Socioeconomic and Biophysical Influences on Forest Cover type in the Alabama's eight Counties: A logistic Regression Analysis using GIS and Remote Sensing Techniques

Buddhi Gyawali, Wubishet Tadesse, Rory Fraser, Yong Wang

Abstract

Land use and land cover study has recently become an important subject in understanding social and economic dynamics of the landscape. The availability of census data at the finer scale and development of spatial analysis tools for analyzing raster and vector data have made such studies more practical and relevant. This study examined the relationship between land cover and socioeconomic and biophysical characteristics of Alabama's eight counties at the census block group levels. This study analyzed U.S. census 2000 and Landsat 2000 imagery data, soil, elevation, road, and streams data using ERDAS, ArcView 3.2, and ARCGIS. The classified land cover raster image was converted to the vector format and overlaid to a vector layer of census 2000 block groups and biophysical data. This information was statistically analyzed using binary logistic regression model. The result suggested that biophysical variables are better predictors of forest cover than socioeconomic variables.

Introduction

The Southwest region of Alabama consists of eight counties with the lowest Human Development Indices (HDI) in the state (Bukenya and Fraser 2003). Afro-Americans constitute over 60% of the region's population and have the lowest share of the gross value of agriculture and timber products (USDA, 1999), the lowest employment rates in forest-based pulp and paper industries (Bailey et al. 1996), and the lowest participation rates in non-timber forest product harvesting and recreational activities on public lands (Johnson, 2000). Social theory based studies suggest a correlation between natural resource and Afro-Americans shaped by resource dependency (Schelhas and Zabawa 2000; Bliss et al. 1998), power relations and land tenure (Schulman 1991), labor structure (Bailey et al. 1996), race and class based discrimination (Mitchell 2001). All of these studies have recognized that upheavals in black landownership and tenancy have disconnected Afro-American involvement in the natural resources section (Gilbert et al., 2001; Gavanta, 1995; Ayers, 1992). However, none of these studies has explicitly addressed the spatial dimensions of the "connection between people, poverty, and natural resources (Wallace and Knight 1996), which is considered an important 'subject of study' in the contemporary research (Fox et al., 2003, Moran et al., 2003). Studies in global poverty and economic development have analyzed this 'connection' and found spatially explicit explanations for poverty (Leslie, 2000). Such research has shown the need for 'level of analysis at fine scale' in order to better understand of the factors that shape the relationship between people and the available economic and natural resources (Rindfuss et al., 2003).

The proposed study therefore, utilizes spatial data at a finer geographic scale to analyze the relationship between people and the resources upon which they depend on for their livelihood (Goodchild, 2004). Since the economy of the black belt region is primarily based on natural resource activities (agriculture and natural and plantation forests), the relationship between available resources and the people who are entitled to use these resources is important for understanding the poverty of the study area. Non-spatial studies of these counties have indicated that landscape characteristics (type of landownership and land cover, location of the property, population distribution, and road network) play an important role in how people have benefited from agricultural and forest resources (Joshi, et al., 2000, Bliss et al.,1998). A Recent study, which was conducted using the information available at the census block groups, found that the type of land cover of the black belt counties is correlated with population density, poverty, and Afro-American populations (Gyawali et al., 2004). However, studies in different parts of the world suggest that other non-socioeconomic variables such as type of soil, elevation, slope, water availability and channels, and road networks are significantly correlated with the agricultural and forest resources (Fox et al., 2003; Moran et al., 2003). In this research, socioeconomics and biophysical variables are examined at the census block group (CBG). The CBGs are chosen ‘as the unit of analysis’ because these are the lowest unit for which the most important socioeconomic information are readily found.

Theoretical Framework, Selection of Methodology and Variables

This research is guided with the perception that poor and socially marginalized people live in the geographic and biophysical conditions which are considerably different than other populations. In the literatures of ‘spatial study of the global poverty research’, the constraints such as access (to roads, railroads, and coast), climate (precipitation, growing season, climate zones, droughts), demography (density and urbanization), topography (elevation and slope), soil quality, disease (e.g. malaria), as well as water availability conditions are identified and assessed. Such data is aggregated into the standard grid and analyzed using multiple regression or discrete regression models (such as logit or probit) to identify which variables explain poverty, what combination of the variables generates the best fit, and what proportion of the variance is accounted by social characteristic and biophysical characteristics.

