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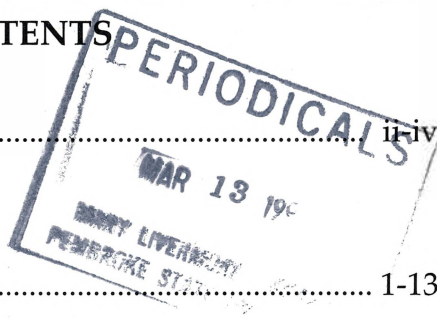
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EDITORIAL COMMENT

Ole Gade

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In this, the fourth volume of *The North Carolina Geographer*, we have included articles that represent each of the three subject cornerstones in the science of geography, physical, cultural, and regional geography.

Specifically, there are three contributions that emerge from a physical environmental foundation to show how people in North Carolina have been affecting, through their varied land uses, some particular condition of our natural resources. In these articles the primary focus is on soils and on hydrology, or water resources. Our authors are concerned not only to demonstrate the newest in geographic tools used to assess the particular environmental problem, but also to show how changing pressures on the land require new approaches to land resource management. And so it is also for the articles that on the one hand focuses on cultural attributes, specifically mill villages, and on the other, the changes occurring in multi-county government organization and impacting the state's communities.

Craig Seaver and Mike Mayfield from Appalachian State University provide a study of soil erosion rates as they are affected by shifting land uses over nearly four decades. Soil erosion is especially problematic for hilly tracts of land, and none are more so than those found in the Appalachian mountains. Here the problem received considerable attention beginning in the 1930s, with the initiation of the Tennessee Valley Authority, and soil conservation measures have since been widely applied. The authors use geographic information systems technology to assess shifts in erosion rates, finding that the reduction in erosion is probably more related to a gradual changes from agriculture to urbanization related land uses, rather than specifically to the application of soil conservation measures.

Tom Ross of Pembroke State University has for several years been focusing his research on improved rural land management practices in the southern part of the state's coastal plains region. Through a detailed assessment of agricultural productivity he finds that the use of irrigation to supplement the natural, but irregularly occurring pattern of precipitation, provides an important boost to crop yields. Though he suggests that further work is needed on understanding the availability and quality of irrigation water from its two main sources, groundwater and surface, he shows that the irrigated acreage can be expanded.

County-wide wellhead protection is a new state encouraged approach for local government to identify and manage the recharge areas for public water. The persistent threat of public water contamination provides the motivation for this important public program. Will Harman and Steve Smutko, both associated with the Agricultural Extension Service, Harman as a Field Agent in Gaston County and Smutko as an Extension Specialist with North Carolina State University, are the authors of this report on how Gaston County is approaching the development of a wellhead protection program. So far unique in the state, the Gaston approach may serve as a model for other counties as they begin to address county-wide wellhead protection.

Doug Eyre of the University of North Carolina at Chapel Hill returns us to a recurring *North Carolina Geographer* theme in the cultural geography, the condition and future of our communities and smaller towns. As a major feature in the state's settlement history, the changing character of mill villages and towns certainly deserve particular attention. In this comparative case study of Bynum, Saxapahaw, and Carrboro, Eyre traces their evolution from their initial selection as textile mill sites. The three mill villages have emerged as very different settlements. Though all three have been negatively affected by locational shifts in the textile industry, their present status reflects their differing proximity to the heart of a rapidly expanding urban region, the Piedmont Triangle, within which they are emerging as economic satellites.

Rapidly expanding metropolitan regions reveal only one of several patterns of change and development in the state. North Carolina, like her sister states, is characterized by a persistence in the geographic unevenness of its development, both economic and social. In an earlier day this was in part ameliorated by multi-county regional governments whose task it was to channel federal social welfare benefits to the state's localities. Ole Gade of Appalachian State University provides an analysis of how earlier attempts at ensuring local access to federal programs now may be encumbered by a postfederal deemphasis on revenue sharing to the local level, and the newly emerging regional structure which takes its cue from local private enterprise initiatives plus state government support for new or relocating industries. Gade suggests that communities in the state's more rural periphery will be the losers by this new vision of public responsibility.

As always, the *Journal* closes with comments on ongoing research that finds display of its results on the front and back cover. While the back cover represents a multicolor version of a figure provided in the Seaver / Mayfield article, the front cover includes a set of visuals from a map sheet, *North Carolina's Place in the World*, recently published by the Department of Geography of Appalachian State University. An undergraduate major in the Department, David Lambert, discusses the visuals.

On the behalf of the North Carolina Geographical Society, I must thank those individuals and departments who have provided the additional support needed to publish this issue of the *Journal*. Continued support is provided, both technical and financial, by the Appalachian State University GIS and Image Processing Labs. By their sponsored advertising I acknowledge the support of the departments of geography of the following institutions, East Carolina State University, The University of North Carolina at Chapel Hill, and The University of North Carolina at Wilmington. Due to the yearly appearance of this Journal it is not feasible to publish in every issue the names of one of its most critical human resources, the readers who provide invaluable assistance in rendering objective and knowledgeable judgment and recommendation on the articles presented to the Editor for possible publication. I hope that the readers will bear with me. They may expect to see their names listed in tribute only every third issue.

Finally, I apologize for the inadvertent omission in last year's issue of the Acknowledgment paragraph of the article by Eugene J. Palka and Thomas W. Crawford.

The Editor



THE UNIVERSITY OF NORTH CAROLINA
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Is proud and pleased to support the continued publication of
The North Carolina Geographer

RECYCLED MILL VILLAGES

John D. Eyre

Introduction

Doug Eyre is Professor emeritus of the Department of Geography at the University of North Carolina, Chapel Hill

Industrialization in North Carolina quickened in the 1880s, led by the textile industry. Textile mills sprang up in rural areas and towns where they could use local surplus farm labor, water supply and later the electricity generated by the Duke Power Company. By the 1920s when the industry reached its peak, mills were concentrated in a broad southwest to northeast swath across the inner Piedmont and continued into South Carolina. In order to attract and hold their labor force, mill owners built mill villages nearby consisting of clusters of simple but durable frame houses of various sizes marked by similar architectural styles and starkly basic facilities. The grander home of the owner, or larger houses for supervisors, commonly stood nearby. A company store provided a narrow range of basic foods and supplies for worker families, often on a credit basis, and church, school, baseball field and a few other amenities added to make the village self-contained.

Numerous historical studies, some based upon oral accounts by mill workers, tell of the typically hard life: primitive, often dangerous working conditions in the mills, low pay that made it hard to make ends meet and the patronage of mill owners attempting to keep workers productive and tied to the mill (Miller, 1980, Tullos, 1989 and Hall, 1989). For the urban geographer interested in the process of town genesis, mills and mill villages created new free-standing communities or were distinctive additions to existing towns. In either case, they frequently were the nucleus around which a larger and more diversified urban unit eventually grew.

By the 1930s, changed economic circumstances brought the usefulness of mill villages into question. Accelerated road building in the 1920s enabled mill workers to live elsewhere and to commute to work by car. Federal and state governments attentive to social conditions were legislating or advocating higher housing standards and working conditions, shorter work weeks and higher wages, all of which meant higher costs for mill owners. These trends, spurred by the Great Depression, were omnipresent in the 1930s, slowed during World War II, and accelerated after the war. Once cost efficiency replaced labor retention as the priority owner concern, mill villages became a liability and, consequently, mill houses were sold en masse to resident workers or at public auction during the 1930s, 1940s and 1950s

The author compares the different fates of three Piedmont mill villages, Bynum, Sazapahaw, and Carrboro

(Herring, 1949). In one case where the mill burned down, the houses were sold and moved to other localities (Foushee, 1977).

Many circumstances have contributed to the decline of the mills, but how the villages have fared is a matter determined largely by their unique location

The North Carolina economy has grown greatly in size and diversity since the 1970s. The historically important textile, furniture and tobacco industries, while still locally important, have declined in relative terms and have been replaced or supplemented by new industries and services. The major concentration of new employment and higher income and living standards is in the Piedmont Urban Crescent, the arc of growing cities between Raleigh and Charlotte, and in dispersed localities on its periphery. Most former mill villages lie within or near this dynamic zone and have been affected by external economic forces to some degree. This article traces the broad outlines of how the functions and character of three former mill villages - Bynum, Saxapahaw and Carrboro (Figure 1) - have been altered by the widening economic influences of one part of the Piedmont Crescent, Chapel Hill and the broader Research Tri-

angle region. Bynum and Saxapahaw were introduced briefly in this journal earlier (Patrick et al, 1992).

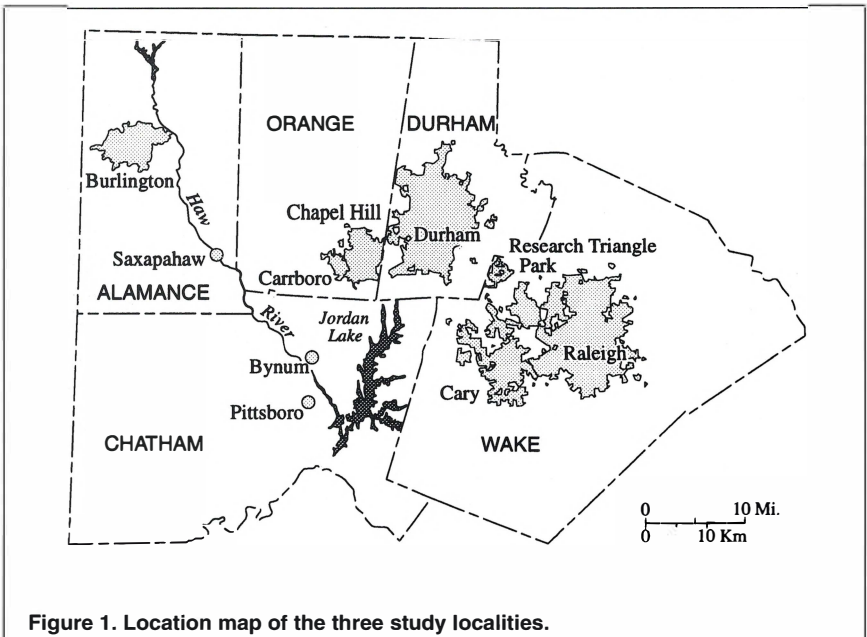


Figure 1. Location map of the three study localities.

Chapel Hill has almost 40,000 population and an economy shaped around the University of North Carolina at Chapel Hill (23,000 students, 2000 faculty, 6000 staff) and North Carolina Memorial Hospital (2000 staff).

Chapel Hill, Durham and Raleigh are the anchor cities forming the Research Triangle, which is centered on the Research Triangle Park, one of the nation's largest and most successful (35,000 employees) industrial research parks.

Bynum

Of the three study sites, Bynum is the smallest. It lies in northern Chatham County along the Haw River five miles north of Pittsboro, the county seat, and 15 miles south of downtown Chapel Hill, on the short Bynum Road that branches eastward from and curves northward to rejoin NC 15-501, the main Pittsboro-Chapel Hill highway. Like so many unincorporated places, it is of vague extent within its township. From its former mill village nucleus on and around a hill on the Haw River north bank, more recent housing is scattered along Bynum Road. It ranges northward and consists of simple bungalows, larger and more expensive properties and a small trailer park. One informant volunteered that "some rural people who live as far as ten miles away claim to live in Bynum." Local guesses place the core settlement at "about 200 or 250".

Bynum derives its name from a local pioneer family who built a dam across the river and set up a grist mill in the early 1800s. Members of the same family organized the Bynum Manufacturing Company in 1872 and built a wooden cotton mill, the oldest in Chatham County, on the present town site. Fourteen frame houses for workers were also built on the mill above the mill. Two better houses were built and occupied by Bynum brothers, one on either side of Bynum Road, at that time the main link between Pittsboro and Chapel Hill, to facilitate check on workers' movements (Williams, 1988).

Changes came gradually to the new mill village as opportunity and necessity dictated. The original wooden mill, destroyed in a 1916 fire, was rebuilt with brick and underwent modest expansions, the last in 1952. A concrete dam that replaced the old timber dam in 1922 remained the only electric power source for mill and village until private utility lines were extended from Pittsboro in 1928. Bynum Methodist Church, an attractive brick edifice on the crest of "The Hill" was organized in 1901. The number of mill houses increased sporadically from 14 to 44 (another account lists 48). The mill itself endured mixed economic times under the Odell Manufacturing Company from 1886 until 1979, a long tenure marked by gradual decline and a final work force of about 250 (Williams, 1988). New owners kept a reduced operation for only seven years before the mill was resold, used as a lamp and lampshade factory with only two employees before closed for good. Today the derelict mill is boarded up, a forlorn reminder of Bynum's former economic focus.

Several important developments along with the mill's decline and eventual closing, have shaped Bynum's present. The mill sale of 1979 was a

landmark event because the Odell firm sold all the mill houses to individual buyers, and federal-county funds brought paved streets, new water and sewer lines and house improvements, including indoor plumbing. Such improvements were badly needed; newspaper accounts of the day called the mill houses "substandard and in great disrepair". The mill's turbine was also sold to new owners who sell its electric output to the local utility company. Then in 1951, NC 15-501 was rerouted over a spacious modern bridge a short distance upstream, a shift that effectively isolated Bynum and Bynum Road from the main north-south traffic flow. The old bridge, popularly called the "chicken bridge" because of the former heavy flow of trucks across it with stacked crates of live chickens from Chatham County poultry raisers destined for northern markets, is still marginally functional.

Bynum wooden cotton mill, originally built in 1872, burnt in 1914, and was rebuilt in brick with subsequent modest expansions. Resold twice, it was closed for good in 1987

Although the mill was still operating in the 1960s, increasing numbers of mill family workers were attracted to Chapel Hill, where University growth and the new N.C. Memorial Hospital meant jobs with better pay and fringe benefits. This made it necessary for the mill to hire more outside workers; "by the 1970s there were as many mill workers coming from outside as there were in it" (Williams, 1988). The Chapel Hill labor shed continued to expand southward in the following decades to where it now encompasses Pittsboro and much of northern Chatham County.

The early 1970s brought a reverse trickle of "outsiders" in response to the social upset of the Vietnam War era and the search for a simpler and cheaper lifestyle free of formal restraint. Since the 1980s, the influx of newcomers has increased and includes retirees and younger professional families seeking a quiet, pleasant, semi-rural place to live, and others with modest income seeking cheaper and more affordable land and homes, either in the old mill village or in newer areas nearby. Until the 1960s, Bynum could claim a small commercial function consisting of a movie theater and five stores, including a gas station, grocery and barbershop. Only one grocery remains. Most shopping is done in Chapel Hill or at intervening stores by the heavy daily flow of commuters to Chapel Hill jobs. Nearby Pittsboro has few job opportunities but does provide Bynum with legal and governmental services, water supply and police and fire protection, and schools.

More prosperous residents have spruced up the former mill houses with modifications and decoration to match owner needs and taste (Figure 2). One of the most unusual mill houses belongs to Clyde Jones, a self-taught local folk artist who specializes in large wooden sculpture fashioned from weirdly shaped tree trunks and limbs with garish embellishments. Bynum's best known resident, he has only a tiny income but refuses to sell

Figure 2. Well-maintained former mill houses in Bynum. Some others have been expanded or otherwise modified.



