

**DEMOGRAPHIC CHANGE AND THE EXPANSION OF
URBAN AREAS IN MARYLAND, 1970 TO 2000**

by

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EXECUTIVE SUMMARY

Maryland has witnessed tremendous changes in population, economy and landscape in recent decades. We outlined these changes in Chapters Two through Five. In this study, we also measured the extent of changes in developed land, agricultural/open land and forested land in two counties in Maryland over three time periods. We subsequently implemented a statistical model to identify the conditions that influence a parcel's change from agriculture to urban use. Here we summarize the results and implications of the findings from this study.

Population trends

From 1970 to 2000, Maryland's population increased by almost 1.4 million people. Current projections suggest that Maryland's population will grow to 6.7 million by 2030, an increase of additional 1.4 million since the 2000 Census. Counties that witnessed the most substantial population change between 1970 and 2000 are in the metropolitan areas of Baltimore and Washington DC. Of these counties, Montgomery County experienced the largest increase with the addition of 350,000 people during this period, a 67 percent increase. Recent figures suggest this county will grow from about 873,000 in 2000 to more than 1.1 million by 2030. Howard County witnessed the largest percentage population change – 300 percent – from 1970 to 2000; followed not far behind by Calvert County at 261 percent and Charles County at 153 percent.

Traditionally rural counties also experienced substantive increases in population over the thirty year period. Combined, counties in Southern Maryland witnessed an increase of

more than 165,000 people since the 1970s, a growth rate of 140 percent. Worcester County, beginning with a population of a little over 25,000 in 1970, almost doubled in population by 2000. Similarly, St. Mary's County experienced a population increase of 80 percent. Population increases of this nature put tremendous strain on both the natural resources and local infrastructure of what are primarily rural counties.

Household formation also increased in Maryland from 1970 to 2000. The number of households, particularly among metropolitan counties, has increased in large numbers although the rate of household formation in non-metropolitan counties is higher than that of metropolitan counties. From 1970 to 2000, the number of households in metropolitan counties increased by 717,820 households, or by 68 percent. During this same period, the number of households increased in rural or non-metropolitan counties by more than 88,000, or by 73 percent.

Projections indicate that household formation will continue at a rapid pace, particularly in counties such as Charles and Frederick. There are projected household increases of over 80 percent from 2000 to 2030 in both these counties. Non-metropolitan counties are also expected to see large increases in the number of households, with the projected addition of more than 108,000 households between 2000 and 2030. Among these non-metropolitan counties, the largest projected growth in households is in Cecil County where there is expected to be an additional 30,000 households by 2030. Household formation of this magnitude means large numbers of additional housing, and added strain on the public school system and other services.

An analysis of population density in Maryland indicates that much of the growth has followed major highways and roads. The principal urban centers along these routes have expanded at a tremendous pace.

Immigration is a key driver of population growth, although domestic migration does matter for specific counties. For instance, there was an in-migration to Maryland of populations from surrounding states, particularly into Prince Georges County. Analyzing the movement of people within Maryland, we found that few metropolitan counties experienced net migration gains from rural counties. In fact, for counties such as Prince George's and Harford there was substantially more out-migration to rural counties than in-migration of rural populations between 1995 and 2000. This suggests that there is some out-migration from metropolitan to non-metropolitan areas of the state. Out-migration or sprawling further out from the metropolitan areas to rural areas greatly impacts farmland, forested areas and open space in the state.

Housing Development Trends

To keep in step with population growth and change, housing development has occurred at a rapid pace in Maryland with the addition of almost 900,000 houses from 1970 to 2000. Most of this additional housing was built in metropolitan counties although some rural counties experienced substantial development. For instance, Somerset Cecil and Cecil counties more than doubled their housing stock from 1970 to 2000. Specific areas within rural Maryland also witnessed large increases. For instance Ocean City added 38,000 new housing units, including individual condos, from 2000 to 2003 alone. Housing expansion

in such small urban centers of the state is important since these centers act as a springboard from where further development occurs. This subsequently has tremendous consequences for the loss of farmland and open space surrounding these once small rural towns.

Employment Trends

There have been massive shifts in the economy of Maryland that both reflect and drive population growth throughout the state. Job growth, as with population growth, has occurred at a tremendous pace with the workforce expanding from 1.6 million in 1969 to 3.1 million in 2001, a growth rate of 86 percent. During these thirty years, there has been a shift away from farm and manufacturing employment to a more service-based, high-technology economy. Employment has shifted location, dispersing away from central cities to employment centers primarily in the Central Maryland region.

Metropolitan counties are important sources of employment for the state. Employment in the Washington suburban counties of Montgomery, Frederick and Prince George's combined increased from almost 450,000 workers in 1969 to more than 1.1 million workers in 2001, a job growth rate of 147 percent. The Baltimore region has more workers – 1.5 million in 2001 – but the workforce in the region is growing at a slower pace than the suburban counties of Washington DC. The Washington DC area, in particular, is the site for many professional jobs in industries located along I-270 and I-70.

Employment structure in both metropolitan and non-metropolitan counties has changed dramatically in recent decades. Farming is less important as a source of employment in every county; and manufacturing employment has taken a sharp decline in recent decades. Among rural counties, the effects are quite devastating. For instance, in 2001, fourteen percent of Washington County's workforce was employed in the manufacturing sector, the highest percentage rate for manufacturing employment among metropolitan counties in the state. However, this represents a decline in manufacturing employment from 30 percent of total employment in Washington County in 1969.

Many rural counties have turned to the retail trade and service sectors as sources of employment in the new economy. Employment growth in the retail sector of non-metropolitan counties was substantial with the addition of almost 32,000 retail jobs from 1969 to 2001, a growth rate of 123 percent. In 2001, the service sector accounted for 30 percent of non-metropolitan county employment. At the same time, farming accounts for three percent of employment in non-metropolitan counties. The local economies of rural counties rely less on the land or manufacturing sector and more on consumer growth and service. This reliance encourages further urban growth.

Trends in Farming

In the past 30 years, there has been a dramatic reduction of land in farms in Maryland. Land in farms in the state declined from 2.6 million acres in 1978 to about 2 million acres in 2002. Similarly, the number of farms in the state declined from 14,776 farms in 1987 to 12,198 in 2002.

Metropolitan counties in both the Washington DC and Baltimore areas experienced decline in the percentage of land area in farming from 1978 to 2002. The most extreme cases were Harford, Howard, Frederick and Montgomery counties. The land area in farming declined by around 13 percent in each of these counties from 1978 to 2002.

Non-metropolitan counties in Maryland also experienced a loss of land in farms. The Eastern Shore as a whole had more than 1 million acres of land in farms in 1978, declining to less than 973,000 acres by 2002, a loss of 114,707 acres. The largest loss of acres in farms from 1978 to 2002 occurred in Kent County which lost a total of 21,401 acres of farmland during this period.

The number of farms in the Baltimore region declined by 609 farms from 1987 to 2002, and the suburban Washington DC counties lost 489 farms during this same period. Among regions in the state, the Lower Eastern Shore experienced the largest decline, with the number of farms in this region dropping from a high of 2,203 in 1987 to 1,567 in 2002, a loss of 636 farms.

We analyzed changes in farm size and found that, in some cases, farm size increased in recent decades. For instance, in Wicomico County, the average farm size increased from 116 acres in 1978 to 173 acres by 2002. Similarly, in Caroline County, the average farm size increased from 183 to 227 from 1978 to 2002. The most profound case of a change in the structure of farmland among rural counties occurred in Worcester County where the average size of farms increased by 150 acres from 1978 to 2002. Looking closer at

Worcester County, there has been an increase in the percentage of farms between 10 and 50 acres in size as well as an increased in the percentage of farms 1,000 acres or more in size. Small farm producers are important in Worcester County. However, the county has also witnessed increased importance of large farm production as the percent of farms over 1,000 acres increased from 4 percent in 1982 to 10 percent in 2002.

These changes in farm size indicate more profound changes in the nature of farming in Maryland. On the one hand, there is increased importance in large farm production while, on the other hand, farming is adapting to urban development with increased reliance on small farm production and recreational farming that accomdates the urban consumer.

Land cover change and fragmentation of land classification types

Chapters Two and Five show a clear pattern of overall population, housing and employment growth and decentralization to non-metropolitan areas. In Chapter Six and Seven, we performed more detail analyses in Montgomery and Frederick counties to determine the affect of this growth and decentralization on agricultural land and open space. To analyze these effects, we performed an object based classification of land cover for Montgomery and Frederick Counties for the years 1986, 1995 and 2001. In this analysis, we fused remote sensing data and tax assessment data to obtain a more accurate assessment of the extent of developed land over time.

Figures 6.2, 6.3 and 6.4 are maps of the results of our land classification over multiple time periods. Our analysis found evidence of urban encroachment of agricultural/open

and forested land in both Frederick and Montgomery counties. According to our analysis, Montgomery County lost a total of 20,884 acres of agricultural/open land and 15,003 acres of forested land from 1986 to 2001. During this same period, the amount of developed land grew by 32,122 acres, 11,509 acres of low density development and 20,613 acres of high-to-medium density development. There was more high-to-medium than low density development in Montgomery from 1986 to 2001, suggesting the possibility of in-fill development over this time period; and the county lost more agricultural/open land than forest during this period.

Frederick County lost a total of 14,744 acres of agricultural/open land and 11,243 acres of forested land from 1986 to 2001. During this same period, the county gained 25,809 acres of developed land, 12,475 acres of low density development and 13,334 acres of high-to-medium density development. As with Montgomery County, there was more high-to-medium density development than low-density development from 1986 to 2001. This again suggests the likelihood of in-fill development. Frederick County lost more agricultural/open land than forest to urban development.

Development in Frederick County occurred largely along major roads and, particularly around towns that line I-70. Development in Montgomery County consisted of in-fill development of previous existing low density development and that the expansion of low density development along the Potomac River and around towns such as Damascus and Germantown.

Examining these land classifications closer, we found evidence of fragmentation of forested and agricultural/open land and the consolidation of developed areas in parts of Montgomery and Frederick counties. The location of these areas is displayed in the maps in Figure 6.7, Figure 6.8 and Figure 6.9 in Chapter Six.