Landscape ecology related studies have found the relationships between socioeconomic change and land use changes (which is considered a major indicator of economic development) (Moran et al., 2003). The land use change is induced through favorable ecological characteristics (richness of high economic value land and forest species, water resources, and fertile soil, favorable road network and slope), which attracts more investors and increases human population with greater opportunities for natural resource -based activities. For instance varying elevation and erratic distribution of topography, climate, and soil may cause variation of forest species thereby causing varying net primary productivity of forest products.

Studies also suggest that poor transportation access, poor agricultural conditions (sandy soil, drought), and inefficient geography (territories smaller, farther apart residents) have a significant relationship in causing high poverty. For instance, Axinn and Barber (2003) found that size of investment in infrastructure plays an important role in poverty alleviation as it opens the opportunity for investment. Roads create accessibility to the resources and assists in transportation of logs, agricultural goods and farm inputs. Roads provide an opportunity for the farmers to involve in a wider range of economic activities (Gibson and Rojelle, 2003). Access to roads affects the price farmers receive from selling the crops and price they pay for purchased consumer goods. Distance between the point at which people can get access to roads and the center of the government offices (center of economic activities) is also relevant. Other studies (Walsh et al., 2003) found that increasing distance of roads decreases diversification of economic activity (number of income earning activities). The study by Gibson and Rojelle (2004) shows that poverty is dominant in rural area, and is related to those communities that have poor access to services, markets, and transportation.

Studies have found that economic status of households living in steep slope areas are comparatively poorer than the households living in the flat areas. The lands in the steep slope are subject to inundation and suffer periodic shortfall of the rainfall. These factors may create difficulty in building roads (Pascual and Edward, 2004). Steep slope, waterlogged and inundated soils can also reduce the agricultural potential (low acreage of croplands). Soil degradation due to poorly drained or unsuitable soils for particular crops affects agricultural productivity, which is manifested through their impacts on variances in yield and total productivity of agricultural goods. These impacts increase economic costs in the form of loss of income, increased risk, and increased costs of production.

Moran et al. (2003) suggest that natural forests are associated with high infiltration rate and low soil erosion indicating lower numbers of streams. However plantation/secondary forests do not necessarily have these characteristics due to the higher number of roads, logging activities, artificial drainage ditches, etc. Fox et al. (2003) discovered that forest management activities may increase flood due to cultivation, road construction, increased stream density, and soil compaction during logging.

Profile of the Study Area

The major socioeconomic and biophysical characteristics of the study region, which are summarized at CBG level are presented in the Table 1. The study site (-86.4 to-88.4 degree E, 31.13 to 33 degree North) consists of eight counties (Dallas, Green, Hale, Lowndes, Marengo, Perry, Sumter, and Wilcox) located in the southwest part of Alabama. The area covers 6,479 square miles (4,197,125 acres). The region is called black-belt because of the predominant African American population and presence of the black calcareous soil. The total population of the region is 149,378 of which 65% are Afro-Americans (U.S. Census 2000). The population density is 22 people per square mile. Thirty two percent of the people live with income below the national poverty standard. The record of medium household income and bachelor graduates for whites is two times greater than the same records for the Afro-Americans (U.S. Census 2000).

The mean elevation of CBG in the eight counties is 180 meter above the sea level. The road and stream channel density is found to be 3.67 and 5.13 meter per acre in the CBGs. The average percentage of forest and crop/pasture cover in the census block groups is 48.41% and 29% respectively (Gyawali et al., 2004). The major forest tree species are loblolly, oak-pine, oak-hickory, longleaf slash pine, and oak-gum cypress. The major agricultural crops are peanuts, soybean, and hay crops. The study area is mostly rural and population mostly depends on forest-based industry, agricultural, and livestock employment. The lower percentage of people employed (47.78 for whites and 37.92 for blacks) indicates that most of the people do not have a full-time job.