Figure 3. Tuck's Country Store, Bynum's only store and post office.

Figure 4. Former Saxapahaw mill houses now serving as rentals, neatly landscaped and maintained.





Figure 5. The Sazapahaw Community Center, Built by B. Everett Jordan and the Sellers Manufacturing Company. Privately funded, it houses a wide range of community athletic and social activities.

Figure 6. Carr Mill Mall, the commercial center piece of Carrboro's revitalized former mill village and mill-related business district.



Figure 7. Carrboro's former train station, now a restaurant, located adjacent to Carr Mill Mall.

few of his creations even though the best are temporarily on loan in art museum shows across the U.S.

Bynum boasts no institutional organizing center, although the Methodist Church, a Ruritan chapter and summer Haw River Festival, an educational program organized by a local group, promote limited community cohesion. The one common town facility is Tuck's County Store. An old-fashioned store housed in a frame building, it provides postal services, staples, local foods and crafts, a corner for old-timers to sit and swap stories and a large front window where announcements of community interest can be posted (Figure 3). Christmas brings a toy display, holiday foods and a visit from Santa. The store has been Bynum's nerve center and gathering place under three sets of owners since 1938.

Saxapahaw

Saxapahaw lies 15 miles upstream from Bynum on the Haw River in an Alamance County location between NC54 (Chapel Hill-Burlington) and NC87 (Pittsboro-Burlington) (Figure 1). The bulk of its 1990 population of 1178 is concentrated in and around a former mill village that is divided by the winding river into eastern (or northern, by local reference) and western (or southern) positions. The former contains the main mill buildings, while both share the residential function. Saxapahaw has been a classic mill village where the mill remained in operation until 1994 and the mill company retained ownership of its mill houses until 1978, much as in Bynum. However, its more isolated location meant greater delay in getting paved roads to outside centers and longer retention of its mill village form and function. It is distinctive in the degree of direction given its improvement by B. Everett Jordan, who rose to prominence as U.S. Senator from North Carolina, 1958-73. Since 1978, his son, John M. Jordan, has continued the family leadership with a long-range plan for the town's role within the Chapel Hill economic orbit, which also now encompasses southeastern Alamance County.

The early growth of Saxapahaw, whose name is derived from Indians living there in pre-colonial times, is recounted by a long newspaper account by local historian Ben Bulla (1949), based in part on oral accounts by old residents. A local Quaker, John Newlin, built the first mill in 1844-48 on the hilly east bank of the Haw River. A rock dam across the river and a mill race provided water and power, and surplus farm labor from the surrounding countryside manned the mill. Following sale of the mill to larger Burlington interests in 1873, production was expanded and diversified and the first mill houses were built. By the 1920s, 66 company-owned houses had been joined by a store, post office, church and grade school.

In 1927, the mill was sold to the Sellers Manufacturing Company, formed of Sellers and Jordan family members. As secretary, treasurer and general manager, B. Everett Jordan took up residence in a comfortable home

in the village, quickly made operations profitable and showed a generous hand in dealing with the mill labor force. Additional company houses were built in the 1930s, and in the postwar 1940s a community center was added and some houses owned by mill personnel were built with company financial assistance. Mrs. Jordan personally oversaw the planting of grass, trees and shrubs and the painting of the mill houses to make worker life brighter. The company donated land on which the present elementary school was built and contributed to the expansion of three churches. A new concrete dam and power plant enhanced the electric power supply.

A reversal of Saxapahaw fortunes coincided with the Jordans' move to Washington, D.C. for his long period of public service. Mill houses and grounds deteriorated; car ownership and improved roads encouraged more mill workers to live elsewhere; and growing job opportunities with higher salaries lured young people away from mill employment. The village was literally dying and some mill houses stood vacant. In 1978, Sellers Manufacturing sold the mills to Dixie Yarns of Chattanooga, TN. The dam and power facilities were sold to another outside firm. Sellers Manufacturing also disposed of the mill houses, selling 33 houses on either side of the river and 600 acres of raw land to Jordan Properties, owned and directed by John M. Jordan, a former N.C. State Representative. The mill continued in operation until 1994, when severe storm damage and the closing of uneconomical mills by the parent firm brought its demise.

Saxapahaw's cotton mill was built in 1844-46. Expansion and modifications followed sales to new owners, the last being Dixie Yarns which closed the mill in 1994

Jordan Properties adopted different strategies for its mill house holdings on the two sides of the river. Those on the west bank were sold; first option was given resident mill personnel at easy financial terms, yet the response was so limited that three-fourths of them had to be sold on the open market. However, the 33 east side houses were retained, upgraded and beautified as rentals. They remain attractively painted, planted trees provide screens and shade, generous sized yards allow home gardens and large wood stoves using local wood supplies provide supplementary winter heat (Figure 4). The targeted market for the rental houses from the outset has been graduate and professional students in Chapel Hill. The short commute, quiet environment and rental prices well below the Chapel Hill average have kept the houses fully occupied. In addition to the flow of renters, home owners from both sides of the river commute to Chapel Hill jobs. Jordan Properties, which also develops property at locations other than Saxapahaw, has subdivided a large tract near its rentals into 110 building lots that are targeted at retirees and Chapel Hill home buyers. Several small, unrelated housing developments by other owners are being carved out of rolling farmland along the road between Saxapahaw and NC54 as the pace of land speculation increases.

Saxapahaw has among its assets three churches, an elementary school and a heavily used Community Center (Figure 5). However, it must turn to the nearby Eli Whitney volunteer department for fire protection, to the Alamance County Sheriff's Office in Graham for police protection, to middle and high schools some eight miles away on NC87, and upon medical services in Chapel Hill and elsewhere. Since there are no retail stores or gas stations, residents who formerly shopped in Burlington, their "downtown" of two decades ago, now shop in Chapel Hill-Carrboro or convenience stores along NC54. However, in early fall, 1995, Jordan Properties purchased the deserted textile mill buildings and plans to convert them into an apartment - office - shop complex that will add measurably to the town's commercial attractiveness for further growth.

No event captures the community spirit of the "new Saxapahaw" as it moves away from its mill village past than the Redbud Festival staged by residents and renters in April, 1995 to raise funds for the Saxapahaw Community Center. Major events included a demanding triathlon and a host of family - oriented fun activities. The festival is to become an annual event.

Carrboro

Carrboro's growth and functions have been strongly conditioned by its location adjacent to Chapel Hill in southern Orange County. Its character as an expanded mill village served by a small commercial area prevailed until the 1940s and mill closure. It then became an economic appendage of Chapel Hill, home to primarily blue-collar and office staff employed at the university. Large-scale apartment construction in the 1970s to house university students reinforced its dependence as a bedroom town for its neighbor. However, the past two decades or so of spirited growth in population (11,552 in the 1990 census) have been accompanied by a transition from small town to full-fledged, varied urban form and function. Improved government and political awareness have created the full range of municipal services; a vigorous commercial life is shaped around a central shopping mall fashioned from part of the former textile mill, several other shopping centers, a farmers' market and several downtown blocks of small shops, offices and restaurants/bars; and new suburban housing developments that are annexed periodically expand the town's corporate limits.

Carrboro traces its origins to 1882, when a railway spur from what was later the Southern Railway was built southward to a point, soon called West End, one mile west of Chapel Hill. The main purpose of the line was to ship iron-ore from a small local deposit to Pennsylvania, but the venture was short-lived. (The mining site is now occupied by Ironwoods, a Chapel Hill housing development). It had a

*Rail transport
provided in
1882 the
nucleus of
manufacturing
establishments
from which
emerged the
Carr cotton
mills as the
dominant force
in 1909*

more durable function in shipping local farm output and as a destination for students attending the university. Serving as a nucleus, the station attracted a commercial cluster - grist mill, cotton mill, flour mill, cotton brokerage, blacksmith shop and some stores (Brown, 1983). Following the trend for cotton textile manufacturing expansion in the Piedmont, already noted, a cotton spinning mill was built in 1899. Ten years later, the mill and additions were sold to the wealthy Durham industrialist, Julian Carr, as another unit in his large textile, especially hosiery, operations. The little commercial cluster was renamed Venable in 1911 to honor a UNC president, and two years later Carrboro in honor of the mill owner.

Mill-owned housing to accommodate workers moving from rural areas was built, mostly in the 1910-15 period, on several tracts near the mill. The frame houses were much like their counterparts in other mill villages, with variations in size and structural details. The worker housing stock was greatly expanded by the construction of privately owned rental houses of similar design on adjacent areas opened for speculation. "In 1920, when Carrboro had approximately 280 textile workers, only one-third of the town's 223 houses were owned by the mills" (Brown, 1983). Some mill workers built their own homes, some larger houses were operated as boarding houses, and a few more substantial houses were occupied by mill supervisors. A black community already well established in Chapel Hill spread westward into Carrboro. Overall, the housing was relatively good compared to many mill villages - Sturdivant's 1924 study found all houses painted, two-thirds with electric lights and one-third with refrigerators.

The mill ownership exercised typical paternalism: rents were cheap; space was set aside for a pasture, orchards and gardens; trees and shrubs were planted; land was donated for a church and school; and recreational facilities were built. Through concern for worker welfare, Julian Carr experimented with a program in "industrial democracy" that involved worker representation in mill operations and profit sharing. Short-lived, it did create the basis for later good management-labor relations (Brown, 1983).

Non-mill employment increased with growth in the lumber industry; by the early 1920s, Carrboro was a major railway crosstie shipper and had several lumber firms. The commercial area adjacent to the mill village also grew. By the early 1920s, it provided a range of goods and services - groceries and meats, drugs, hardware, auto repair, shoe repair, laundry, barber-shop, bank and pool hall (Brown 1983). Stores along the main street were converted from frame to brick construction.

The Great Depression brought an end to mill operations, partly in 1930 and the rest in 1938. Company-owned mill houses were sold, some to occupants and others to investors as rentals. There was a brief use of part of the mill during World War II as an ammunition plant and subsequent use for woolen goods before permanent closure in the mid-1950s. At that time, Carrboro retained its small-town, semi-rural atmosphere but was already

dependent upon employment with the university and the newly opened N.C. Memorial Hospital in Chapel Hill. Occasional rumors of impending political merger with Chapel Hill found no approval among Carrboro residents, who viewed such a move as leading to loss of its distinctive identity, and dominance by its larger neighbor.

A boom in apartment and new home construction in the 1970s touched off the urban growth that continues to push the built-up area westward. The resultant entry of waves of UNC student renters and new home owners soon diluted the former mill village population. Revitalization of the historic mill village area got under way during the same decade. Many mill and mill-related houses were in disrepair or had been converted to non-residential users, and some had been demolished for space to build new large commercial buildings. A keystone preservation project was the conversion of part of the mill complex into a distinctive, award-winning shopping mall (Figure 6). The old train station, converted into a trendy restaurant, and several mill units won listing in the National Register of Historic Places in 1976 (Figure 7).

The Friends of Old Carrboro was organized in 1981 to promote further preservation. A first needed step was inventory, and the town Appearance Committee hired geographer Dr. John Florin of UNC-CH and two of his graduate students to conduct a detailed study of more than 150 properties erected prior to 1930. Results of their survey, joined with an excellent historical account of Carrboro's evolution (Brown, 1983), were used by a subcommittee of a Downtown Revitalization Task Force considering historical district zoning. However, such strict zoning did not prove popular and preservation has been largely left to individuals with a resultant unevenness in old house condition and appearance ranging from run-down to stylish gentrification. The old business area sports new restaurants, bars, small shops and offices due to much lower rents than in Chapel Hill and a Carrboro town revolving loan fund for new enterprises. A farmers' market and an active arts center are well patronized by the Chapel Hill - Carrboro communities.

Interaction between Chapel Hill and Carrboro has become commonplace and accepted by both, as shown by joint action in the school systems, water supply, volunteer ambulance service and chambers of commerce. Business in general treats the two as a single commercial entity. Yet older Carrboro residents are proud of the lingering small-town, slower paced, simpler and more dynamic and outer-oriented Chapel Hill, and hope that it will not be swept away by current trends. Their old mill village center provides them with a tangible link with the past as well as showing them how much things have changed.

Concluding Thoughts

The three localities show the range of change that may occur, or may have occurred, in former mill villages through some combination of internal developments and outside influences. All three have become economic satellites of Chapel Hill and the adjacent Research Triangle area to varying degrees. In Bynum, change has come through unstructured, individual action; in Saxapahaw through planned growth directed by a leadership family; and in Carrboro through the actions of town government as well as increasing formal and informal interaction with Chapel Hill. Size differences are obvious: Bynum is small and growing slowly; Saxaphaw is also small but new growth coupled with historic preservation is under way; and Carrboro has boomed into urban character. Hopefully, these broad-brush profiles will generate more widespread, and more detailed, investigation in what is happening to other former mill villages in and around the Piedmont Urban Crescent, as one facet of North Carolina's changing urban structure.

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Considerable differences now exist in the fortunes of the settlements that started life as mill villages: Bynum lags through isolation, initial small scale of development and unstructured change; Saxapahaw benefits from a strong leadership family with a concern for historic preservation; and Carrboro is redeveloping benefited by its proximity to Chapel Hill

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East Carolina University

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WHO IS BEING SERVED? NORTH CAROLINA REGIONS IN A NEW AGE

Ole Gade

Introduction

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In recent decades North Carolina has seen a shift in the evolution of its formally designated regions that raises a question concerning the foundations for regional change and progress. Are these foundations anchored more securely by focusing public support on the social welfare needs of localities, or on local economic development initiatives? Perhaps there have always been reasons to question why states find it necessary to define formal multi-county regions for dispensing public revenues, especially since the implementation of such regions establishes another layer of public administration. But the issue grows more complex when recent changes in national political philosophy have contributed to the superimposition of a new set of North Carolina regions on one already existing. For the average citizen, and for many communities, it is becoming increasingly difficult to determine just what public is being served by the different and geographically overlapping regions, and to what end.

In North Carolina, multi-county regions became more politically problematic with the 1994 legislative mandate of seven economic development regions (Partnerships), whose boundaries only partially coincide with those of the existing 18 Lead Regional Organizations (LROs), that were established in 1971. This evolution is an issue in this paper, as is the probable impact of the state's intercession on individual counties that may not fit as readily into the new regional compacts as initially expected. Whereas the LROs represented a top-down redistribution of federal funds, the decline of federalism over the past two decades has encouraged a postfederal response where localities are now playing a greater role in determining their economic development prospects (Clarke and Gaile, 1992). Emerging from these conditions were a number of bottom-up, city-metropolitan centered economic development regions. These were subsequently formalized by the legislature as Partnership Regions to blanket the state in 1994. What are then the implications of this new postfederal regional structure for traditional issues in local-regional development? Have the issues of people versus place welfare, balanced growth, and support of lagging rural regions gotten lost in the shuffle? Are the LROs able to main-

*Are the emerging
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tain their commitment in the postfederal world, and to what degree might their potentially declining role be hastened by the new regional order?

