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MULTIRESOURCE ANALYSIS & INFORMATION SYSTEM CONCEPTS FOR INCORPORATING LANDSAT & GIS TECHNOLOGY INTO LARGE AREA FOREST SURVEYS

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This oaoer addresses the problem of relating different classifications at each stage of a multistage, multiresource inventory using remotely sensed imagery. A solution was needed to complete the concepts development for a Multiresource Analysis and Information System (MAIS) for the USDA Forest Service.

In many existing methods, with more than two stages, a single parameter is estimated (e.g., timber volume), whereas with multiple parameters, such as land use proportions, only two stages are generally used. In the latter case, the traditional approach has been to make the first stage classification (e.g., Landsat), conform to the second stage ("ground truth"), as closely as possible by optimizing the classification accuracy. A perfect classification accuracy is seldom, if ever, attainable, however, in the case of multiresource inventories. Therefore, much emphasis has been placed recently on "co-occurrence" matrices which describe the correspondence between classifications of adjacent stages.

A new type of co-occurrence matrix has been developed, termed a class transformation matrix, which allows one to convert a set of proportions at one stage (e.g., spectral class proportions), to a set of proportions at the subsequent stage (aerial photo class interpretive proportions), through the use of a linear model. In this context, the emphasis is on a good correlation between two classification systems rather than on the classification accuracy for one stage. The class transformation matrix and its associated covariance matrix can be rigorously estimated from the proportions derived from a set of matching sample units using regression estimation techniques. The sample units (currently one square mile in size), are manipulated and stored using GIS technology. A cell system is used for the Landsat-type remote sensing data, whereas a polygonal system is employed for high resolution aerial photo interpretation data and maps, as well as ground data. The row sums of the class transformation matrix must add to one and the elements must be greater than or equal to zero. These constraints are enforced through the use of inequality constrained least squares estimation. A quadratic programming algorithm was used to obtain the matrix elements and a special variance computation method was implemented to compute the covariance matrix of the elements.

The technique was tested by applying a prototype MAIS system to Kershaw County, South Carolina. Correlation coefficients of 0.76 (land use) to 0.99 (water), and highly significant F statistics were obtained for correlating unsupervised Landsat spectral classifications with aerial photo land use interpretations. Using the linear model, these correlations were then exploited to estimate land use proportions for the entire county. In turn, these proportions were used to stratify current annual increment (CAI), field plot data to obtain a total CAI estimate for Kershaw County. This estimate differed by only 1% from the published figure, while the estimated standard errors were comparable (7.56% and 7.25%). In addition to estimating CAI, the flexibility of the system was demonstrated by estimating potential sediment loss as well as a variety of land use classifications based on published ground land use definitions.