Table 1. Descriptive Statistics of Socio-economic and Bio-physical variables

Characteristics	**Mean (N = 161)**	**Median**	**Std. Deviation**	**Standard Error**
Total acres	24419.8	14749.44	28931.91	2280.5
Crop%	29.03	25.95	24.78	1.95
Forest%	48.41	54.23	30.27	2.38
Elevation	179.57	179.6	.94	.0075
Road (m/acre)	3.67	2.187	3.91	.30
Creek/acre (m/acre)	5.13	5.00	2.32	.18
Total Population	928	841	406.27	32.02
Population density (people/acre)	1	1	1.83	.14
Whites (%)	33.58	26.68	26.30	2.07
African Americans (AA) (%)	65.40	72.93	26.83	2.11
Population below poverty(%)	31.64	31.87	14.14	1.11
White High school Graduates (%)	32.63	33.79	17.48	1.37
White Bachelor Graduates (%)	10.90	9.59	9.440	.74
AA High School graduates (%)	33.38	32.86	13.43	1.05
AA Bachelor Degree (%)	4.27	3.16	4.26	.33
White Employed (%)	47.78	51.87	19.53	1.53
AA Employed (%)	37.92	36.44	13.02	1.02
White Medium Household Income ($$)	36276.10	36793	18366.69	1447.50
Black Medium Household Income ($$)	17543.09	15528	9007.20	709.87
White Per capita Income ($$)	21136.66	19660	14591.99	1150.01
AA Per capita Income ($$)	9003.50	8127	3361.26	264.90

Data Sources

Four sets of data were used in the study. These were: Census 2000 block group vector layer, Landsat 2000 $^{ETM+}$ image, Census 2000 socioeconomic data, and biophysical data.

A. U.S. Census 2000 Block group shape file

Eight African-American dominant counties were selected from the southwestern region of Alabama (Figure 1). Census block groups layers of each county were downloaded from census 2000 data base and merged together utilizing ArcView's Geoprocessing extension. There were 161 block groups (polygons) with varying shape. The average area of the CBGs is 24,419 acres. These CBGs were considered as 'the unit of analysis' for extraction of other socioeconomic and biophysical data.

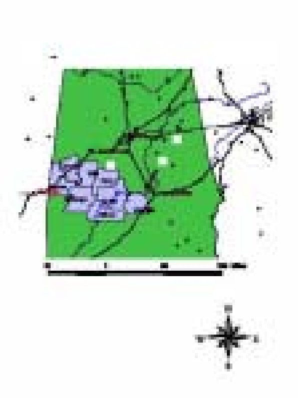

Figure 1 (a) Study area showing Eight counties in southwest region of Alabama

Figure 1 (b) A census block group layer of the study area

B. Landsat 2000 ETM Data

Landsat Enhanced Thematic Mapper (ETM+) satellite image of 2000 was used to derive different land use types. The Landsat data recorded in September 2000, and was rectified, terrain corrected, and geo-referenced to local UTM zone (WGS84 Datum). The positional accuracy was ± 50 meters RMS. The black-belt region required three scenes (Path/row: 20/38, 21/37, and 21/38) which were combined to create a mosaic of the study area. A vector layer of the UTM projected boundary map of eight black-belt counties was used to create a subset of landsat image for image classification.

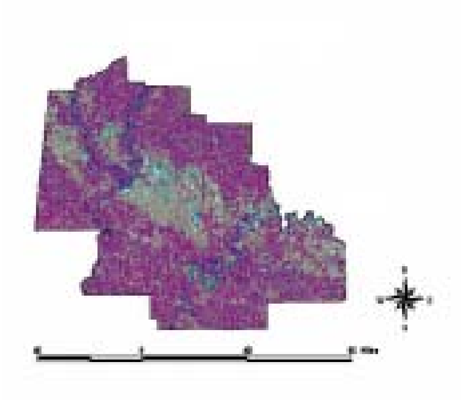

Figure 2 (a) Landsat^{ETM+} subset image of the study area

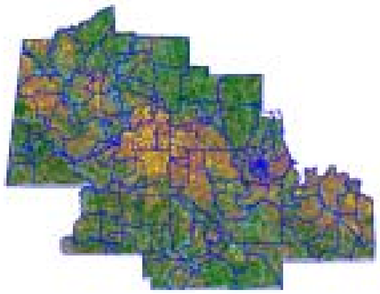

Figure 2 (b) An overlay of classified image and census block group layer

The Landsat $^{ETM+}$ image was preprocessed using ERDAS IMAGING 8.6 software to increase the contrast and brightness using a principle component analysis. The total number of six bands was reduced into three components. The new image had a better view for image classification.