Influences on location of future growth and its implications

We developed a statistical model to determine the conditions that influence a parcel's change from agricultural to residential use. The results of our analysis point to the significance of certain variables in influencing land use change from agricultural to urban use. Our findings suggest that the smaller an agricultural parcel, the more likely it will change to urban use; the closer an agricultural parcel to non-agricultural parcels, the more likely it will change to urban use; the closer an agricultural parcel is to the interstate exit, the more likely it will change to urban use; and the less agriculturally productive a parcel is, the more likely it will change to urban use.

Since a change in the status of an agricultural parcel is a function of its closeness to highway exits, it is important that land conservation policy and transportation policy work together to optimize the preservation of valuable farmland. Also, since a shift in land use is likely for agricultural parcels near residential parcels or for small agricultural properties, preventing farm fragmentation by residential development is paramount. Maintaining a consolidation of valuable agricultural parcels is the best strategy for preservation of farmland.

Using the results of our statistical analysis, we mapped probability scores for agricultural parcels in Frederick County. This map is displayed in Figure E.1.

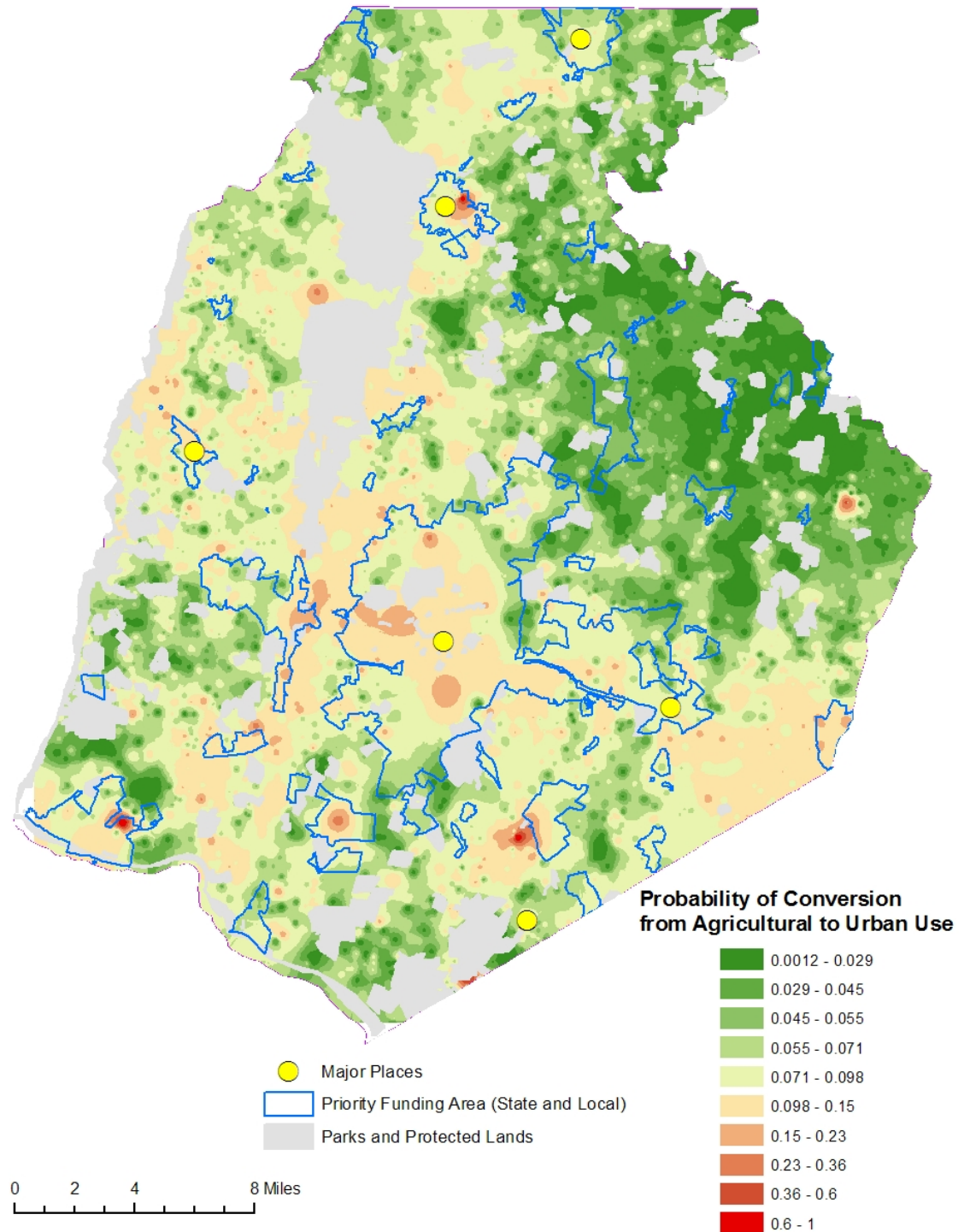


Figure E.1 Map of probability land will change from agricultural to urban use

Areas in Frederick County most likely to stay in agricultural production are in the northeastern and southwestern portions of the county. The several reddish-orange pockets spread throughout the middle of the county are most likely to shift to residential land uses. There are a number of ‘hotspots’ for growth as indicated by the areas of red or deep pink.

The value of this map for land use policy is threefold. First, where reddish areas fall into Priority Funding Areas, market forces will encourage development where the county government wants this growth to go. Much of this land area is around Frederick City and around some smaller towns or rural villages in the county. We predict that the agricultural properties within these areas will continue to be developed.

Second, in those locations of high probability that fall *outside* the Priority Funding Areas, government intervention will be required to keep such areas in agricultural use. As this map indicates, there are such areas, particularly in the southern part of the county. These parcels, if not already protected, need appropriate land use controls such as agricultural easements to prevent continued urban encroachment.

Thirdly, when the red colored parcels fall in areas deemed environmentally sensitive, the County should pay attention to be sure the appropriate land use controls are in place to keep these areas from turning to residential developments. The results of our analysis indicate that left to market forces, all these reddish areas will transition from agriculture to residential use.

CHAPTER ONE

INTRODUCTION

Maryland has witnessed tremendous changes in population, economy and landscape in recent decades. This study reports on these, and examines the conditions that encourage urbanization and growth to occur in specific locations in the state. There are three primary objectives outlined. First, we examine and describe the transformation of population, housing economy and agriculture in Maryland counties from 1970 to 2000, with some references to future projections. Second, using innovative methodologies, we measure the loss and fragmentation of agricultural land over three time periods –1986, 1992 and 2001 – in Frederick and Montgomery counties. Third, we identify the location of potential growth resulting from the conversion of agricultural land into urban development in the transitional county of Frederick. We also explore the policy and planning implications of the results of this analysis for Frederick County.

Approach and organization of the report

This report uses a number of different approaches and methodologies to describe and analyze the processes and results of urban growth in Maryland. First, we use an analytical approach to demonstrate changes in the population, economic structure, and agriculture economy at a broad county level scale. We analyze and describe changes in the local economies and population structure of both “rural” and “urban” counties. In this case, non-metropolitan counties are loosely defined as rural counties and metropolitan counties, urban counties.

More precisely, metropolitan or urban counties are part of a metropolitan statistical area. Under the 2000 standards, the U.S. Bureau of the Census defines metropolitan statistical areas as having a central county or counties with an urbanized area of at least 50,000 people, plus adjacent outlying counties having a high degree of economic integration with the central county, as measured through commuting patterns. In the case of Maryland, metropolitan counties are those counties that are part of the Washington-Baltimore consolidated metropolitan statistical area (CMSA). Non-metropolitan counties are those counties that are outside the metropolitan area. Metropolitan and non-metropolitan counties are listed in Table 1.1.

Table 1.1 Metropolitan and non-metropolitan counties in Maryland, 2000

Metropolitan Counties	Non-Metropolitan Counties
Anne Arundel County	Allegany County
Baltimore City	Caroline County
Baltimore County	Cecil County
Calvert County	Dorchester County
Carroll County	Garrett County
Charles County	Kent County
Frederick County	Somerset County
Harford County	St. Mary's County
Howard County	Talbot County
Montgomery County	Wicomico County
Prince George's County	Worcester County
Queen Anne's County	
Washington County	

The local populations, agriculture and economic growth of these counties are explored and compared. This examination is outlined in Chapters Two, Three and Four of the report.

Next, using Landsat imagery, we measured the extent of urban development within Montgomery and Frederick counties, performing an object based classification of land

cover for years 1986, 1995 and 2001. Others have used Landsat imagery to determine the extent of development in the Maryland region. Our methodology is novel in that it integrates MD Property View data with Landsat imagery in an object-oriented classification. Details on the methods as well as the results of this land classification are outlined in Chapter Six.

Third, we develop a logit probability model to determine the conditions that influence a parcel's change from agriculture to residential use in Frederick County. We spatially analyzed the model results by mapping the probability a parcel would change from agricultural to a residential use over the next four years - 2004 to 2008 - assuming conditions such as road infrastructure remains constant. The results and policy and planning implications of this model are outlined in Chapter Seven.

CHAPTER TWO

MARYLAND'S CHANGING POPULATION

Maryland is the nineteenth most populated state in the United States. Its population has increased by 35 percent in the past thirty years. In 1970 the population was 3.9 million, increasing to 5.3 million by 2000, an addition of almost 1.4 million people. Current projections suggest that Maryland's population will continue to grow to 6.7 million by 2030. Household formation, a driving force behind land consumption and residential development, is following a similar path. The total number of households in Maryland was 1.1 million in 1970 compared to almost two million in 2000. The number of households is expected to increase to 2.6 million by 2030¹.

Population change

As Table 2.1 indicates, all counties in Maryland – except Baltimore City and Allegany County – experienced population increases since 1970. As to be expected, many metropolitan counties in the Baltimore and Washington DC regions experienced the highest growth in population in the state in the last three decades. From 1970 to 2000, these metropolitan counties experienced a total increase of more than 1.2 million people. This trend is likely to continue with the metropolitan counties projected to increase by almost 1.2 million people by 2030. Of these counties, Montgomery County witnessed the largest increase of 350,000 people from 1970 to 2000, a 67 percent increase. Recent figures suggest this county will grow to more than 1.1 million by 2030.

¹ Projections suggest that Maryland will increase in population and employment as a result of the federal Base Realignment and Closure (BRAC) process. As much as possible, our projection figures are based on recent analyses of the BRAC impacts.

Anne Arundel County and Howard County experienced population increases of more than 192,000 and 185,000 people respectively. Combined, the counties in Southern Maryland witnessed an increase of more than 165,000 people since the 1970s, the second largest growth in population regionally. Howard County witnessed the largest percentage population change – 300 percent – from 1970 to 2000; followed not far behind by Calvert County at 261 percent and Charles County at 153 percent.

