

Forces of Change

Watauga County, North Carolina

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A Report Created For the MountainKeepers



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Forces of Change

I. Introduction

The last thirty years have seen unprecedented growth in Watauga County, North Carolina. Since the early 1970s, the area has transformed from a small mountain college community into a major tourist center. At the same time, Appalachian State University has continued to expand, thus contributing to the growth of the area.

As the population has increased, the demographic makeup of the area has changed, from one dominated by multi-generational residents with a long local heritage to a populace consisting of numerous groups, differing not only in age and race, but also attitudes and belief systems.

As the population has grown and diversified and subsequent development occurred, local governmental officials have come under pressure to take prudent steps to manage said growth. Subdivision ordinances and other forms of land use controls have been utilized to influence growth while not stifling it.

Population increase and related development in this region is a two-edged sword. The increased building seen over the last thirty years has stimulated the local economy, providing many jobs and a healthy construction-based sector. Additionally, other service industries have also benefited directly and indirectly from the influx of tourists, college students and faculty, and second-home owners that have come to the area during the last thirty years.

The increased population and resultant construction has also placed unprecedented pressure on the local environmental resources of the region. Forest and agricultural land have been converted to various types and scales of developed land in order to house the increased population and continue to support the growing economy.

In recent years, local governmental officials of the region have faced the daunting task of trying to balance the economic benefits of increased development and its related amenities with the conservation of the natural resources of the region, which make the area the unique place and destination that it is. Subdivision ordinances and other forms of land use controls are in place in Watauga County, but some citizens feel that more needs to be done. Other citizens are happy with the status quo and are concerned that increased controls will negatively affect the local economy as well as impinge on private property rights.

This report, based on scientific evidence generated using Geographic Information System (GIS) and Remote Sensing technology as well as analysis of socioeconomic data, intends to lend some science to the ongoing debate concerning land cover change and possible controls in Watauga County, NC. It seeks to answer two questions:

- 1) How much did land cover change in Watauga County, NC between 1986 and 1999? (How much development occurred during that period?)
- 2) What forces drove that change? (and continue to influence land cover change in Watauga County?)

This report was generated by a private company, funded through a grant from the Z. Smith Reynolds Foundation, disseminated through the MountainKeepers, a non-partisan group of local individuals dedicated to educating the public on various issues and providing numerous service projects. This report has attempted to focus on providing information that will hopefully be used as a resource by the citizens and local government to make the best choices for the future of the economy and natural resources of Watauga County for years to come.

II. Background

Physical Environment

Watauga County is nestled in the northwestern portion of North Carolina on the eastern side of the Blue Ridge Mountains. The land is quite mountainous by eastern United States' standards, with an average slope of 17.37 percent (See Maps 1 and 2). Elevation ranges from 1,350 feet above sea level on Elk Creek near the Triplett community in the extreme southeastern portion of the County to just under 6,000 feet atop Grandfather Mountain. Lush vegetation and abundant water dominate the natural environment, making for suitable habitat for numerous species of flora and fauna. The nature of the land varies, but tends to be rocky with rich soils.

Two rivers find their headwaters in Watauga County. The Watauga River actually begins just across the County line in Avery County, but increases substantially in size before entering Valle Crucis and heading into Tennessee via the Watauga River gorge. The internationally renown New River begins as three different forks within the eastern portion of the County. The Middle Fork finds its source in Blowing Rock while the South Fork begins just off the Blue Ridge Parkway near Price Park. The North Fork starts in the extreme northern portion of the County.

Although quite mountainous, the County does have two significant valleys. The Town of Boone lies in one of the valleys, situated in the center of the County. In the shadow of Howard's Knob and Rich Mountain, Boone sits at 3,200 feet above sea level. The other valley is located in the Sugar Grove community and is one of the prime agricultural locales within the County. Tobacco, corn, and other crops are still farmed in large fields in this portion of Watauga County.

Population and Municipalities

Boone is the largest town in Watauga County and the county seat (See Map 3). Blowing Rock is the next largest town and a tourism center, boasting great shopping and a vibrant downtown. Other towns include Beech Mountain and Seven Devils, both seasonal towns that tend to swell in the summer and winter.

Most of the permanent population of Watauga County resides in or around Boone, but is well dispersed throughout the county. Many folks reside north and west of Boone in the communities of Sugar Grove and Vilas, while Foscoe, located southwest of Boone on highway 105, has seen a distinct population increase in recent years. Many more reside near highway 421 toward Deep Gap and out highway 194 toward Meat Camp.

Many people live on land that's been in their family for a number of generations, but annually, more subdivisions are added to the County, where newcomers and second homeowners tend to purchase or build homes. In 2001, the MountainKeepers funded a project that examined the increase in subdivisions over a 20-year period. Two of the

SEE MAP 1.PDF

SEE MAP 2.PDF

SEE MAP 3.PDF

maps produced for that project displayed the locations of subdivided land in Watauga County in 1980 and 2001 (See Maps 4 and 5). Additionally, the acreage of properties in subdivisions were summarized and compared to determine the approximate increase in subdivided land over that study period.

It was found that subdivided land had increased in 21 years by over 300% (over 13,000 acres). It was inferred that not all of that land had necessarily been built upon or developed, but it seems logical that it was subdivided for imminent development at some time in the future.

Local Economy

- Tourism

Tourism is one of the most significant industries in Watauga County. Annually, thousands of tourists make their way to the area to enjoy the natural resources and optimal climate. The natural features noted above as well as man-made accommodations invite people from other parts of North Carolina and the entire southeastern United States to come to the area, stay awhile, and spend money. In turn, that money drives a large part of the economy by providing jobs and numerous opportunities for business.

Watauga County and the rest of the High Country of northwest North Carolina are year-round tourist centers with three distinct tourist seasons. In the summer, people come for the cool climate. In the fall, visitors arrive for the spectacular scenery and in the winter, winter sports enthusiasts descend on the area for a very unique recreation opportunity given the location. This is a distinctive difference when comparing the High Country to other tourist centers in this part of the country. Most other locales in western North Carolina have little or no winter tourist season. Other areas such as the coast do not have three healthy tourist seasons, as most visitors come during the summer season. This is important in terms of the effect on the local economy within Watauga County and also the pressure it puts on the area from a natural resource perspective. Tourism and its effects on the land cover and associated phenomena within the study area will be examined further in the *Analysis* chapter.

- Appalachian State University

One of the centerpieces of the local economy is Appalachian State University. Boasting an enrollment of over 12,500, ASU is the largest employer within Watauga County (See Table 1). Now over 100 years old, ASU has grown steadily in size and stature throughout its existence (See Table 2). There is no question regarding its importance to the local economy. However, the size of the University and non-stop growth over the late 20th century has significantly affected the land cover of Watauga County. These affects will be examined further in the *Analysis* section.

SEE MAP 4.PDF

SEE MAP 5.PDF

Table 1: Top Ten Employers in Watauga County, 2003
 Source: Boone Area Chamber of Commerce

Employer	Number of Employees
Appalachian State University	2200
Watauga County Board of Education	900
Watauga Medical Center	800
Beech Mountain Resort	350
IRC/TT Electronics	300
Appalachian Ski Mountain	275
Wal-Mart	270
Samaritan's Purse	251
Charleston Forge	250
Tweetsie Railroad	245

Table 2: ASU Enrollment, 1980-2002
 Source: Appalachian State University, Institutional Research and Planning

Year	Enrollment	Year	Enrollment
1980	9,794	1992	11,650
1981	9,690	1993	11,641
1982	10,051	1994	11,866
1983	9,844	1995	12,020
1984	9,507	1996	11,909
1985	9,760	1997	12,108
1986	10,419	1998	12,386
1987	11,070	1999	12,150
1988	11,130	2000	12,499
1989	11,501	2001	12,856
1990	11,483	2002	13,185
1991	11,367		

- Second Home Development

The unique nature of Watauga County and the High Country makes it an ideal location for second home development. With its cool climate, many upper class folks from areas such as the piedmont of North Carolina and Florida choose to have summer residences in the High Country.

Over the years, this steady influx has increased to the point that a significant number of the existing structures are second-homes and their owners definitely add to the

seasonal population increase found annually. This second home development serves the local economy by partially driving the construction sector and related services.