The 2000 image was initially used to extract 15 classes based on clustering algorithm in unsupervised classification using the Anderson level 2 classification schemes. Since the resolution of this data was 28.5 meters, it wasn't possible to conduct higher level classification (level III or IV) (Jensen, 1996). For this reason, the residential area (low density and high density areas) was not clearly visible in the classified image. The 15 classes were further reduced to five major classes: Forest, Agriculture, Pasture, Water, and Other category (combination of residential, commercial, transportation, and other type of land). To ensure the accuracy of classification, the following ancillary data sources (National Land Cover data of 1992 classified image), current topographic maps, GPS recorded coordinates of private farms, known coordinates of towns, airports and road intersections were used. A standard accuracy assessment analysis using the groundtruthing samples could not be carried out at this stage.

C. <u>Socioeconomic Data</u>

Socioeconomics data such as population density, African American population, poverty, education, employment, household income, and per capita income were derived from the census 2000 data for each CBG.

D. <u>Biophysical Data</u>

Elevation, road networks, soils, and streams layers were derived from National elevation Data (NED), Tiger 2002, NRCS's STATSGO soil data, and TIGER 2000 hydrograph data, respectively.

The National Elevation Dataset (NED) with the 30X30 meter resolution (1:24,000 scale) was utilized for delineating the elevation for each CBG. First, the subset of NED for the study area was acquired and converted to grid format. An ArcView extension (CRWR-Raster) was used to derive the average elevation from the grid for each CBG using 'average grid value on polygon' command.

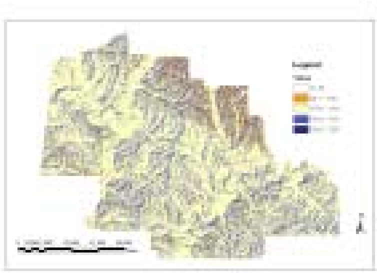

Figure 3 (a). Elevation map of the study area

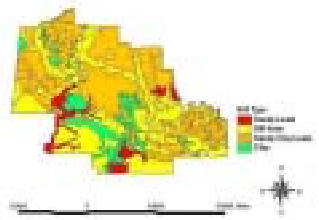

Figure 3.(b) Soil map of the study area.

NRCS's STATSGO soil data was used to derive the soil type for each CBG in the study area. There were four types of hydrologic soil groups in the Statsgo data set: . Group A, which includes sand, loamy sand or sandy loam types of soils and have low runoff potential and high infiltration rates; Group B, which includes silt loam or loam and has moderate infiltration rate; Group C, which includes sandy clay loam, has low infiltration rates, and Group D soils, which are clay loam, silt clay loam, sandy clay, silt clay or clay and have the highest runoff potential and lowest infiltration rates and permanent high water table. In the logit model, a binary soil class was created merging

Groups C and D (which have a higher proportion of clay soils with low infiltration) into a single class.

The TIGER 2002 road data was used for delineating the total length of major highways (such as interstate, state and county roads) available in each CBG. ArcView's geoprocessing (Intersect) was used to extract the length of such roads. Finally, the total length of these roads was divided by the total acres of CBG for calculating the road density (m) for each CBG.

