International Journal of Ecology & Development
Fall 2009; Vol. 14, No. F09 ; Int. J. Ecol. Dev.
ISSN 0972-9984 (Print); ISSN 0973-7308 (Online)

Human Well-Being and Land Cover Types in the Southeastern U.S.A.

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ABSTRACT

The west-central region of Alabama is rich in natural resources. Yet changes in land use seem unrelated to improvements in human well-being. Satellite imagery and U.S. census data for 1980 and 2000 were analyzed to test whether changes in land cover were related to changes in a human well-being index - of income, employment, and education at the Census Block Group (CBG) level. A spatial regression model revealed that considerable human well-being improvements were only weakly, though significantly, correlated with changes in land covers. This relationship varied over geographic locations in response to the initial human well-being and socioeconomic conditions as well as changes in racial composition, population structure, income distribution, and industry structure. The results suggest that lack of understanding of the regional phenomenon may increase the risk of misguided economic development policies.

Key Words: African-Americans, Census Data, Human Well-being, Land Cover, Satellite Imagery

JEL Classification: O13, O18, R12, R14.

Mathematics Subject Classification: 62-xx: 62Hxx, 62-xx: 62Jxx

1. INTRODUCTION

Understanding the relationship between people and natural resources has been a priority research area since the mid-1900s (Gasper 2004; MEA 2003; Stedman et al. 2004; Vemuri and Costanza 2006). Studies explaining this relationship have become more complex and challenging due to the changing dynamics of the measures of human well-being and access and use of natural resources (Donoghue and Sturtevant 2007; Fox et al. 2003; McGillivray and Clarke 2006). This paper presents an exploratory attempt to examine the relationship between changes in human well-being and changes in land cover. The objectives of the research were: (1) to examine the relationships between human well-being and major land cover types in 1980 and in 2000, and (2) to examine the relationship between the changes in human well-being and changes in land cover types over the 20-year period.

The study area is Alabama's west-central region, one of the largest contiguous area in the southern United States in which a minority (African-American) group makes up a majority (66%) of the population Gyawali et al. 2007). This is an endemically poor area with a wealth of forest resources

(Bliss and Bailey 2005). The region includes eight counties (Dallas, Greene, Hale, Lowndes, Marengo, Perry, Sumter, and Wilcox), which were among the 100 poorest counties in the nation with poverty rates (37%) for the African-American population twice as high as the rate (17%) for the rest of Alabama's population (Geolytics 2005).

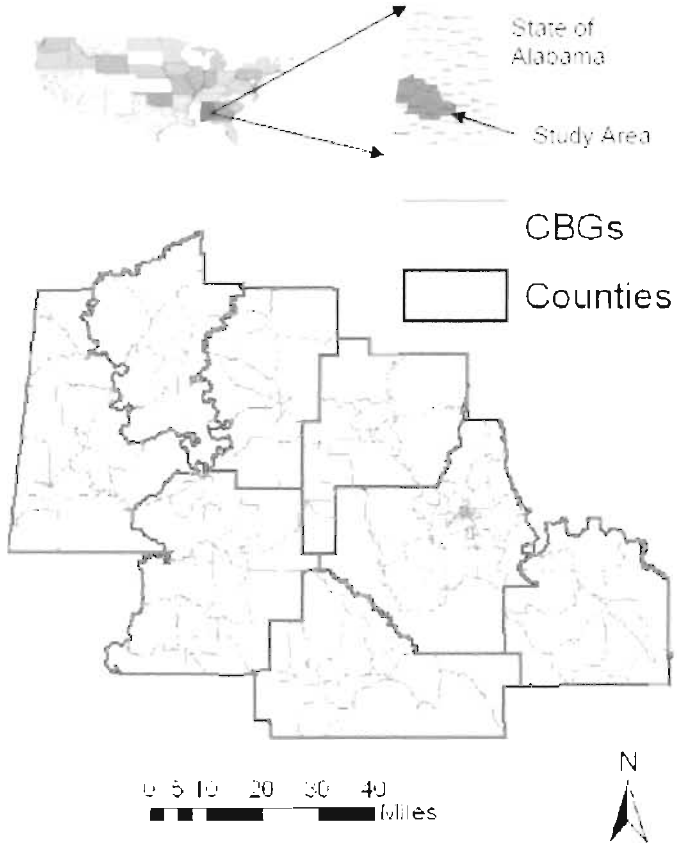

Figure 1. Study Area showing eight Counties and 161 Census Block Groups (CBGs) in the West-central Region of Alabama