Table 2.1 Population change in Maryland, 1970 to 2000

Metropolitan Counties	1970	2000	1970 - 2000	1970 - 2000 (%)
Anne Arundel	297,539	489,656	192,117	65%
Baltimore City	905,759	651,154	-254,605	-28%
Baltimore	621,077	754,292	133,215	21%
Calvert	20,682	74,563	53,881	261%
Carroll	69,006	150,897	81,891	119%
Charles	47,678	120,546	72,868	153%
Frederick	84,927	195,277	110,350	130%
Harford	115,378	218,590	103,212	89%
Howard	61,911	247,842	185,931	300%
Montgomery	522,809	873,341	350,532	67%
Prince George's	660,567	801,515	140,948	21%
Queen Anne's	18,422	40,563	22,141	120%
Washington	103,829	131,923	28,094	27%
Total	3,529,584	4,750,159	1,220,575	35%
Non-Metropolitan Counties	1970	2000	1970 - 2000	1970 - 2000 (%)
Allegany	84,044	74,930	-9,114	-11%
Caroline	19,781	29,772	9,991	50%
Cecil	53,291	85,951	32,660	61%
Dorchester	29,405	30,674	1,269	4%
Garrett	21,476	29,846	8,370	39%
Kent	16,146	19,197	3,051	19%
Somerset	18,924	24,747	5,823	31%
St. Mary's	47,388	86,211	38,823	82%
Talbot	23,682	33,812	10,130	43%
Wicomico	54,236	84,644	30,408	56%
Worcester	24,442	46,543	22,101	90%
Total	392,815	546,327	153,512	39%

The non-metropolitan counties also experienced population increases. More than 150,000 people were added to non-metropolitan counties from 1970 to 2000, a population

growth rate of almost 40 percent. In raw numbers, St. Mary's County experienced the largest increase in population with an addition of almost 39,000 people. This was followed by Cecil County's population increase of more than 32,000 from 1970 to 2000.

The percent increase in population is substantial in many traditionally rural counties. For instance, Worcester County, beginning with a population of a little over 25,000 in 1970, almost doubled in population by 2000. Similarly, St. Mary's County experienced a population increase of 80 percent. Changes of this nature puts a strain on the agricultural landscape, natural resources and local economies of rural counties, the various aspects of which are explored in following chapters.

Household formation

Household formation, a driver of housing development, has been substantial in many counties in Maryland, particularly in the metropolitan counties. As Table 2.2 demonstrates, overall, metropolitan counties experienced an increase of more than 700,000 households from 1970 to 2000, a growth rate of 68 percent. Montgomery County witnessed the largest increase in the number of households. From 1970 to 2000, the number of households in Montgomery County increased by almost 168,000. Baltimore County had the second largest increase in the number of households, adding more than 114,000 households from 1970 to 2000. Anne Arundel and Prince George's counties were not far behind with an increase in households of more than 97,000 and 93,000 respectively between 1970 and 2000.

In terms of percentage increase in households, Howard County had the largest percentage increase of 433 percent from 1970 to 2000. Calvert County was not far behind with a percentage increase of almost 360 percent. Charles County more than doubled the number of households and Frederick County experienced a 180 percent increase in households from 1970 to 2000.

Table 2.2 Household Formation by County, 1970 to 2000

Metropolitan Counties	1970	2000	1970 – 2000	1970 - 2000
Anne Arundel	81,100	178,670	97,570	120%
Baltimore City	289,349	257,996	-31,353	-11%
Baltimore	184,890	299,877	114,987	62%
Calvert	5,540	25,447	19,907	359%
Carroll	19,623	52,503	32,880	168%
Charles	12,098	41,668	29,570	244%
Frederick	24,926	70,060	45,134	181%
Harford	32,026	79,667	47,641	149%
Howard	16,880	90,043	73,163	433%
Montgomery	156,674	324,565	167,891	107%
Prince George's	192,963	286,610	93,647	49%
Queen Anne's	5,795	15,315	9,520	164%
Washington	32,463	49,726	17,263	53%
Total	1,054,327	1,772,147	717,820	68%
Non Metropolitan Counties	1970	2000	1970 – 2000	1970 - 2000
Allegany	27,857	29,322	1,465	5%
Caroline	6,360	11,097	4,737	74%
Cecil	14,242	31,223	16,981	119%
Dorchester	9,725	12,706	2,981	31%
Garrett	6,315	11,476	5,161	82%
Kent	5,109	7,666	2,557	50%
Somerset	5,945	8,361	2,416	41%
St. Mary's	12,100	30,642	18,542	153%
Talbot	7,914	14,307	6,393	81%
Wicomico	17,170	32,218	15,048	88%
Worcester	7,869	19,694	11,825	150%
Total	120,606	208,712	88,106	73%

In the rural, non-metropolitan counties of Maryland there has also been considerable household formation and growth, with the addition of more than 88,000 households from 1970 to 2000. The rate of household formation of 73 percent for non-metropolitan counties is 5 percent more than the household growth rate in metropolitan counties.

Worcester County witnessed the largest percentage increase at 150 percent, while Cecil County saw the largest number increase at almost 17,000 households. Wicomico County is not far behind, with an increase of more than 15,000 households from 1970 to 2000. This increase in households is happening across most counties of Maryland, even in areas of population decline (i.e. Allegany County).

As Table 2.3 indicates, there will be an increase in household formation in the future. Overall, the number of households is expected to increase by more than 550,000 in the metropolitan counties of the state by 2030. The number of households in non-metropolitan counties is expected to increase from 208,000 in 2000 to 317,000 by 2030. Among metropolitan counties, Charles and Frederick counties stand out. The number of households in Charles County is expected to increase by almost 36,000 by 2030, an 86 percent increase. In Frederick County, the number of households is projected to increase by more than 57,000 by 2030, an 82 percent increase. Among non-metropolitan counties, the highest rates of household formation are in St. Mary's and Cecil counties. In St. Mary's, it is anticipated that the number of households will increase by almost 29,000 by 2030. In Cecil County, projections indicate that the number of households will almost double by 2030.

Household formation has a direct effect on land consumption as it leads to substantial housing development and a subsequent loss of agricultural and forested land. In the past, the doubling and tripling of households puts a direct strain on natural resources and agricultural land, especially in the traditional rural counties of Maryland. Household

projections suggest this is likely to continue into the future, changing the nature of land use throughout the state.

Table 2.3 Household formation projections to 2030

Metropolitan Counties	2000	2030	2000 – 2030	2000 - 2030
Anne Arundel	178,670	228,225	49,555	28%
Baltimore City	257,996	265,950	7,954	3%
Baltimore	299,877	346,700	46,823	16%
Calvert	25,447	38,625	13,178	52%
Carroll	52,503	71,900	19,397	37%
Charles	41,668	77,650	35,982	86%
Frederick	70,060	127,575	57,515	82%
Harford	79,667	117,300	37,633	47%
Howard	90,043	127,600	37,557	42%
Montgomery	324,565	441,875	117,310	36%
Prince George's	286,610	379,850	93,240	33%
Queen Anne's	15,315	25,125	9,810	64%
Washington	49,726	75,875	26,149	53%
Total	1,772,147	2,324,250	552,103	31%
Non Metropolitan Counties	2000	2030	2000 – 2030	2000 - 2030
Allegany	29,322	30,225	903	3%
Caroline	11,097	19,125	8,028	72%
Cecil	31,223	61,825	30,602	98%
Dorchester	12,706	17,725	5,019	40%
Garrett	11,476	14,100	2,624	23%
Kent	7,666	10,075	2,409	31%
Somerset	8,361	10,500	2,139	26%
St. Mary's	30,642	59,325	28,683	94%
Talbot	14,307	18,725	4,418	31%
Wicomico	32,218	47,175	14,957	46%
Worcester	19,694	28,500	8,806	45%
Total	208,712	317,300	108,588	52%

Population density

Population density, an important indicator of the competition for space in the environment, has also changed dramatically in recent decades. As to be expected, the densest counties in Maryland are the metropolitan counties of Baltimore City, Montgomery, Prince George's, Baltimore, Anne Arundel and Howard counties. As Table 2.4 indicates, Montgomery County had the largest population density increase of all Maryland counties, increasing by almost 600 people per square mile from 1980 to

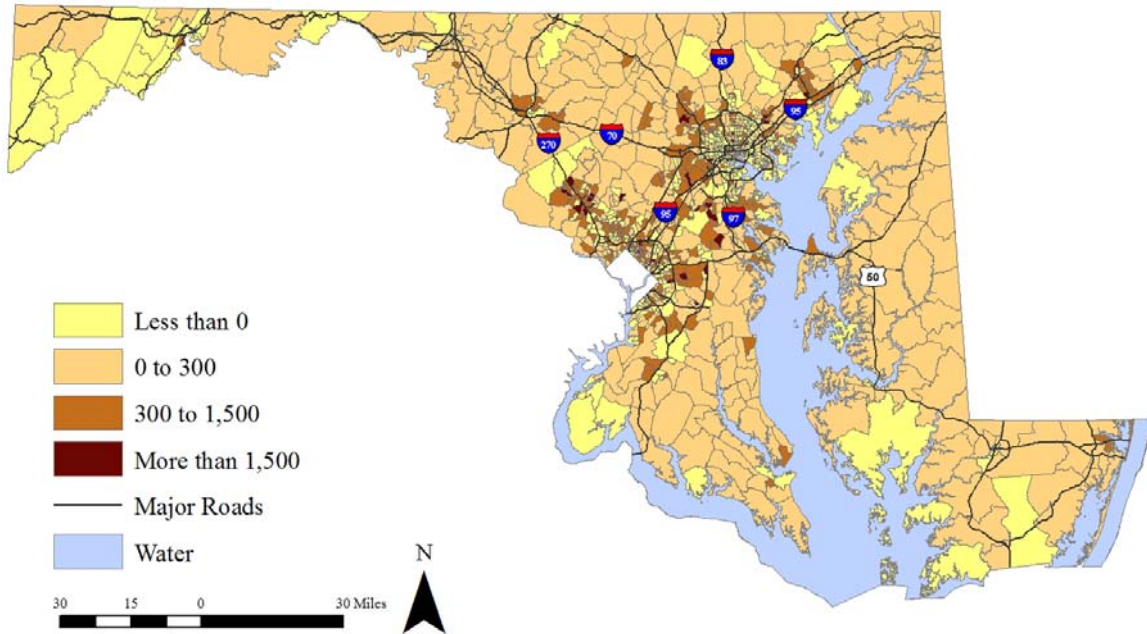
2000. Howard County, while having a relatively low population density in 2000 when compared to other metropolitan counties, had a density increase of 511 people per square a mile from 1970 to 2000.

