k-NN MAPPING OF FIRE FUEL PARAMETERS USING SATELLITE IMAGERY AND FIELD DATA FROM FOREST INVENTORY PLOTS

ABSTRACT

This project was designed to study techniques and prototype methodologies for mapping meaningful vegetation parameters that can be used as input variables to fire management systems, such as FARSITE. Satellite remote sensing data may be effectively used to model and map the natural vegetation types and vegetation structure classes that are essential elements of fire fuels characterization. The k-Nearest Neighbor (k-NN) classification algorithm was evaluated for several parameters to yield the most useful data for fuels mapping.

When classifying pixel "x", the k-NN algorithm finds the training plots that are most similar to x and chooses the class prevailing among these plots; where k is the number of nearest training plots. The algorithm can utilize any continuous variable for training and classification, and output continuous or class values. Previous studies using a k-NN classifier, usually to characterize land cover, have not evaluated several key input parameters for best results, especially for fire fuels mapping. This study was conducted with the k-NN algorithm to evaluate the size of the sample to use (number of plots), the number of neighbors (k), and the number and combination of spectral bands and dates of satellite data, from three seasons of imagery. Several additional input variables, including topography (elevation, slope, aspect, topographic position) and soils (available water content, organic carbon, and a quality index) were examined.

The k-NN algorithm and the results of the parameter evaluation were used to map the spatial distribution of several key vegetation variables by integrating U.S. Forest Service Forest Inventory and Analysis (FIA) field survey plot data with Landsat-7 ETM+ remote sensing imagery. Mapping results were evaluated using several methods, including a field evaluation of the classifications. The results displayed in the graphs and the table are from the analysis of a Chesapeake Bay test site. The map examples are from a southern Utah test site. Forest type classes were successfully mapped, along with estimates of basal area of coniferous and deciduous forest, total above ground biomass, crown cover, tree height and forest size class (saplings, pole, and saw timber). The research results will be useful for science and land management agencies to map fire fuels with remotely sensed data for predicting fire behavior using models such as FARSITE.

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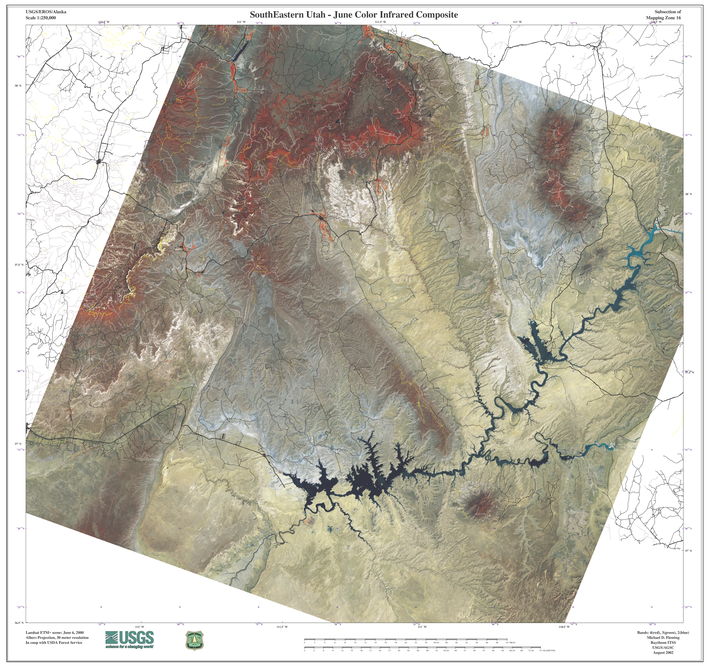

