Integration Of Inventory And Field Data For Automated Fuzzy Accuracy Assessment Of Large Scale Remote-Sensing Derived Vegetation Maps In Region 5 National Forests

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Abstract.---The U.S.D.A. Forest Service Remote Sensing Lab located in Sacramento, CA is currently developing methods to automate procedures for determining the accuracy of forest-wide regional vegetation maps derived from Landsat Thematic Mapper imagery. Procedures are being developed to use both GPS-controlled FIA (Forest Inventory Analysis) data and additional field data to assess the accuracy of these maps. Methods based on fuzzy set theory are being used in conjunction with this data to determine the nature, magnitude, frequency, and source of error in the maps. This will assess the error for lifeform vegetation labels, CALVEG labels, tree size, and tree cover. The key step under development is the definition of rules for translating field measurements of vegetation properties into fuzzy membership values for the various map classes. GIS layers are utilized for developing necessary data tables for the accuracy assessment procedure.

INTRODUCTION

This paper is a preliminary report of methods currently being developed to define and automate procedures for determining the accuracy of forest-wide regional vegetation maps derived from Landsat Thematic Mapper imagery and GIS modeling.

The Remote Sensing Lab in Region 5 is mapping existing vegetation for the National Forests utilizing a mapping system developed in conjunction with Boston University (Woodcock et al. 1994 and Miller et al. 1994). These vegetation layers are used in the management of the National Forests. For the proper utilization of

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this data, it is important to provide users with as much information as possible about any error or limitations in the data. All maps have error but it is often difficult to obtain accuracy information on existing data as conducting an accuracy assessment on a data layer can be a cost prohibitive process.

The Remote Sensing Lab is currently developing a methodology with Boston University to assess systematically the accuracy of these vegetation layers using fuzzy sets (Woodcock and Gopal 1992) and an independent field data sample from the Forest Inventory and Analysis (FIA) Permanent Plot Grid System. Utilization of the FIA Grid data will provide for a cost effective means of conducting accuracy assessment.

ACCURACY ASSESSMENT METHODS

Field Data

The FIA Permanent Plot Grid consists of five-point cluster plots sampled on a 3.4 mile grid (U.S. Forest Service 1995). Densification of the grid is sometimes necessary to adequately represent under-sampled forest types. In addition to collecting the cluster plot data, inventory crews also fill out an accuracy assessment form for each point in the plot. This form is intended to capture “expert evaluation” of “best and second best” primary lifeform, CALVEG type (U.S. Forest Service 1981), tree size, and tree density; as well as the same ratings for secondary vegetation types where appropriate. This form may be modified as results from the accuracy assessment methodology are evaluated.

Development Of Accuracy Assessment Fuzzy Ratings

Lifeform and CALVEG

Map labels from the vegetation layer to be evaluated are added to the field data files by “overlaying” the locations of the five-point cluster plots on the vegetation layer in a Geographic Information System. Matrices are developed to compare the map label assigned to each cluster point with the expert evaluations on the accuracy assessment form. Fuzzy ratings are assigned to these unique combinations based on descriptions of the mapped vegetation types, “best and second best” expert evaluations from the accuracy assessment form, and the density of the forest stand where appropriate. For example, in a 20% forest stand with a shrub under-study, a shrub label would get a higher rating of accuracy than in the case of a 60% (denser) forest stand with a shrub label. Fuzzy ratings consist of:

5) Absolutely right: No doubt about the match. Perfect.
4) Good Answer: Would be happy to find this answer given on the map.
3) Reasonable or acceptable answer: Maybe not the best possible answer but it is acceptable.
2) Understandable but wrong: Not a good answer. There is something about the site that makes the answer understandable but there is clearly a better answer.

1) Absolutely wrong: This answer is absolutely unacceptable.

(Woodcock and Gopal 1992).

Tree size and density

The Forest Inventory Analysis (FIA) software system allows for the generation of a summary report by position for each cluster plot. This report gives calculated values of mean tree dbh (diameter at breast height), mean crown diameter, and mean canopy cover percent for predominant, dominant and codominant trees in the top-story, and intermediate and suppressed trees in the under-story (U.S. Forest Service 1995). Using these calculated figures may prove to be a more unbiased procedure for assessing the accuracy of tree size and density map labels. Both the mean and their standard errors are used in assigning fuzzy membership values.

Final Accuracy Results

Special considerations will be necessary in reporting final accuracy figures for the nature, magnitude, frequency, and source of error in the maps. Results will need to be weighted with respect to such variables as grid sampling density, representation of vegetation types sampled by the grid, and the five-point cluster plot.

CONCLUSIONS

The accuracy assessment methodology currently under development represents a potentially cost effective means of systematically providing important accuracy information for large scale remote-sensing derived vegetation maps being created in the Region 5 Remote Sensing Lab. This type of information is integral to a user's ability to responsibly utilize these maps for management decisions in the National Forests. The key to the success of this effort is the ability to translate field measurements into fuzzy membership values for map classes.

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REFERENCES


**BIOGRAPHICAL SKETCH**

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