In addition, this healthy second home industry has driven up property values in Watauga County. Sales prices as well as tax values have climbed steadily and there appears to be no end in sight. Whether purchasing vacant land or a home, people can expect to pay top dollar for property in this area. A study funded by the MountainKeepers in 2001 examined average land value per acre per township in Watauga County, as determined by the County Tax Office. Those values per township ranged from \$1,245 per acre in the remote North Fork township located in the northern portion of the County to \$15,305 per acre in the Blowing Rock township to over \$60,000 per acre within the Boone township (See Map 6). Comparing those overall values to average values within subdivisions indicate that the subdivision of property is driving the overall land value averages skyward (See Map 7). Land value averages within subdivisions per township ranged from \$3,955 in the Beaver Dam township to \$24,703 in the Watauga township. Overall, the average land value countywide was more than 65% higher within subdivisions than outside of them. When you factor in that real estate tends to sell at around 30% more than the appraised value in this area, the costs for a home or land is quite expensive and the second home development is undoubtedly helping to drive these values up. Since the 2001 study, property values increased again due to the 2002 countywide tax revaluation.

Many of the second homes in the study area tend to be extremely high class and costly to build. It should be noted that many of these are not average homes by modern standards, but can be quite large and extravagantly designed. As a result, it takes much more to build these homes and thus, the effect resonates throughout the local economy.

- Agriculture

Agriculture has always been an important piece of the area economy and overall, still remains fiscally important. The industry has changed significantly in recent years however, as traditional crops production has decreased while the Christmas tree industry has grown.

It should be noted at this point that these two different types of agriculture do not typically compete for land. Traditional crops, such as corn, tobacco, and soybeans are best suited to the flat bottom land found primarily in the Sugar Grove and Todd areas while Christmas tree production occurs mostly on steeper slopes all over Watauga County. This is an important fact to consider as it relates to the forces affecting land cover change within the County. At this time, traditional farmland occupies some very valuable property. In addition to the flat nature of this land, much of it abuts picturesque waterways and makes for ideal development property where it is not in the floodplain.

Conversely, Christmas tree farms occupy land that many times would otherwise be relegated to timber. Much of it faces north and tends to be steeper. Many enterprising

SEE MAP 6.PDF

SEE MAP 7.PDF

landowners have chosen to use the otherwise unusable land (in many cases) as a means of income. In some cases, this can be considerable, based on the size of the farm and entrepreneur's sales and distribution abilities. Some Christmas tree farms are also on valuable land suitable for development, but not exclusively relegated to it as with traditional crops.

While the taxable value of their land has increased over the years, landowners who wish for their land to remain agricultural can take advantage of specific North Carolina tax laws and government programs. The Present-Use-Value program set up via the Machinery Act allows landowners to register portions of their property as producing cropland with the County Tax Office, giving them decreased tax values as long as the land remains in production. In addition, the Voluntary Farmland Preservation program administered by the County allows farmers similar benefits. Were it not for these programs, it is possible that many of the remaining farms may have ceased production and been sold and / or subdivided for residential or commercial purposes.

With Christmas tree farms, the pressure to sell is not always as strong since often the land is typically not ideal for development. Additionally, Christmas tree farms are usually also included in the aforementioned government programs, giving the landowners some tax relief. Another difference is the amount of money generated per acre. Besides tobacco, Christmas trees are a more valuable cash crop than most traditional agriculture.

Traditional agriculture is no longer a very significant portion of the local economy. Outpaced by construction and services, farm-based income and employment does not compare to tourism, second-home development, or ASU. On the other hand, Christmas tree farming is undoubtedly a key piece of the annual economy, but is much harder to quantify. During the research for this report, the authors found no hard numbers verifying Christmas tree acreage within Watauga County. All types of agriculture are critical in terms of land cover, however. Fortunately, Watauga County still retains a lot of traditional farmland, which helps to account for the abundant wildlife and stunning views.

Agriculture and its importance as a distinct land cover type and other related topics will be explored further in the *Findings* and *Analysis* chapters of this report.

- Other Factors

Outside of the major economic factors already discussed, the construction, retail, and service sectors, as well as local government drive the economic engine in Watauga County. These sectors have all increased in recent years to mirror the increase in population pressure.

- Seasonal Economy

Due to the temperate climate found in Watauga County as well as the unique topography and scenery, the area has a very seasonal economy. This is apparent when looking at the top employers in the County, where three of the top ten are seasonal businesses (See Table 1).

Beech Mountain Resort (and Ski area) is the fourth largest employer in the County. Beech Mountain actually has two different seasons, clientele, and to a large extent, sets of employees that work their respective season. During the summer and fall, employees work at the Beech Mountain Golf and Country Club in order to service those tourists and second home owners present in the warmer months. During the winter, most of the employment is related to the Ski Resort and its amenities.

Appalachian Ski Mountain, the sixth largest employer, only has one season per se, but still manages to employ almost 300 people for winter labor. Tweetsie Railroad, located nearby, comes in at number ten on the employment list with 245 individuals, and operates from May until October, doing most of its business in the summer.

Many of the faculty at Appalachian State University are employed year round and in large part do not seem to be employed seasonally. However, there is a university season, primarily during the fall (late August until early December) and spring (mid-January until early May) semesters. During those times, the student population in Watauga County is at its largest, thus affecting the local economy in a somewhat seasonal fashion.

Watauga County is blessed with a healthy, seasonal economy. The summer season is always wide-open, with a large influx of tourists and second homeowners present and spending money. During the fall, tourism and second homeowners tend to still be in the area for the spectacular fall scenery while the ASU population is also at its annual highest level. In the winter, people from all over the southeast US flock to the area for the unique skiing opportunities. In the spring, while tourism is at its annual low point, the ASU population is full, and the students drive the economy during that period.

The diverse local economy helps explain why Watauga County consistently has one of the lowest unemployment rates in the state (See Table 3). However, the area also has a distinct underemployed (people greatly overqualified for their job) workforce (See Table 4). It's not atypical to find people with graduate degrees waiting tables or working in construction. While the local economy does have several seasonal sectors, the combination makes for a healthy year-round economy.

Table 3: Unemployment Rates, Watauga County and North Carolina, 1990-2003
 Source: Texas A & M University Real Estate Center

Year	Watauga County	NC
1990	4.5%	4.2%
1991	4.4%	5.8%
1992	3.5%	6.0%
1993	2.8%	4.9%
1994	2.3%	4.4%
1995	3.3%	4.3%
1996	2.9%	4.3%
1997	2.1%	3.6%
1998	1.8%	3.5%
1999	1.4%	3.2%
2000	1.5%	3.6%
2001	2.1%	5.5%
2002	2.4%	6.7%
2003	3.1%	6.3%

Table 4: Selected Watauga County Educational Attainment Statistics, 2000 (percent)
 Source: U.S. Bureau of the Census

	Bachelor's Degree	Master's Degree	Doctorate	Other Professional Degree
Watauga County	18.75%	8.60%	3.87%	2.02%
NC Average	15.30%	4.80%	0.88%	1.48%

III. Findings

The amount of data generated and assembled during this project was considerable. The land cover layers for each satellite image were only the starting point for this study. Many other data sets for Watauga County communities, the County as a whole, the region (western North Carolina), the state, and the country were necessary to correctly ascertain the nature of the final data, to verify land cover findings, and discover any other patterns relating to land cover change within Watauga County over the last 15-20 years.

Determinations were made as to the relevance of certain data and a hierarchy created as to importance and how those facts related to land cover change.

Complete land cover statistics are provided in Table 5. There are many different ways one can read in to these statistics and several methods will be explored in the analysis phase.

Table 5: Land Cover Statistics, Watauga County, 1986 and 1999

Land Cover Class	1986		1999		% Change
	Acres	% of County	Acres	% of County	
Developed	4,239	2.11%	6,430	3.21%	+51.69%
Agricultural	43,343	21.6%	47,317	23.63%	+9.17%
Forest	152,900	76.23%	146,340	73.12%	-4.29%

1986 Image

In 1986, developed land represented 4,239 acres within Watauga County (See Map 8). Agricultural land (cropland, grassland) represented approximately 43,000 acres while forested land made up the majority of the rest of the County land, totaling approximately 152,000 acres.

Developed land at that time was primarily centered around the town of Boone. Other clusters of developed land cover were found around Blowing Rock and the backside of Beech Mountain. Additionally, developed land was found along the Highway 105 corridor in and around the Foscoe community. Other developed land was found along the main Highways in the county as well as secondary roads.

For the 1986 image, not surprisingly, forest cover was by far the most dominant, making up around 152,000 acres, or 76% of the County. Agricultural (grassland, pastureland, cropland) cover was the next most dominant with 43,000 acres, or approximately 21% of county acreage, while developed / built-up land made up 4,239 acres, or about 2.11% of Watauga County.