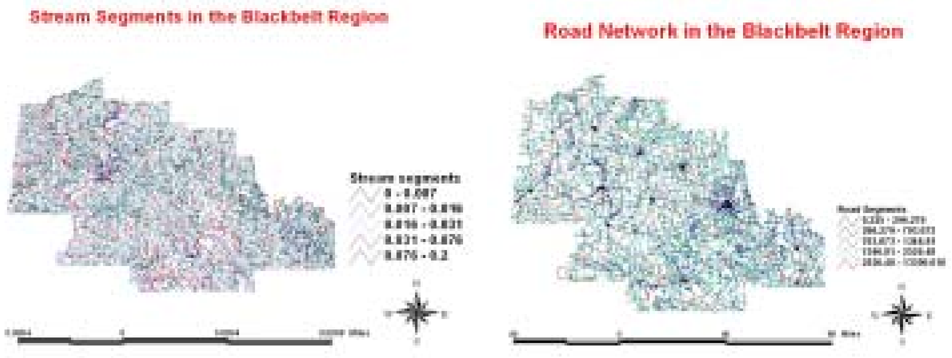

Figure 4. Stream and Road network maps of the study Area

Tiger 2000 hydrograph data was utilized to derive the total length of all the available stream channels in each block group. The total length of the entire streams was calculated utilizing ArcView's geo-processing (intersection), which was then divided by the total area of each block group for calculating the total length of stream channels per acre in each CBG.

Model Specification

To examine the effect of a particular variable conditional to the effect of other variables requires multivariate analysis. Multivariate discrete analysis techniques such as logit or probit are common in most of the spatial land use land cover models (Turner et al, 2003). In this study, binary logistic analysis was employed for examining the relationship between dependent and independent variables

To examine the relationship between dependent and independent variables, following functional relationships were specified.

Forest dominated CBGs = function (population density, Afro-American population, education, employment, poverty, income, elevation, soil, roads, and stream)

Table 2 summarizes the dependent and independent variables, their description, and the direction of the association between dependent and independent variables. The expected relationship between dependent and independent variables are based on literatures. A negative relationship is expected between population density and forest cover suggesting that forest dominated block groups contain sparse population. Similarly negative relationship is expected between forest cover and Afro-American population, their employment rate, and education because whites and corporate owners are the ones who are mostly benefited from forest based industry activities and their 'indicators of well-being are better than Afro-Americans. Also, whites and corporate are the pre-dominant group who owns or manages most of the forest lands in Alabama (Bliss et al.,1998). A negative association is expected between poverty and forest cover with an assumption that forest based industries provide high net farm income comparing to non-forest activities, therefore the people who live in forest dominant CBGs are expected less poorer compared to the CBGs which are not dominated by forest cover. The relationship between forest cover and roads and stream channels are expected to be negative because of the less likelihood of the intensive road networks in densely forest area. The literature suggest that natural forests are mostly accessed by unpaved roads not by interstate, county or state highways and there is a less likelihood of development of artificial stream channels due to less erosion potential in forest covered lands. The relationship between clay soil and forest cover is expected to be positive because clay soil has higher water retention potential comparing to sandy soil. However, in case of elevation, the relationship is expected to be positive as more forestlands are expected in the higher elevation area.

Table 2. Expected Relationship between Dependent and Independent variables

Independent variables	**Description**	**Data type**	Expected association with Dependent Variable (forest cover)
1. Population density	Total Population per acre	metric	**-ve**
2. Afro-American population	Total AA population per acre	metric	**-ve**
Poverty %	% of total people below poverty level	metric	**-ve**
Education	% of AA people with bachelor degree	metric	**-ve**
Employment	% of AA employed	Metric	**-ve**
Elevation	Average elevation of each CBG (M)	Metric	**+ve**
Road	Total major roads length (interstate, state, and county roads) per acre in each CBG	Metric	**-ve**
Soil	Clay soil, low infiltration rate	Dummy (1 = clay soil)	**+ve**
Stream Channels	**Total stream length per acre area (all types of streams) in each CBG**	**Metric**	**-ve**

Logit Model

A binary logistic analysis was used to model the probability of a census block group being covered by forest cover as a function of the independent variables. The dependent variable for a logistic regression analysis was binary (Y =1 means CBGs with 0ver 60% forest cover and Y =0 means otherwise or non-forest dominant CBGs). The following equation specifies the logistic relationship (Gujrati, 1995).

$$L_i = 1n\left(\frac{P_i}{1 - P_i}\right) = Z_i = \beta_0 + \Sigma \beta_i X_i$$

Where L_i was the natural log of the odds of forestland being dominant in CBG *i* (=> 60%), also called the logit, Z_i is a linear combination of independent variables ($b_0 + b_1X_1 + b_2X_2 + b_3X_3 +\ldots.+ b_nX_n$). P_i ranges between 0 and 1. If P_i represents the probability of forestland to be dominant in a CBG *i*, then $(1 – P_i)$ represents the probability of forestland not to be dominant in a CBG *i* (=< 60%). The odds ratio (exp (b) in a logit result (table 3) describes the effect of an independent variable on the odds for an event (forest dominant CBG).