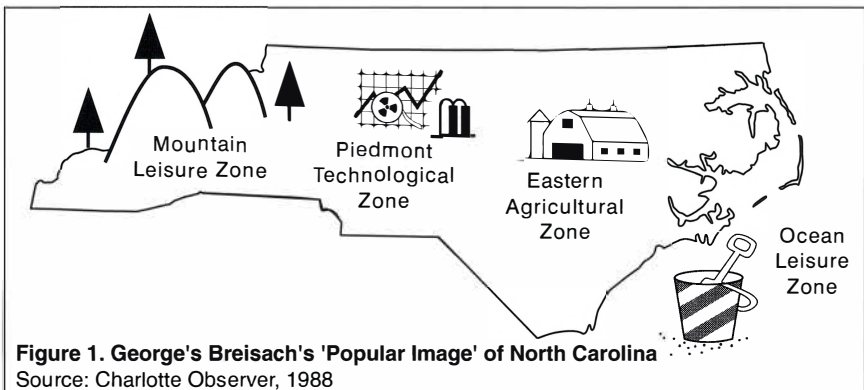
I will first assess the varied conditions of our regions. How have demographic and economic development shifts over recent decades affected their potential for growth? How has this led to concerns that uneven development may continue to require direct state intervention in those counties least able to provide for their citizens? In this manner a typical regional geographic analysis of spatial variations evolving over time is complemented by a study of how public policy has shifted to further influence the concentration of economic activities and settlement patterns.

The Tarheel State has a rich diversity of physical and cultural environments in its 500 mile east-west reach from the shores of the Atlantic Ocean to the peaks of the Appalachian Mountains. This diversity is traditionally divided into the following physical/cultural landscape regions, Tidewater, Coastal Plains, Piedmont, and Mountain. Providing details on these varied landscapes will be our point of departure for evaluating North Carolina's changing socioeconomic regions.

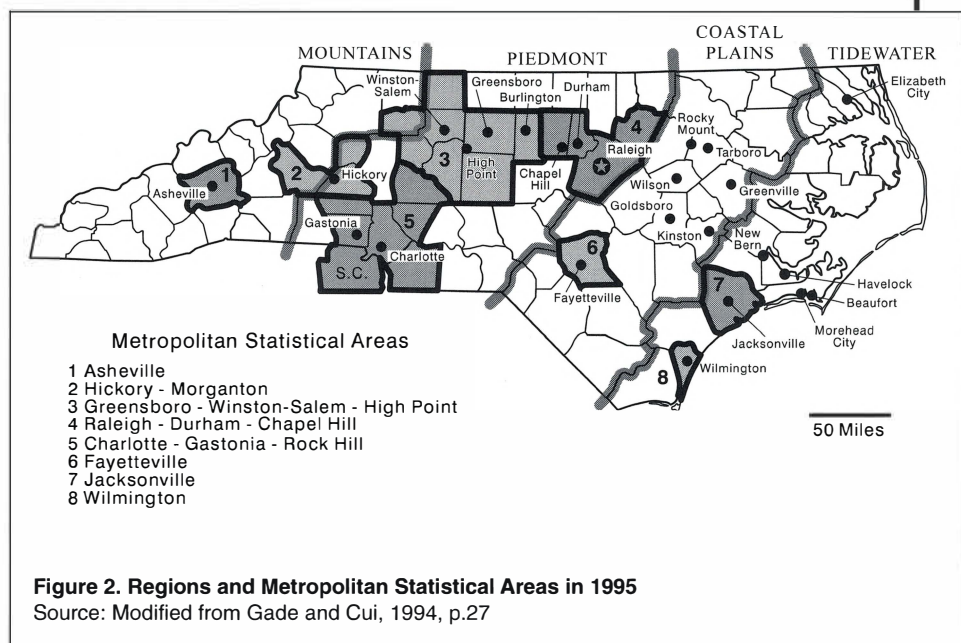
The Environmental Context of Regional Development

North Carolinians have persisted in their belief, in spite of evidence mounting to the contrary, that the state is essentially rural. It is true that there exists no major dominant urban center, but rather three almost comparably populated urban regions sharing the "Urban Crescent" of the Piedmont. In fact, it was not until the 1990 U. S. Census of Population that the state's official rural population dropped to below 50 percent! So the historic absence of a primate city, as exemplified by Georgia's Atlanta, combined with a relatively evenly distributed rural population, persist in providing sustenance for the state's rural self image.

Popularity held perceptions of North Carolina's regional variations are united in the simplistic image rendered by cartoonist George Breisach in the *Charlotte Observer* in the mid-1980s (Figure 1). Traditionally, geogra-



phers complement this image with a set of regional boundaries that define the four regions of Tidewater, Coastal Plains, Piedmont, and Mountain (Figure 2) (Clay, Orr, and Stewart, 1975; Gade, Stillwell and Rex, 1986).



Tidewater Region

Along the 300 mile coast settlement pattern of small towns only the Hatteras National Seashore provides a break. Traditionally dependent on fishing and coastal trade these communities are increasingly dominated by seasonal economies related to leisure activities. Riverine settlements from colonial times dominate the remainder of the Tidewater. Their fortunes are tied to fishing, port functions, small scale manufacturing, forest and food products, public services, and local / regional administration. Medium and small cities in this region, Elizabeth City (15,669, 1993 estimated population), New Bern (21,106), Beaufort/Morehead City (10,347), Havelock (20,072), Jacksonville (78,250), and Wilmington (59,378) have, in recent decades, benefited from extra-regional investment in state port expansion, higher education, military installations, and public services. The absence of a significant port city, like Charleston or Jacksonville, FL is notable. On the other hand, the highest small town population growth in the state is being experienced by the coastal resort communities (North Carolina Municipal Population 1993, 1994).

Coastal Plains Region

Here an agricultural economy and its dispersed rural settlement have persisted for several centuries. Urbanization is dominated by small agricultural service centers and a few medium sized cities, dependent until quite recently on labor intensive and low wage manufacturing industries. In the mid-1980s, three counties began billing themselves as Triangle East, the eastern manufacturing entrance to the Research Triangle (Cook, 1992, p. 22). Triangle East coalition towns of Rocky Mount (51,257), Wilson (37,638), and Tarboro (11,105), however, continue to show only slight population increases.

A larger urban region enters the economic growth mosaic when Triangle East is extended to the immediate east and south, to include adjacent counties. With East Carolina University's recently inaugurated medical center leading the expansion, Greenville (51,149) is the fastest growing urban center in the region, closely followed in size by Goldsboro (44,807) with its traditional economic anchor, Seymour Johnson Air Force Base. Kinston (25,863) is the designated home of that newest of North Carolina's large scale public/private joint venture economic planning efforts, the Global TransPark. Now, after nearly four decades of the success of the Research Triangle Park, state development experts point to the 21st Century as the century of air transportation, responding to the need for linking new economic growth to international markets, just-in-time production, and multi modal transportation. With legislative support in 1991, a several billion dollar investment in a 5,000 acre international air-cargo industrial complex centered by runways of 11,500 feet has been initiated (Kasarda, 1995). Fayetteville (79,320), with its Fort Bragg military installation, provides another source of economic stability in the Coastal Plains. Elsewhere, agriculture and its processing facilities, largely food and tobacco related, have provided decreasing employment opportunities in a region where a number of counties contain a majority African-American and/or Native American population. In the southern Coastal Plains, agriculture has recently turned around with the emphasis on large scale hog production. An estimated state hog population of 7.5 million, with about 80 percent of the production in this subregion, was recorded in July of 1995.

Piedmont Region

The settlement pattern of this region is best described as a multi nucleated "Urban Crescent". It has three distinct urban clusters: "Metrolina" with its core of Charlotte (450,716) and Gastonia (56,219); the "Piedmont Triad" with Greensboro (187,726), Winston-Salem (162,595), High Point (70,190) and Burlington (41,916); and the "Piedmont Triangle" with Raleigh (234,220), Durham (144,276), Cary (57,187) and Chapel Hill (42,918). These clusters are em-

The Piedmont Region is accommodating an increasing share of the state's population, but regional economic disparities persist through the state

bedded within designated Metropolitan Statistical Areas, which, along with the much smaller Hickory (29,201) MSA, demonstrate an almost spatially continuous urban region (Figure 2). A number of Piedmont counties continue to be largely rural in character, though several are affected by spill over suburban and exurban growth.

The Piedmont's three urban clusters comprise 19 of the state's 100 counties, and contain about 45 percent of the state's 1994 estimated population of 7,023,663. Functionally, this is a very complex industrial and service region with a diversity of jobs that act as an important magnet for growth due to migration.

Mountain Region

In this region there are two distinct patterns of settlement. In its eastern foothill portion there is an extension of the western Piedmont's dispersed and slow growing small manufacturing towns, depending largely on textiles, apparel and furniture production, with interstices of relatively dense rural settlement. Connected to this is the Asheville (65,064) Basin, with its concentration of tourism facilities and manufacturing plants. The remainder of the Mountain Region is dominated by relatively small towns, mostly retail service centers and county seats. Several of these have been affected by large scale tourism and recreational resort development, as, for example, those centralized in Watauga-Avery counties in the northwest, and dispersed through the southwestern mountains to the Great Smoky Mountains on the Tennessee boundary.

Four Decades of Regional Change

To lead into a discussion of the state's role in regional definition and development, let us provide first a brief on the changing regional conditions of population settlement and economic development for the most recent decades (Gade, 1989; Gade, 1991; Gade and Cui, 1994; Gade, Stillwell and Rex, 1986).

1950s

Previous decades of net out migration from North Carolina culminated in the 1950s. Peripheral regions, the Mountain and Coastal Plains, are approaching exhaustion of their surplus labor and are developing an aging population. Non-peripheral rural areas similarly lost population, but in their case, mostly to adjacent urban areas within the state. Growth is largely confined to the Piedmont cities and to areas with large military installations, like Fayetteville and Jacksonville.

1960s

Selective out migration from rural areas continued, but at a reduced rate. A significant turnaround in intrastate migration fueled growth in

metropolitan areas. Central cities saw an increasing share of their population relocating to their fringes. In the process, they became more segregated by race, a process also influenced by the gradual increase in returning Afro-Americans to their home state, though not necessarily to their home county. The Piedmont initiated a megalopolitanizing process with the gradual fusing of the three major urban clusters. Meanwhile, Mountain and Coastal Plains counties became more disadvantaged, though labor intensive, low wage industries, dominated by branch plants, were localizing in rural areas and slowed the outflow of people.

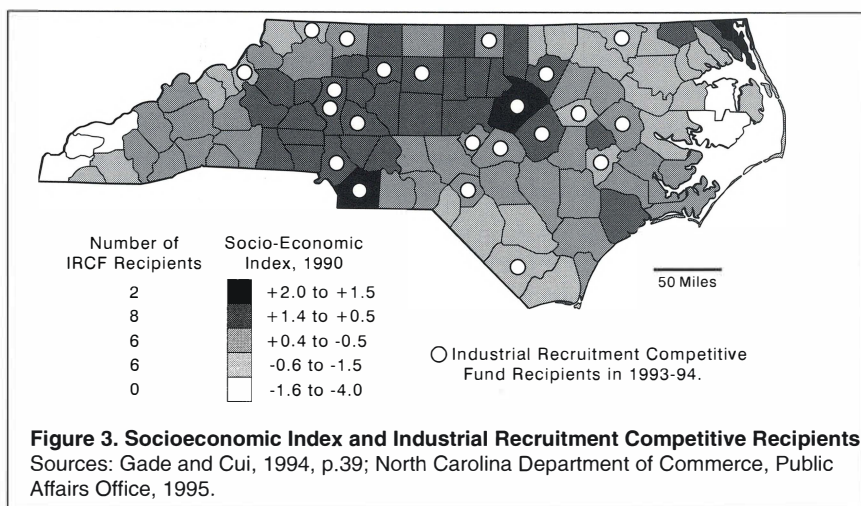
1970s

This was North Carolina's decade in the sun. The sun-belt migration took hold with the state experiencing unprecedented regional change. Positive impacts though became largely to the rapidly growing metro regions, where stronger inter regional linkages were facilitated by an expanding interstate highway system. These influences continued the growth of suburban and exurban employment, service, and residential centers. General improvement in the quality of life and inter regional transportation also aided the growth of the mountain and seashore related retirement, and vacation home and resort, communities (Bennett, 1992).

1980s

The slowing of the sun-belt phenomenon and a lessening of inter regional migration appeared to be offset by a willingness of more people to travel even further from their home to their place of work. An increasing percentage of metropolitan residents were vacationing and owning second homes in the state's periphery, intensifying flows and linkages between regions. However, the relative distance in per capita income levels between the wealthiest and poorest counties persisted at a rate approximating 250 percent, as it has been the case since the 1950s. Piedmont counties also continued to see an increasing concentration of the state's residents (Gade, 1989).

Net returns of these decades of change to regional development are well summed in Figure 3. This shows one set of results from a larger study that evaluates three decades of change in North Carolina's counties (Gade and Cui, 1994). The socioeconomic index was fashioned by combining different data sets including: 1. unemployment rate; 2. percent persons in poverty; 3. median family income; and 4. percent aged / disabled receipts of social security income, food stamps, and AFDC aid to dependent, aged and disabled individuals. These comprise essentially the measurements used by the state in defining disadvantage counties. On this basis, the best conditions of life in the state (highest scores) are found, with very few exceptions, in a large set of contiguous, essentially urban, Piedmont counties. Conditions of the peripheral counties appear to worsen with increasing distance from the urban counties of the state.



The State Anchors Its Economic Development Policy

What has been the state response to obvious needs in socioeconomic development and to patterns of regional disparity? It is Archibald Murphey, a lawyer and state senator from Orange County, who is generally credited with providing the initial direction for what became the persistent twin cornerstones in state planning policy, transportation improvement and public education. In 1815, Murphey presented the first set of state economic development reports, wherein the problem of people fleeing the state for perceived better opportunities in the West was highlighted; "thousands of our poorer citizens being literally driven away by the prospects of poverty" (Escott 1991, 35). The state chartered the North Carolina Railroad in 1849 and underwrote two-thirds of the cost of construction to link Goldsboro with Charlotte over Raleigh, Hillsborough, Salisbury and Concord. Commercial agriculture flourished in the Piedmont and Central Coastal Plains by the 1880s, and with it the market towns, as well as further initiatives for rail transportation.

By mid-19th Century the state was sailing toward the terra incognitae of balanced regional development with public policy firmly anchored in transportation and education access for all

North Carolina became known as the "Good Roads State" in the early part of the century. Continued investment in road building earned the state the sobriquet of "progressive" southern state, and yielded one of the most extensive networks of state maintained road systems in the nation (Escott 1991, 36), a system whose future was secured in 1989 by the enactment of the \$9 billion Highway Trust Fund. Yet, it may be that this extraordinary emphasis in state support for land transportation has further encouraged the concentration of industrial and urban development in

the Piedmont. Recently, this emphasis was further aided by a legislative yearly subsidy to improve passenger rail transportation between Charlotte and Raleigh, over the Urban Crescent. The move to redirect the geography of economic development by initiating the Global TransPark in the eastern Coastal Plains could then be viewed as an important regional development effort in the traditional spirit of "transportation improvement".