SEE MAP 8.PDF

1999 Image

In 1999, forest cover once again was the dominant classification, totaling approximately 146,000 acres (73.12%), while agricultural increased to over 47,000 acres (23.63%) (See Map 9). Developed land increased to 6,430 acres or about 3.21% of County land.

According to the data, developed land increased in Watauga County by almost 2,200 acres between 1986 and 1999. Upon careful examination of the *1999 Land Cover Assessment Map*, development increased all over the County, but was really significant in three key areas:

- 1) The new Highway 421 corridor from Deep Gap to Boone,
- 2) The Blowing Rock area, and
- 3) The Town of Boone.

Other locations of increased development include:

- The area just west of the Highway 221 corridor from Deep Gap to the Ashe County line,
- The area between Highway 321 and the Blue Ridge Parkway (Bamboo / Deerfield area),
- The Highway 421 corridor from Sugar Grove to the state line,
- The Highway 194 corridor from Vilas to Valle Crucis, and
- The Highway 321 corridor from Sugar Grove to the state line including areas to the north of that highway.

Agricultural land cover (including cropland, grassland, and pastureland) increased only slightly overall (just under 4,000 acres). This increase seems to be most apparent in the Deep Gap area as well as the Bamboo / Deerfield region. Most likely, these increases were the result of subdivision development, Christmas tree harvesting, and earth moving related to the Highway 421 project.

Forest cover decreased by around 6,500 acres during the study period. This decrease seems to be well distributed throughout the County and most likely occurred simply through yielding to agricultural and developed land, although could also be due to the harvesting of Christmas trees.

SEE MAP 9.PDF

More Detailed Analysis

In the following sections, numerous other data sets will be examined in order to corroborate or otherwise dispute the data generated here. Before proceeding with that analysis, however, it was determined that the land cover data be mined and segregated in order to reveal some important facts.

Since the 1999 data set is purported to be the most important due to its temporal proximity, it was the data set chosen for most of the extensive geographic analysis. By segregating results according to specific geographic phenomena, it was hoped that more meaningful information could be gleaned from the raw statistics.

The first geographic phenomenon utilized in the data segregation was slope. It was previously noted that Watauga County is generally steep, with an average slope of over 17%. Thus, the authors wondered what impact slope might have had on development. It is common knowledge that people build virtually anywhere except ridge tops in Watauga County. Builders routinely build homes on slopes exceeding 25% and higher. Thus, the data were examined for a relationship between slope and the rate of development (See Table 6).

Table 6: Land Cover Statistics by Slope, Watauga County, 1999

Flat Land			Slope Less Than 10%		
Land Cover	Acres	Percentage	Land Cover	Acres	Percentage
Developed	641.32	14.64%	Developed	4046.34	7.64%
Ag / Grassland	2254.08	51.45%	Ag / Grassland	22676.39	42.84%
Forest	1349.25	30.8%	Forest	25888.89	48.91%
Total Area	4380.91	2.19%	Total Area	52930.78	26.4%
Slope Less Than 25%			Slope Greater Than 25%		
Land Cover	Acres	Percentage	Land Cover	Acres	Percentage
Developed	6249.33	3.76%	Developed	172.05	0.51%
Ag / Grassland	44861.76	26.96%	Ag / Grassland	2391.19	7.04%
Forest	114827.82	69.02%	Forest	31390.37	92.37%
Total Area	166375.91	82.99%	Total Area	33982.15	16.95%

Not surprisingly, the overall percentage of developed land increased inversely to slope. Almost 4,400 acres in Watauga County qualifies as ‘flat’ (2.19% of all land). Of that, almost 15% was classified as developed land in the 1999 image. Of all land less than 10% slope within the County, 7.6% was developed land. Conversely, of all the County property with over 25% slope, only 0.51% was classified as developed land. Thus, it’s safe to conclude that the gentler the slope, the more that the land has already been developed.

To reiterate this point, statistics for the flattest portions of the County were generated and compared for both 1986 and 1999 (See Table 7). Although only a small portion of the County (total of 4,380 acres) qualifies as flat, the land cover change trend is alarming. During the study period, developed land increased in these areas by almost 25%, while agricultural cover increased by around 37%. As a result, forest cover decreased by almost 38%.

Table 7: Land Cover Change Statistics of Flat Land, Watauga County, 1986 and 1999

Land Cover	1986		1999		% Change
	Acres	Percentage	Acres	Percentage	
Developed	513.66	11.74%	641.32	14.64%	+24.85%
Ag / Grassland	1640.35	37.48%	2254.1	51.45%	+37.42%
Forest	2168.64	49.55%	1349.3	30.8%	-37.78%

Next, aspect was examined in relation to land cover. It was assumed that more land would have been developed on the sunny southern side of the mountains, but that was not the case. In general, the percentage of developed land was almost identical no matter which direction the land faced.

Next, public lands and otherwise protected lands were removed from the equation to see how much of the private, unprotected land was classified as developed (See Map 10). Once again, none of these scenarios proved significant. The overall percentage of developed land did increase, but only a fraction. Although these protected lands constituted around 15,000 acres, the results were not revealing.

Municipal land was then removed from the equation in order to determine how much of the land strictly under the County’s jurisdiction was classified as developed and how much it had changed during the study period (See Table 8). The 1999 image yielded results of 2.37%. However, this was not meaningful without looking at the 1986 image. In 1986, only 1.42% of the land in Watauga County outside of the 1999 municipal boundaries was classified as developed land. While the amount of that land (2,648 acres) does not seem significant, what is important is that developed land outside of municipalities did increase by over 66% during the study period. If that rate is to

SEE MAP 10.PDF

continue, the nature of the rural portions of the County could change considerably in the near future.

Table 8: Land Cover Change Statistics of County Land Excluding Municipalities, Watauga County, 1986 and 1999

Land Cover	1986		1999		% Change
	Acres	Percentage	Acres	Percentage	
Developed	2645.92	1.42%	4405.5	2.37%	+66.5%
Ag / Grassland	39413.06	21.18%	43355.51	23.31%	+10%
Forest	143960.2	77.36%	137970.58	74.17%	-4.16%

A couple of other geographic phenomena were considered and examined in an attempt to more closely scrutinize development in Watauga County. Proximity to highways and streams seemed to be an important geographic factor worth examination. Once again, it seemed important not only to look at the situation in 1999, but to also see how development along these corridors had changed throughout the study period. As with the removal of municipal lands, these examinations proved worthwhile.

In 1999, developed land within 100 feet of County highways constituted over 29% of total land within 100 feet of County highways (See Table 9). Thirteen years before, in 1986, that portion was just under 25%. Thus, over the course of the study period, development within 100 feet of County highways increased 19%. Within 500 feet of highways, developed land represented almost 17% of total land area in 1999, a net increase of 32.6% over thirteen years (See Table 10).

Table 9: Land Cover Change Statistics - Land Within 100 Feet of Highways, Watauga County, 1986 and 1999

Land Cover	1986		1999		% Change
	Acres	Percentage	Acres	Percentage	
Developed	541.68	24.57%	644.83	29.24%	+19.04%
Ag / Grassland	1046.41	47.46%	1014.6	46.01%	-3.04%
Forest	628.7	28.51%	533.65	24.2%	-15.12%

Table 10: Land Cover Change Statistics - Land Within 500 Feet of Highways, Watauga County, 1986 and 1999

Land Cover	1986		1999		% Change
	Acres	Percentage	Acres	Percentage	
Developed	1384.83	12.81%	1823.21	16.99%	+31.66%
Ag / Grassland	4157.05	38.44%	4550.1	42.41%	+9.46%
Forest	5270.6	48.74%	4355.24	40.59%	-17.37%

Development within 100 feet of County waterways was less pronounced than development adjacent to County highways. In 1999, 5.45% of all land within 100 feet of County streams was classified as developed property, whereas in 1986 that total was roughly 4.6% (See Table 11). Within 500 feet of streams, 4.84% of total land area was developed in 1999, up from 3.53% in 1986 (See Table 12). Once again, perhaps more importantly, the percent changes over the study period seemed more distinct than the overall portions of developed land at either time. Developed land increased by almost 20% within 100 feet of streams, while there was a 37% increase in development within 500 feet of streams. In all cases, forest cover decreased near County waterways.