Natural resources have acted as an engine of economic growth in Alabama (Sinclair et al. 2003). As a result of the civil rights movement, federal and state policies as well as local initiatives in Alabama's Black Belt were aimed at the effective management of lands and the development of infrastructure based on equitable civil and landownership rights, and improved access to education and employment (Joshi et al. 2000). Since the 1970s, these efforts have been focused on realizing the economic potential of forest resources by targeting pulp and paper industries in the expectation they would bring jobs and revenues to local communities (Bliss and Bailey 2005). Monoculture pine plantations were introduced and land owners were encouraged to become involved in meeting the favorable national and international demands for timber. Federal, state, and community, as well as financial and manufacturing institutions emerged to facilitate the development of the nascent forestry sector (Onianwa et al. 2004). Forestry operations led to a change in land use and land cover patterns as the landscape was transformed from an industrial farming system to an industrial timber production system (Fraser et al. 2005). These modifications in landscapes, policies, and community actions produced differential socioeconomic influences in the region: some communities prospered while others became more economically vulnerable.

2. METHODOLOGY

Our study is one of the first attempts to use spatial regression models to examine the relationship between land cover and human well-being at the sub-county level. U.S. Census and classified remotely-sensed satellite imagery data at the Census Block Group (CBG) level were used to examine the intra-county variations in land cover types, human well-being indicators, and other social and economic factors. Analyses at the CBG level utilized the lowest geo-political level at which reliable and valid data are available. This study goes beyond previous studies such as Howze et al. (2003), Joshi et al. (2000), and Norton et al. (2003), which relied on county-level socio-economic and forest inventory data in their examinations of the relationship between timber dependency and economic development in the southern United States.

2.1 Data Preparation and Variables Description

Demographic and socioeconomic data were obtained from the Time Series Research Package released by Geolytics Inc. (Geolytics 2005). These data are available for each CBG in Alabama for 1980 and 2000. Income, education, and employment data were used to develop a well-being index for 1980 and 2000. These measures incorporate three basic factors considered important in the Millennium Ecosystems Assessment (MEA) concept of human well-being (MEA 2003). The measure of education is the percentage of persons over 24 years old who graduated from high school and then from college. The measure of income is per capita income in real (2000) dollar values. The employment measure is represented by the percentage of persons 16 years and older who were employed. Indexes of income (I_{in}), high school (I_{hs}) and college education (I_{ge}), and employment (I_{em}) were created as per UNDP (2005). For instance, the per capita income index was created using the following equation:

$$I_{in} = \frac{(X_{in} - MinimumX_{in})}{(MaximumX_{in} - MinimumX_{in})} \quad \text{.........(1)}$$

where X_{in} is the average per capita income for a CBG, and $MaximumX_{in}$ and $MinimumX_{in}$ are the highest and lowest average per capita income, respectively, for all CBGs. These index values were computed in order to normalize the values of the variables included in the Human Well-being Index (HWBI), so that all values would fall between 0 and 1 (UNDP 2005). Then, the four indexes were averaged to obtain the HWBI for each CBG (Bukenya and Fraser 2004; UNDP 2005).

$$HWBI_{x} = \left(\frac{I_{in} + I_{hs} + I_{ge} + I_{em}}{4}\right) \quad \text{.........(2)}$$

Table 1. Variables Description for the Relationship between Human Well-being and Land Cover Types in 1980, 2000, and 1980-2000 in the West-central Region of Alabama