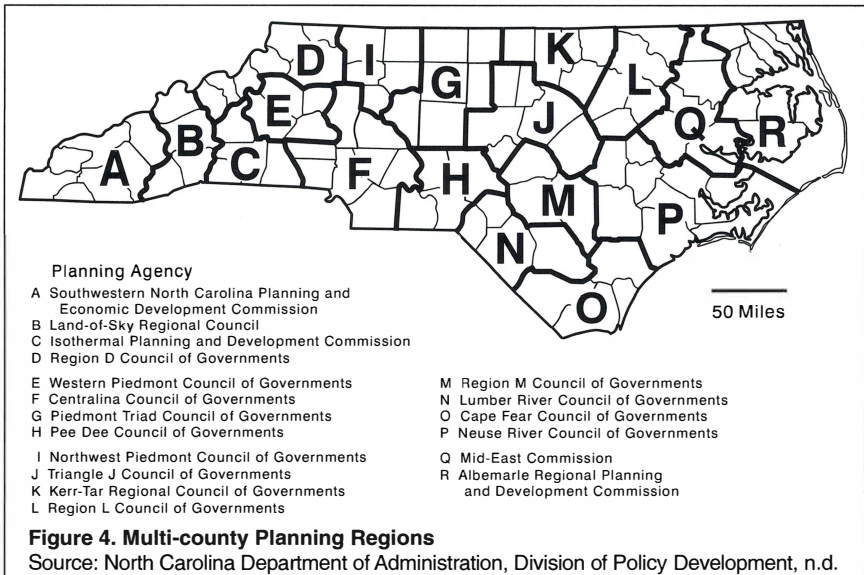
By contrast, the state's role in educational improvement does not have as glorious a history. And this in spite of the success in establishing a comprehensive 58-campus system of community and technical colleges, as well as the 16-campus university system. On the downside, the state lags considerably the national average in the percent of its population having completed high school. The problem is compounded by the relatively low state wages paid public school teachers, who then find the wealthier counties willing to provide a salary supplement. Considerable unevenness in the quality of public education develops as the better teachers are drawn to the wealthier counties.

State Defined Regions and Balanced Growth

It is clear that state initiatives have contributed to the centralization of economic development in the Urban Crescent, and to related regional disparities, a core-periphery condition hardly unusual in economically advanced countries. Having one hundred counties additionally caused an unwieldy passage of top-down central government support programs, whether they flowed from national or state government levels. Complicating the flow problem was the vast increase in such programs during the 1960s. By 1968 there were eight major federal programs that required multi-jurisdictional cooperation. To insure a smoother transition U.S. Congress passed the Intergovernmental Cooperation Act in 1968. Within a few years this led to the emergence of 670 regional organizations throughout the country. Seventeen were founded in North Carolina after the General Assembly's edict of 1969, that the Department of Administration work in developing "a system of multi county regional planning districts to cover the entire state" (Regionalism..., 1980, p. 3). This was not to be achieved in any haphazard way, but through administrative constellations. Thus regional boundaries were defined by careful evaluation of the following factors: "the economic and social interrelationships between urban centers and surrounding areas, existing cooperative programs between counties and municipalities, and the existence of physical boundaries, such as mountain ranges or rivers, that might separate one region from another; ... no region (was) to contain less than three counties, nor fewer than 100,000 people" (Regionalism..., 1980, p. 3). Local governments chose whether they supported a Council of Government (COG) or a Regional Planning and Economic Development Commission (RPEDC) form of regional organization. Only five organizations chose the latter. It merits noting that the RPEDCs, Regions A, B, C, Q, and R, are at the geographic opposite extremes in the

state (Figure 4). Internal schisms in Region G, the Piedmont Triad, led in 1978 to a division comprising the present regions G and I. To complement its regional policy the state, in May of 1971, created the Lead Regional Organization (LRO) concept. The result was to assign all regional programs administered through the state and the federal governments to the COGs and the RPEDCs .

In spite of considerable criticism, especially from metro regions who thought of LROs as administrative devices that favored rural and peripheral areas at the expense of urban development, the LROs became the vehicle for funneling federally mandated and state resources to local governments. Other critics pointed to the absence of taxing powers, the inability to condemn property, and the absence of independent power to implement their own plans. In addition, the fact that local governments can renounce membership at any time, was suggested to be a critical factor weakening the organizations (Stuart, 1979). On the other hand, the LROs brought important benefits to the table. They had a strong state mandate, and developed considerable expertise in delivering federal funding to localities. They served increasingly well in articulating local needs to higher levels of government and provided mid-level support in attracting federal funds to areas in special need. But, they seemingly fell short in providing linkages for localities to attract economic investment capital, especially to regions lagging in economic development.



Governor Hunt's first administration tried to ameliorate this situation when, in 1976, it initiated a balanced growth policy. The objective was to target federal resources to disadvantaged small towns and rural areas. A

rather simple formula was devised to determine degree of regional disadvantage for each of the LROs, as follows:

% of total jobs in region / % of total state working population in region

That the formula masks some other critical conditions, such as comparative growth rates, labor market and wage conditions, and unemployment differences, appeared to either be of little significance or to unduly complicate the model. When applied to actual conditions the model yielded a range from .75 to 1.16, with the low ranked LROs included R (.75), A (.77), D and M (.84), and N (.87). The high ranked regions included E (1.16), F (1.08), J (1.07), and G (1.05) (Gade, 1989), thus reflecting core-periphery contrasts. Aided by President Carter's image of the virtue of nationally balanced growth, the state policy initially was successful in obtaining federal agency agreement to steer to the so defined disadvantaged regions \$1.2 billion out of a total state annual federal allocation of \$7.6 billion. Soon, however, the initiative lost out to a new federal administration.

For rural LROs the Executive Director of Region D COG noted:

The ultimate effectiveness of the regional council in rural areas has to lie in their ability to meet locally perceived needs either through actually providing the needed services and resources or by being in a position to broker the services and resources of other governmental and private sources.... (Region D COG) has been more involved in building local capacity (Fender 1991, p. 99).

Certainly this is a much less ambitious objective for the rural disadvantaged areas than that envisaged by the Governor's Office, but perhaps more reasonable in the context of the already diminishing flow of federal dollars to the localities. Clearly, though, the focus of LRO activities has always been more social welfare than economic development in nature.

Regions Gone Astray?

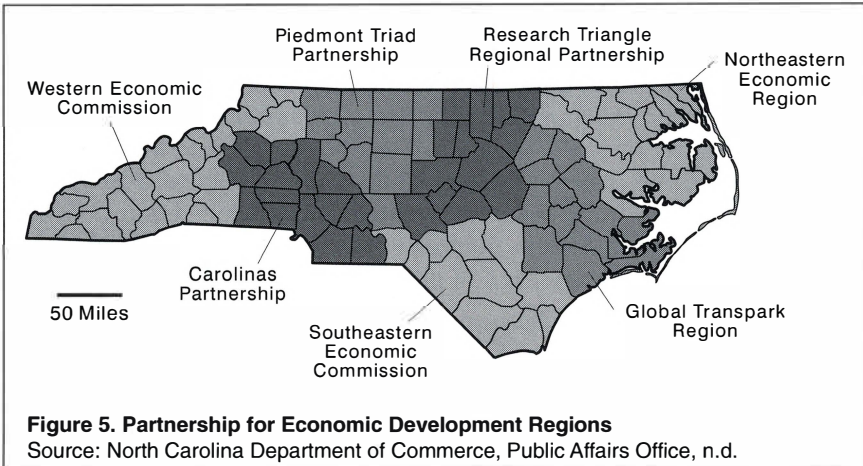
New federal and state agendas of decentralized government, decreased public involvement in the affairs of individuals and their communities, and a greater expectation of local initiatives, developed in the 1980s, and has continued into the 1990s. This new vision of public responsibility is coupled with corporate restructuring and global investment initiatives, which seem to further the interests of those growth regions that possess the appropriate opportunity structure, while providing disincentives for positive change in the lagging regions. In concert is the not so subtle philosophic shift away from the social welfare to the economic development agenda.

The greater capacity of Piedmont counties to marshal and assert their cooperative spirit resulted in the founding of three economic development partnerships. For example, the Greater Charlotte Economic Development Corporation was the product of an early 1980s effort in joint promotion of the region's economic potential. It held a meeting in 1990 to discuss strate-

gies for operating under its new name, the Carolina Partnership, Inc. While largely a chambers of commerce idea, it was soon broadened to include other citizen groups, but critically, it was a private enterprise venture! So were the two other Piedmont groupings, the Piedmont Triad Partnership, and the Research Triangle Partnership. And these 'partnerships' evolved without the counsel or direct support of the COGs. Business interests, for example, here fused the formerly disharmonious Regions I and G COGs. So a marked policy shift from public to private sector regional planning initiatives mirrored the new federal philosophy of the 1980s.

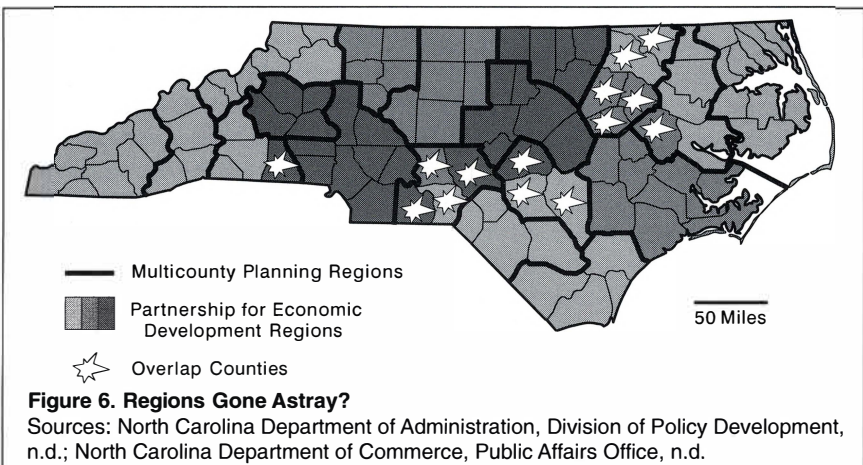
With the beginning of the second Hunt Administration in 1992 came renewed support for state involvement in regional development favoring the disadvantaged counties. Hunt's regional development programs provided them extra advantages in attracting new industries. Most critically this was through the Governor's Industrial Recruitment Competitive Fund (IRCF), funded with an initial appropriation of \$5 million in 1993. The Fund, which provides \$1000 for each job created by a new or relocating industry, complemented other state industrial investment incentives. These include, (a) the Building Renovation Fund for counties declared economically distressed, (b) the Income Tax Credit of \$2,500 for each new employee beyond nine that is hired by an industry located in a distressed county, and (c) the Department of Transportation Site Access Program for roads built to new industrial facilities; and others. It should be noted that of the \$3.5 million IRCF monies dispensed in 1993-94, about one third went to the urbanized Piedmont Crescent counties, while only about one half of the new jobs generated went to economically distressed counties (Figure 3 locates the counties that received IRCF funds). The North Carolina's legislature's enthusiasm for the Fund clearly dampened as its allocation of \$20 million for 1994 was scaled down to \$5 million for 1995. Presently the constitutional legality of transferring public funds directly to new or relocating private businesses is being tested in the state courts, so the future of the IRCF is uncertain.

In 1993 a North Carolina Economic Development Board was convened to assess the state's annual \$100 million economic development program. The total program was found to be quite inefficient in its delivery, an "octopus with many tentacles" (Tuttle, 1994, p. 4), and the Board recommended streamlining the delivery process by creating seven regions through which economic policy could be implemented and resources reallocated. In 1994 the General Assembly created five new economic development commissions (EDC), and provided a \$2 million budget for their initiation to be shared with existing partnerships. It was expected that the EDCs would evolve into partnerships like the three in the Piedmont, and thereafter join the Partnership Board. Figure 5 labels and identifies the boundaries of the seven Partnerships, which, after some initial juggling of a few counties for most desired alliance, are now in place. In 1995, the North Carolina Partnership for Economic Development, chaired by the Secretary of the De-



partment of Commerce, was founded as the state/private enterprise joint venture for planning and implementing the new state policy through the seven partnerships (Tuttle, 1995, p. 16).

Partnership boundaries are determined by local governments using the following criteria: primary economic linkages, principally through commuting patterns; existing development organizations and relationships; natural boundaries; principal economic centers or "engines" within the region; anticipated major projects; and other bases for cooperation (*Making North Carolina....* 1994, p. 16). This is not a set of criteria significantly different from those earlier used in defining the existing LRO boundaries. But there are 18 LROs and only eight Partnerships! Figure 6 shows the degree to which a coincidence exists between the two sets of regions. Seen here are the 14 counties that appear to have been maneuvered out of place, in the



context of their continuing membership in an LRO where boundaries do not coincide with the particular county's position in a new partnership. These "overlap" counties take on a regional pattern of their own, especially in identifying a kind of intermediate region positioned between the wealthier Piedmont Crescent counties and disadvantaged eastern counties. Note also the comparison here to the location of low level socioeconomic counties in figure 3. The vast majority of the state's more disadvantaged counties are gathered into in the larger and more peripherally located Northeast Economic Region, Southeastern Economic Commission, and the Western Economic Commission. In the latter only Cleveland County, which chose to switch out of the Western Economic Commission, exists as an "overlap" case. Otherwise, a clearly disjunct western region of 22 relatively disparate counties comprises its own partnership.

So, an interesting regionalizing system has evolved where internal geographic harmony seems to come natural to only the three Piedmont Crescent partnerships, and possibly also to the Global TransPark Region. These four partnerships clearly have their "economic engines" in place, but what about the largely non-urban peripheral partnerships? The Northeastern Economic Region is totally without a dominant central place; the influence of Asheville in the Western Economic Commission reaches not much beyond the counties adjacent to Buncombe, and in the Southeastern Economic Commission, the two medium sized cities of Fayetteville and Wilmington may find that they have too little in common to profitably provide the leadership needed for the Partnership.

And what now for the future role of the LROs? A traditional problem for the state in regional politics is the general absence of regional alignment among state agency geographical divisions. As recently as in 1992 this was seen by the North Carolina General Assembly, Government Performance Audit Committee as a situation conducive to inefficiencies and lack of cooperation among agencies charged with furthering the interests of the citizens (GPAC, 1992, p. 4.3). LROs are assigned the task of supporting local governments and of channeling, if not administering, the revenue flow of federally mandated programs to localities. In postfederal times their situation appears to have weakened considerably. The worst case scenario, perhaps, is realized by Region H, whose five counties have been absorbed into no less than four different economic development partnerships. Whose interests are being served here?

So, Who is Being Served?