Table 2.4 Population density by county, 1980 to 2000

Metropolitan Counties	1980	1990	2000	1980 to 2000
Anne Arundel	886	1,027	1,177	291
Baltimore City	9,798	9,109	8,058	-1,739
Baltimore	1,097	1,156	1,260	163
Calvert	162	239	347	184
Carroll	213	275	336	123
Cecil	168	205	250	79
Charles	161	219	261	100
Frederick	173	227	295	121
Harford	326	414	496	170
Howard	472	743	983	511
Montgomery	1,169	1,531	1,762	594
Prince Georges	1,366	1,500	1,651	286
Queen Anne's	69	91	109	40
Washington	248	265	288	40
Non-Metropolitan Counties	1980	1990	2000	1980 to 2000
Allegany	191	176	176	-15
Caroline	72	84	93	21
Dorchester	52	54	55	3
Garrett	40	43	46	6
Kent	60	64	69	9
Somerset	57	72	76	19
St. Mary's	161	210	239	78
Talbot	99	114	126	27
Wicomico	170	197	224	54
Worcester	65	74	98	33

The non-metropolitan rural counties also experienced an increase in population density. Wicomico County has 224 people per square mile, the highest population density of all non-metropolitan counties. This county also experienced the highest increase in population density, experiencing a density increase of 54 people per square mile from 1980 to 2000.

Figure 2.1 illustrates the population density change from 1990 to 2000 by census tract, providing a more detailed picture of density increases, particularly in the Baltimore/Washington corridor, around Baltimore city, Washington DC, and in parts of Southern Maryland.



**Figure 2.1 Change in Population Density
by Census Tract in Maryland, 1990 to 2000**

Areas between Frederick City and Washington DC also increased in density, much of it following Interstate 270 and nearby. In fact, population density increases have generally followed major highways and roads with places such as Aberdeen and Havre de Grace further north along I-95, developing rapidly. Highway access and population growth are intertwined, and residential development occurs along major transportation routes.

Population diversification

The population of Maryland has become more diverse, particularly in the last two decades. One aspect of this diversification is increasing minority suburbanization. There was an increase in the number of African American and ethnic populations, particularly in the suburban counties of Baltimore and Washington DC.

There were total of 1.4 million African Americans living in Maryland in 2000, 28 percent of the total population. From 1990 to 2000, the number of African Americans in the state increased by more than 280,000. In 2000, 95 percent of the African American population lived in the metropolitan counties, and the remaining 5 percent in the non-metropolitan or rural counties. More than 1.3 million African Americans or 29 percent of the metropolitan population lived in the metropolitan counties of Maryland.

As Table 2.5 indicates, since 1990, the metropolitan counties in Maryland have witnessed an increase of more than 278,000 African Americans. Increases were significant for the suburbs of Maryland. The percentage of African Americans living in the suburban counties of Prince George's and Montgomery was almost 63 percent and 15 percent respectively in 2000. Twenty percent of Baltimore County's population and more than 14 percent of Howard County was African American in 2000.

While the African American population of the central city of Washington DC declined from 66 percent to 59 percent from 1990 to 2000, the suburban counties of Frederick, Montgomery and Prince George's experienced an increase from 28 percent African

American in 1990 to almost 35 percent African American in 2000. While the percentage of the African American population in Baltimore City increased in the 1990s, the number of African Americans decreased from 435,768 to 418,951 as the city lost African American as well as white populations. Meanwhile, the number of African Americans in the suburban counties of Baltimore and Howard increased from 107,000 in 1990 to more than 187,000 in 2000, and in Baltimore County alone the African American population increased by over 66,000, an increase of more than eight percent in the 1990s.

Table 2.5 African American population by county, 1990 to 2000

Metropolitan Counties	Black 1990	Black 1990 (%)	Black 2000	Black 2000 (%)
Anne Arundel	50,525	11.8	66,428	13.6
Baltimore City	435,768	59.2	418,951	64.3
Baltimore	85,451	12.3	151,600	20.1
Calvert	8,046	15.7	9,773	13.1
Carroll	2,933	2.4	3,433	2.3
Charles	18,419	18.2	31,411	26.1
Frederick	8,010	5.3	12,429	6.4
Harford	15,530	8.5	20,260	9.3
Howard	22,019	11.8	35,730	14.4
Montgomery	94,578	12.4	132,256	15.1
Prince George's	367,480	50.8	502,550	62.7
Queen Anne's	3,839	11.3	3,560	8.8
Washington	7,245	6.0	10,247	7.8
Total	1,119,843	26.0	1,398,628	29.0
Non-Metropolitan Counties	Black 1990	Black 1990 (%)	Black 2000	Black 2000 (%)
Allegany	1,535	2.0	4,006	5.3
Caroline	4,459	16.5	4,398	14.8
Cecil	3,240	4.5	3,361	3.9
Dorchester	8,423	27.9	8,708	28.4
Garrett	105	0.4	128	0.4
Kent	3,534	19.8	3,343	17.4
Somerset	8,943	38.2	10,172	41.1
St. Mary's	10,275	13.5	12,003	13.9
Talbot	5,502	18.0	5,193	15.4
Wicomico	16,573	22.3	19,717	23.3
Worcester	7,467	21.3	7,754	16.7
Total	70,056	14.0	78,783	14.0

Other metropolitan counties experienced an increase in African American population. Combined, the metropolitan counties in Southern Maryland experienced an increase of almost 15,000 African Americans in the 1990s, bringing the total African American population to more than 41,000 by 2000. Charles County witnessed the largest increase, jumping from an African American population of 18,419 to one of 31,411.

The African American population of rural Maryland was almost 79,000 in 2000, 14 percent of the total rural population. There was an addition of almost 9,000 African Americans in rural Maryland in the 1990s, maintaining a stable percentage of African Americans over the decade. A substantial percentage of the population of the Lower Eastern Shore counties of Somerset, Wicomico, and Dorchester were African American in 2000. By the end of the 1990s, forty one percent of Somerset County's population was African American followed by 30 percent of Dorchester County's population. African Americans have a long history of settlement in the Eastern Shore of Maryland, back since the times of slavery and beyond. Although in raw numbers, the increases in African American population can be substantial, in some rural counties they declined in percentage terms. For instance, the African American population decreased by almost 5 percent from 1970 to 2000 in Worcester County. In Caroline, Cecil, Kent, Talbot, and Worcester counties the total population growth outpaced the growth in African American population.

Another aspect of diversification in Maryland is immigration. This is a driver of population growth in the state². In recent decades, the foreign born population has increased dramatically. The number of foreign born residents in Maryland was less than 125,000 in 1970, quadrupling to more than 518,000 by 2000. By 2002, Maryland ranked tenth among states in numbers of immigrants admitted.

Most immigrants entering the Maryland in recent decades settled in the suburban counties of Montgomery and Prince George's. More than half of all new immigrants in the 1980s settled in Montgomery County, and three quarters of new immigrants during this period settled in Montgomery and Prince George's counties combined. In the 1990s, there was a slight shift in immigrant settlement patterns to the suburban counties of Baltimore, Howard, Anne Arundel, and Frederick counties. During the 1990s, almost 11 percent of new immigrants settled in Baltimore County, bringing the number of foreign born residents in the county to almost 54,000 by 2000.

Howard County attracted five percent of entering immigrants in the 1990s for a total of more than 28,000 foreign born residents by 2000. However, as Figure 2.2 indicates, despite this change in settlement patterns, Montgomery County still had the largest number of immigrants – more than 230,000 – in 2000, followed closely behind by more than 110,000 foreign born in Prince George's County that same year.

² According to a recent analysis by the Maryland Department of Planning, the influx of immigrants to the state in the 1990s accounted for almost 45 percent of Maryland's population gain during this time period. Their analysis indicates that more than 89 percent of population growth during the 1990s in Montgomery County is explained by immigration. Similarly, 71 percent of the population increase in Prince George's County is due to the influx of immigrants.

In Howard County, more than half of all foreign born in 2000 were Asian. Similarly, 38 percent of the foreign born in Montgomery County were from Asia. Montgomery County also had an equal percentage of Latin American immigrants, and almost half of the foreign born in Prince George's County were Latin American in 2000. Among the Latin American immigrants in the Baltimore/Washington region, the majority are from El Salvador, Mexico and Guatemala while Asians tend to come from China, Korea and India. The regional economy of the Baltimore/Washington corridor is highly attractive to the foreign born. Many of the high-skilled immigrants are from Asia, working in the high-technology sector while lower-skilled workers tend to emigrate from Latin American.