Variables	Description	Variable Type
Human well-being	A composite index of education, income, and employment indices (ranges from 0 to 1).	HWBI
Change in well-being	Differences in human well-being index	ΔHWBI
Population Density	Population per acre	SEF
African-American	Percentage of Black population	SEF
Income Inequality	Gini Coefficient (ranges from 0-1)	SEF
Age Dependency Ratio	Ratio of % of persons <15 years and > 64 years to % of persons in the economically productive (16-64 years) years (ranges from 0 to 1)	SEF
Farm/Forestry Jobs	% of work age pop. in farm/forestry jobs	ISF
Manufacturing Jobs	% of work age pop. in manufacturing jobs	ISF
Farm/Forestry Firms	% of county's firms in the agricultural sector	ISF
Manufacturing Firms	% of county's firms in the manufacturing sector	ISF
Change in Population Density	Differences in population density	ΔSEF
Change in Race	Differences in % of African-American population	ΔSEF
Change in Age Dependency	Differences in age dependency ratio	ΔSEF
Change Income Inequality	Differences in Gini Coefficient	ΔSEF
Change F/F jobs	Differences in the % Farm/Forestry jobs	ΔISF
Change Mfg. jobs	Difference in the % manufacturing jobs	ΔISF
Change in F/Firms	Differences in the % Farm/Forest firms in county	ΔISF
Change in Mfg. Firms	Difference in the % Manufacture firms in county	ΔISF
Pine Plantations	% of lands in pines in a CBG	LCT
Hardwood Forests	% of lands in hardwood forests	LCT
Mixed Forests	% of lands in mixed forests	LCT
Cropland	% of lands in croplands	LCT
Pastures	% of lands in pasture	LCT
Developed Land	% of lands in developed areas	LCT
Inland Water	% of lands under water	LCT
Changes in Pines Plantations	Differences in % of lands in pines	ΔLCT
Change in Hardwoods	Differences in % of lands in hardwoods	ΔLCT
Changes in Mixed Forest	Differences in % of lands in mixed forest land	ΔLCT
Change in Pastures	Differences in % of lands in pasture	ΔLCT
Change in Cropland	Differences in % of lands in cropland	ΔLCT
Change in Developed land	Differences in % of lands in developed areas	ΔLCT
Change in Inland Water area	Differences in % of lands under water	ΔLCT

Differences denote the difference in the corresponding values between 1980 and 2000.

Land cover change data were obtained from the classification of terrain corrected Landsat Thematic Mapper (TM) and Landsat Enhanced Thematic Mapper (ETM+) for 1980 and 2000. The study area (-86.4° to -88.4° East, 31.13° to 33° North) is covered by 3 scenes (Path/Row: 21/37, 21/38, and 20/38). All scenes were acquired from USGS/EROS data center, Sioux Falls, South Dakota, U.S.A. A hybrid classification approach using both unsupervised and supervised techniques was employed to derive accurate and reliable land cover classes (Lillesand et al. 2004). Anderson's Level II classification scheme was primarily employed to define the major land cover types (Anderson et al. 1976). Classified images were further corrected by using a 3x3 model filter to remove any noise pixels, which could have occurred due to the result of spectral mixing within a pixel (Lillesand et al. 2004).The seven land cover classes in the classified thematic map were: (1) evergreen forests, (2) mixed forests, (3) deciduous forests, (4) croplands, (5) pasture lands, (6) developed lands, and (7) water. The overall accuracy of the 1980 and 2000 classified images were 87.20% and 88.20%, respectively.

ArcGIS 9.1 software was used to extract land cover data (ESRI 2005). The classified images of 1980 and 2000 were overlaid on the CBG vector layer to extract area covered by each land cover types in each CBG in 1980 an 2000. There were 161 CBGs in the study region. The area (acres) of each land cover class in each CBG was extracted and the change in a land cover in a CBG was computed by subtracting the area covered by that land cover type in 1980 from the area covered by the same land cover in 2000.

Variables (Table 1) were included in the regression analysis as controls in determining if the change in the human well-being was a result of the initial socio-economic conditions or actual changes in land cover types. Four socioeconomic factors (SEF) – population, race, age dependency ratio, and income inequality – have often been identified as important variables. Population density among other things is an indicator of the availability of a labor force as well as the level of urbanization, i.e. measures of economic development potential (Levernier et al. 2000). Racial segregation of space in this region was evident from prior research and, therefore, race had to be a factor considered in this study (Onianwa et al. 2004; Schelhas et al. 2003). Age distributions in populations have been shown to be connected to poverty rates (Albrecht and Albrecht 2007; Crandall and Weber 2004). Hammond (2006) theorized income inequality is a major driving force for regional economic growth in depressed regions because it serves as a stimulus for investors to create jobs and promote economic growth. Gini Coefficients for 1980 and 2000 were computed using the gross income and household distribution information within each CBG in the corresponding years. A Gini coefficient is a measure of the inequality in the distribution of income; it ranges from 0 to 1, a larger *Gini* suggesting more inequality.

Four industry factors (ISFs) were also considered as control variables. Literature suggests that the manufacturing sector and associated jobs are often the force driving the economies of resource-dependent communities (Bliss and Bailey 2005). Joshi et al. (2000) have found the changing structure of industries has affected well-being in many rural communities of Alabama. The percentage of county-level firms listed as manufacturing and farm and forestry establishments were computed from National Historical Geographic Information System data (Adams et al. 2004). Employment statistics for the manufacturing and farm and forestry sectors in the CBGs were obtained from Census Data.