Glocalization - North Carolina Style

The idea behind the somewhat awkward term, glocalization, is that global competition makes regional/local cooperation necessary for expanding existing internationally competitive industries and in attracting new regional investment. It being the avowed purpose of the Governor's Office

'Partnership Regions' may deepen traditional rural-urban economic development contrasts, and rob the LROs of some of their effectiveness in supporting local government

to provide direct state support for the localization of new plants, the question then focuses on the extent to which the new state measures may succeed. Will the new regional delimitations for economic development help localities define their place in the world, or will it deepen their struggle for maintaining some measure of community identity? Will the place wars (Haider, 1992), which deepened in North Carolina through the 1980s diffusion of county based economic/ industrial development committees/boards, be intensified where independence of action appears to be usurped by (a) a new powerful urban presence, or (b) the inability of a more peripheral region, without a competitive urban center, to remain investment attractive? Some of the evolved "Partnership Regions" may have difficulties in identifying their "core competencies" due to their much larger and diffuse territories. Certainly the state is hoping that this new approach will realize a long sought North Carolina goal, providing an even playing field for its varied regions in their search for equal socioeconomic development opportunity and cultural sustainability. For county residents of the non-urban periphery, there may be less appreciation for the sentiment recently expressed in a *Charlotte Observer* editorial piece, "regionalism provides an avenue for communities to avoid being lost in the world, if they can overcome their fear of being lost in the region," (Bradbury, 1994, 18A). Their newly formalized Partnership regions, absent in 'internal economic engines' may provide for them a strait-jacket within which they will have even less assurance of needed state support for economic development initiatives.

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HISTORICAL LAND USE AND ACCELERATED SOIL EROSION IN WATAUGA COUNTY, NORTH CAROLINA (1950-1988)

H. Craig Seaver and Michael W. Mayfield

Introduction

Accelerated soil erosion is a serious concern in all parts of the world due to the numerous effects it has on the environment and humankind. Activities such as agriculture and construction often increase soil erosion to unacceptable rates (Brown and Wolf, 1984). It has long been known that poor land management practices can result in a loss of topsoil at rates substantially above the rates of replenishment through pedogenesis (Birkeland, 1984). Crop yields and soil productivity are often reduced, and there are clear economic impacts associated with these reductions (Harlin and Berardi, 1987). Population growth and consequent increases in agricultural needs are likely to result in greater soil erosion, decreasing productivity levels, and could contribute to difficulties in feeding human populations. The purpose of this research was to examine historical land use patterns in a southern Appalachian watershed and to utilize Geographic Information System (GIS) techniques to relate those activities to estimated spatial and temporal patterns of soil erosion within the watershed since the implementation of soil conservation programs.

Methods for Estimating Soil Erosion

Researchers have utilized various methods to estimate current or recent rates of soil erosion from local to global scales (Beach, 1994; Phillips, 1990; Trimble, 1973). A few have utilized GIS to accomplish this task (Harden, 1990; Pelletier, 1985; Spanner, et al, 1983).

When accurate measurements of soil loss are possible, these impacts can be quantified since a value can generally be placed on both crops and topsoil. The total costs of soil erosion, both monetary and environmental, are unknown and probably can not accurately be calculated (Dunne and Leopold, 1978). Organized soil conservation programs in the United States have been in effect for over 50 years, and hundreds of millions of dollars have been spent in an effort to control the rapid soil loss which has occurred since early European settlement. There has been a notable decrease in

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In southern Appalachia poor land management has resulted in substantial losses of topsoil, a problem recently reduced through soil conservation and land use changes

erosive land use in the southeastern Piedmont region of the United States since the mid-1920s (Trimble, 1973). Based on qualitative historical evidence, it is believed that erosion and sedimentation have been reduced in the Appalachian region as well (Glenn, 1911; Silver, 1990). The watershed of

the East Fork of the South Fork of the New River (subsequently referred to as the East Fork) is within Watauga County, North Carolina (Figure 1). This part of the Blue Ridge is characterized by some of the highest elevations in the Appalachian Highlands and overlooks the Piedmont to the east (Hunt, 1990). The East Fork watershed covers an area of approximately 7.3 square miles (18.9 sq.kms). Within the watershed are numerous agricultural ponds which were constructed primarily for livestock use.

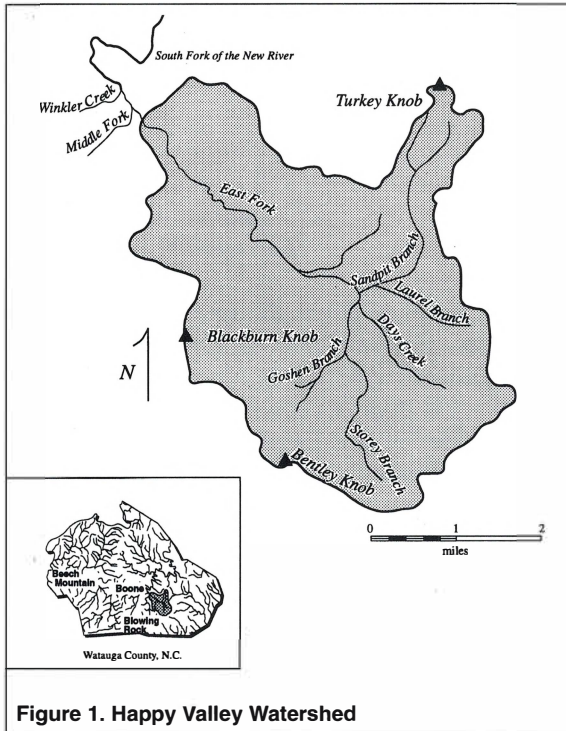


Figure 1. Happy Valley Watershed

In the Southern Appalachian region, there is a need to assess the effectiveness of soil conservation programs implemented over 50 years ago. Such programs included management practices such as contour plowing and crop rotations, and discouraging row crop agriculture on steeper slopes. In order to accurately assess soil conservation achievements, it is necessary to determine the nature, extent, and intensity of land use through time. The variables associated with most soil erosion models include: precipitation characteristics; the ability of soils to absorb water and their inherent susceptibility to detachment and transport; topographic characteristics such as slope length and gradient; and the local vegetation cover. Geographic information system and remote sensing technologies were jointly utilized to generate a database in a GIS format containing these basic variables.

In choosing a model appropriate for demonstrating the relationships among the relevant variables, the Universal Soil Loss Equation (USLE) was selected. This model is considered to be substantially accurate for predict-

ing long term averages over time. Alternative storm-event driven models require rainfall duration and intensities as input data. Without such data the models are not accurate predictors, nor do they function the way they were intended (Beaseley, phone interview, 1995). And rainfall duration and intensity data do not exist for the Happy Valley catchment.

The USLE was simulated in a raster based GIS and modeled for the Happy Valley basin during the years 1950, 1963, 1976, and 1988. Happy Valley is believed to be representative of numerous upland catchments in the Appalachians. Results were analyzed and compared to patterns of land use change and sediment deposition in the aforementioned agricultural ponds. Sediment cores served as an indicator of the magnitude of watershed stream transported sediment over time by applying sediment delivery ratios (SDRs). These SDRs are derived from volumes of pond sediment representing a percentage of the total gross erosion transported in a watershed over time. Sediment delivery ratios were developed for the thirty-nine year period, but are beyond the scope of this paper.

Agricultural History of the Region

European settlement of the upland southeastern United States began in Virginia about 1700 and ended in Alabama during the 1830s. In the late 17th century, European settlers crossed into Virginia and continued on to North Carolina by 1740 (Trimble, 1973). In North Carolina, much of the settlement was still of the pioneer type with most agricultural activity taking place in the valleys along streams (Hall, 1948, 50). Population growth placed increased pressure on the landscape and colonists often had to adjust their methods of agriculture to correspond with such changes as noted by Silver (1990),

Planters adjusted first by planting corn on the worn tracts and then by allowing them to lie fallow. That worked until the population and labor force grew too large to allow depleted fields adequate time to recover (p. 195).

Land was incessantly and continuously cleared, farmed poorly until perceived to be infertile, and then abandoned (Trimble, 1973, 41). Consequently, farming techniques utilized here could hardly be considered sustainable or conservationist.

European settlement of the Appalachian region lagged behind the rapid migrations into the Piedmont. Happy Valley was one of the wider, larger valleys in Watauga County and was one of the initial sites for settlement in northwestern North Carolina. Although the population was largely agricultural and steadily increasing during the mid 1800s, industries such as

Changes in soil erosion rates for Happy Valley of Watauga County are in this paper assessed by the use of GIS and remote sensing techniques.

Up to and including the Depression years, population increases pressed agriculture onto slopes too steep for rational utilization of the land

lumbering and cattle grazing slowly became more profitable to outsiders. Portions of the region were properly agricultural land, but migration pressures and poor practices brought increasingly more land under cultivation on the steeper slopes. Fields were often worn out and abandoned before the larger girdled trees had fallen. The new fields were then cleared beside the old ones in the same destructive manner, and normally on steeper slopes (Glenn, 1911).

During the 1930s the Depression spawned an increase in the number of farms in the Appalachian region, much of it on land which was ill-suited to cultivation (U.S. Department of Agriculture, 1938). During the period, population densities among farm populations were greater than those of the more productive Mid-west Corn Belt (U.S. Department of Agriculture, 1938). These rapid migrations of people compounded the problem of ignorant farming practices in the region. Despite the concerns of George Washington and Thomas Jefferson with soil erosion, it was not until the 1930s that Congress recognized it as a real problem. This era marked the beginning of conservation efforts in the United States (Harlin and Berardi, 1987).

Even so, by the 1970s, there were growing concerns about the limited acceptance of soil conservation programs among farmers throughout the United States (Dunne and Leopold, 1978).

The temporal pattern of land use change in Happy Valley mirrors regional trends during the same time period. In 1944, the average farm in Watauga County covered approximately 68 acres with 34 acres of cropland, and it produced mainly for the farm household (USDA, 1990). The number of farms in Watauga County declined from 2,553 in 1950 to only 715 in 1987. The acreage of farmland declined by over 60% during the same time period (U.S. Bureau of the Census, 1950; 1987). These figures can be compared to employment figures for agriculture from 1950-1960. In 1950, 665,000 (25.1%) people in North Carolina were reported to be employed in agriculture; the number decreased to 316,000 (11.1%) by 1960 (USDA, 1965).

Estimating Soil Loss in the Happy Valley Watershed

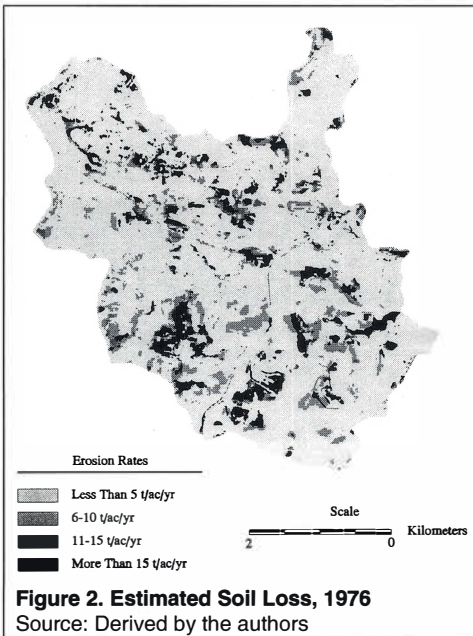
Modeling gross annual erosion for the watershed and determining the extent of erosive land use change over time required the use of available aerial photographs. Individual aerial photograph series for each available year were scanned, rectified (corrected geometric distortions), and merged into mosaics. For a detailed discussion of the steps involved in image processing for earth resource analysis, see Jensen (1996) or Lillesand and Kiefer (1994). The mosaics were imported into a package for processing and mod-

During the 1950s and early 1960s there was a sharp reduction in cultivated areas, and an increase in open pasture land

More recently pasture lands have reverted to forest, and urban usage has extended considerable into the valley

eling. Land use was determined for each scene through an unsupervised classification process. Results of the automated classification were rechecked against the aerial photography and by ground truthing for the 1988 image. The land cover classes from each image mosaic were used as one of the primary variables in order to model soil erosion in tons/acre/year.

Because of the very limited area of other land cover types (water, urban, and specific vegetation groups) and the limited spectral resolution of black and white air photos, only three land cover types were recognized. The land use classes which were used were (1) forest, (2) pasture/open, and (3) cultivated/bare soil. While deciduous trees could be distinguished from coniferous tree stands, there was no reason to make such a differentiation, as the two forest types have similar hydrologic and erosional characteristics. Within each land use class, a cover factor was assigned for USLE input based on a conservative interpretation. For example, the "C" factor values for forest range from 0.0001 to 0.009, indicating two orders of magnitude of variability (U.S.D.A., 1983). In this study, all areas covered by forest were assigned a "C" factor of 0.001. For all variables except slope, a pixel size of 5m x 5m was utilized. Slopes were calculated from a USGS digital elevation model with a spatial resolution of 30 meters.



Patterns of land use change in Happy Valley from 1950-1963 reflect a sharp reduction in cultivated areas and a reversion from agricultural cropland to open pasture; a slight drop in forested areas was also observed (Table 1; Figure 2). The greatest change occurred along the northern boundary of the watershed, an area that revealed very high rates of erosion in 1950. This is an area that experienced substantial reforestation from 1950 to 1963. From 1963-1976, a large portion of pasture reverted to forest. This is seen on the modern landscape in the many stands of white pines found on steeper slopes and ridge lines in the watershed.

This tree species reaches harvest maturity in 20-40 years and is often chosen for woodland conversion for this reason.

	1950	1963	1976	1988
Forest	40.11%	36.77%	47.78%	44.47%
Pasture	36.13%	50.90%	38.82%	45.87%
Cultivated	23.76%	12.33%	13.40%	9.66%
Total Erosion	52,539	34,002	33,110	30,131

Table 1. Temporal land use change and estimated gross basin erosion

Source; Derived by the authors

The beginning of an urban expansion / construction period in the basin is revealed in the 1976 image, with an increase in the cultivated / bare soil class. This trend continued through 1988, with decreased forest area and increased open space. During this period the watershed and county experienced significant population growth. Erosion in Happy Valley was graphically reduced from 1950 to 1963. Much of the agricultural activity taking place on steeper slopes was halted and vegetation reverted predominantly to forest. Erosion figures for the watershed show only slight reductions from 1963-1988. Reductions in agricultural erosion were largely offset by suburban development. In the land cover classifications, these suburban areas show up primarily as forested areas that were cleared and converted to grass. The spectral signature of a lawn is essentially the same as that of pasture. During the construction phase, large amounts of bare soil are exposed, resulting in very high sediment erosion rates (Wolman, 1967). The temporal resolution of aerial photography is not great enough to reveal a large amount of bare soil associated with home construction.

Conclusions

The decline in modeled soil erosion from 1950-1988 appears largely to be a result of the socio-agrarian transitions and not to regional soil conservation programs implemented over the time period studied. Implementation of conservation programs has had little to do with the reductions observed in erosive land use and associated soil loss in Happy Valley. Rates of adoption of conservation programs were low. Changes in land use from an emphasis on row crop agriculture to livestock, forestry, and land subdivision and suburbanization have had a much greater impact on soil erosion in the basin. This marked a decrease in agricultural activity that corresponds to several trends nationwide. As of 1989 only 1,300,000 American farms were family owned and operated, down by nearly 50% from 2,184,000 in 1976 (Hunst and Powers, 1991).