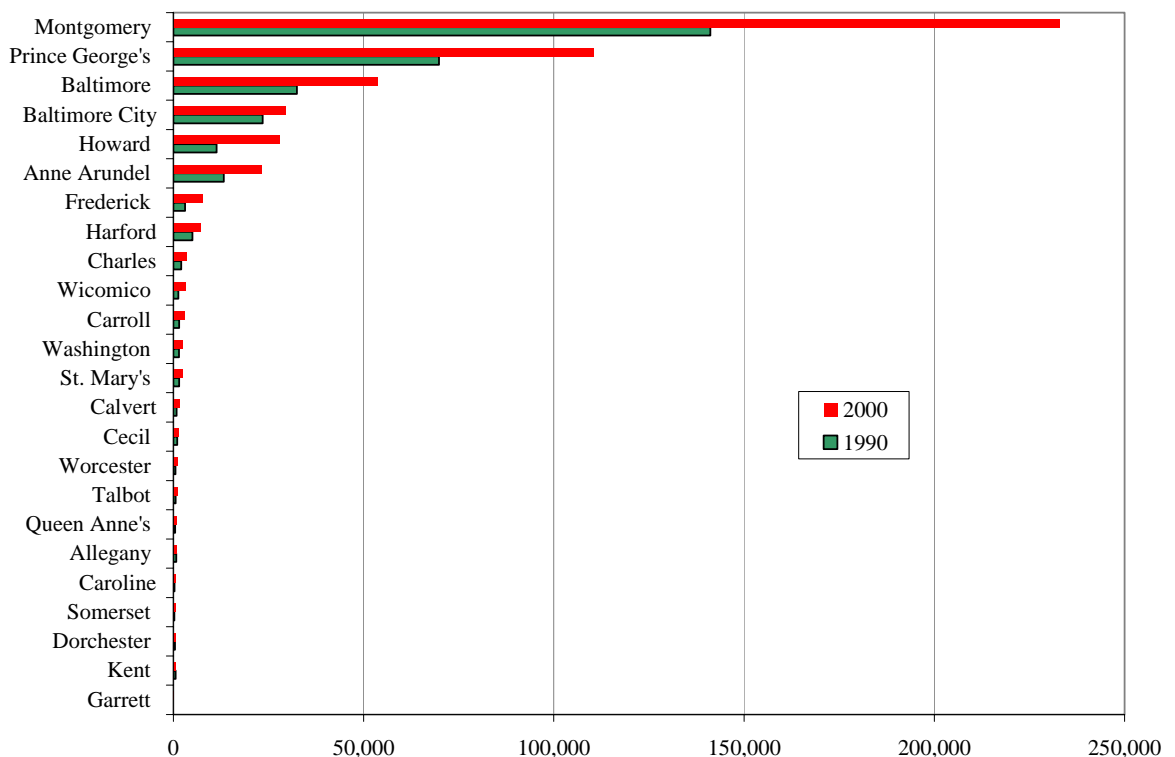


Figure 2.2 Foreign born by county, 1990 and 2000

In- and out-migration of population

Population change is partly the result of a flow into and out of the state. To further tease out the sources of in-migration for each county, we examined population movement in the state from 1995 and 2000. There was a tremendous amount of population movement during this time period with more than 1.6 million moving in, out and among the counties of the state. As Table 2.6 indicates, from 1995 to 2000, 642,459 people moved into Maryland and 514,875 moved out of the state for a net migration of more than 127,584 people.

Table 2.6 In- and out-migration in metropolitan and non-metropolitan Maryland, 1995 to 2000

	Total In-migration	In-migration (other states)	In-migration abroad	In-migration (surrounding states)
Maryland	642,459	495,152	147,307	204,113
Metropolitan	581,811	439,681	142,130	177,269
Non-metropolitan	60,648	55,471	5,177	26,844
	Total Out-migration	Out-migration (other states)	Out-migration abroad	Out-migration (surrounding states)
Maryland	514,875	514,875	0	194,687
Metropolitan	465,296	465,296	0	170,762
Non-metropolitan	49,579	49,579	0	23,925
	Net-migration	Net-migration (other states)	Net-migration abroad	Net-migration (surrounding states)
Maryland	127,584	-19,723	147,307	9,426
Metropolitan	116,515	-25,615	142,130	6,507
Non-metropolitan	11,069	5,892	5,177	2,919

In our analysis of in-migration, we found that three quarters of all in-migrants to Maryland moved from other states and the remaining quarter from abroad. Of the inter-state in-migrants, forty percent were from Maryland's surrounding states. Between 1995

and 2000, there were a total of 514,875 people who moved out of Maryland, with all of them moving to other parts of the United States. A third of all out-migrants moved to surrounding states. In fact, more people moved out of Maryland to other states than vice versa as Maryland witnessed a net loss in inter-state migrants of almost 20,000 people.

This net loss was offset by the net gain of 147,307 people from abroad from 1995 to 2000. Also, the inter-state net loss was to faraway states since Maryland had a net gain of almost 9,500 people from surrounding states. The sources of migration gains in Maryland were in-migration from abroad. There was net out-migration at the domestic level despite more in-migrants than out-migrants from surrounding states.

Analyzing within Maryland, a similar picture emerges for the metropolitan counties. To begin, in-migration to Maryland was mostly to metropolitan areas with 89 percent of all in-movers migrating to metropolitan counties between 1995 and 2000.. The majority of the population from abroad to Maryland moves to metropolitan counties, with less than four percent of these movers entering rural counties. Foreign migration is an important source of migration gains for metropolitan counties with 142,130 migrants from abroad entering between 1995 and 2000. Three quarters of in-migrants to the metropolitan counties came from other states. However, there was a net loss in domestic migration for metropolitan counties with a loss 25,000 people to other states.

Rural counties, on the other hand, experienced a net migration gain from both domestic and foreign migration. Domestic migration gains from 1995 to 2000 for rural Maryland

were 5,892, a similar statistic to gains of 5,177 for foreign migration. Almost half of all domestic migration gains for rural counties were from surrounding states. Contributions to population in rural Maryland came equally from domestic migration and migration from abroad.

Migration also occurs internally within Maryland. Many counties in Maryland attracted populations from other counties between 1995 and 2000. More than 465,100 Marylanders moved internally within the state over this five year period. We found that more than 390,000 people or 44 percent of metropolitan out-movers moved internally within the metropolitan counties during this same time period. Meanwhile, more than 33,000 or 3.8 percent of all metropolitan county out-movers migrated to non-metropolitan counties in Maryland.

At the same time, more than 26,000 or a quarter of rural county out-movers moved into metropolitan counties, and almost 13,500 or 15 percent moved internally within rural or non-metropolitan areas of Maryland. There were more residents of rural counties who moved into metropolitan counties than vice versa. Almost four percent of the out-migrants of metropolitan counties moved to rural Maryland from 1995 to 2000 while 44 percent of the out-movers of metropolitan counties moved internally within the metropolitan area.

An analysis of migration patterns at a county level enables us to determine the sources of migration gains and losses for Maryland. We found that all of the counties, with the exception of Somerset County and Baltimore City, had overall migration gains but that

the sources of these gains varied. Examining net migration gains for each county, we found an important contributor for many of the metropolitan counties was migration from abroad. Migration gains from other states were less important for metropolitan counties, with the exception of Prince George's County which has net domestic migration gains of almost 18,000 people. Montgomery County had the largest net migration gains from abroad with 55,967 in-migrants from outside the U.S. between 1995 and 2000. In fact, if it were not for in-migration from abroad, Montgomery County would have a net migration loss since there were more out-movers to other parts of Maryland and other states than in-movers from these areas to the county between 1995 and 2000.

During this same time period, almost 60,000 people in-migrated to Prince George's County from states surrounding Maryland, with more than 20,000 people in-migrating from these states than out-migrating to them. Most other metropolitan counties had net migration losses or minimal net migration gain from other states, surrounding or otherwise.

Aside from foreign migration, the source of net migration gains for most metropolitan counties was from other counties in Maryland. For instance, Baltimore County had a net migration gain from metropolitan counties of more than 46,000 people. The in-migration of more than 77,000 people from Baltimore city accounts for the importance of metropolitan level net migration gains for Baltimore County, and also explains the net-migration loss experienced by the City from 1995 to 2000.

An interesting finding in our analysis of net migration is the fact that few metropolitan counties experienced net migration gains from rural counties in Maryland. For counties such as Prince George's and Harford there was substantially more out-migration to rural counties than in-migration of rural populations between 1995 and 2000. For instance, there were more than 2,700 out-movers from Harford County to the Upper Eastern Shore county of Cecil but less than 1,000 moving the opposite direction.

Table 2.7 Sources of net migration gains and losses for Maryland counties, 1995 to 2000

Rural counties	Total Net Migration	All Maryland	Metro Counties	Rural Counties	Other States	Surrounding states	Abroad
Allegany	1,695	663	758	-95	729	-1,415	303
Caroline	806	1,058	1,129	-71	-580	-593	328
Cecil	4,486	2,573	2,795	-222	1,341	1,610	572
Dorchester	82	-149	143	-292	75	81	156
Garrett	277	498	363	135	-271	182	50
Kent	636	205	117	88	189	204	242
Somerset	-6,000	-6,806	-6,677	-129	553	214	253
St Mary's	6,284	2,060	2,515	-455	2,815	1,484	1,409
Talbot	1,878	925	868	57	622	477	331
Wicomico	3,980	2,864	2,228	636	-28	168	1,144
Worcester	4,074	3,238	2,890	348	447	507	389
Metropolitan Counties	Total Net Migration	All Maryland	Metro Counties	Rural Counties	Other States	Surrounding states	Abroad
Anne Arundel	14,245	8,532	10,971	-2,439	-4,671	-249	10,384
Baltimore City	-79,567	-73,418	-73,625	207	-18,805	-6,738	12,656
Baltimore	59,456	45,113	46,474	-1,361	-36	-2,359	14,379
Calvert	7,312	5,485	5,239	246	1,135	1,310	692
Carroll	6,521	9,927	10,351	-424	-4,561	-2,691	1,155
Charles	6,029	4,870	6,371	-1,501	-922	116	2,081
Frederick	11,755	9,178	9,504	-326	-24	-782	2,601
Harford	10,367	8,325	10,570	-2,245	-969	-1,793	3,011
Howard	19,126	11,434	11,963	-529	90	-56	7,602
Montgomery	28,342	-16,262	-14,641	-1,621	-11,363	1,689	55,967
PG	15,091	-33,034	-30,475	-2,559	17,658	19,505	30,467
Queen Anne's	3,809	3,391	4,159	-768	91	45	327
Washington	6,900	9,330	3,139	6,191	-3,238	-1,490	808

A different picture emerges when analyzing migration patterns from 1995 and 2000 for the rural counties. The majority of net migration gains for rural Maryland are from the

metropolitan counties in the state. This is especially true for St. Mary's, Wicomico and Worcester counties with net migration gains from metropolitan counties of 2,060, 2,864 and more than 32,000 respectively. St. Mary's County also experienced substantially in-migration from other states without losing population to these states. Half of St. Mary's County net migration gains from other states were from surrounding states. There were also substantial net migration gains from abroad for rural counties from 1995 to 2000. St. Mary's and Wicomico counties experienced net migration gains from abroad of more than 1,400 and 1,200 respectively from 1995 to 2000.