Table 11: Land Cover Change Statistics - Land Within 100 Feet of Streams, Watauga County, 1986 and 1999

Land Cover	1986		1999		% Change
	Acres	Percentage	Acres	Percentage	
Developed	562.52	4.6%	671.37	5.45%	+19.35%
Ag / Grassland	3,852.14	31.47%	4,415.09	35.82%	+14.61%
Forest	7,798.8	63.71%	7,003.72	56.82%	-10.19%

Table 12: Land Cover Change Statistics - Land Within 500 Feet of Streams, Watauga County, 1986 and 1999

Land Cover	1986		1999		% Change
	Acres	Percentage	Acres	Percentage	
Developed	2,107.93	3.53%	2,889.83	4.84%	+37.09%
Ag / Grassland	16,288.72	27.29%	18,316.31	30.68%	+12.45%
Forest	41,222.33	69.06%	38,141.23	63.9%	-7.47%

Comparative Analysis

Image processing and analysis is a technical and difficult process and requires careful attention in order to yield worthwhile results. In the *Methodology* appendix, the general process for acquiring the land cover data for this project is detailed, and interested readers can get more specific information on the exact procedures used within the complex software used for this project. Many other studies of this type have been done all over the world, so it should be pointed out that the steps taken represent a normal study of this kind.

The focus of this section of the report is to attempt to validate the stated results outlined above. This will be achieved by examining a collection of previously created

data sets from a variety of sources in order to corroborate the results offered in this report. Sources of data examined include the Bureau of the Census, the North Carolina Department of Commerce, and numerous documents generated by Watauga County government.

Unfortunately, specific data sets related to land cover data are not available exactly on the dates of the imagery, but fluctuate according to the type of data. In many cases, data collection and reporting techniques have changed, becoming more detailed over the last 15 years. Thus, more robust data are available now than in 1986. However, valuable data relating to the mid-1980s has been acquired and will be parsed for comparison purposes.

- Developed

Developed land within Watauga County increased by almost 52% between 1986 and 1999. For those living in Watauga County during this period, this may not be a surprise. In that time, the Town of Boone witnessed unprecedented growth, as did the remainder of the County. During that time, buildings, parking lots, roads, and yards replaced numerous tracts of forest and / or agricultural land.

For example, within the study period in question, the Shoppes on the Parkway complex was built, creating a large developed area where there was previously was not one. In addition, during that time, the University Commons apartment complex was put up, creating the largest apartment complex in the County. Once again, this replaced former rural land with developed cover.

- Agriculture / Grassland

Agricultural / grassland land cover actually seemed to increase during the study period from 43,000 acres to 47,000 acres (+9.3%). Based on the definition of agricultural land within this study, this result may be misleading. It could be easy to assume that agricultural practices were expanding within Watauga County during this time, but remember that this class includes pasture (grassland) and cropland. Now it could well be that Christmas tree production did in fact increase over the study period to account for a portion of the increase found. It could also be assumed that new development is accounting for a portion of this increase. When someone clears a previously wooded lot for development, the former forest cover ends up either as a rooftop, driveway (could be dirt, gravel, or pavement), or grass (the yard), at least in the short term. Thus, a portion of the increase in this class could well be the combination of many different small developments where grassland expanded due to the creation of yards.

There are several data sets by which to compare the classification results. According to the study conducted by the Natural Resources Conservation Service in 1994-95, there was at that time a total of 52,700 acres of cropland and pasture. That

figure is a bit over 5,000 acres more than our 1999 numbers, making for an 11.38% difference.

The Watauga County Soil and Water Conservation District reported a total of 63,900 acres in agricultural land in 2000. This figure is 35% higher than our findings and it is believed that the difference is likely in the methodology used to acquire the data.

There is no doubt that traditional agriculture has decreased in recent years. While Christmas tree production has likely increased, traditional farms have decreased according to the data. According to the North Carolina Agricultural Census, the number of farms has decreased since 1987 from 875 farms to 674 farms in 1997 (-23%). Meanwhile, the acreage in farms decreased from 59,980 to 56,508 (-5.79%).

- Forest

According to the results, forest cover decreased during the study period from approximately 152,000 acres to around 146,000 acres (-4.3%). The only reliable data source that could be used for comparison was collected from the North Carolina Division of Forest Resources, who did detailed forest inventories in 1984 and 1990. According to their data, in 1984, there were approximately 119,000 acres of forested land in the county while in 1990 the total forested land increased to around 136,000 acres. Comparing that figure to our 1986 findings, we note a difference of 34,150 acres (-22.47%) and 16,348 (-10.53%). At first, this seemed alarming, but more research was done including several conversations with NC Division of Forest Resources personnel that helped to explain the difference in findings.

First of all, upon speaking with NC DFR personnel, it was learned that the figures generated from the 1984 and 1990 inventories are statistically robust only at the state level. According to the NC DFR, once the data are drilled down to the county level, they can deviate by as much as 25%. That point certainly helps to account for the disparity in the figures.

Secondly, there is no doubt that some of the Christmas tree farms found in Watauga County in both 1986 and 1999 ended up classified as forest instead of agriculture. This is not necessarily error in the classification process, but differences in the way that tree farms are classified based on their age and field density. Additionally, these tree farms were in no way included in the forest inventory done by the NC Division of Forest Resources.

The 1999 classification was so far removed temporally from the 1990 DFR inventory that the comparison seems irrelevant.

Unfortunately, there are no other reliable sources of forest inventory data for Watauga County during the study period. However, it should be pointed out that the focus of the study was more concerned with the increased in developed land cover.

- Conclusion

After careful analysis of the findings, it is concluded that forest cover was likely overstated during this study, conversely leading to an understatement of agricultural and developed land covers. Despite the lack of a concise, reliable data source for forest information, other data sets point to an underestimation of the latter cover types.

IV. Discussion

Land cover is an ever-changing phenomenon and Watauga County is no exception. Many different factors affect land cover change directly and indirectly. For example, direct factors could include new highway construction or the cutting of timber from a forested tract. Indirect factors are more difficult to isolate and could include factors such as demographic shifts and economic variability. In addition to quantifying the amount and type of land cover change that took place in Watauga County between 1986 and 1999, this study aims to identify the direct and indirect factors affecting that change. This chapter will focus on the forces at work over the study period that directly or indirectly caused the land cover change measured during the image analysis phase. Many data sets were perused in this endeavor and the ones that seem to have the most meaning will be examined closely at this point.

There is no doubt that Watauga County is mostly covered in forested land. This was true in 1986 and 1999 and remains true today, as the forest cover for both dates exceeded 73%. Agricultural land seemed to increase throughout the study period (an increase of about 4,000 acres), while developed land also increased.

While developed land only represented 3.21% of County land in 1999, a more important observation seems to be the 51% increase in that total from 1986. While still numerically small, this is a significant point. In 13 years, developed / built-up land increased 51.6%.

As previously noted, a 2001 study sponsored by the MountainKeepers found that subdivision acreage in Watauga County increased from 4,677 acres in 1980 to over 18,000 acres in 2001, an increase of over 300%. While we know that those numbers do not directly translate to developed land cover, it is an indication of the kind of suburban development that has occurred in the area as well as the gross increase over the study period.

The concerns about developed land are primarily environmental. Increased development means more impervious surfaces, which can lead to increased flooding and sedimentation of adjacent waterways. Increased sedimentation can lead to fish kills and the propagation of harmful bacteria. In addition, increased development results in the decrease of another land cover, such as forest or agricultural land, with aesthetic consequences. In a tourist area like Watauga County, this could be detrimental in the long-term, with the possibility that folks may stop coming to the area and spending their money because the beauty that originally brought them to the area is eroding.

Population Pressure

Outside population pressure is the primary driving force behind land cover change in Watauga County. While this may not seem like a revelation, it is nonetheless a fact that deserves closer scrutiny. In Watauga County, population pressure is occurring on several fronts. From 1980 to 2000, the year-round population of Watauga County increased from 31,666 to 42,033, a 32.74% increase (See Table 13). Over the same period, the state population increased 31.57%, so Watauga County did not stand out in that respect. The similarity in the growth rate does not address the land cover change question, however. It is likely that the entire state land cover is changing just as fast. A recent report indicates that North Carolina land is being developed faster than all but four states (See Table 14).