Erosive land use in Happy Valley has been greatly reduced since the period of federal soil conservation program implementation. It is believed that the USLE results provide a reasonable account of the relative rate of soil loss which have occurred in

Though soil erosion rates have been reduced the reason more probably lies within the changing socio-agricultural environment than with the implementation of soil conservation programs

the basin over time. The modeled soil erosion estimates should however not be considered absolute data, but merely a representation of the magnitude of changes in accelerated soil loss and associated erosive land use.

The golden age of family farming in Happy Valley has virtually ended and not due to the implementation of soil conservation programs, but rather to a combination of corporate consolidation farming trends and to a fast-paced socio-economic transition to suburbanization and related expansion of service industries. Subsistence family farms have disappeared, college graduates have proliferated, and a service economy has largely replaced a form of living which used to be essential to clan and family survival in the region (Raitz and Ulack, 1984).

Accelerated soil erosion has not been eradicated in Happy Valley, but it has been reduced significantly and the activities causing it have largely changed. Increases in urban encroachment and development are likely to continue just as population growth shall. Future research should focus on the impacts of continued urban development and construction as the primary contributors to accelerated soil erosion in the Appalachian region.

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GEOGRAPHY at UNC-WILMINGTON

Geography at the University of North Carolina at Wilmington is housed in the Department of Earth Sciences. There are five full-time geography faculty. Research interests and specialties include cultural-historical geography, material culture studies, environmental planning, and fluvial geomorphology. Equipment available for teaching and research includes modern PC-based cartographic and image-processing lab, and photographic and darkroom facilities. The university library contains a strong geography collection including all major journals, and is a repository for government documents and maps. About 40 majors are working towards a B.A. in geography.

Wilmington, North Carolina's premier port city, is located on the Cape Fear River and is only ten miles from the Atlantic shore. It is linked to the research Triangle area directly via Interstate 40. With a metropolitan area of over 130,000 residents, Wilmington is the economic and cultural hub of southeastern North Carolina. Climate is warm and humid during the summer, and exceptionally pleasant during the rest of the year, enhancing the variety of coastal recreational activities of the region.

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IRRIGATION IN SOUTHCENTRAL NORTH CAROLINA

Thomas E. Ross

Introduction

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Agriculture is the predominant economic activity in southcentral North Carolina. More than 531,000 acres, about one-seventh of the total land area, is devoted to agriculture (NC Agricultural Statistics 1993, 27). Two of the region's counties, Robeson and Columbus, consistently rank among the top six counties in farm cash receipts and illustrate the region's apparent comparative advantage. Thus, continued and expanded agricultural production is an important component of the overall economic development in this part of the state. Though abundant arable land is available for increased production, expansion and refinement of the agricultural base is hindered more by the quality of the crops than by quantity. Although the region is included in the humid subtropical climate, it does experience frequent and sometimes severe droughts, associated with

high temperatures and sandy soils. This results in reduced yields of poor quality crops that are not acceptable on most commercial markets. For example, although Campbell Soup Company has a large processing facility in the region and uses large quantities of fresh vegetables, Campbell purchases very little from local farmers because of the consistently poor quality of the produce. It is argued in this paper that increased rates and levels of irrigation applied to more acreage, given that only three percent of the cultivated land is irrigated, would result in a consistent and higher quality product. A secondary use of irrigation water would be to cool crops as they are harvested and to keep them cool after harvest. These two actions would significantly enhance an already important agricultural base.

The feasibility of expanding irrigation acreage was the focus of a study made in 1988 in which more than 300 farmers and other water users were interviewed over a four month period (Ross, 1990a). This study was an attempt to gain a better understanding of the water situation in the region as it affected economic development. Questions pertaining to acres irrigated and adequacy of water supplies were important components of the survey. Much of the data presented in this paper were extracted from that study.

The author's objective is to show how important irrigation is to agriculture in southcentral North Carolina, and to raise questions concerning the availability of additional irrigation water

Frequent and sometimes severe droughts result in reduced yields of poor quality crops and therefore the need for irrigation

The purpose of this paper is to describe the extent of irrigation usage in south-central North Carolina, with particular emphasis upon the sources of irrigation water and the degree to which the region's surface and groundwater supplies are capable of supporting an increased irrigated acreage. A discussion of crops and land uses that benefit from irrigation water is also included.

The Study Area

South-central North Carolina, as defined in this study, includes the counties of Blade, Columbus, Cumberland, Hook, More, Montgomery, Richmond, Robeson and Scotland (Figure 1). It is a region of approximately 6,000 square miles, inhabited by more than 700,000 persons. Located astride the Piedmont and Coastal Plain physiographic regions, the study area's topography ranges from rolling and hilly Piedmont to undulating and level Coastal Plain.



Figure 1. Study Area: Southcentral North Carolina

Underlying geologic material in the region is as varied as the topography and greatly impacts the availability and accessibility of groundwater. The rocks are divided into three major units, based on lithology and age. They include the Late Proterozoic to Cambrian metamorphic rocks of the Carolina Slate Belt, Triassic sedimentary and igneous rocks, and Cretaceous and younger sediments. Cretaceous sediments are found mainly in the Coastal Plain, although there are some small outliers in the Piedmont. In the Piedmont of Richmond, Montgomery and Moore counties, the rocks of the Carolina Slate Belt are mainly metamorphosed volcanic materials. Triassic rocks, also found in the same counties, are conglomerates, sandstones and mudstones with some intrusive igneous diabase dikes. Triassic sediments were deposited in a down-dropped fault basin that trends north-east-southwest. Cretaceous and younger sediments of the Coastal Plain

part of the study area consist mainly of interbedded sand, clayey sand, mud and clay layers and lenses.

Water movement is restricted to the more permeable sandy layers which lie between the less permeable layers of clay. This is known as confined, or artesian, water. Artesian wells, derived by overflow, are common along many of the streams in the Coastal Plain. Shallow groundwater also occurs in the zone of saturation, or water-table aquifer.

Regional Water Sources

More than 88 percent of the irrigation water used in the region came from surface sources in 1987 (Table 1). Of the more than ten million gallons used in the region, Moore County used 50.1 percent, of which about 95

County	Surface Water	Groundwater	Total
Bladen	221.45	293.19	514.64
Columbus	253.60	36.50	290.10
Cumberland	423.09	464.17	887.26
Hoke	263.26	---	263.26
Montgomery	691.44	6.02	697.46
Moore	4,877.90	260.74	5,138.64
Richmond	781.02	---	781.02
Robeson	1,311.96	46.62	1,358.58
Scotland	232.77	83.55	316.32
Totals	9,056.49	1,190.79	10,247.28

Table 1. Water Withdrawals for Irrigation, 1987
Note. Data is provided in million gallons/year; to convert to million gallons/day divide by 180 under the assumption that water is applied over a six month period
Source: Ross 1990a

percent was derived from surface sources. The second major user was Robeson County, with about 13.3 percent of the total used and about 96.6 percent of this coming from surface sources. Bladen and Cumberland were the only counties in which more than one-half of the irrigation water was derived from groundwater sources. About 57 percent of Bladen's water was groundwater sourced as was 52 percent of Cumberland's. Hoke and Richmond acquired all irrigation water from surface sources, and more than 99 percent of Montgomery's irrigation water was surface sourced. The spatial pattern of surface water withdrawals illustrates the high level of withdrawal in the Sandhills and Piedmont as compared to most of the Coastal Plain (Figure 2). More specifically, surface water irrigation is concentrated in the southern half of Moore, the northeastern part of Richmond and the eastern half of Montgomery. A secondary concentration exists along the Fall Line and extends across Scotland and Hoke into eastern Cumberland. In the Coastal Plain, surface water irrigation is important in southeastern Robeson and southern Columbus. Eastern Bladen is a fourth, less distinct area of surface water irrigation.

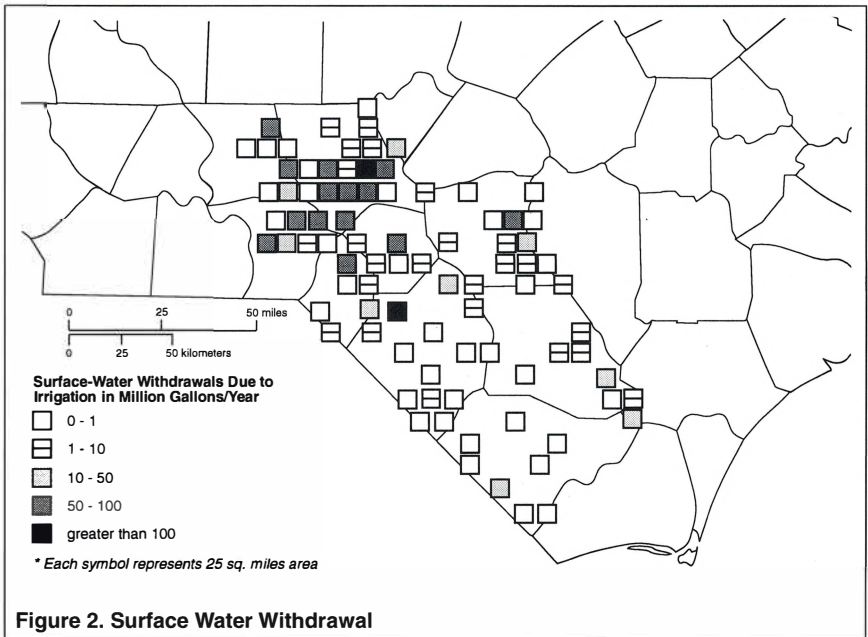


Figure 2. Surface Water Withdrawal

Surface water is taken from the rivers and swamps that wind through the region and from farm ponds maintained by groundwater discharge from the surficial aquifer. Rivers supplying water include the Pee Dee, Lumber and Cape Fear, and their tributaries. The average discharge of the Pee Dee is about 5,000 million gallons per day (mgd), the Cape Fear about 3,200 mgd and the Lumber River 950 mgd.

The Little and Deep Rivers and tributaries are the primary sources in Montgomery County. In Moore, the Little River, though not the Little River of Montgomery, and Drowning Creek drainage basins provide surface water. Tributaries of the Pee Dee are the source of much surface water used in Richmond, while Shoe Heel Creek, Gum Swamp and several Pee Dee tributaries are used in Scotland. Cumberland's farmers secure water from the South, Little and Cape Fear and their tributaries. Most of the water used in Robeson and Hoke is from the Lumber River drainage basin. The Lumber also provides water to Columbus, as does the Waccamaw River. Bladen counts upon the Cape Fear and South Rivers and their tributaries for the bulk of its surface water needs.

Average runoff of streams in the region is 0.6 to 1.0 mgd per square mile, a level which could support much more irrigation. An expansion of surface water consumption upwards to 50 percent of the runoff is realistic and probably would not compromise other water users or interfere with watershed or other natural actions associated with the water. With few exceptions, the surface water supply has for the past four or five decades been sufficient to meet demand. Surface water quality is good, but is un-

der increasing threat of pollution from expanded industrial and residential development and widespread use of agricultural pesticides. A more recent threat is waste from huge hog farms that have been established throughout the region. The waste from the several million hogs inhabiting these farms is required to be dumped in lagoons. During the summer of 1995 a number of lagoons overflowed due to excessive rains and/or poor construction with waste materials draining into and polluting adjacent rivers.

Groundwater quality is good, the major problem being a higher than desired level of iron (Ross 1990b). Yields vary from place to place, depending on the geologic structure which holds the water. The groundwater used in the region comes from the surficial sands aquifer, the Black Creek Formation, the Cape Fear Formation and basement rocks underlying the Cretaceous formations and the rocks of the Cambrian and Triassic. The latter, in the western end of the study area, are of minor significance as a source of irrigation water.

Water withdrawals from each of the groundwater sources vary greatly. The most important aquifer in the region is the Black Creek, which supplies most of the groundwater used in Robeson and Scotland. Portions of Cumberland, Bladen, Columbus and Moore also depend upon the Black Creek Formation. The primary groundwater source in Cumberland is the surficial sands aquifer, while Moore and Montgomery draw upon the Triassic rocks and the Cape Fear aquifer is of some value to Bladen County.

In the slate belt, at the western edge of the region, good water can be found at less than 300 feet below the surface. Average yields, though, are not high, usually much less than 100 gallons per minute (gpm). Regardless of the low yields, this large aquifer is a dependable supplier of water to the region. The best sites to find water in the slate belt zone are in valleys and other low places, in areas where the weathered zone (decomposed rock) is thick and near quartz veins and dikes. The Triassic rock region does not have a dependable water supply because the rocks are compacted and tightly cemented. Some water can be found near faults, but the supply is very small, usually less than 10 gpm. Deep drilling does not enhance the supply.

The Cretaceous aquifers, such as the Black Creek, Cape Fear and Pee Dee, are in many places more than 600 feet thick. In the clay aquifers, yields range from 10 to 20 gpm while the sand aquifer, which is 250 to 600 feet thick, has yielded more than five gpm per foot of depth, though one gpm per foot is more customary.

There are three distinct regions of groundwater withdrawal in the study area (Figure 3). All are closely related to the Coastal Plain: the largest is in eastern Cumberland and Bladen; second largest is in southern Moore; and a smaller withdrawal region is in Scotland.

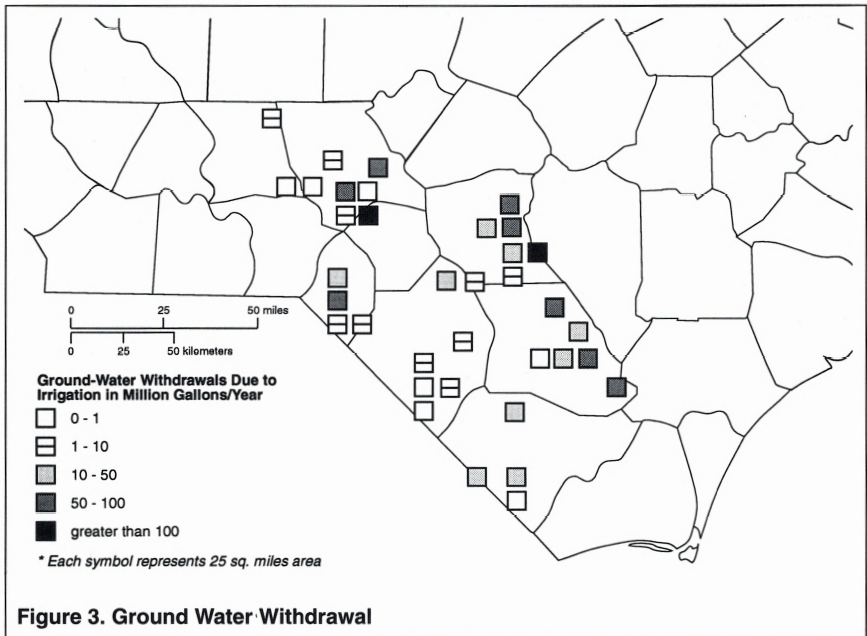


Figure 3. Ground Water Withdrawal

Three counties took irrigation water from the surficial sands aquifer: Cumberland mined the most, well over 100 million gallons per year (mgy). Columbus extracted a lesser amount and a small volume is produced in Moore. The Black Creek Aquifer provided irrigation water for all of the region's counties except Hoke and Richmond. Scotland, Moore, Robeson, Bladen and Columbus were the major users of this water. Cumberland and Montgomery used a lesser amount. The Upper Cape Fear Aquifer provided a small amount of water to Bladen and a small amount was also taken from Triassic and Cambrian bedrock in Montgomery and Moore.