Results and Discussions

Table 3 presents the result of the logistic analysis. Out of total 161 block groups, only the data contained on 141 block groups (excluded CBG had 0 percentage for forest and crop cover) were utilized for examining the relationship between dependent variable (forest cover) and independent variables. A SPSS version 10. software was used for analyzing the data. The result shows that elevation and road are significant variables at 1% probability level.

The significant Chi-square value (44.13, df 10, P<.001) and high correct classification percentage (74.5%) indicated the perfect fit of the model in explaining the relationship between independent and dependent variables (Table 3). The R square of Nagelkerke indicates that about 33.9% of the total variance in the dependent variable (forestland) was explained by independent variables.

In case of elevation, the result shows a negative significant relationship, which indicates that the likelihood of forest cover will be high in lower elevation CBGs. In other words, one unit decrease in the elevation causes the odds of forestland increased by a factor of 0.427. Likewise, the logit result shows a negative significant relationship with road density indicating that lower density of roads increases the probability of forestland in a CBG. The decrease in one unit road intensity causes the odds of forestland increase by a factor of 0.756.

The result did not indicate any significant relationship between forest cover and streams, clay soil as well as socioeconomic variables.

Table 3. Result of the Logit Analysis

Variables	B	S.E.	Wald	Sig.	Exp(B)
Elevation**	-.852	.284	9.015	.003	.427
Road**	-.280	.100	7.865	.005	.756
Creek	-.231	.138	2.796	.094	.794
Clay Soil	.134	.421	.101	.750	1.143
Population Density	-.691	.686	1.016	.313	.501
% of AA population	-.014	.012	1.444	.229	.986
% of below poverty	.037	.029	1.644	.200	1.038
AA Bachelor Degree	-.002	.057	.001	.969	.998
AA employed	.017	.026	.424	.515	1.017
AA medium Household Income	.000	.000	.056	.812	1.000
Constant	154.417	51.306	9.058	.003	1.154
Chi-Square value	44.13				
Nagelkerke R square	.339				
Correct classification (%)	74.5				

** Significant at 1% level.

Comparison of the effects of socio-economic and bio-physical variables

Table 4 compares the differences in the logit result between biophysical variables socioeconomic variables, and both types of variables combined. The table depicts that the inclusion of socio-economic variables moderately increased the model strength (Chi-Square valued increased from 36.67 to 44.13). The inclusion of socioeconomic variables caused a very small increase in the Nagelkerke R square from 31.45% to 33.9%. However, the percentage of correctly classified cases has not been changed. Moreover, there is no additional contribution from socioeconomic variables as none of the socioeconomic variables became significant in the 'combined variables' model. In case of the combined variables, both significant variables (elevation and road) are retained. This result indicates that the role of bio-physical variables is stronger than socio-economic variables in explaining the variation in forest cover in the black belt region.

Table 4. Comparison of the Logit result

Parameters	**Bio-physical**	**Socioeconomic**	**Socioeconomic and biophysical variables**
Variables used *	4	6	10
Chi-Square value	36.67	19.20	44.13
-2loglikelihood value	152.36	175.69	148.90
Cox & Snail R square	.235	.127	.254
Nagelkerke R square	.314	.170	.339
Correct classification	74.5	62.4	74.5
Significant variables at 1% level	Elevation. Road, creek	Population density	Elevation, road,

* Variables included population density, % black population, poverty, medium household income of AAs, % of AAs with bachelor degree, % of AAs employed

Conclusion

This analysis identified the type of land cover in the 161 census block groups of eight counties of Alabama using GIS and remote sensing techniques. The availability of innovative modules and extension in ArcView assisted to acquire, and manipulate data effectively. The result showed that forest land was the dominant type followed by pasture and agricultural land. The study analyzed the statistical relationship between forest cover and socioeconomic and biophysical variables through logit model. The result indicated that elevation and major roads have a strongly significant correlation with forest cover. The ‘elevation’ variable turned out to be a negatively significant factor which goes against the previous assumption. This suggests that the increased density of roads along with an increased elevation cause decline in the forest cover. Although the logit result was consistent with the expected signs, the result did not indicate significant relationship with soil, streams channel, and socioeconomic variables. The inclusion of socioeconomic variables did not cause much difference in the total variation in forest cover. This suggests that biophysical variables are strong predictors of forest cover comparing to the socioeconomic variables.