Table 13: Population, Watauga County, 1960 – 2000

Source: U.S. Bureau of the Census

Year	Population	% Increase
1960	17,529	N/A
1970	23,404	33.52%
1980	31,666	35.3%
1990	36,952	16.69%
2000	42,033	13.75%

Table 14: Change in Total Land Developed, 1992-1997, Top Five States

Source: Carolina's Land Conservation Network

State	Acres Developed
Texas	1,219,500
Pennsylvania	1,123,200
Georgia	1,053,200
Florida	945,300
North Carolina	781,500

Another form of population pressure occurring in Watauga County directly relates to the tourist industry. Actual tourism numbers are difficult to acquire, but other data are available that allude to the amount of tourism occurring in Watauga County. From 1990 to 2000, county tourism revenues increased from \$81.98 million to \$147.32 million, an increase of 80% (See Table 14). This number is a little misleading due to inflation, but represents a significant fact: tourism increased substantially throughout the 1990s.

Another revealing statistic is that of retail sales per capita. Although Watauga County is the 55th most populous county in the state, it ranks number seven (\$12,760) in retail sales

per capita. This is another strong indication of the impact of tourism (via shopping) on the local economy. Throughout the study period, businesses were constructed to accommodate this tourism demand, such as lodging facilities, shopping centers, and such. This construction as a result of tourist demand undoubtedly altered the county land cover.

Table 15: Tourism Revenues, Watauga County, 1990 – 2001 (\$Millions)

Source: N.C. Department of Commerce

Year	Revenues
1990	\$81.98
1991	\$84
1992	\$91.45
1993	\$97.42
1994	\$103.67
1995	\$112.78
1996	\$118.55
1997	\$120.67
1998	\$130.23
1999	\$143.64
2000	\$151.29
2001	\$147.32

The second home market also increased during the study period. As more people visited the area, more decided to build summer homes, adding to the land cover change issue. Two statistics from the 2000 Census illuminate this trend in Watauga County. According to the Census, the percent of vacant housing units in Watauga County in 2000 was approximately 28.6%, more than twice the state average (11.1%). Of those vacant units, 77% were designated for “seasonal, recreational, or occasional use”. Once again, that figure more than doubled the state average of 34.4%. A map outlining this dataset affirms that the counties with the highest portions of vacant housing designated for recreational uses; etc. are by and large either in the mountainous or coastal counties, with exceptions near the Sandhills region of the state (famous for golf) (See Map 11).

Another revealing statistic that illustrates this point is the percentage of seasonal housing units present in Watauga County municipalities. According to the 2000 Census, almost 50% of all housing units in the Town of Blowing Rock are seasonal while that figure skyrockets in Beech Mountain and Seven Devils (See Table 16). In Boone, the number is low, demonstrating the more permanent nature of that town’s population (excluding the University of course).

SEE MAP 11.PDF

Table 16: Seasonal Housing in Watauga County Municipalities, 2000
 Source: Bureau of the Census

Municipality	Total Housing Units	Seasonal Housing Units	% Seasonal
Beech Mountain	1,868	1694	90.69%
Blowing Rock	1,524	712	46.72%
Boone	4,748	90	1.90%
Seven Devils	345	272	78.84%

A study sponsored by the MountainKeepers in 2001 found that people not residing in the County owned 45% of Watauga County parcels (See Map 12). While the permanent residences of all of the absentee landowners were not analyzed, it can be assumed that many of these people reside in Florida, Georgia, South Carolina, and other, more urban locales of North Carolina.

Appalachian State University continued to expand during the 1990s and represents the final type of population pressure being brought to bear on Watauga County. More students meant more housing and more businesses and roads to accommodate the growing student population. As the student population increased during the study period, many more structures were built to accommodate those people, including apartments, condominiums, and houses. According to the 2000 Census, Watauga County has the highest percentage of non-family households in the state (43.1%), a full 38.5% higher than the state average of 31%. This number is likely in large part attributed to the large number of rental units required to house the ASU student population. This large student population, specifically those living off campus, drives the need for more construction in the way of housing. In turn, this affects county land cover by way of more land converted to housing. For example, during the late 1990s, the large apartment complex known as University Commons was built at the intersection of Highway 105 and 105 bypass. Formerly, that area was a mix of residential, grassland, and forest cover that was subsequently converted into large parking lots and buildings.

An indirect affect of ASU is that many people that come to the area to attend the university end up staying long-term. For many, attending ASU offers folks from other areas their first exposure to Watauga County and the mountains of North Carolina. After spending four or more years in the area, many adapt to the mountain climate and slower pace of life (at least compared to the larger urban areas) and cannot bear the thought of leaving. Many take lower paying jobs that they are overqualified for so they can pay the bills and continue living in the area. This adds to the full-time population of the area and consequently to the population pressure on the area.

Although simplistic, this report does confirm that population pressure has substantially increased in Watauga County over the study period. Whether driven by

SEE MAP 12.PDF

people moving to the area permanently or the burgeoning tourist and second home markets, this pressure is undoubtedly affecting the county land cover. People need places to stay and live and the service economy demands man-made structures to thrive. This population shift in turn increases the demand for roads to ease congestion, which tends to lead to linear development along those corridors, which can lead to more traffic issues.

Population Diversity

As the population residing in and visiting Watauga County has increased over time, it has also diversified considerably. One of the truly amazing things evident about the area found during the research for this report is the demographic makeup of the County. It's unlikely that one will find such a diverse local population anywhere else in western North Carolina.

Local residents born and raised in Watauga County are likely no longer the majority in the area, but do comprise a vitally important demographic. Many of these families have been in the area for numerous generations and tend to be small business owners, laborers, or work somewhere in the services sector.

Another important demographic is the college students at ASU. Mostly ranging in age from 18 to the late-20s, this group drives the local economy during portions of the year. Although more fluid than most of the demographic groups that comprise the county population at any one time, this cluster does represent a constant that has continued to increase as the university has expanded enrollment.

ASU faculty represent another independent demographic and tend to be higher educated and more politically progressive.

Florida transplants (residents) represent another distinguishable sector and have fully integrated into the local culture over the years. It's not uncommon to find many different working class people from Florida throughout Watauga County and the High Country. Many of these are small business owners and have moved here for the climate and to escape the chaotic cultural landscape and crowding of the Sunshine State.

Florida tourists and second-home owners (nonresidents) are also a critical portion of the population throughout part of the year and tend to represent some of the wealthiest people in the area. Many of them own extravagant second homes, helping to drive the local construction sector and related services as well as the healthy real estate market.

Middle-class families that have relocated from other areas for the climate, rural lifestyle, and local school system represent another distinct group.

Many ASU alumni stay in the area after graduation, unable to leave after four plus years in the High Country. Many of these folks tend to be underemployed, but choose lifestyle and environment over economics.

Another critical group that has increased significantly in recent years is the Hispanic population. Most of these folks have moved to the area to work in the Christmas tree industry, but also work in ornamental nurseries and other labor-intensive positions. A considerable number of this group also tends to be seasonal, but the year-round Hispanic population now almost equals African-American residents in Watauga County and seems to be increasing.

Watauga County has a complex population in terms of age as well. According to the Census, the county has the highest percentage of working-age adults in the state (72.7%). However, the median age of the county population is the third lowest in the state (29.9 years). Additionally, Watauga County has the lowest percentage of children under the age of five in the state (3.9%) and the second smallest average household size (2.26 persons). Obviously, the student population is driving the average age and family size statistics down and the percentage of working-age adults up. ASU is a large enough University that its enrollment greatly affects the county averages in a number of ways.

ASU and the tourism industry are the primary forces driving this diversity and the nature of the population is likely to continue to change in the future.

Corridor Development

The increased population pressure in Watauga County is apparent when driving in the area. Anyone who has spent any length of time in the area will likely agree that traffic has increased over the last twenty years. This factor has facilitated increased development along transportation corridors. More gas stations and related businesses have sprung up in response to the thick traffic in a purely entrepreneurial fashion. With thousands of potential customers driving down the road on a given day, this makes perfect sense. Looking into the future, it is easy to infer that this will continue to evolve as traffic counts continue to increase.

The North Carolina Department of Transportation records traffic counts in all 100 counties in the states in many locations. These figures allow for the analysis of congestion and traffic in general, and also for one to determine the approximate increase in traffic in a given area over a specified length of time.

For this study, traffic count maps for Watauga County were obtained in order to determine just how much traffic increased over the study area. Fortunately, data were available for both 1986 and 1999, allowing for a robust comparison. It was hoped that these data would indirectly support the land cover findings as well as indicate just how much tourism (and population pressure in general) increased during the study period, supporting the arguments noted in the previous section.