Summary of analysis of population change

From 1970 to 2000, Maryland's population increased by 1.4 million people. Current projections suggest that Maryland's population will increase by an additional 1.4 million by 2030. The largest population increases occurred in Montgomery, Anne Arundel, Howard and Prince George's counties. The non-metropolitan counties also experienced population increases with the addition of more than 150,000 people from 1970 to 2000. Household formation has also increased in Maryland during this time period. The number of households, particularly metropolitan counties, has increased in large numbers although the rate of household formation in non-metropolitan counties is higher than in metropolitan counties. Projections indicate that metropolitan counties, particularly Charles and Frederick, are likely to witness large increases in the number of households by 2030. An analysis of population density indicates that much of the growth has followed major highways and roads, and around existing urban centers in the state. Much of the population growth in the state is driven by foreign immigration. In terms of

domestic migration patterns, there was an in-migration of populations from surrounding states, particularly into Prince Georges County. Analyzing the movement of people within Maryland, few metropolitan counties experienced net migration gains from rural counties. In fact, for counties such as Prince George's and Harford there was substantially more out-migration to rural counties than in-migration of rural populations between 1995 and 2000.

CHAPTER THREE

HOUSING DEVELOPMENT IN MARYLAND

To keep pace with population growth and household formation, housing development has occurred at a rapid pace in Maryland, particularly in the last decade. In 1970, there were almost 1.3 million housing units in the state. By 2000, an additional 895,469 housing units were built for a total of 2.1 million, almost a 72% increase. In the 1990s, Maryland witnessed an increase of more than 250,000 units, and the number of housing units per square mile increased from 193.6 units in 1990 compared to 219.5 units in 2000.

Table 3.1 Housing development in Maryland counties, 1970 and 2000

Metropolitan Counties	1970	2000	1970 – 2000	1970 - 2000
Anne Arundel	89,036	186,937	97,901	110%
Baltimore City	305,530	300,477	-5,053	-2%
Baltimore	190,682	313,734	123,052	65%
Calvert	7,932	27,576	19,644	248%
Carroll	20,175	54,260	34,085	169%
Charles	13,577	43,903	30,326	223%
Frederick	26,292	73,017	46,725	178%
Harford	33,487	83,146	49,659	148%
Howard	18,096	92,818	74,722	413%
Montgomery	161,378	334,632	173,254	107%
Prince George's	200,637	302,378	101,741	51%
Queen Anne's	6,841	16,674	9,833	144%
Washington	34,585	52,972	18,387	53%
Total	1,108,248	1,882,524	774,276	70%
Non Metropolitan Counties	1970	2000	1970 – 2000	1970 - 2000
Allegany	29,660	32,984	3,324	11%
Caroline	7,033	12,028	4,995	71%
Cecil	16,421	34,461	18,040	110%
Dorchester	11,008	14,681	3,673	33%
Garrett	8,683	16,761	8,078	93%
Kent	6,300	9,410	3,110	49%
Somerset	14,214	34,081	19,867	140%
St. Mary's	6,996	10,092	3,096	44%
Talbot	9,070	16,500	7,430	82%
Wicomico	18,430	34,401	15,971	87%
Worcester	13,751	47,360	33,609	244%
Total	141,566	262,759	121,193	86%
Figures for this table are from the U.S. Bureau of the Census				

Much of the housing development occurred in metropolitan counties. From 1970 to 2000, these counties added almost 775,000 new housing units. The Baltimore region witnessed substantial housing development in the last three decades, particularly in Carroll, Queen Anne's and Howard counties. These counties combined added almost 120,000 housing from 1970 to 2000.

In raw numbers, housing development in Montgomery, Prince George's and Baltimore counties far outpaces other counties in the metropolitan area. In Montgomery County alone, more than 173,000 housing units were built between 1970 and 2000. During this period, the Southern Maryland counties of Charles and Calvert built almost 50,000 new houses, with the majority of these housing units built in Charles County.

The percentage change in housing units from 1970 to 2000 in counties of the Baltimore-Washington and Southern Maryland regions was dramatic. For instance, Howard County experienced a 400 percent increase in the number of housing units during this period. This is followed by a 250 percent increase in Calvert County; a 225 percent increase in Charles County; and a 200 percent increase in Frederick County.

Housing development also occurred in the non-metropolitan counties of Maryland. Between 1970 and 2000, these rural counties added more than 121,000 housing units. Somerset Cecil and Cecil counties witnessed substantial development, more than doubling their housing stock from 1970 to 2000. During this same period, the number of housing units in Wicomico County increased by almost 16,000 units.

Figure 3.1 illustrates the extent of residential development in Worcester County.

Particularly noticeable is the extent of development in the Salisbury area and along the Ocean City shoreline. According to the 2004 tax assessment data, Worcester County added more than 38,000 new housing units, including individual condos, from 2000 to 2003.

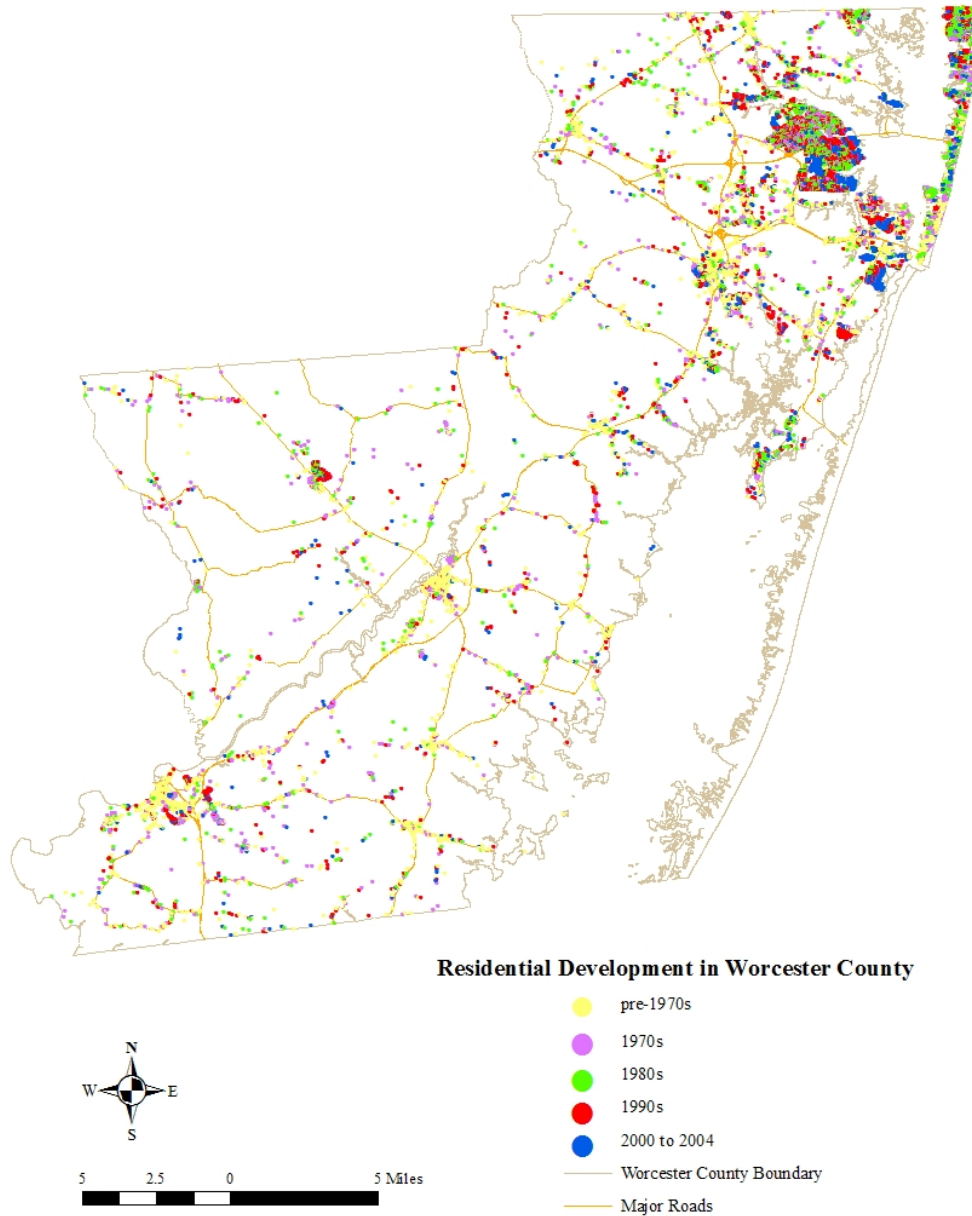


Figure 3.1 Residential development in Worcester County

The housing development in Worcester County is prompted by the continuing expansion of Ocean City as a tourism hub and location of vacation homes.

Similar to Ocean City, many one-time rural villages in Maryland expanded in recent decades. Figure 3.2 illustrates the places in Maryland that are fast growing or important urban centers or, in some cases, edge cities.

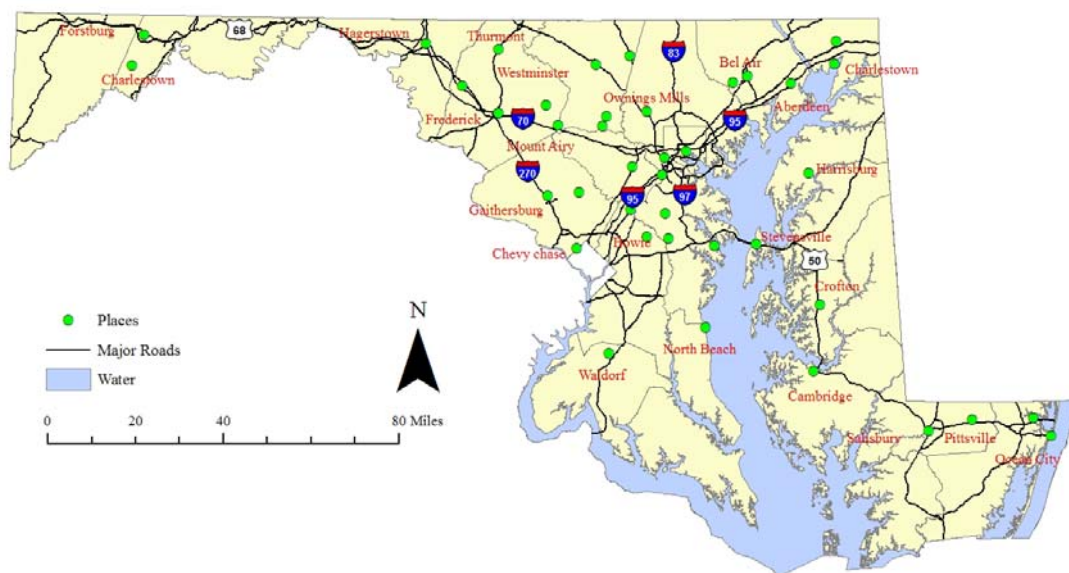


Figure 3.2 Examples of major places in Maryland

These places generally fall along major transportation routes, with many fast-growing towns developing along Route 50 to Ocean City, I-70, I-270, I-95, and Route 68 going west. We examined housing development from 1990 to 2000 in a number of these places, some of which are labeled in the above map. We focused on change in the historic and new urbanizing cores on the outer reaches of metropolitan counties and in the more rural counties of the state. As Table 3.2 indicates, some fast-growing towns such as

Myersville in Frederick County and Stevensville along Route 50 in Queen Anne's County more than doubled their housing stock in ten years. Similarly, places such as Bel Air, Mount Airy, Odenton and Thurmont are expanding.