This study suggests that the determinants of land cover type can be examined utilizing the census and remotely sensed data that are available at the block group level. Since this analysis did not indicate a significant relationship of forest cover with the socio-economic variables as expected, the result could not be utilized to generate ‘spatially explicit explanation of poverty’ for the study area on the basis of current land cover data. However, this model can be improved by incorporating micro-level socioeconomic factors which can be collected through interviews from the diverse group of households, landowners, and institutions (Fox et al., 2003). Also, during image processing, the forest cover data can be disaggregated into ‘plantation forest’ and ‘natural forest’ because in these counties many forest-dependent economic activities are based on plantation/secondary forests.

References

Axinn William G. and J.S. Barber, 2003. Linking People and Land Use: A Sociological Perspective. In Fox J. R. Rindfuss S. Walsh and V. Sharma (ed) *People and the Environment Approaches for Linking Household and Community Surveys to Remote Sensing and GIS.* . Kluwer Academic Publishers.

Ayers, E. 1992. *The promise of the New South Life after Reconstruction*. Oxford University Press.

Bailey, Conner, P. Sinclair, J. Bliss, and K. Perez. 1996. Segmented Labor Markets in Alabama's Pulp and Paper Industry. *Rural Sociology*, 61 (3): 475-496.

Bliss, John C, M. Sisock, T. Birch. 1998. "Ownership Matters: Forestland Concentration in Rural Alabama." *Society and Natural Resources*. Vol 11 (4).

Bliss, John C., Tamara Walkingstick, and Conner Bailey. 1998. "Sustaining Alabama's Forest Communities: Development or Dependency?" *Journal of Forestry* 96(3): 24-31.

Bukenya, J. O., and Rory Fraser 2003. "Estimation of the Human Development Index for Alabama Counties." In Emmanuel Omojokum (Ed.), Southeast Decision Science Institute's Proceedings-- Thirty-Third Annual Meeting, Williamsburg, Virginia Pp. 45-50.

Fox Jefferson, R. R. Rindfuss, Stephen j. Walsh, and Vinod Mishra.2003. *People and the Environment approaches for linking household and community surveys to remote sensing and GIS*. Kluwer Academic Publishers. Boston/Dordrecht/London.

Gaventa, J. 1995. "The political economy of land tenure: Appalachia and the Southeast." Paper presented at *Who Owns America? Land Tenure Issues in a Changing Environment*, Madison, Wisconsin.

Gibson John and S. Rojelle, 2004. Poverty and access to roads in Papua New Guinea. Article accepted for publication in "*Economic Development and Cultural Change*."

Gilbert Jess, G. Sharp; and M. S. Felin. 2001. The Decline (and revival?) of black farmers and rural landowners: a review of the research literature. Working Paper No. 44 North America Series. Land Tenure Center University of Wisconsin-Madison.

Goodchild M. 2004. Social Sciences: Interest in GIS Grows. "*Arc News*" Vol 26(1), ESRI.

Gujarati, D. N. *Basic Econometrics,* McGraw-Hill, Inc., Third Edition, 1995.

Gyawali, Buddhi, Rory Fraser and Wubishet Tadesse. 2004. Landscape and Socio-Economic Characteristics of the Black Belt Region of Alabama. Proceedings of American Water Resources Association's 2004 Spring Specially GIS and Water Resources Conference III, May 16- 19, 2004, Nashville, TN.

Jensen, J. John. 1996. *Introductory Digital Image Processing a remote sensing perspective*. Prentice Hall New Jersey.

Johnson, C., J.M. Bowker H., and Cordel K. 2001. “Outdoor Recreation Constraints: an Examination of Race, Gender, and Rural Dwelling”. *Southern Rural Sociology*. Vol 17: 111-133.