2.2 Empirical Models

Initially, the following three Ordinary Least Square (OLS) models were estimated in examining the relationship between human well-being and land cover types in 1980 and 2000, and between 1980 and 2000:

$$HWBI_{1980} = \alpha + \beta_0 SEF_{1980} + \beta_1 ISF_{1980} + \beta_2 LCT_{1980} + e_{1980} \quad \text{.........(3)}$$

$$HWBI_{2000} = \alpha + \beta_0 SEF_{2000} + \beta_1 ISF_{2000} + \beta_2 LCT_{2000} + e_{2000} \quad \text{.........(4)}$$

$$\Delta HWBI = \alpha + \beta_0 SEF_{1980} + \beta_1 ISF_{1980} + \beta_2 LCT_{1980} + \beta_3 \Delta SEF + \beta_4 \Delta ISF + \beta_5 \Delta LCT + \beta_6 HWBI_{1980} + \varepsilon, \quad \text{.........(5)}$$

where *HWBI* (dependent variable) is the human well-being index in a CBG in either 1980 or 2000, LCT is a vector of seven land cover types, and SEF and ISF are vectors of four socioeconomic and four industrial structure factors in a CBG, respectively. In equation 5, Δ indicates change in the variable between 1980 and 2000, LCT_{1980}, SEF_{1980}, ISF_{1980}, and $HWBI_{1980}$ denote the initial conditions of LCT, SEF, ISF, and HWBI in 1980 (see Table 1).

Later, to take account for spatial dependence, we modified the OLS models by including the spatial lag (Equations 3a, 4a, and 5a) using GeoDa 0.9.5-i5 spatial statistical package (Anselin 2003).

$$HWBI_{1980} = \alpha + \rho WHWBI_{1980} + \beta_0 SEF_{1980} + \beta_1 ISF_{1980} + \beta_2 LCT_{1980} + e_{1980} \quad \text{......................(3a)}$$

$$HWBI_{2000} = \alpha + \rho WHWBI_{2000} + \beta_0 SEF_{2000} + \beta_1 ISF_{2000} + \beta_2 LCT_{2000} + e_{2000} \quad \text{......................(4a)}$$

$$\Delta HWBI = \alpha + \rho W\Delta HWBI + \beta_0 SEF_{1980} + \beta_1 ISF_{1980} + \beta_2 LCT_{1980} + \beta_3 \Delta SEF + \beta_4 \Delta ISF + \beta_5 \Delta LCT + \beta_6 HWBI_{1980} + \varepsilon \quad \text{...............(5a)}$$

where scalar ρ is the spatial lag coefficient to be estimated, $WHWBI_{1980}$, $WHWBI_{2000}$, *and* $W\Delta HWBI$ are the spatially lagged dependent variables for a spatial weights matrix for 1980, 2000, and 1980-2000 models, respectively, and ε is a vector of error terms conforming to normality and homoscedasticity requirements. In other words, $WHWBI_{1980}$, $WHWBI_{2000}$, and $W\Delta HWBI$ in a CBG are the spatially weighted average of all other adjacent CBGs' HWBI in 1980 and 2000, and the change in adjacent CBGs' *HWBI* between 1980 and 2000, respectively. The weight matrix *W* was constructed using first-order binary "rook contiguity" (0 if non-contiguous and 1 if contiguous). The spatially lagged endogenous variables ($\rho WHWBI_{1980}$, $\rho WHWBI_{2000}$, and $\rho W\Delta HWBI$) in equations 3a, 4a, and 5a for the dependent variables accounts for spillover effects from neighboring CBGs (Anselin 2003; Janikas and Rey 2005).

3. RESULTS

3.1 Descriptive Statistics

Human well-being indexes increased on average across the region. There was an overall 6% increase, from 0.49 to 0.52, in the average HWBI between 1980 and 2000 (Table 2). There were significant improvements in incomes, employment and education across the CBGs with some areas seeing large positive changes. However, there is a widening gap between the "haves" and "have-nots". In 54 CBGs, the HWBI declined between 1980 and 2000. The range of HWBI was wider (minimum lower and maximum higher) in 2000 than in 1980 and there seems to be some spatial pattern developing with areas in and around Demopolis (Marengo County) doing exceedingly well while some areas in next door Sumter and Wilcox Counties were in deep decline. The inference here is that while there has been an improvement in incomes, this was enjoyed by a few and the majority may not have seen the same level of improvement.