The changes in traffic counts over the course of the study period were considerable (See Table 17 / Map 13). Included in the table and on the map are twenty locations, all of which were located on the County's highways. The percent change of these particular data ranged from 28% to 125%. The average traffic increase for these twenty locations was 74.5%. In thirteen years, traffic counts skyrocketed, confirming the increased population pressure noted previously. This also reinforces the notion that tourism also increased substantially.

Currently, one large highway project is nearing completion in Watauga County while another will be reaching the County soon. Highway 421 has been widened and when open, will provide a four-lane corridor from the east side of Boone all the way to Interstate 40 in Winston-Salem. Highway 321, coming up to the area from Lenoir to Blowing Rock, is currently being widened and will likely be a lengthy project, culminating in a four-lane highway from the south side of Boone all the way to Interstate 40 in Hickory.

These projects will have many benefits to the area, but the side effects could be substantial for years to come. There's no arguing that the need for more lanes to alleviate the heavy traffic found on these corridors en route to Watauga County and the High Country as a whole will be beneficial to commuters, truckers, and tourists approaching and departing the area. When completed, Highway 321 south of Blowing Rock will likely be much safer than it currently is.

In addition to the safety issue, these newly widened highways will have economic benefits as well. With multiple four-lane highways to the area, some manufacturing companies may consider locating in Watauga County. The increased infrastructure will allow for more efficient travel of tractor-trailers, thus potentially enticing certain companies. The expanded infrastructure may also entice some tourists to come to the area who were previously intimidated by the narrow two-lane roads coming to the county.

Another benefit of these large highway projects is jobs and temporary economic stimulus during the construction phase. Numerous local paving and heavy construction companies generally benefit from these sorts of projects and more jobs are provided.

These projects will also have some long-term problems associated with them. For one, while traffic problems may be alleviated on the corridors en route to the area, the already heavy traffic in Watauga County will undoubtedly increase further. Thousands of tourists, students, business professionals, truckers, and others will cruise up to the County on the newly completed highways only to be stopped in their tracks in downtown Boone.

The fact that even more people will likely come to the area on a regular, semi-permanent, or permanent basis will increase the population pressure already on the area. This ultimately means more development that in turn means increased environmental degradation. More traffic will increase air pollution as well as noise pollution. Larger roads will mean loss of wildlife habitat and the further fragmentation of valuable wildlife

SEE MAP 13.PDF

corridors. The increased overall traffic in the region will likely make for more dangerous situations on the two lane roads that lace the county. While the highways proper may be safer, the smaller, two-lane roads might become more dangerous.

Table 17: Traffic Counts, Various Locations, Watauga County, 1986 and 1999
Source: NC DOT

Point #	Area	1986	1999	%Increase
1	Hwy 105 / Broadstone Road - south of intersection	8,000	14,000	75.00%
2	Hwy 105 / Broadstone Road - north of intersection	10,200	16,000	56.86%
3	Hwy 221 South (near Grandfather Mtn)	700	900	28.57%
4	Hwy 221 North (Deep Gap to Ashe Cty line)	3,900	7,700	97.44%
5	Hwy 421 (just west of Hwy 221 intersection (Deep Gap))	6,600	11,000	66.67%
6	Hwy 421 (just east of Hwy 221 intersection (Deep Gap))	4,400	7,000	59.09%
7	Hwy 194 North (just north of Howard's Creek Rd Intersection)	3,300	7,000	112.12%
8	Hwy 88 (just before Ashe County line)	500	810	62.00%
9	Hwy 421 (just before Hwy 194 intersection in Vilas)	7,700	14,000	81.82%
10	Hwy 421 (by the Tater Hill Rd intersection)	3,700	7,300	97.30%
11	Hwy 321 (by the Watauga River bridge in Sugar Grove)	2,400	4,100	70.83%
12	Hwy 194 South (near the Avery County line)	400	810	102.50%
13	East King Street (between Hwy 105 Ext and Hwy 194 North)	15,000	25,000	66.67%
14	Hwy 105 / 321 Intersection (just South on 105)	12,000	27,000	125.00%
15	Hwy 321 / 421 Intersection (in front of Daniel Boone Inn)	8,100	12,000	48.15%
16	Hwy 421 (just east of Bamboo Road Intersection)	9,700	17,000	75.26%
17	Hwy 421 (just east of Hwy 194 Intersection (New Market))	12,000	19,000	58.33%
18	Hwy 421 (just west of Hwy 105 bypass)	7,000	14,000	100.00%
19	West King Street (past Pinnacle Street)	6,700	11,000	64.18%
20	Hwy 105 (just west of Hwy 105 bypass Intersection)	12,600	18,000	42.86%

As traffic increases, more businesses will likely continue springing up along the transportation corridors. There will be more demand for facilities, which will mean more development and less agricultural and forest land. As a result, the local environment will be put under additional stress and the aesthetic qualities of the area could suffer.

Optimal Land Development

In the *Findings* section, it was documented that according to the land cover classification, developed land, as an overall portion of the County, is still relatively small. However, it was found that the flattest land has the highest percentage of development. Likewise, lands within close proximity to highways and streams saw more development over the study period and are continuing to be developed at a higher rate. Surprisingly, aspect does not seem to play as important of a role in the development equation, and the removal of protected lands did not yield useful results one way or the other.

While developed land as classified in this study is a relatively small portion of the overall county area, it is apparent that the 'best' land is being developed more rapidly

than county property as a whole. Once again, it's important to remember that much of the land is steep and rocky and unsuitable to development. While slope problems can be overcome, limiting soils characteristics generally cannot.

Much of the property in the County is remote and will not be developed for some time, at least until roads are constructed to provide access. However, as population pressure continues to increase, more roads will likely be built in response to the demand for real estate.

Thus, while the sum total of developed land may not be a high percentage of the overall land area of the county, the data indicates that the optimal land, i.e. the flattest and nearest to surface water and existing roads, is being developed at a rapid pace. Going into the future, as the population pressure swells, the majority of optimal land will likely continue to be developed.

Pressure to Sell

Complicating the situation is the pressure on large landowners to sell their land. In many cases, landowners simply cannot afford to pay the annual taxes on their property. While Watauga County currently has one of the lower tax rates in the state, land values are high as a result of the massive demand for real estate. Add to that the fact that the area does not supply an abundant amount of high paying jobs, and many folks are not left with a choice. If possible, they may farm and participate in one of the state programs that decrease their tax burden, but many have no solution but to sell at least part of their property to decrease their tax burden and get cash.

Many times, as the older generations pass on, the descendants decide to cash in on inherited property for the same reasons noted above. Many do not want to continue the farming lifestyle, cannot afford to keep the land and pay the inheritance taxes on the property, or see an opportunity to make money.

Conservation Easements

In recent years, the environmental community has been using conservation easements and the tax benefits they provide to help preserve land. Landowners, typically with the help of land conservation entities, elect to place a portion of their land into an easement and, in exchange, receive tax breaks as mandated by state law. Also, perhaps more importantly, they rest assured that their beloved property, in some cases their homeplace, will never be developed.

As of 2003, there are over 1,185 acres of land in Watauga County under conservation easement (See Map 10). Local land trusts, most notably the High Country Conservancy and the Blue Ridge Rural Land Trust, continue to work with landowners to preserve significant properties and there's no doubt of the long-term conservation benefits.

Farmland Preservation

Another government program that helps local farmers to continue their agricultural endeavors is the Farmland Preservation Program. This voluntary program provides tax incentives and other amenities in order to encourage farming and ensure the long-term existence of farmland and the associated lifestyle in the County. As of this writing, there are 77 registered farms totaling over 2,250 acres in Watauga County (See Map 14).

What does this all mean?

Land cover change is not necessarily a negative phenomenon. When a stand of timber is removed, it can grow back and replace the trees that were originally felled. If someone elects to plant crops on that land, then they're replacing timber with another valuable, renewable resource.

This study focused on three broad land cover types: agricultural / grassland, developed, and forest. These general types were created and analyzed in hopes of determining the trend of overall land cover change in Watauga County over a rather prosperous period for the area. The differences between the different cover types are relatively obvious. However, there is one difference between agricultural and forest cover and developed land cover that is significant: developed land tends to be more permanent. While buildings can be torn down and asphalt pulled up, that does not always happen in the modern United States. On the other hand, forests can be regrown, crops can be replanted, and grass will come back annually. The relative permanence of development is cause for concern for many people.

Some development is necessary and valuable by creating wealth for some, jobs for others, and amenities for yet others. Problems seem to arise when development occurs unchecked. That is not to say that development must be strictly limited, but it certainly helps to know how much development is occurring in a given locale. Some believe that as long as the local economy is healthy, growth and subsequent development should continue to occur. However, this view ignores the negative long-term effects of unchecked development.