Only two counties in the region, Bladen and Cumberland, used more ground than surface water for irrigation. No groundwater consumption was reported in Hoke and Richmond. Moore County uses the most water for irrigation, but of the 5,100 mgy used, 3,802 mgy were used to water golf courses.

Groundwater withdrawals are concentrated in the Coastal Plain portion of the region, with very little groundwater used in the Piedmont. The leading area of withdrawal in the region is that area in and near the Cape Fear Valley. Another area of importance is found in southern Moore. Southcentral Scotland and southeastern Robeson are also significant users of groundwater.

Application of Irrigation Water

A wide range of uses of irrigation water, as well as a substantial difference in the level of irrigation for each of the uses, exists throughout the region (Table 2). The only crop irrigated in every county of the study was

CROP	BLA	COL	CUM	HOK	MON	MOO	RIC	ROB	SCO
Corn	.261	.000	.264	.000	.082	.453	.162	.033	.184
Soybeans	.098	.000	.035	.218	.055	.401	.000	.000	.000
Tobacco	.203	.043	.334	.231	.201	.209	.252	.088	.158
Peanuts	.098	.000	1.316	.000	.545	.000	.000	.000	.000
Cucumbers	1.960	.817	.325	.000	.000	.000	.327	.014	.000
Vegetables	.799	.029	.386	.000	.349	.316	.274	.400	.308
Truck veg.	.000	.000	.755	.000	.181	.135	.293	.164	.000
Grains	.000	.000	.027	.000	.000	.000	.054	.041	.000
Grass	.000	5.881	.000	.000	10.209	1.608	.077	4.496	.000
Pasture	.000	.000	.000	.000	.000	.000	.054	1.742	.055
Strawberries	.156	.183	.490	.000	.521	.808	.545	.134	.217
Blueberries	.651	.193	.490	.000	.763	.000	.000	.000	1.429
Watermelons	.000	.000	.000	.000	.136	.343	.166	.215	.000
Cantaloupes	.000	.817	.000	.000	.135	.110	.104	.215	.000
Sw. potatoes	.000	.000	.081	.000	.136	.261	.111	.000	.000
Cotton	.000	.000	.000	.000	.000	.000	.000	.000	.109
Tomatoes	.000	.817	.000	.000	.000	.816	.251	.110	.000
Nurseries	.000	.816	.000	.000	1.225	.503	.000	.715	1.258
Peaches	.000	.000	.000	.000	.393	.149	.109	.000	.150
Misc.	.000	.000	.000	.871	.817	3.675	.719	.000	.000
Golf courses	.327	10.663	.000	.272	.982	2.198	.000	3.485	.855
Totals	.478	1.480	.310	.516	.806	1.036	.220	1.414	.263

Table 2. Amount of Water Applied per Acre, 1987

Source: Ross, 1990a

the region's big cash crop, tobacco. Other widely irrigated crops included corn, vegetables and strawberries. Golf courses were irrigated in all counties except Richmond and Cumberland. It is most likely, however, that golf courses in these counties did receive irrigation just that data were not collected to verify this. In Bladen, cucumbers received the most water per acre, but only five acres were irrigated. In Columbus, Montgomery and Robeson, grass was the leading recipient of irrigation water while peanuts received the most in Cumberland. In Scotland, blueberries were the most intensely watered. The miscellaneous category led in Hoke, Moore and Richmond. The crop least likely to be irrigated was cotton, but it was not grown widely in the region.

CROP	BLA	COL	CUM	HOK	MON	MOO	RIC	ROB	SCO
Corn	250	0	1202	0	6	191	151	20	260
Soybeans	60	0	100	90	4	202	0	0	0
Tobacco	29	73	949	132	246	2159	874	465	105
Peanuts	40	0	76	0	4	0	0	0	0
Cucumbers	5	3	213	0	0	0	211	41	0
Vegetables	15	10	109	0	5	42	363	1	42
Truck Veggies.	0	0	152	0	15	55	97	23	0
Grains	0	0	20	0	25	0	30	8	0
Grass	0	10	0	0	0	312	55	260	0
Pasture	0	0	0	0	0	0	50	46	190
Strawberries	5	14	20	0	12	23	6	27	3
Blueberries	591	48	8	0	8	0	0	0	5
Watermelon	0	0	0	0	5	14	111	1	0
Cantaloupe	0	3	0	0	2	0	88	1	0
Sw. Potatoes	0	0	15	0	12	137	42	0	0
Cotton	0	0	0	0	0	0	0	0	391
Tomatoes	0	3	0	0	0	5	5	1	0
Nursery	0	14	0	0	8	38	0	65	10
Peaches	0	0	0	0	148	23	1450	0	5
Misc.	0	0	0	225	360	30	23	0	0
Golf Courses	80	18	0	63	5	1730	0	2	190
Totals	1075	196	2864	510	865	4961	3556	961	1201

Table 3. Acres Under Irrigation, 1987
Source: Ross 1990a

Crops and uses which consumed more than one billion gallons of surface water per acre were cucumbers in Bladen, vegetables in Cumberland, grass in Montgomery, Moore and Robeson, pasture in Robeson, blueberries in Scotland, nurseries in Montgomery and Scotland, miscellaneous in Moore and golf courses in Columbus, Moore and Robeson. Only four counties applied more than a billion gallons of groundwater per acre to any crop or use: Columbus to golf courses; Montgomery to nurseries; Moore to grass, nurseries, miscellaneous and golf courses; and in Scotland to golf courses.

As shown in Table 3, only 16,189 acres of farm land in the region is irrigated. For example, less than one-half of one percent of the cropland in Robeson was irrigated in 1987. There is little likelihood that the percentage of irrigated cropland varies substantially in other counties within the region. More than 50 percent of the land under irrigation was usually occupied by only one or two crops or uses. In Bladen, for example, 55 percent of the irrigated acres were in blueberries and 23 percent were in corn; in

Cumberland, corn accounted for 42 percent and tobacco for 33 percent; in Moore, tobacco was planted on about 43 percent of the irrigated land with golf courses occupying another 35 percent; peaches used 41 percent of Richmond's irrigated land and tobacco 25 percent; in Robeson, tobacco took 48 percent of the irrigated cropland and grass 27 percent; in Scotland, cotton accounted for 33 percent and corn 22 percent; 37 percent of irrigated land in Columbus was in tobacco and 24 percent in blueberries.

In summary, the four largest crops or uses of irrigated land in the region were, in order, tobacco (5,032 acres), golf courses (2,088 acres), corn (2,080 acres) and peaches (1,626 acres). These occupied 67 percent of the irrigated acres. Of this, 31 percent was in tobacco, while golf courses and corn each took about 13 percent, and peaches occupied 10 percent. Other crops accounted for four percent or less.

Although the amount of water available for irrigation does not appear to be a major factor in whether a farmer uses irrigation or not, there is a distinct regional pattern in terms of how much water is applied to crops, and to which particular crops (Table 2). For example, tobacco is one crop for which irrigation is especially beneficial. Irrigation leads to increased yields and better quality tobacco, which translate into more profit for the grower. Yet, the amount of water applied ranged from about 43,000 gallons per acre in Columbus to 334,000 in Cumberland. Another crop with wide geographic differences in the amount of water application is corn. Robeson farmers applied just 32,800 gallons of water per acre, but Cumberland producers used about 264,000 gallons per acre. Moore corn farmers led the region in water applied, committing more than 452,000 gallons per acre. For all crops, however, Columbus applied more water per acre than any other county in the region, averaging about 1,500,000 gallons per year per acre. Robeson was second and Scotland applied the least amount per acre.

The amount of water used for irrigation purposes depends upon several characteristics of the soil and land surface form. For example, sandy soil with sparse vegetation located on a steep slope is much more likely to need irrigation than an area with abundant vegetation on a clay-loam soil in a gently sloping area. In terms of crops irrigated, the westernmost counties of Richmond, Montgomery and Moore irrigate a wider range of crops, while Hoke has the smallest range.

Generally, tobacco and golf courses are the two largest recipients of irrigation activity. The situation is fluid, however, especially in view of the projected demise of tobacco production by the early part of the twenty-first century, and it poses some interesting questions. One, will the volume of water presently applied to tobacco be used for other crops or products, such as produce or aquaculture, especially since

Tobacco and golf courses are generally the largest users of irrigation water, though the projected demise in land requirements of the former and the probable increase in the latter raise interesting questions

the infrastructure to get the water to the fields is already in place? What about the increasing demand for golf courses as more people in the region demands quality courses? The variations between crops and locales within the region could be the result of physical factors, such as soil texture and depth, precipitation patterns, rates of evapotranspiration, slope of land, and availability of water at a reasonable cost. For example, an acre inch of precipitation is about 27,000 gallons of water.

Cultural factors also affect the level of irrigation in terms of how receptive landowners are to investing in the equipment necessary to have a successful irrigation operation. None of the farmers surveyed in 1988 could document the impact of irrigation upon yield or profit. Nor could they offer more than estimates (guesses) on the return on investment of their irrigation systems. Most of them assumed that irrigation was cost effective.

Summary and Conclusions

This study has established data that show how much water was used for irrigation throughout the region in 1987. It does not provide insight into how much drawdown is occurring in the aquifers or the effect of the withdrawal and subsequent use for irrigation on the overall quality of the water. Before farmers in the region greatly increase the number of acres under irrigation, the issues of quantity and quality of water capable of sustaining additional irrigated acreage must be addressed.

Increased use of irrigation practices will result in improved yields and product quality and improved agriculturally linked prosperity

Several questions evolved out of the study. What is the effect of irrigation upon crop yields and profit, or the difference in yields with irrigation when there is normal rainfall and when there are drought conditions? What effect does chemical applications on farm lands have upon surface and groundwater? What are the consequences of expansion of golf courses and amenity settlements in southcentral and southeastern North Carolina upon the availability of water for crop irrigation?

In conclusion, water is a critical resource for agricultural activities in the region and other activities related to economic development. It is apparent that the region has access to enough water to put more acres under irrigation, and thus produce a higher quality crop, which would greatly enhance farm income. Higher quality crops would most likely lead to the establishment of additional agriculturally based industries and convert the region from a typical southern farm region to a prosperous farm region.

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PROTECTING UNDERGROUND WATER SUPPLIES: A COUNTY-WIDE WELLHEAD PROTECTION PROGRAM

William A. Harman III and L. Steven Smutko

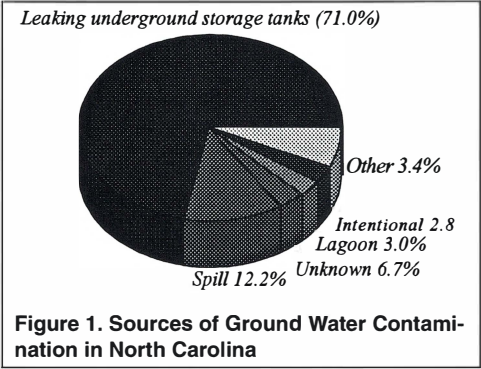
Introduction

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Many North Carolina citizens rely on ground water for their drinking water. In fact, 55% of all North Carolinians and 97% of rural citizens receive their drinking water from underground. In the past, most people assumed that ground water resources would always be free of harmful chemicals. As contamination incidents continue to rise, however, many people are beginning to realize the importance of preventing ground water contamination. Once ground water becomes contaminated, it is often difficult and costly to remediate. The increase in concern about the health risks associated with ground water pollution have led to the enactment of federal and state laws regulating the use, storage and transport of hazardous substances, as well as establishing human exposure limits. The goal of these laws is to protect ground water quality, however, enforcement often takes the form of penalties after a contamination incident has occurred.

Major sources of ground water pollution come from underground storage tanks, chemical spills, landfills, abandoned dumps, and pesticide and fertilizer applications (Figure 1) (McLaughlin, et. al, 1994). A relatively new approach to protecting ground water supplies is through a wellhead protection program. The purpose of this report is to provide a general overview of the federal and state government's role in wellhead protection and highlight a North Carolina County (Gaston County) in the process of developing a county-wide wellhead protection program.

In North Carolina concern about ground water pollution is resulting from an increase in contamination incidents and is leading to a major effort for its control



Background

A wellhead protection area, as defined by the Federal Safe Drinking Water Act, is "the surface and subsurface area surrounding a well or wellfield, supplying a public water system through which contaminants are likely to move toward and reach such well or wellfield (US EPA, 1991)." Once identified, these areas can be protected from contamination by sources above and below the ground to prevent degradation of underground water supplies. Well head protection may be broadly defined as a program that reduces the threat to the quality of potable ground water by identifying and managing recharge areas to specific wells or wellfields. The program consists of two basic components: (1) identification of the wellhead protection area; and (2) management approaches that can be undertaken to reduce the threat of land-based contaminants entering well recharge areas and polluting public water supplies. Protection measures may range from simple practices involving basic housekeeping procedures at local businesses and industries, to extensive and comprehensive land use planning and restrictions.

A wellhead protection program also includes several other components. A plan must be developed that details the roles of specific agencies and organizations in protecting public water supplies. Public participation is required before a program will be approved by the state. The citizens of the community should be involved in deciding what to protect and how much protection is needed. An inventory of all potential sources of contamination within delineated wellhead protection areas also must be made. Finally, in the event that a community well becomes contaminated, contingency plans must be in place to ensure an adequate supply of clean water to the residents affected (EPA, 1991).

In Gaston County, citizens are involved in identifying wellhead areas, whose protection and management will aid in removing possibilities of pollution

Over the past four years, Gaston County, North Carolina has explored options for protecting its public community water supply wells. Gaston County, located in the southwestern Piedmont of the state includes fifteen municipalities with a total population of 180,000. The eastern half of the county is becoming increasingly urbanized. While the western is not as densely developed, it supports a variety of commercial and industrial activities. Groundwater provides drinking water to over 90,000 (50%) County residents. More than 200 public community water supply wells in the county's rural areas provide over 30,000 Gaston County residents with about 3 million gallons of groundwater per day (Thompson, 1994). In addition, over 50 public non-community wells supply water to schools, churches, businesses and parks throughout the county. Public com-

munity wells are defined as those that supply water to at least 15 water supply connections or 25 people on a regular basis.

Water drawn from Gaston County's aquifers is generally of good quality (Levi, et al., 1990). However, groundwater is susceptible to pollution from many activities on or below the land surface. Land disposal of wastes, storage and/or use of hazardous substances for industry and agriculture, poorly designed and failing septic systems, accidental spills, and leaking underground storage tanks, are all sources of groundwater pollution. Since North Carolina began keeping records in 1982, there have been over 50 incidents of groundwater contamination in the County, 35 of these having been caused by leaking underground storage tanks. Since 1988, four public wells have been contaminated by chemical substances — three public community wells, and one non-community well. These contamination incidents affected 240 households connected to those wells. An additional 134 nearby homes connected to private wells and one elementary school were also contaminated. Costs to connect affected households to alternate water supplies exceeded \$2 million (Thompson, 1994).