The most noticeable change in this region was the increasing urbanization of CBGs and the decrease in cropland areas (Table 3). Developed land increased by 56% over the 20-year period. The changes in developed land were most apparent along the major road corridors such as U.S. Highway 80. Meanwhile, there was a 63% decline in the average lands classified as crops in the CBGs. Much of the decline was evident in the northwestern and southeastern areas.

Table 2 Descriptive Statistics of the Dependent and Independent Variables used for the Relationship between Human Well-being and Land Cover Types in 1980, 2000, and 1980-2000.

Variables	Minimum		Maximum		Mean		% Change in Mean*
	1980	2000	1980	2000	1980	2000	1980-2000
Total Population	433.00	314.00	2,555.00	2,459.00	1,034.33	929.39	-10.15
Population Below poverty%	6.79	0.00	64.06	73.82	36.82	31.80	-13.63
Population Density (per acre)	0.01	0.01	15.70	9.70	1.10	0.84	-23.64
African Americans%	5.06	0.91	91.37	100.00	61.55	65.74	6.81
Non-African Americans%	8.43	0.00	94.44	99.09	38.12	33.25	-12.78
Age Dependency Ratio	0.61	0.16	1.09	1.63	0.80	0.67	-16.25
Gini Coefficient	0.15	0.15	0.42	0.58	0.28	0.34	21.43
Farm/Forestry Jobs%	0.42	0.00	13.19	12.58	2.68	1.79	-33.21
Farm/Forestry Firms%	0.00	1.48	3.49	11.21	1.46	4.17	185.62
Manufacturing Jobs%	3.50	0.00	23.04	26.14	13.20	10.45	-20.83
Manufacturing Firms%	7.81	3.78	25.20	9.33	12.00	5.69	-52.58
HWBI Indicators							
High School Graduates%	8.03	8.84	38.23	54.68	27.52	33.58	22.02
Bachelor Graduates%	2.14	0.00	22.18	56.10	9.88	11.85	19.94
Employment%	25.72	22.01	62.44	70.54	45.59	42.64	-6.47
Per Capita Income (in 2000 $$ value)	4,452.00	4,814.00	19,917.00	42,986.00	9,834.00	13,094.00	201.51
HWBI	0.32	0.24	0.69	0.82	0.49	0.52	6.12

HWBI = Human Well-being Index, * = $[(Mean_{2000} - Mean_{1980})/Mean_{1980}]*100$.

Table 3. Descriptive Statistics of Land Cover types in the CBGs for 1980, 2000, and 1980-2000

Land Cover types	Min. (%)		Max. (%)		Mean (%)		% change in mean
	1980	2000	1980	2000	1980	2000	1980-2000
Developed land	0.22	1.13	94.42	98.39	10.96	17.07	55.74
Water	0.00	0.00	21.96	22.19	2.43	3.61	48.55
Pastureland	0.00	0.00	34.01	57.69	8.78	12.43	41.57
Evergreen	0.00	0.00	37.23	48.55	10.57	16.70	58.00
Mixed Forest	0.00	0.00	34.77	19.08	14.41	7.41	-48.58
Cropland	0.52	0.00	64.42	28.41	21.81	8.11	-62.81
Hardwoods	0.47	0.40	62.76	56.81	31.04	34.67	11.69
Total Forest land	0.47	0.40	92.50	90.46	56.02	58.78	4.93
Total Ag. Land	0.52	0.00	76.43	66.43	30.59	20.54	-32.85

Total Forest land = Evergreen + Hardwood + Mixed,
Total Agricultural land = Cropland + Pasture Land,
% change in mean = $[(Mean_{2000} - Mean_{1980})/Mean_{1980}]*100$