There is no doubt that tourism and the second home market is a crucial part of the local economy. Additionally, folks continue to move here from other cities and states due to the increased quality of life, low unemployment, and natural environment. It is critical that this area continues to offer that combination of attractive benefits for years to come to ensure economic viability. Uncontrolled development could lead to the erosion of some of these amenities over the long term.

SEE MAP 14.PDF

V. Conclusion

Watauga County experienced a surge of growth and development throughout the last several decades of the 20th century. All relevant data indicates that no time was any more prosperous than the late 1980s and the entire decade of the 1990s. While other less fortunate mountain communities were struggling due to closing factories or other economic factors, Watauga County surged, due in large part to its vibrant tourism industry and the sustained growth of ASU.

Growth does not come without a price and for Watauga County, that price is land cover change. As more people flocked to the area for recreation, college, or relocation, the natural resources of the County came under increased pressure. Agricultural and forest cover were cleared or somewhat altered to allow for more development, be it in the form of residential communities, roadways, or commercial endeavors.

The economy of Watauga County is unusually vibrant and diversified for a western North Carolina mountain county. A healthy tourist base, a growing university, an ample workforce, and strong construction and services sectors have provided a multitude of jobs and many entrepreneurial opportunities.

The strong economy and special natural resources have continually brought more people to the area over the years putting serious population pressure on the environment. One doesn't have to drive long in Boone to experience this in the form of traffic. The county's traffic rates saw massive increases during the study period.

Current trends will ensure that developed land in Watauga County will increase as the population pressure increases. The data indicate that more people are in Watauga County than ever before and they have to have places to live, work, and do business. The fact that developed land increased by over 50% in thirteen years and that traffic increased by an average of 75% during the same study period is significant.

What happens in the future is up to the citizenry and local authorities of the County. Watauga County currently has problems that many other areas would love to have. While some may see the traffic and environmental degradation as detriments, the contradiction is that there seems to be no shortage of jobs, even if they are low paying. Opportunities for small businesses are rampant and the local governments' tax bases continue to grow as more land is subdivided and more buildings constructed.

Watauga County may reach a point where development reaches a crescendo, with tourists electing to go elsewhere. Frustrated by the traffic situation and eroding scenery, people could find somewhere else to spend their vacation and their money. While tourists and second homeowners represent only a portion of the local economy, a decrease in gross tourism numbers would no doubt harm the local economy and ripple throughout, affecting employment opportunities as well as small business owners.

Appendix 1: Generic Methodology

This study utilized satellite image technology and geographic information systems (GIS) to try and determine just how much the land cover of Watauga County has changed from 1986-1999. These dates were not arbitrary, but chosen due to limitations in the availability of suitable satellite imagery.

Since the inception of the idea for this project, it was determined that the primary mission should be to look at change from sometime in the early 1980s to the present. However, suitable, cloud-free satellite imagery for this area was not available in the early 1980s and it was found that the farthest back possible to go was 1986. Along the same lines, imagery available for 2000-2002 were not sufficient, but a clear 1999 image was located.

A considerable amount of fieldwork was necessary early on in the project in order to try to increase the accuracy of the classification of the 1999 image. Since the latest image utilized in this study was only three years old, it was concluded that fieldwork in 2002 would be worthwhile in order to verify land cover for specific locations. GPS points were collected in numerous parts of Watauga County, specifically in locations where land cover had not changed according to the author's memory since well before 1999. Those points were then placed on top of the 1999 satellite image. Where those points fell on the image, measurements were taken for differing parts of the light spectrum. The software then searched for other locations on the image with similar measurements and classified them accordingly.

Additionally, points were created using 1999 digital orthophotography in the same manner. Specific locations on the photography were flagged according to the obvious land type found there, and then input into the classification process. Originally, many different classes were used, and systematically condensed into four final types: *agricultural* (cropland and grassland), *developed* / built-up land, *forest*, and *water*. This was an intensive process and the most time-consuming of the project.

Aerial photography was used to verify the land cover classification scheme. Fortunately, 1999 digital orthophotography were available to make for an ideal accuracy assessment situation. Points were randomly selected all over the county and the data compared to the photography to determine overall classification accuracy.

The 1986 image was classified strictly utilizing aerial photography, since no other method was feasible due to time-lapse constraints. Two sets of photography were available throughout this phase; one, 1984 photos of the county in 9-inch x 9-inch prints and the other, 1986 orthos in large-scale mylar plots. Data were gathered by looking over the hard copy photographs and locating different land cover types, determining location through traditional mapping techniques based on scaled distances and specific locations displayed along the edge of the media for reference.

Points were generated for overlay with the 1986 satellite image and land cover data created based on the same logic noted for the 1999 image. The software was then used to process the remaining data for the given image, generating a land cover layer that can be used to determine the specific amount of each type countywide. Patterns can be visually interpreted and other data explored to support or dispel specific findings.

Once land cover data were created and finalized, a detailed accuracy assessment was undertaken. Points were randomly generated for each image via image processing software. The land cover at each point was then determined and the aerial photography was then examined to compare the land cover classification to the land at that point on the image. An error matrix was then created and final accuracy determined (See Tables 18 and 19).

Table 18: Accuracy Assessment Matrix, 1986 Image

Overall Accuracy = $71 / 90 = 78.88\%$

Classification	Water	Development	Agricultural	Forest	Row
Water	0	0	0	0	0
Development	0	9	2	0	11
Agricultural	0	3	25	3	31
Forest	0	0	11	37	48
Column	0	12	38	40	90

Table 19: Accuracy Assessment Matrix, 1999 Image

Overall Accuracy = $78 / 92 = 84.78\%$

Classification	Water	Development	Agricultural	Forest	Row
Water	2	0	0	0	2
Development	0	8	3	0	11
Agricultural	0	0	27	5	32
Forest	0	0	6	41	47
Column	2	8	36	46	92

Overview of Imaging Technology

Current satellite imagery and related software allow for the pursuit of scientific knowledge on a scale unavailable until recently. The imagery acquired for this project was very suitable for a study of this size.

The imagery used in this project was acquired from satellites launched and operated by NASA and known as Thematic Mapper (TM). This imagery has been available since the early 1980s and allows for the gathering of valuable information at a reasonably large scale. Additionally, advances in technology and a competitive imagery market have driven prices down, making this a doable endeavor.

Satellite imagery are essentially pictures of portions of the Earth, from which valuable data can be extracted. Modern image processing software can use the imagery, which is actually multiple layers of data, along with experienced technician following proven methods to generate data layers such as land cover. Many studies exist in the public domain that have utilized this technology.

For this study, the land cover classes of note are agricultural land (encompassing open fields, grassland, and cropland), forest cover, and developed land. While more classes can be determined for a study such as this, these classes seemed to make the most sense in terms of their simplicity and basic conclusions that can be drawn.

One of the overriding, albeit indirect questions of this study is ‘How much development occurred in Watauga County between 1986 and 1999?’ It is widely accepted that the area boomed during the period and this report will offer evidence to support that conclusion. Additionally, this study will attempt to isolate and analyze the factors at work during that time period.

The image processing noted above was but one part of this project. Various socioeconomic, agricultural, and forestry data were also utilized to compare findings from the image processing phase. These data were also analyzed independently to validate all conclusions made in this document.

Aside from the generation of the land cover data, the rest of the project involved the accumulation of other existing data into a concise usable format for comparison to the land cover data. The land cover data was isolated based on certain geographic constraints in an attempt to better understand trends within the data. For example land cover statistics were generated for all land within 100 feet of county roadways to see if there were any meaningful patterns not seen at the county level. All of these results will be examined in the *Findings* chapter and analyzed in the *Discussion* section.

Accuracy Issues

The classification of land cover done for this project was simplistic. Three basic classes were generated: agricultural / grassland, developed land, and forest cover. This approach was utilized due to the simple questions being asked:

- How much has land cover changed from 1986-1999?
- How much development has really occurred during that period?
- What forces drove that change?

Much more complex classification schemes can be attempted, but in this case it wasn't as important to break the land cover down any further. For example, different forest types could be classified with more effort, but that was not necessary within the scope of this report. Thus, the stated classification was used.

All studies of this type have some inherent difficulties. Image processing is not an exact science, but can certainly be used as a tool to yield valuable representative data. As with this study, steps can be taken to gauge the accuracy of the findings, but suffice it to say that it is virtually impossible to measure land cover over a 300 square mile area with 100% accuracy.