Federal Requirements

Wellhead protection originated from the federal Safe Drinking Water Act Amendments of 1986. The goal of the program was to encourage all states to develop a methodology for preventing public water supply contamination, recognizing that remediating groundwater contamination is proving costly and sometimes impossible (EPA, 1995). The EPA is charged with providing oversight and technical and financial assistance to states that are developing wellhead protection programs. So the Safe Drinking Water Act requires that all states develop a program, however, EPA does not have authority under this program to reprimand states that choose not to implement it. States that do develop a wellhead protection program, however, are required to address the public water supply wells issue. The following states have approved protection programs by EPA Region IV: Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama and Mississippi. The only state within Region IV that does not have an approved program is Florida (EPA, 1995).

States have authority over water allocation and therefore have historically been responsible for ground water management. Recognizing that all states differ in state water laws and hydrogeology, the federal wellhead protection program is designed to integrate existing state water protection regulations and programs. Therefore, broad federal guidelines are set for designing a program.

North Carolina's Wellhead Protection Program

The North Carolina Wellhead Protection Program (NCWPP) is part of the national strategy to prevent groundwater contamination of public community wells. This complements the state's ongoing programs to reduce the potential for groundwater pollution. And, although it is the state's re-

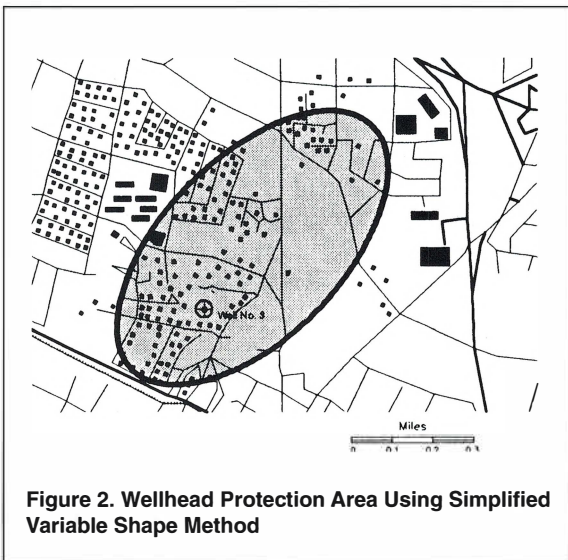
The state has provided a basic water pollution regulatory program that counties are then able to enhance in the context of their particular needs

sponsibility to develop standards, local communities are the primary beneficiaries of clean water supplies. Moreover, local governments possess the legal mechanisms — such as land use and subdivision regulations — to implement specific protection objectives. The NCWPP is designed to provide local governments with the ability to broaden the protection already provided by the state through its regulatory programs, as well as to protect public water supplies from currently unregulated contamination sources. Two state agencies are responsible: the Groundwater Section of the Division of Environmental Management and the Public Water Supply Section of the Division of Environmental

Health, both within the Department of Environment, Health, and Natural Resources. As the lead agency, the Groundwater Section is responsible for establishing the state criteria and for developing an approval process for local governments wishing to implement their own wellhead protection programs. The Public Water Supply Section has responsibility for developing and enforcing public water supply rules (Smutko, 1994). The state program consists of six basic components:

1. Identifying a wellhead protection area. In 1987, the United States Environmental Protection Agency (EPA) defined five criteria for delineating a wellhead protection area. These include: 1) distance, 2) drawdown, 3) time of travel, 4) flow boundaries, and 5) assimilative capacity (US EPA, 1991). Since aquifer characteristics vary greatly across the country, the EPA has given states the authority to determine appropriate methods for delineating wellhead protection areas (WPAs). North Carolina has adopted well

drawdown criterion for defining WPAs in each of the three physiographic regions of the state. The size of an area is determined by the recharge needed to sustain the permitted well yield (Heath, 1991). Communities may choose from one of two delineation methodologies: the calculated fixed radius or simplified variable shape. Figure 2 shows an example of the simplified variable shape method.



2. Non-regulatory or regulatory management approaches to reduce the threat of contaminants entering well recharge areas and polluting public water supplies. Wellhead protection measures may range from targeted education measures, the use of best management practices (BMPs) to prevent pollution at local businesses and industries, and site design standards for facilities that handle hazardous substances, to prohibitions of specified substances within WHPAs, or a number of other options.

3. Clarification of the roles that specific agencies and organization will play in protecting public water supplies.

4. Public participation in developing and implementing the program.

5. An inventory of all potential sources of contamination within delineated wellhead protection areas.

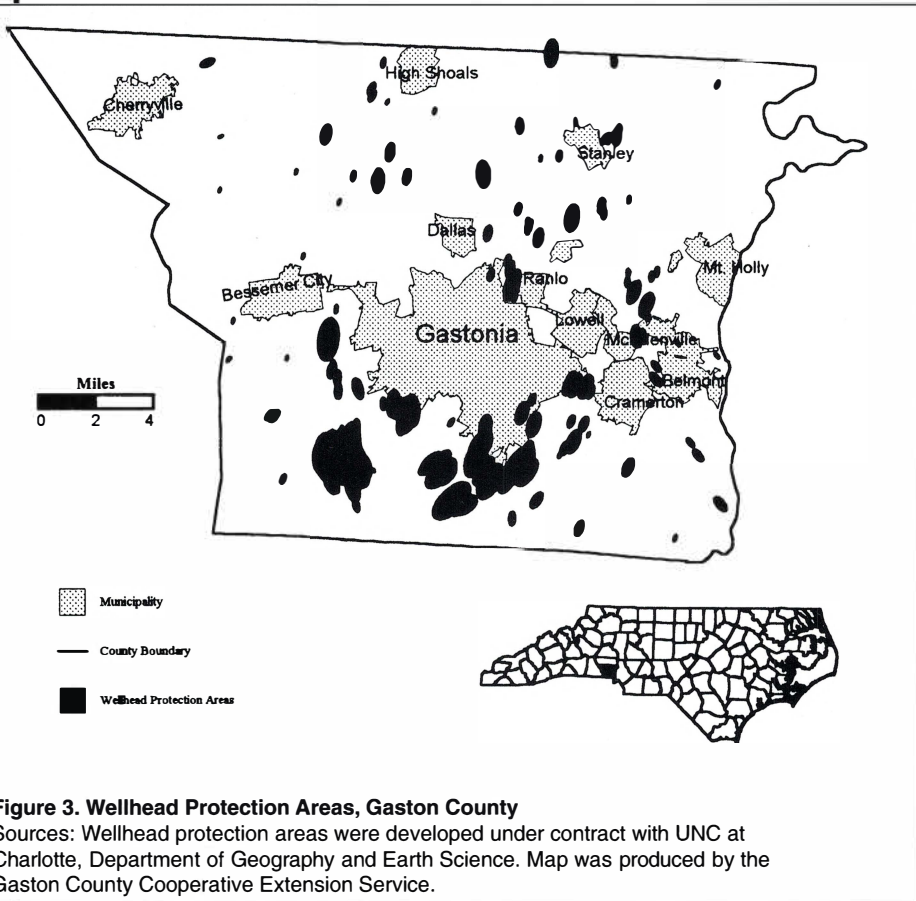
6. Contingency plans to ensure an adequate supply of clean water to the residents affected (Smutko, 1994).

Gaston County Wellhead Protection Program

The lead organization for developing a wellhead protection program in Gaston County is the Quality of Natural Resources Commission (QNRC). The QNRC is an organization of 54 volunteer members appointed by the Board of County Commissioners. Members represent municipalities, county government, business/industry, developers, physicians, environmental organizations, retired citizens, among others. QNRC's purpose is to advise the County Commissioners on environmental issues and policy options, evaluate the quality of the county's natural resources, and provide educational programs to county citizens.

Gaston County adopted the simplified variable shape method for delineating wellhead protection areas around public community wells. This method determines the size, shape and location of the protection area with respect to the well yield. The resulting shape is an ellipse oriented in the direction of groundwater movement with a 2:1 ratio between the long and short axes (Figure 2). In Piedmont and Mountain regions this method is recommended for aquifers where groundwater moves through fractures in bedrock (Heath, 1991). The variable shaped method requires knowledge of average daily pumping rates, average recharge rates, direction of bedrock foliation and transmissivity. In sizing the ellipses the basic assumption is that recharge equals well yield.

Researchers at the University of North Carolina at Charlotte (Forsythe, et. al, 1995), who mapped Gaston County's wellhead protection areas also chose to include land use (impervious cover), geology and soil type as parameters for determining the size of each area. This has resulted in a more accurate estimate of each well's contributing area. While applying the delineation methodology at the county level, researchers discovered that the



close proximity of wells to one another resulted in substantial sizing errors because of well competition for recharge. To accommodate the effects of too closely spaced wells, they developed a Geographic Information System (GIS) based algorithm. This, along with impervious cover, created larger wellhead protection areas than the state's method alone (Figure 3)

Selection of Management Alternatives

One of four QNRC working committees, the QNRC Water Committee, met monthly for nearly two years developing the necessary policy components for a successful county-wide wellhead protection program. This Committee is comprised of a broad cross section of county-wide representation (see Figure 4). Its deliberations placed strong emphasis on education and non-regulatory controls. Examples include household hazardous waste collection days, direct mailings to potential contamination sources and water users, conservation easements, signs, and community workshops.

**Water Committee
Representation**

County Public Works Director
Community Well Owner
Gastonia Public Utilities
Director
Soil & Water Conservation
Board
Business Sector
EDC Representative
Junior League
Crowders Mountain
Community
Audubon Society
Board of Health
Environmental Health Director

City of Cherryville
City of Bessemer City
Schiele Museum
Well Drillers
Riverbend Community
School System
Leadership Gaston
Medical Association
County Planning Board
Home Builders
Technical Support
Cooperative Extension
Service
County Health Department
University of North Carolina
at Charlotte
Rural Water Association

Figure 4. QNRC Water Committee Representation

Rather than establish a new regulatory program to protect community water supplies, the QNRC elected to focus existing programs to new purposes. A concern of the group was the presence of manufacturing and commercial facilities that handle large quantities of hazardous materials within a wellhead protection area. The 1993 revisions of

the state building code specify that hazardous substances be used and stored in such a way that, while reducing the risk of employee exposure and fire hazard from these materials, their escape into the environment is also prevented (11 NCAC 8.024 with specific reference to 408.3, Special Hazardous Materials). The QNRC recommended that the County use existing site plan review and building inspection programs to ensure that new and expanding facilities handling hazardous substances conform to the most current revisions of the State and County Building Codes.

In addition, the QNRC recommended that before approval is granted for a new public community well, an inventory of sites using hazardous substances be taken within the projected wellhead protection area. In cases where facilities with hazardous substances on site exist, facility owners would be advised of the placement of the new well and given information on voluntary pollution prevention measures. If the County were to determine that existing facilities pose a significant risk to users of the new well system, the QNRC recommended that the well be monitored for contaminants on a quarterly schedule. The policy recommendations have been forwarded to Board of County Commissioners for final approval.

Summary

In summary, a wellhead protection program provides a flexible method for preventing ground water contamination in areas supplying drinking water through a community well system. The federal Safe Drinking Water Act Amendments of 1986 requires that all states develop a wellhead protection program. However, general requirements allow states to tailor their programs to reflect the hydrogeology and ground water issues of their state (US

It is hoped that Gaston County's wellhead protection program, unique for the state, will encourage other counties to follow

EPA. 1994). North Carolina has taken a state wide non-regulatory approach, leaving local governments and communities with the ability to create their own programs with guidance from the state.

Gaston County is unique in North Carolina, addressing wellhead protection issues for the entire county. Most programs are developed for a single municipality or community well system. The outcome of this program will benefit many other counties, in North Carolina and the nation, as they begin to address county-wide wellhead protection.

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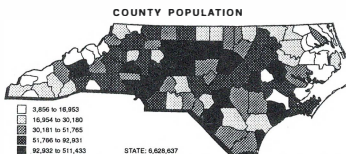
Population	Length of Growing Season
Landuse	Per Capita Income
Annual Precipitation	Hurricanes and Tornadoes
Major Routes	Unemployment

Geographic Perspectives of North Carolina
(Map Sheet #1)

Geographic Perspectives of North Carolina's Economy
(Map Sheet #2)

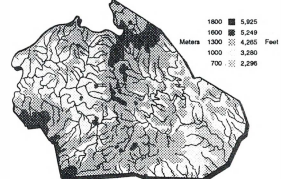
Geographic Perspectives of North Carolina's Climate
(Map Sheet #3)

Geographic Perspectives of Watauga County, North Carolina
(Map Sheet #4)



The 1990 population of North Carolina was more heavily concentrated near the center of the state than on the western and western peripheries. A densely populated urban corridor extends from Charlotte through Winston-Salem, Greensboro, Burlington, Durham, and Raleigh. The coastal plain, particularly in the northeast, and the mountains are generally less densely populated than the piedmont.

excerpt from Map Sheet #1



North Carolina generally rises in elevation from east to west, while Watauga has a more rapid change in elevation. This corresponds to the Blue Ridge Front located in eastern Watauga County. The streams were overlaid on the elevation map to depict the "top-down" or dendritic drainage pattern typical in mountain landscapes. Elevations were interpolated from USGS 1:24,000 scale Digital Elevation Models (DEM's) utilizing Earth Resources Data Analysis System (ERDAS).

excerpt from Map Sheet #4

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() Map Sheet 3 @	\$2.00	_____
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ABOUT THE COVER: NORTH CAROLINAS PLACE IN THE WORLD

David Lambert

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North Carolina plays an increasingly important role in today's world. The changing economic structure of the state has made manufacturing exports more important, with major export destinations including Canada, Western Europe, the Middle East, and the Pacific Rim. State international commercial activities, foreign investments within the state, and the overseas promotional activities of the Tourism Division of the Department of Commerce has benefited international tourism and business travel. More than seventy-three thousand foreign visitors came to North Carolina in 1993. The United Kingdom, Germany and France accounted for ninety-eight percent of the visitors. Others came from Italy, Japan, Switzerland, Netherlands and Sweden.

These realities are depicted on the front cover of this journal. This particular set of map and charts was selected from a full color map sheet entitled *Geographic Perspectives: North Carolinas Place in the World*. Supported by the North Carolina Geographic Alliance the map sheet was designed for use by public school children in the state. Special design considerations were needed because of the prospective young users. Color combinations and map styles were essential choices for displaying complex data in a way for children to understand. Flow line maps, dot maps, and pie charts were used in order to help to attract the interest of students and to avoid the overuse of choropleth mapping. Aldus Freehand provided the ideal software.

North Carolinas Place in the World was the sixth map sheet in the Geographic Perspectives series developed in the Geographic Information System and Image Processing Lab of Appalachian State University's Department of Geography and Planning.

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