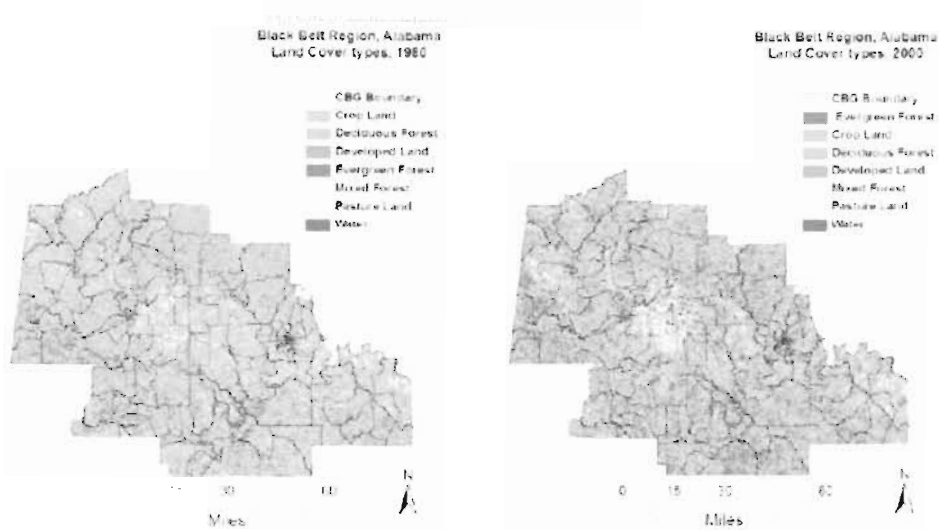

Figure 2 Land Cover Types Showing Seven Land Cover Classes in 1980 and 2000 in the West-central Region of Alabama

There was an increase in forests throughout the region (5%) and decline in agricultural land (33%). Evergreen forests (Pine plantations) increased both in area (58%) and in concentration. The maximum distribution of evergreen (pine) forests in a CBG increased from 37% to 49% over the 20-year period. Deciduous (hardwood) forests also increased 12% in the area, but the allocation was more evenly distributed. The maximum concentration of these forests decreased from 63% to 57% in a CBG. Mixed forests declined from 14% to 7% and their concentration decreased in some CBGs. These results are consistent with the Forest Inventory Analysis (FIA) data for 1980 and 2000 for these counties (Hartsell and Brown 1999).

3.2 Regression Analysis

3.2.1 Human Well-Being and Land Cover in 1980 and 2000

The spatial lag model for 1980 was highly significant (likelihood ratio test = 43.12, $P < 0.01$) and was free of multicollinearity and heteroscedasticity (a Breusch-Pagan test was not significant at $P < 0.1$ level). There were significant relationships between human well-being and two land cover variables: percentages of regenerating (mixed) forests and pastureland in the CBGs (columns 2 and 3, Table 4). The three control variables of statistical significance in the model were all negatively correlated with human well-being. The ratio between the dependent and economically active populations was the significant socioeconomic variable while manufacturing jobs in the CBGs and manufacturing firms in the counties were the two significant industry structure variables. The spatial lag (*rho*) estimate was highly significant (0.58) suggesting a positive neighborhood effect on human well-being in a CBG. This model explained 55% ($R^2 = 0.55$) of the variations in human well-being. Almost two-thirds of the variation (36.4%) was explained by the two resource (mixed forests and pasture land) variables (change in R^2 = 0.15) and spatial lag variable (change in R^2 = 0.214), when the three control variables were first included into the model.

The spatial lag model for 2000 was also highly significant (likelihood ratio test = 11.21, $P < 0.01$) and free of multicollinearity and heteroscedasticity (columns 4 and 5, Table 4). The 2000 model explained 73% of the total variance (total R^2 = 0.727), 18% more than the 1980 model. The two land cover variables were significant and positive: percentages of hardwood forests and developed lands in the CBGs. At the same time, income inequality (Gini Coefficients), and employment in both the manufacturing and farm/forestry sectors in the CBGs were also positive and significant. Two other control variables, percentages of African-Americans and ratio of dependents in a CBG, were significant and negative. The spatial lag variable was also significant (*rho* = 0.25), but its influence on well-being of a CBG was less than it was in 1980. Also, the improvements in R^2 values based on the contributions of the land cover variables and the spatial lag variable were relatively small (2.2% and 2.5%, respectively) when the five significant control variables were first included into the model. This suggests that socioeconomic factors explained a great deal more in 2000 than they did in 1980, while land cover types and clustering effects were much less.

3.2.2 Changes in Human Well-Being and Changes in Land Cover

The results of the spatial lag model (1980-2000) suggests that there is a small but significant relationship between change in the land cover and the changes in human well-being of people living in census block groups of this area[1]. This relationship became stronger when the underlying socioeconomic factors, initial conditions of land covers, and spatial dynamics (equation 5a) were factored into the analysis (columns 6 and 7, Table 4). The final spatial lag model was significant (likelihood ratio test = 4.36, $P < 0.1$) and was free of multicollinearity and heteroscedasticity (Breusch-Pagan test was not significant at the 10% level) Overall, the variables explained a large amount (R^2 = 0.86) of the variations in the changes in human well-being in the CBGs.