Table 3.2 Housing development in urban cores in Maryland, 1990 to 2000

	1990	2000	'90 to '00	Percent change
Hagerstown	16,361	17,068	707	4%
Columbia	30,651	35,289	4,638	15%
Westminster	5,469	6,704	1,235	23%
Gaithersburg	16,059	20,562	4,503	28%
Frederick	16,611	22,052	5,441	33%
Bowie	13,066	18,622	5,556	43%
Olney	7,267	10,429	3,162	44%
Bel Air South	10,296	15,384	5,088	49%
Charlestown	273	415	142	52%
Waldorf	5,038	7,821	2,783	55%
Elkridge	5,581	8,733	3,152	56%
Thurmont	1,387	2,194	807	58%
Fallston	1,828	2,893	1,065	58%
Crofton	4,718	7,616	2,898	61%
Sykesville	870	1,419	549	63%
Mount Airy	1,313	2,171	858	65%
Hampstead	1,110	1,885	775	70%
Ocean Pines	4,184	7,117	2,933	70%
Bel Air North	5,116	8,883	3,767	74%
Pittsville	298	526	228	77%
North Beach	507	897	390	77%
Odenton	4,378	7,902	3,524	80%
Owings Mills	4,102	9,437	5,335	130%
Myersville	192	453	261	136%
Chevy Chase	271	716	445	164%
Linganore	1,506	4,237	2,731	181%
Eldersburg	3,301	9,399	6,098	185%
Stevensville	658	2,172	1,514	230%

Our analysis of land cover change within the transitioning counties of Montgomery and Frederick outlined in Chapter Six similarly illustrates the importance of small urban centers to growth. Land cover change, particularly the expansion of low-density development, moves outwardly from small towns within urbanizing counties. This growth puts tremendous strain on water resources, transportation networks and local government services.. The development of these rural towns, edge cities, and suburbs has a profound effect on surrounding areas as their boundaries expand, and incoming migrants are attracted by employment, amenities and service provision. The formation of these urban centers, particularly on the fringe and in rural areas often results in a loss of farmland and open space; and the subsequent expansion of the road network further encourages additional housing and employment.

Summary of analysis on housing development

Housing development has occurred at a rapid pace in Maryland in recent decades. This development occurred in metropolitan counties, but there is tremendous development in rural counties. In some cases, such as housing development in Ocean City, the results relate specifically to the development of tourist destinations. Housing expansion also occurred in many smaller urban centers throughout the state. The development of these areas has tremendous consequences for the loss of farmland and open space in Maryland.

CHAPTER FOUR

MARYLAND'S ECONOMY

In recent decades, there were a number of marked changes to the economy in the Maryland that both fuel and reflect urban expansion in many parts of the state. Established and developing employment centers within the state were instrumental to spurring population growth, and while farming continues to be an important contributor to some local economies, this industry is not a major source of employment for the newly established population. In the following sections, we highlight major changes in the structure of the labor force, and the development of centers of employment particularly in the Central Maryland region.

Employment change in Maryland

Between 1969 and 2001, employment in Maryland grew from 1.6 million to 3.1 million workers, a job growth of more than 86 percent. As Figure 4.1 demonstrates, much of the employment growth in Maryland was in the service sector. This sector added almost 800,000 service jobs from 1969 to 2000. In 2000, there were more than 1.1 million service workers. By 2000, service employment accounted for more than a third of all employment in Maryland, compared to 20 percent in 1969.

Maryland's closeness to Washington DC provides opportunities for government employment, particularly at the federal level. In 2000, more than half a million workers were employed in the government sector, an increase of more than 100,000 workers since

1969. Of these workers, more than 15,000 were employed in civilian federal government agencies, and more than 30,000 employed in state and local government agencies in 2000. State and local government employment accounted for ten percent and federal government employment five percent of total employment that year.

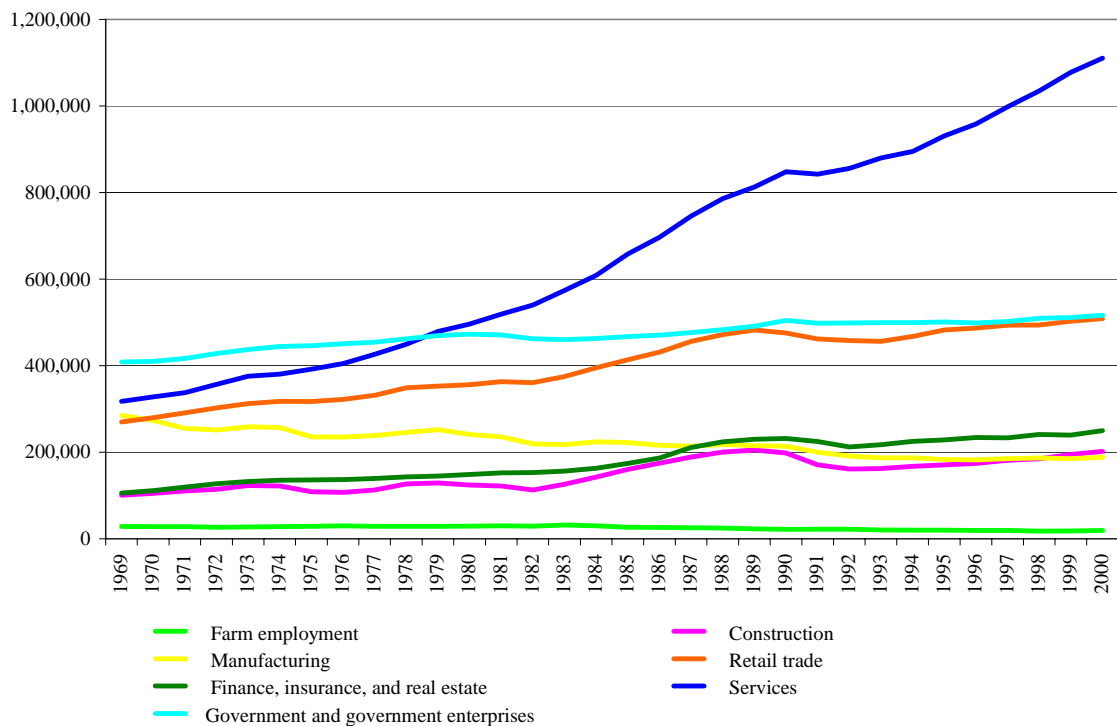


Figure 4.1 Employment by industry in Maryland, 1969 to 2000

Examining further within sectors, employment in finance, insurance and real estate (FIRE) increased by almost 145,000 jobs from 1969 to 2000, with the FIRE workforce comprising eight percent of total employment in the state by 2000. The construction industry grew by more than 10,000 workers from 1969 to 2000. This industry accounted for six percent of total employment in 1969 and 2000. Retail trade, in 2000, had more than 500,000 workers, an increase of more than 238,000 workers since 1969. This sector

was 16 percent of total employment in both 1969 and 2000. Both retail trade and construction industry kept pace with the rising population.

During this same period, the manufacturing and farming sectors experienced employment decline. Farming was not a major source of employment in 1969, and it has continued to decline in importance. In 1969, there were a little more than 28,000 farm workers. This figure declined by 9,000 workers by 2000. Employment in the manufacturing followed a similar trend with the loss of more than 28,000 workers in the last three decades. This sector comprised 17 percent of total employment in Maryland in 1969, declining to six percent by 2000. Overall the sectors of services, retail trade, and government far outweigh manufacturing and farming as sources of employment in the state.

Employment change in metropolitan Maryland

The pattern of job growth in the metropolitan counties is similar to the pattern of job growth for Maryland as a whole. As Figure 4.2 indicates, metropolitan counties witnessed large increases in employment in the FIRE and service sectors. Service employment more than tripled from 1969 to 2000. Currently, there are more than one million service workers in metropolitan Maryland. This sector is by far the most important employment sector, accounting for almost 40 percent of total employment within metropolitan counties.

Among industrial sectors, employment in FIRE experienced the second largest percentage increase, rising by 133 percent from 1969 to 2000. In percentage terms, this

rate was followed closely behind by the construction sector which almost doubled in employed workers between 1969 and 2001.

As a whole, metropolitan counties in Maryland lost manufacturing workers. This sector experienced a decline from a high of almost 260,000 workers in 1969 to almost 158,000 in 2000. As expected in the growth areas of metropolitan Maryland, farm employment declined. There were almost 17,000 farm workers in 1969, declining to more than 11,000 workers by 2000.

A major employer among metropolitan counties is the government sector, employing almost 470,000 workers in 2000, or 17 percent of the metropolitan counties workforce.

