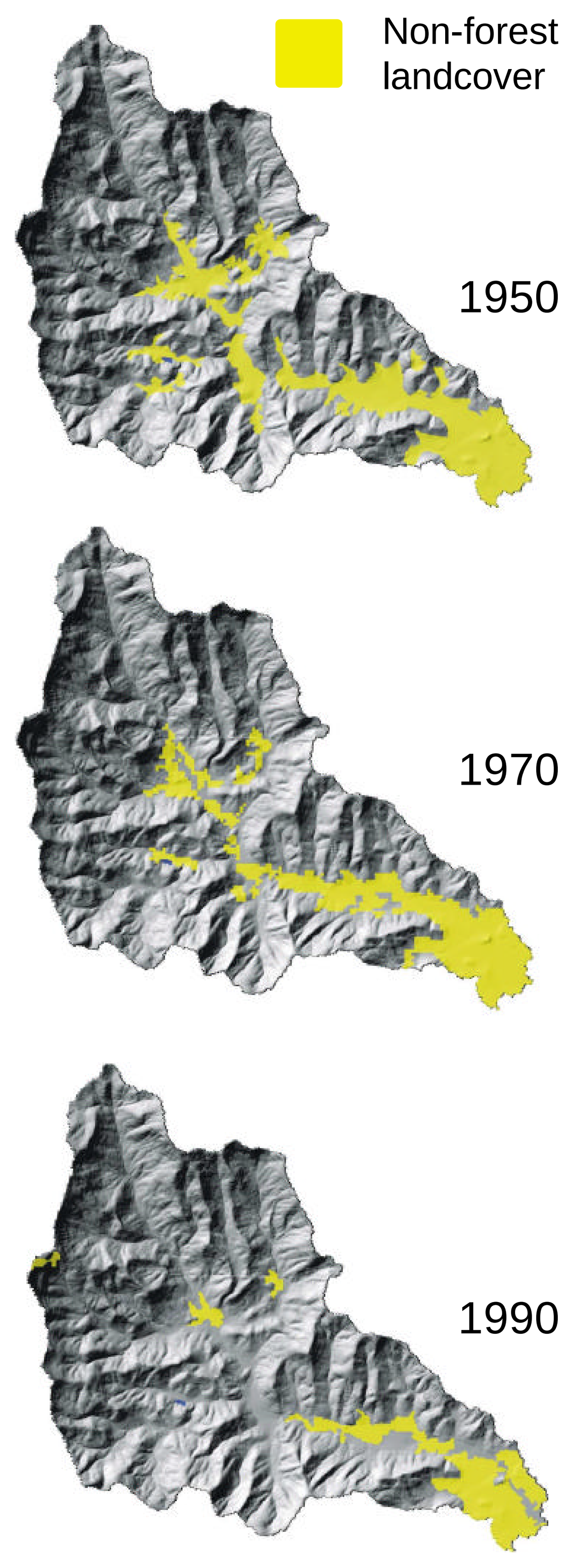