Five land cover variables were significant. Two of these variables were positive: changes in the percentages of hardwood forests and water. Three of the variables were negative: changes in the percentages of mixed forests and croplands, and the initial percentage of mixed forests in a CBG in 1980. However, there were nine underlying social and economic factors that influenced changes in human well-being. Three of these were the initial conditions in 1980 - i.e., human well-being, percentage of African-Americans in the CBG, and the percentage of firms in a county's farm/forestry sector. Changes in socioeconomic variables were also significant. Four of these variables were negative and two were positive. The changes in percentage of African-Americans and dependency ratios in a CBG, as well as the changes in the percentages of manufacturing and farm/forestry firms in a county were significant and negative. Positive changes in *Gini* coefficients and percentages of manufacturing jobs were associated with positive changes in human well-being. The spatial lag (*rho*) estimate was positive (0.13) and significant (z-value = 2.16). This suggests a positive neighborhood effect on the change in human well-being in a CBG.

[1] The explanatory power of the regression model between change in HWBI against the seven changes in land cover types variables only was low (R^2= 0.051, F = 2.43, p <0.05), which is not reported in Table 4.

Table 4. Results of Spatial Lag Model for Predicting the Relationship between Human Well-being and Land Cover Types in 1980 and 2000 and between 1980 and 2000.

Variables	1980 Model		2000 Model		Change Model	
	β coef. 1980	z-value	β coef. 2000	z-value	β coef. 1980	z-value
Constant	0.87***	13.55	0.50***	11.24	0.02***	6.23
Population	ns		Ns		ns	
African-Americans	ns		-0.48***	8.07	-0.06**	10.53
Income Inequality	ns		0.25***	4.48	ns	
Age Dependency Ratio	-0.16***	2.53	-0.12***	2.68	ns	
Farm/Forestry Jobs	ns		0.15***	3.21	ns	
Manufacturing Jobs	-0.26***	4.02	0.16***	3.62	ns	
Farm/Forestry Firms	Ns		Ns		-0.01**	2.61
Manufacturing Firms	-0.22***	3.01	ns		ns	
Well-being in 1980			ns		-0.10**	18.57
Pines Plantations	ns		ns		ns	
Hardwood Forests	Ns		0.09*	1.63	ns	
Mixed Forests	0.15**	2.44	ns		-0.02**	3.92
Cropland	ns		ns		ns	
Pastureland	-0.11*	1.89	ns		ns	
Developed Land	ns		0.19***	3.16	ns	
Inland Water	ns		ns		ns	
B. Changes in variable					**1980-2000**	
Population					ns	
Race					-0.04**	8.07
Income Inequality					0.02**	4.04
Age Dependency Ratio					-0.01**	2.64
Farm/Forestry Jobs					ns	
Manufacturing Jobs					0.01**	2.90
Farm/Forestry Firms					-0.03**	3.08
Manufacturing Firms					-0.04**	3.56
Pines Plantations					ns	
Hardwood Forests					0.01*	2.47
Mixed Forests					-0.03**	5.05
Cropland					-0.02***	4.15
Pastureland					ns	
Developed Land					ns	
Inland Water					0.01**	2.61
Rho (spatial lag)	0.58***	7.71	0.25***	3.48	0.13*	2.16
R Square	0.55		0.73		0.86	
Log Likelihood	-172.01		-124.22		260.11	
MCN	1.86		2.75		6.57	
Breusch-Pagan test	2.18 (ns)		11.75 (ns)		17.27 (ns)	
Likelihood Ratio test	43.12***		11.21***		4.36*	

Only significance β-values are reported. z-values are absolute values.
ns = non-significant at >0.1 level, ***= 0.01, ** =0.05, * = 0.1 level, MCN = Multicollinearity Condition Number

4. DISCUSSION

This paper examined the relationship between changes in human well-being and changes in the land cover types. The relationship was examined by estimating three models for 1980, 2000, and between 1980 and 2000. The first two models provided the type of land covers that were more likely to impact human well-being in 1980 and 2000. The third model used changes in human well-being as the dependent variable and changes in land cover types between 1980 and 2000, and land cover types in 1980 as independent variables. This third model included spatial and control variables such as socioeconomic and industry factors.