The most difficult land cover to measure in a study of this type is mixed land. For example, where you may find an area with sparse tree cover and grass between those trees. A good example of this is land found along highways. Many times that land is not lush forest or smooth grassland, but a mix of short grasses, small trees, along with larger trees. That sort of land can end up classified as forest or agricultural cover but will likely not end up classified as developed land cover. Christmas tree farms are also a good example of this. Depending on the age and density of the trees on a given farm, the area can end up as agricultural or forest cover. Most tree farms are straight lines of trees with grass paths separating the rows. There is variability in the spacing of the rows depending on the farmer. Small trees (i.e. 1-3 years old) will likely end up classified as grassland (falling under the agricultural class), whereas trees about to be harvested (i.e. 6-7 years) will likely be classified as forest cover. These are important facts to consider, and the accuracy assessment should account for these possible anomalies. However, the focus of this study was not really among forest and agriculture, but more centered on developed / built-up land, so these differences were not so important.

Another problem inherent in this sort of study is that of rural development. Obviously, the majority of Watauga County is rural and homes in small, lightly developed areas will many times not end up in the developed land cover class, but in one of the other two primary classes based on the surrounding area. If a house is on a very wooded lot, it likely ended up in the forest class, whereas if it was in a field, it may have been classified as agricultural. This is not necessarily false as the primary land cover is respected in this way. This all relates to the limitations based on the spatial resolution inherent with Thematic Mapper satellite imagery and the scale of the project and was by no means

atypical for this study. Since each pixel of each image represented approximately 10,000 square feet, it only makes sense that the final cover class for a given pixel should be the dominant class of that area. So on a forested lot that may be 10,000 square feet (roughly a ¼ acre), you may have a home that occupies 1,500 square feet (based on a 50' x 30' footprint). Perhaps there is 2,000 square feet of grass (the yard), leaving 6,500 square feet of forest canopy. In that case, it would be correct if that pixel was classified as forest. Again, due to resolution limitations, it is impossible to measure with 100% accuracy the exact cover on the ground, but we end up with a representation of the county based on these types of assumptions.

Likewise, let's look at a strip mall example. Perhaps you have a 5-acre parcel that ends up with a 40,000 square foot building on it, 2 acres of parking lot, and the remainder in light forest and grass. These 20 pixels will likely end up mostly classified as developed land cover and deservedly so. That is the dominant cover and in the end, it was hoped that these differences would even out.

Developed cover classification does have some inherent difficulties. The spectral signature that identifies developed land cover also tends to recognize rock outcrops as well as freshly turned earth in some cases. A prime example with regards to this study, specifically the 1999 image, is that of the newly constructed Highway 421 corridor between Boone and Deep Gap. At the time of imagery acquisition, that was actually freshly plowed and graded dirt. However, the vast majority of that land was classified as developed. In that case, it is this author's opinion that that was the correct classification. An argument could be made that those findings may tend to overstate developed land cover since that corridor was not yet paved, however the accuracy assessment found very few examples of agricultural land classified as developed land.

Appendix 2: Technical Methodology

The raw images were converted to Erdas Imagine format (.img) using Erdas Imagine 8.5. The Watauga County boundary shapefile was also converted to Erdas Imagine format. The satellite images were then clipped with the mask layer (boundary file) using Erdas Imagine Interpreter>Utilities>Mask.

A principal component analysis (PCA) was then performed (Image Interpreter>Spectral Enhancement>Principal Comp) on both images. The PCA allowed for redundant data to be compacted into fewer bands. Six components were selected and stretched to unsigned 8 bit. The results allowed for first three components to be selected for analysis since almost all of the data was represented.

A Normalized Difference Vegetation Index (NDVI) was then performed (Image Interpreter>Spectral Enhancement>Indices>NDVI). The equation

$$NDVI = \frac{band4 - band3}{band4 + band3}$$

was used. This index allowed the interpretation of vegetation characteristics.

A simple band ratio was also performed. The equation $\frac{band4}{band3}$ allows the red shift that occurs in vegetation reflectance to be enhanced.

The spectral enhancement techniques PCA, NDVI, and $\frac{3}{4}$ band ratio were then layered stacked to form a new image (Image Interpreter>Spectral Enhancement>Utilities>Layer Stack). PCA composed the first 3 layers, NDVI was the fourth layer and the $\frac{3}{4}$ band ratio was the fifth. This layer combination allowed for better detection of vegetation in an unsupervised classification.

An unsupervised classification was performed on the 1986 and 1999-layered image using 40 classifications, 20 iterations, and a convergence level of .98 (Classifier>Unsupervised Classification). This produced images that were manageable within the time frame and allowed the greatest chance of success.

The recoding for the 1986 image was performed using orthophotography, on Mylar sheets, from 1984 and orthophotography on traditional paper also flown in April of 1984. The recode was: 1-Water, 2-Developed, 3-Agricultural, and 4-Forest. The Agricultural class was later cluster busted into 3 Grassland, and 5, Cropland.

The recoding of the 1999 layered image was performed using a 1999 Mr. SID image, the Band 8 Panchromatic layer (15m), and the CGIA's 1996 land cover data. Highland Mapping provided control points used during this phase gathered using GPS during the initial fieldwork phase. Each layer was opened into ArcMap 8.2, creating a

layered control image that allowed for the accurate recoding of pixels. The recode was: 1-Water, 2-Developed, 3-Agricultural, and 4-Forest. The Agricultural class was later cluster busted into 3-Grassland, and 5-Cropland.

The classification of Agricultural land was cluster-busted for each image. Each image was recoded as 1 or 0 and the Agricultural classification was masked out of the image. An unsupervised classification was then performed using 30 classes and a convergence threshold of .98. The Agricultural class was then recoded into 3-Grassland and 5-Cropland to distinguish between open grasslands and managed herbaceous using the same techniques as the initial recode. The recoded subsets of 3-Grassland and 5-Cropland were then layered back into the fully recoded 1986 and 1999 images.

Accuracy assessment was performed for each image (Classifier>Accuracy Assessment). 1024 search windows were used to generate a maximum of 100 points. The points were created using a stratified random procedure. This allowed the number of points per thematic layer to be proportional to the distribution of each class. A minimum of 10 points was collected per class. The resulting random points were then checked for accuracy using different methods for each image:

1. The 1999 random points were saved as annotation files, exported from Erdas as a .dxf, file and brought into ArcView 3.2 with the Cad extension. From ArcView the .dxf was converted into a shapefile and loaded into ArcMap 8.2. In ArcMap the points were layered over the 1999 Mr. Sid image. Each point was systemically checked and the corresponding class was entered into the accuracy assessment table.
2. The 1986 random points were saved as annotation files and layered over the fully recoded image. Orthophotography from 1984 was then used to check to placement of the points and the corresponding class was entered into the accuracy assessment table.

Change detection analysis was then performed in ArcMap using Raster calculator found in the Spatial Analyst function. The following formula was used: $((1986 \text{ recoded image} * 10) + 1999 \text{ recoded image})$. This added the recoded values 1 – 5 for each image and allowed easy change detection analysis to take place. A total of 26 separate combinations were produced $((5 \text{ classes } 86 * 5 \text{ classes } 99) + \text{no data})$. The classification of the 1986 image on the left and the classification of the 1999 on the right allowed for the combination of numbers to indicate the change category and direction. 55 means no change in Crop lands from 86 to 99, a 54 indicates change from crops to forest, and a 45 indicates change from forest to crop.

Images Used:

Landsat 5 TM, 1986 image

Projection Type	Universal Transverse Mercator	Zone 17 N
Units	Meters	
Datum	North American 1927	
Ellipsoid	CLARKE 1866	

Landsat 7 ETM+ 1999

Projection Type	Universal Transverse Mercator	Zone 17 N
Units	Meters	
Datum	North American 1927	
Ellipsoid	CLARKE 1866	

1999 Mr.Sid (Multiresolution Seamless Image database)

Projection Type	State Plane North Carolina	FIPS 3200
Units	Feet	
Datum	North American 1983	

CGIA (North Carolina Center for Geographic Information and Analysis)

1996 Landcover mapping project

1984 OrthoPhotographs Mylar Sheets

Tax Office, Boone, North Carolina

Projection Type	State Plane North Carolina
Units	Feet
Date	April 1984
Scale	1:400

1984 OrthoPhotographs Paper Copy

Soil Conservation Office, Boone, North Carolina

Scale	1:20000
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