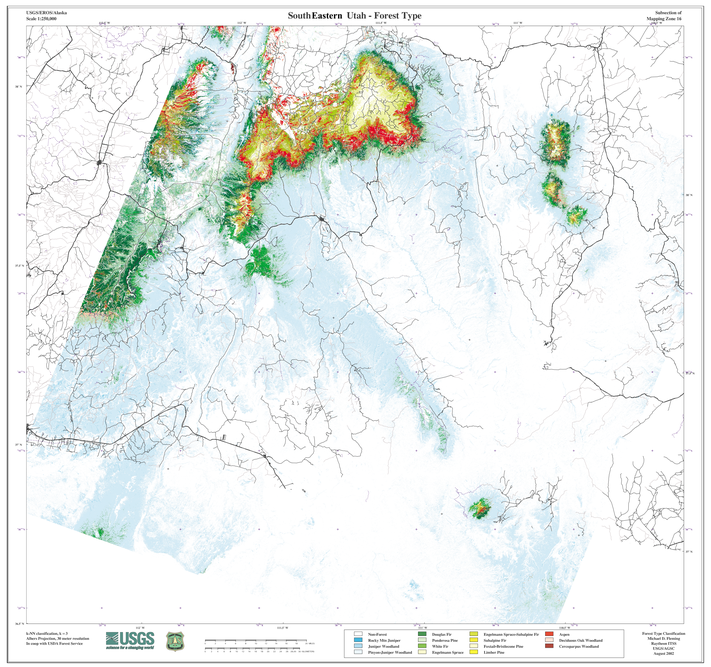

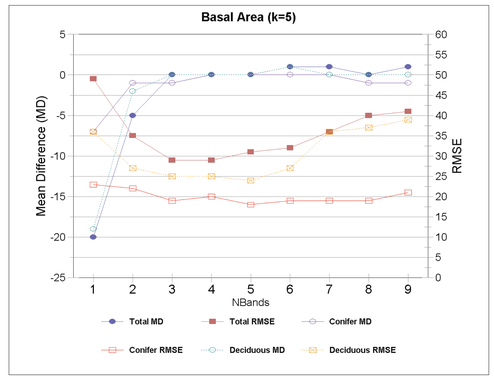

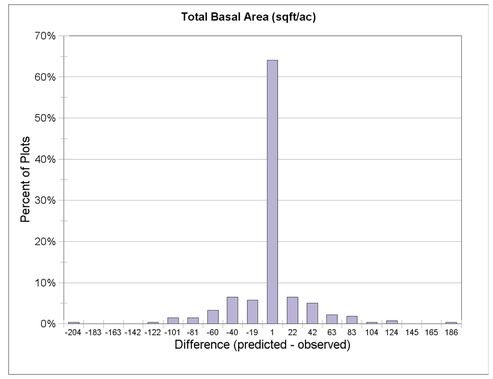

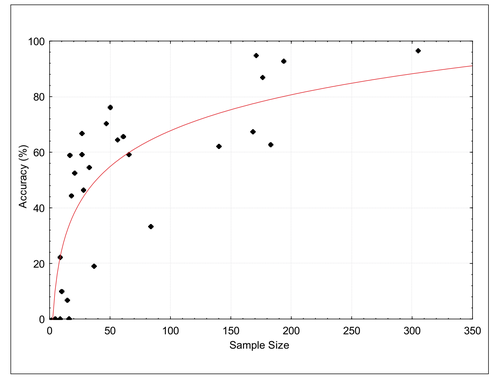

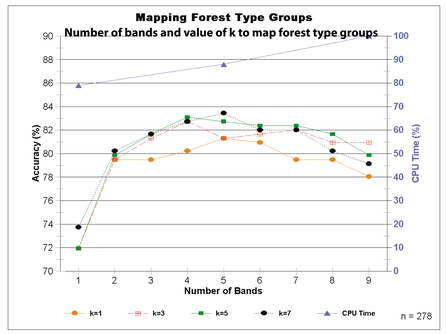

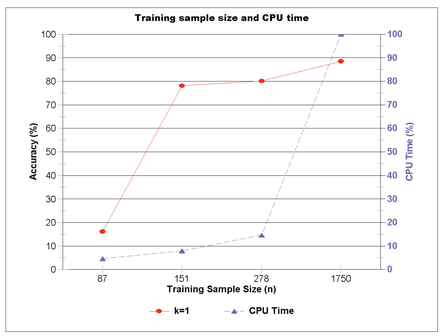

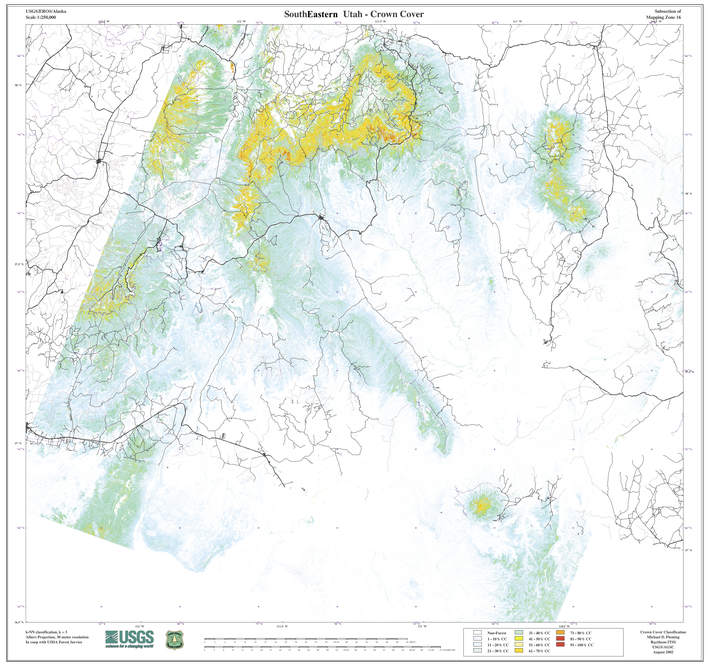

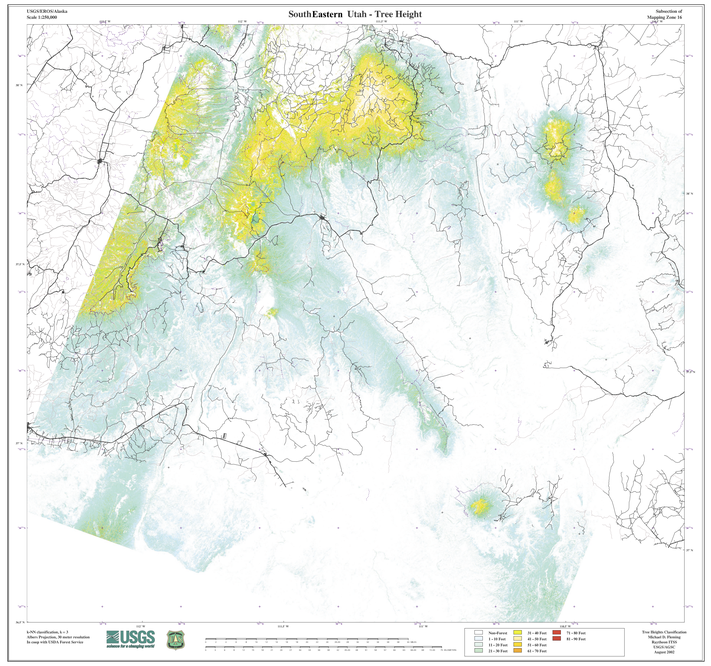

SUMMARY

Sample size is important:
- Accuracy improves with larger sample sizes.
- Don't extrapolate over long distances.
- Need adequate sample for each class.
- Large sample sizes result in longer CPU times.

Value of k is important:
- Most detail, but speckled results with k = 1; when k increases, results are more general and the classification smoother.
- Smaller classes are missed with higher k values.
- No major effect on CPU time.

Number and combination of bands is important:
- Significant effect on accuracy.
- Insignificant effect on CPU time.
- Tasseled-cap transformed data are not significantly different from results with original reflectance data.

Sources of error:
- Temporal difference between FIA data collection and Landsat ETM+ data.
- Plot location accuracy.
- Plot size discrepancy: 30m pixel vs. field plot size of approximately 3x4 pixels.
- Class definitions.

Classification accuracy for several combinations of forest classes:

	# Plots	%Acc
Forest-Nonforest		
non forest	171	95.3
forest	107	99.1
Total	278	96.8
Conifer-Mixed-Deciduous		
non forest	171	94.2
conifer	17	47.1
mixed	47	59.6
deciduous	43	67.4
Total	278	81.3
Forest Types		
non forest	171	94.7
loblolly-shortleaf pine	17	58.8
oak-pine	47	70.2
oak-hickory	33	54.4
oak-gum-cypress	9	22.2
elm-ash-cottonwood	1	0.0
Total	278	80.9