Joshi M. L., J. Bliss, C. Bailey, L. Teeter; K. Ward. 2000. “Investing in Industry, Underinvesting in Human Capital: Forest-Based Rural Development in Alabama. *Society and Natural Resources,* 13: 291-319.

Leslie Lipper, 2000. Dirt Poor: Poverty, Farmers and Soil Resource Investment. FAO Publication.

Mitchell Thomas W. 2001. “From Reconstruction to Deconstruction: Undermining Black landownership, Political Independence, and Community through partition sales of Tenancies in common.” *Northwestern University Law Review*.

Moran E. F., A. Siqueira, and E. Brondizio. 2003. Household Demographic Structure and Its Relationship to Deforestation in the Amazon Basin 2003. In Fox J. R. Rindfuss S. Walsh and V. Sharma (ed) *People and the Environment Approaches for Linking Household and Community Surveys to Remote Sensing and GIS.* . Kluwer Academic Publishers.

Pascual Unai, B.B Edward. 2004. Poverty, labor allocation and soil use in Slash- and-burn Farming. (Accepted for publication in Journal of Development Economics).

Rindfuss, S. J. Walsh and V. Mishra. 2003. “Linking household and remotely sensed data: methodological and practical problems”. In Fox J. R. Rindfuss S. Walsh and V. Sharma (ed) *People and the Environment Approaches for Linking Household and Community Surveys to Remote Sensing and GIS.* . Kluwer Academic Publishers.

Schelhas, John and R. Zabawa 2000. *Minority and Limited Resource Landowners and Forests in the South: Developing Research Agenda*. Southern Research Station, Tuskegee University, Al.

Schulman, B.J. 1991. *From Cotton belt to Sun belt Federal policy, Economic Development, and the Transformation of the* South, 1938-1980. Oxford University Press.

Turner II B. L. and Jacqueline Geoghegan. 2003. Land cover and Land-use change (LCLUC) in the southern Yucatan Peninsular Region (SYPR): and Integrated Approach. In J Fox, R.R. Rindfuss, S. J. Walsh and V. Mishra (eds.) *People and the Environment Approaches for Linking Household and Community Surveys to Remote Sensing and GIS*. Kluwer Academic Publishers.

USDA, National Agricultural Statistical Service, 1999. 1997 Census of Agriculture Alabama State and County Data.

Wallace I. and D.B. Knight 1996. *Societies in Space and Place. In Hampson, F. O. and J. Reppy (eds) Earthly Goods Environmental Change and Social Justice.* Cornell University Press: 75-96.

Walsh Stephen J., R.E. Bilsborrow, S.J. McGregor, B. G. Frizelle, J. P. Messina, W. k.T. Pan, 2003. Integration of Longitudinal Surveys, Remote Sensing Time Series and Spatial Analyses: Approaches for Linking People and Space. In Fox J. R. Rindfuss S. Walsh and V. Sharma (ed) *People and the Environment Approaches for Linking Household and Community Surveys to Remote Sensing and GIS.* . Kluwer Academic Publishers.

Author Information

Buddhi Gyawali, Graduate Student, Center for Forestry and Ecology, Alabama A&M University, P.O. Box. 1208, Normal, Al.
Tel phone # 256-372- 4238
Fax # 256-372-5429
Email: buddhigyawali@hotmail.com

Wubishet Tadesse, Assistant Professor, Center for Forestry and Ecology, Alabama A&M University, P.O. Box. 1208, Normal, Al.
Tel phone # 256-372- 4252
Fax # 256-372-5429
Email; wtadesse@aamu.edu

Rory Fraser, Associate Professor, Center for Forestry and Ecology, Alabama A&M University, P.O. Box. 1208, Normal, Al.
Tel phone # 256-372- 4217
Fax # 256-372-5429
Email. Rory.fraser@email.aamu.edu

Yong Wang, Associate Professor, Center for Forestry and Ecology Alabama A&M University, P.O. Box. 1208, Normal, Al.
Tel phone # 256-372- 4229
Fax # 256-372-5429
Email: ywang@aamu.edu