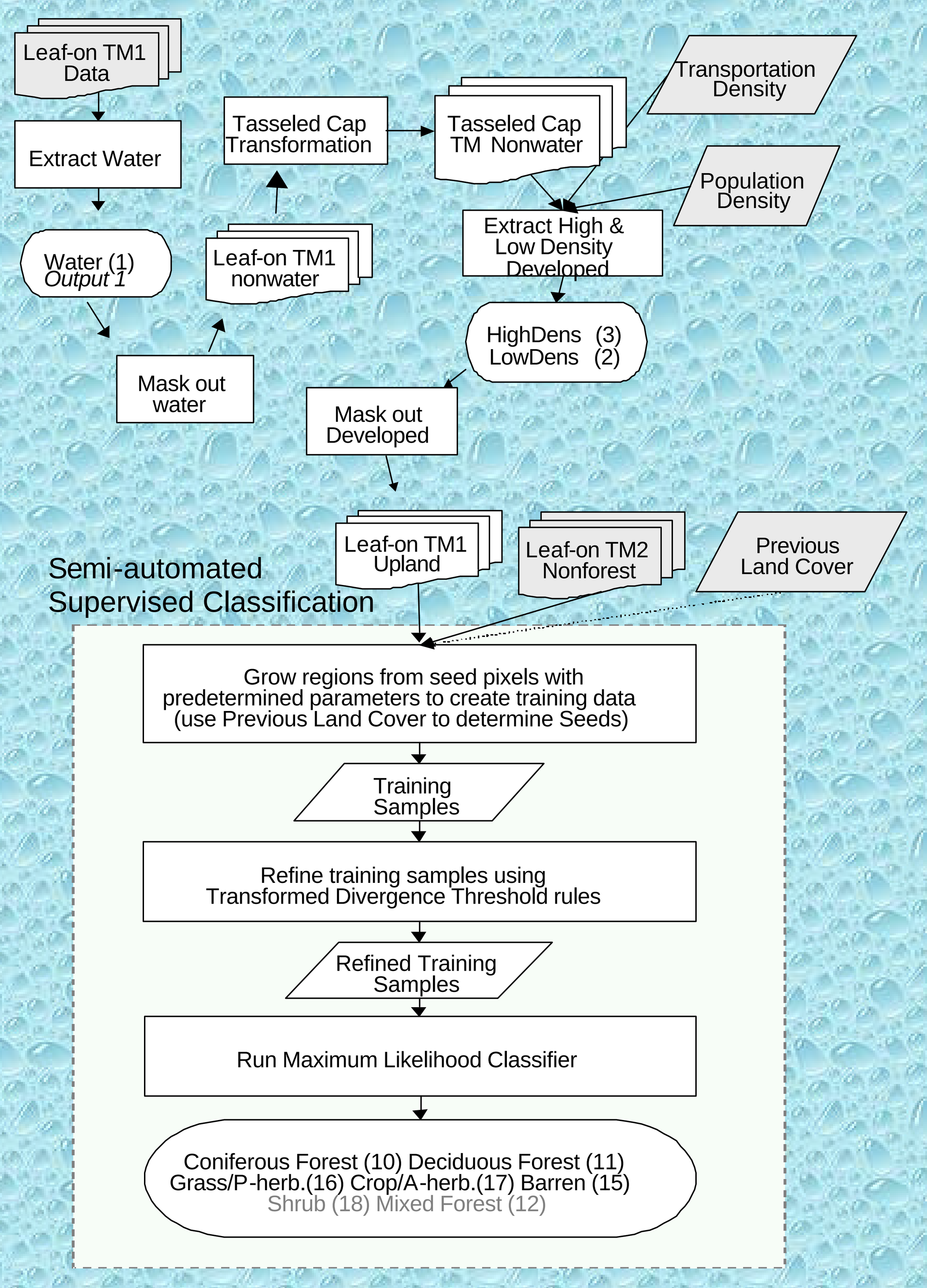