The natural resource base in the study area underwent major changes between 1980 and 2000. First, there has been significant conversion of croplands to other land uses such as pine plantations and urbanized spaces, as well as the reversion of some areas to hardwood forests. At the same time, hardwood forests replaced some pine stands and mixed forests. Pine plantations replaced mixed forests, which were declining over the region. Urbanization occurred at a rapid pace as some forest and agricultural lands were developed into residential or developed and industrial spaces. Inland water systems increased as fish ponds became more evident over the landscape. Cropland areas decreased and concentrated more in rural areas.

A relatively large significant relationship between HWBI and land cover types in 1980 declined precipitously by 2000. Among the most revealing points of this analysis is the negative relationship between pastureland and HWBI in 1980 and the positive relationship between HWBI and developed lands in 2000. What is also revealing is the increasing importance of racial composition, income distribution and employment in the manufacturing and farm/forestry sector in 2000.

The study found a significant relationship between changes in human well-being and land cover types in the study region. However, the relationship was constrained by the initial socioeconomic, well-being, and land cover type conditions. These results suggested that CBGs in the study area with increased populations of African-Americans and dependents, and increased agricultural and manufacturing firms, mixed forests, and croplands experienced a decline in the human well-being index over the twenty-year period. On the other hand, the results indicated an increase in the human well-being index in the areas that experienced increased income inequality, manufacturing jobs, hardwood forests, and inland water areas. These relationships occurred where there were a lower percentage of African Americans, agricultural firms and mixed forests, and low human well-being index in 1980. The study found a contrast in well-being indicators for African-Americans and whites in 1980 and 2000. More importantly, spatial effects contributed positively to the increase in human well-being.

These results indicate that changes in human well-being over the twenty-year period was not as obviously affected by endogenous changes in local land cover types as expected by policy makers and suggested by researchers. The dynamics of race, income distribution, and family and industry structures were also important in enhancing or undermining human well-being. These findings call for more discussion and research on the rural socioeconomic development strategies in Alabama's Black Belt, which have become fixated on industrialization of the natural resource sectors e.g. agriculture and forestry to generate employment and income earning opportunities.

These findings are consistent with anecdotal evidence (Joshi et al. 2000) and county level analyses (Holmes 2002). However, this study goes beyond prior studies in three fundamental ways. First, we explicitly included land cover variables. Next, we used a finer geographic scale. And finally, we incorporated the socioeconomic context of the units of analysis. In the process, this study provides area- specific, explicit statistical analyses of the relationships between people and local resource bases. Estimating the strength of the contribution of land cover to well-being also provides a better understanding of the limited extent of the relationship. Disaggregating and estimating the strength of the contributions of industry and spatial factors provide a new approach to examining the effects of agglomeration, clustering, and land cover. These improvements in the specification of empirical models have provided more definitive inferences about the linkages between people and the local resource base.

5. CONCLUSION

This paper presents an exploratory and innovative attempt to detect a statistically significant relationship between land cover changes and human well-being changes in one of the poorest regions in the United States. The analysis was conducted at the sub-county level and controls for spatial clustering, and initial resource and socioeconomic conditions. The results indicate clearly that land cover changes had very little influences on changes in human well-being in the study region between 1980 and 2000. The initial well-being and the initial and changing conditions of race, in large measure, dictated how well-being in CBGs changed over the period. The results indicated that not much of the changes in human well-being indexes are explained by endogenous changes in the local resource base. These changes are related to other factors such as race, income distribution and exogenous factors such as industry restructuring and urbanization.

The findings also raise some interesting questions about natural resource-based economic development. More specifically, would these results be consistent with sub-county level studies of regions with similar characteristics of forest dependency? It also brings into question rural socioeconomic development strategies that assume a logical "connection" between development of natural resources and human well-being (Bliss and Bailey 2005). Lack of understanding of this sub-county or regional phenomenon may increase the risk of misguided economic development policies. The methodology adopted in this paper can be applied to larger geographic areas such as the state or the entire forest-dependent region of the southern United States.

Acknowledgments

The authors would like to thank the anonymous reviewers of the manuscript for their suggestions and comments. The authors would also like to thank the USDA Forest Service, the Alabama Agricultural Land Grant Alliance (AALGA), and the National Science Foundation (NSF-0420541-HRD) for providing financial support for this study.

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