Figure 5: Minimum-Input Classifier



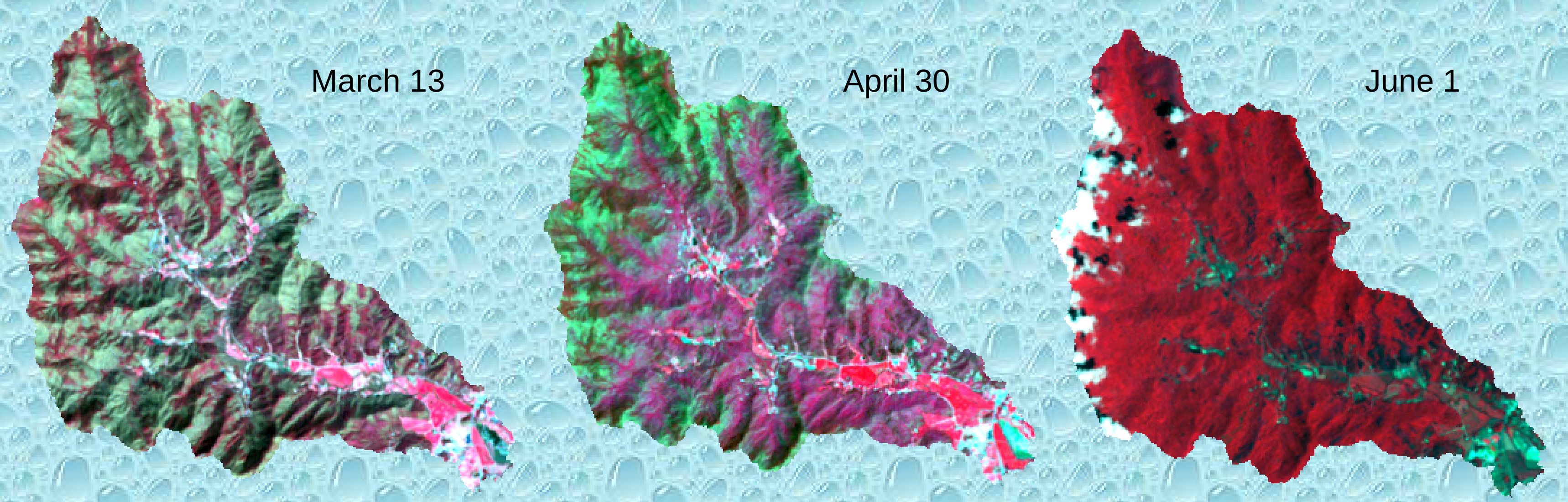
Methods

We apply two main research methods in this portion of the work:

Develop "true" historic and present landcover estimates based on a manual interpretation of terrain-corrected historical aerial photographs, and on corrected current photographic and high-resolution satellite data, and field data (Figure 4). These data are used to drive historic and current estimates of sedimentation in study watershed. These data are also used as "truth" against which the minimum-input classification methods are tested.

Develop minimum-input classifier, and test the effectiveness across a range of input grain sizes. This involves the collection of replicate satellite images at a range of resolutions and seasons for the study watersheds. Radiance-based variance thresholds and seed-pixel locations are then identified for the prototype classifier (Figure 5). The classifier is applied, and thresholds modified, on a series of independent scenes.

Figure 6: Landsat ETM+ Spectral Radiance Change
(color IR images – bands 4,3,2, year 2000)



		Spectral Band Radiance (mW/cm^2 * sr)					
		Red (Band 3)		Near IR (band 4)		Middle IR (band 5)	
Cover Type	**Date**	**Mean**	**St Dev**	**Mean**	**St Dev**	**Mean**	**St Dev**
Forest	March 13	0.158	0.036	0.345	0.058	0.435	0.129
	April 30	0.189	0.017	0.843	0.046	0.560	0.062
	June 1	0.147	0.006	1.219	0.064	0.511	0.031
Grassland	March 13	0.153	0.022	0.716	0.111	0.470	0.050
	April 30	0.177	0.024	1.261	0.149	0.560	0.077
	June 1	0.207	0.022	1.101	0.127	0.579	0.066
Urban	March 13	0.260	0.076	0.379	0.116	0.447	0.107
	April 30	0.453	0.098	0.766	0.150	0.807	0.178
	June 1	0.496	0.126	0.765	0.155	0.904	0.229

Early Results

Satellite data collected from different platforms and time periods show consistent patterns in spectral variance for some cover types, e.g., grassland/pasture categories (Figure 6).

Reflectance varies substantially by class and season, indicating type and phenology-specific variance thresholds are required.

Fixed spectral variances, when combined with a large number of initial seeds may substantially speed classification.