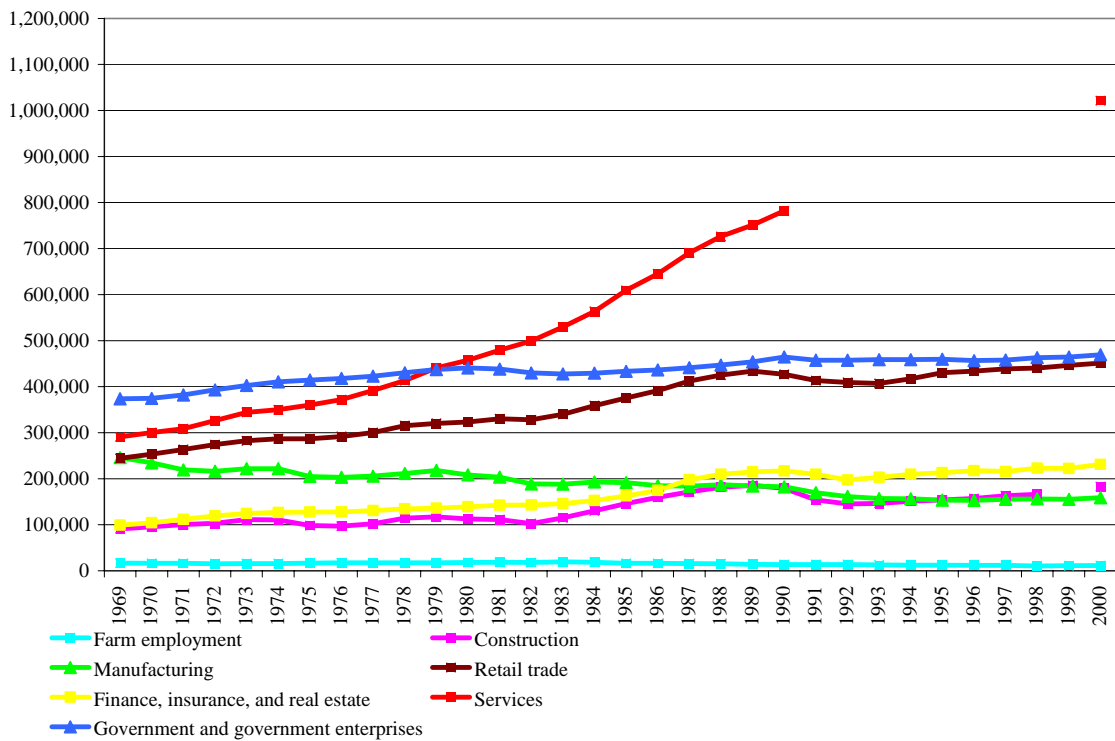


Figure 4.2 Employment by industry in metropolitan Maryland, 1969 to 2000

This is followed closely by retail trade. In 1969, there were 244,000 retail trade workers in the metropolitan counties in Maryland, increasing to more than 450,000 workers by 2000. Sixteen percent of workers in metropolitan Maryland were employed in retail trade in 2000.

Table 4.1 Employment in Metropolitan Maryland, 2000

	Metropolitan Counties, 2000	Percent of Metropolitan County Employment 2000	Percent of State Employment, 2000
Total employment	2,793,761	100%	90%
Farm employment	11,581	0%	61%
Construction	182,858	7%	91%
Manufacturing	158,578	6%	84%
Retail trade	451,212	16%	89%
FIRE	231,323	8%	92%
Services	1,021,575	37%	92%
Government	469,277	17%	91%

As Table 4.1 indicates, in 2000, ninety percent of all employment in Maryland was in the metropolitan counties of the state. That same year, 92 percent of total state service and FIRE employment in the state was in metropolitan counties. Not far behind was government and construction employment which both comprise 91 percent of Maryland employment in these sectors. More than 60 percent of farm employment in Maryland was in the metropolitan counties in 2000. Despite the urban nature of these counties, they are still a substantial source of employment within the farming sector of the state.

Employment growth and change in metropolitan counties

Examining within metropolitan counties, we found that the most significant increases in employment were in counties in suburban Washington DC. Employment in Montgomery,

Frederick and Prince George's counties combined increased from almost 450,000 workers in 1969 to more than 1.1 million workers in 2001, a job growth rate of 147 percent. As Figure 4.3 demonstrates, suburban Washington DC outpaced Baltimore region in terms of growth rate from 1969 to 2000, although the Baltimore region has more workers. The Baltimore region had 1.5 million workers in 2000 compared to 984,000 workers in 1969, a job growth rate of 56 percent. Of counties within the Baltimore region, Howard County had the largest percent increase in employment, increasing its workforce from around 17,000 in 1969 to more than 165,000 in 2001, a job growth rate of more than 840 percent.

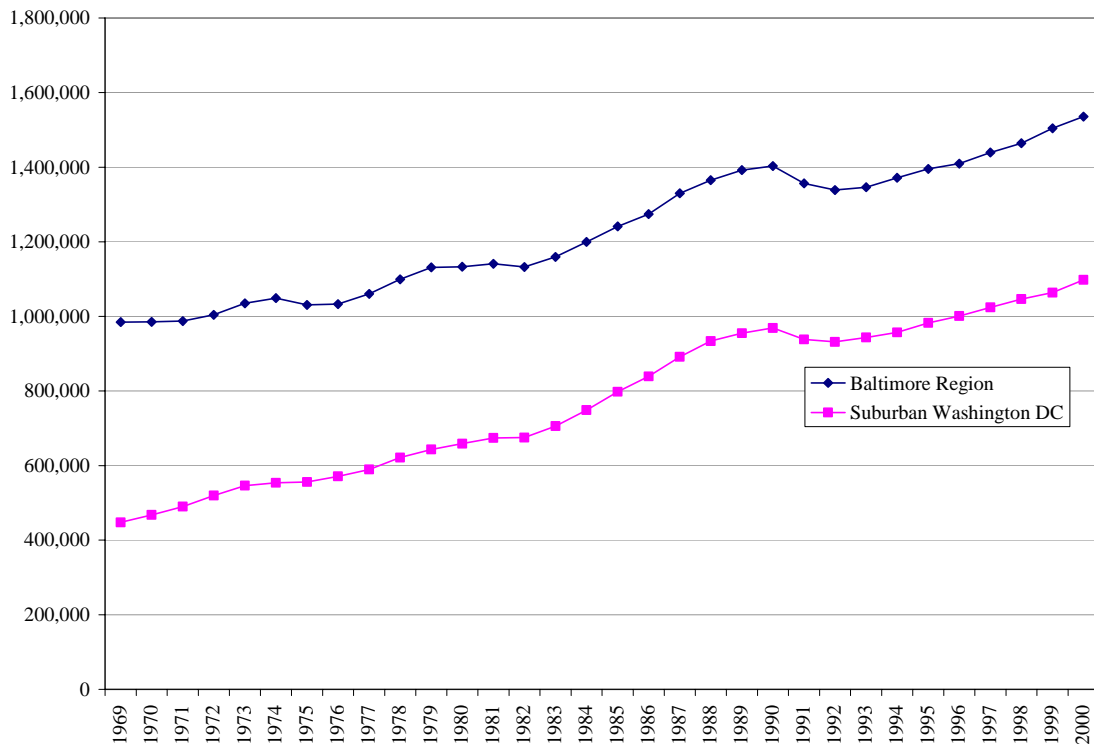


Figure 4.3 Total employment in the Baltimore and suburban Washington DC regions, 1969 to 2000

Southern Maryland's job growth was more than 220 percent for the years 1969 to 2001. Sparsely populated, rural counties in 1969, Charles, Calvert and St. Mary's counties witnessed substantial employment increases. For instance, beginning with a base of 15,000 workers in 1969, Charles County's workforce grew to more than 50,000 by 2000. Calvert County's workforce grew by more than 350 percent and St. Mary's workforce by 160 percent from 1969 to 2000.

As Figures 4.4 and 4.5 demonstrates, the employment structure within the metropolitan counties of Maryland varies by county and has changed over time. Among metropolitan counties, Queen Anne's County relies most heavily on farm employment. Four percent of its workforce was employed in the farming sector in 2000, a decline from 18 percent in 1969. Two percent of the workforce of Washington, Frederick, Calvert and Carroll counties were employed in farming in 2000. Declines among these counties varied. In percentage terms, among these counties, the highest rates of decline in farm employment was in Calvert where farm employment decreased by 11 percent from 1969 to 2000. In raw numbers, the largest decrease was in Frederick County with the loss of more than 700 farm workers during this period.

In 2000, Carroll County had the highest percentage of construction workers among metropolitan counties with 13 percent of its workforce employed in this sector, an increase from seven percent in 1969. In both Queen Anne's and Calvert counties, ten percent of workers were employed in construction in 2000, compared to six percent in both counties in 1969.

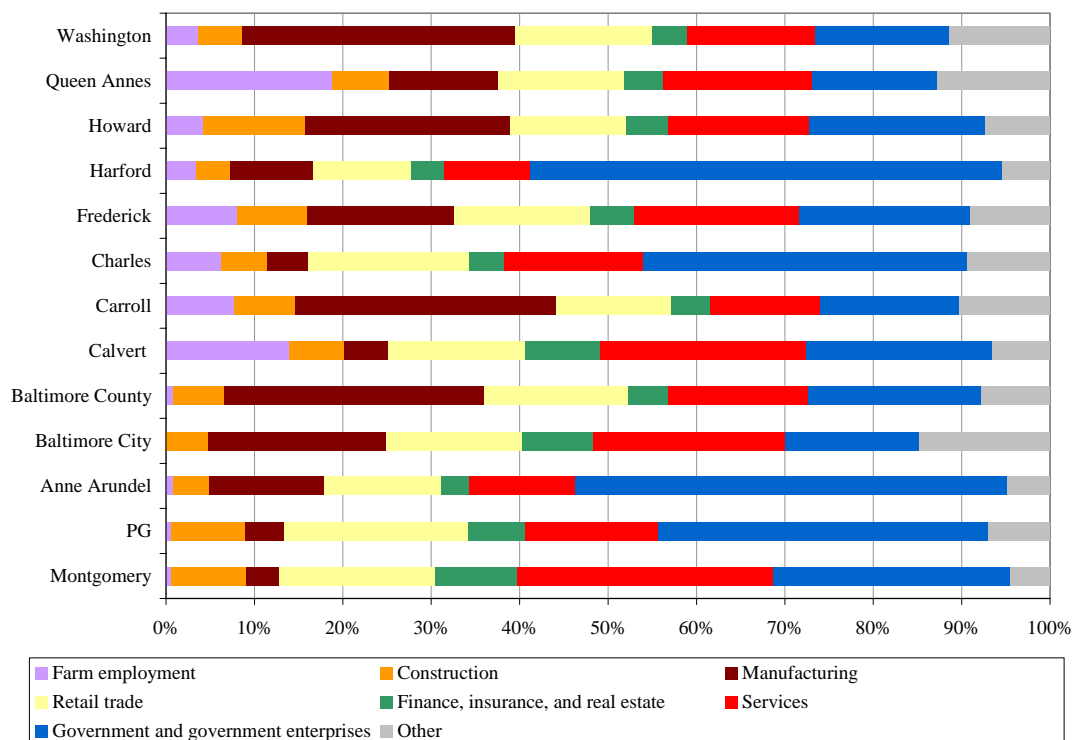


Figure 4.4 Employment by industry within metropolitan counties, 1969

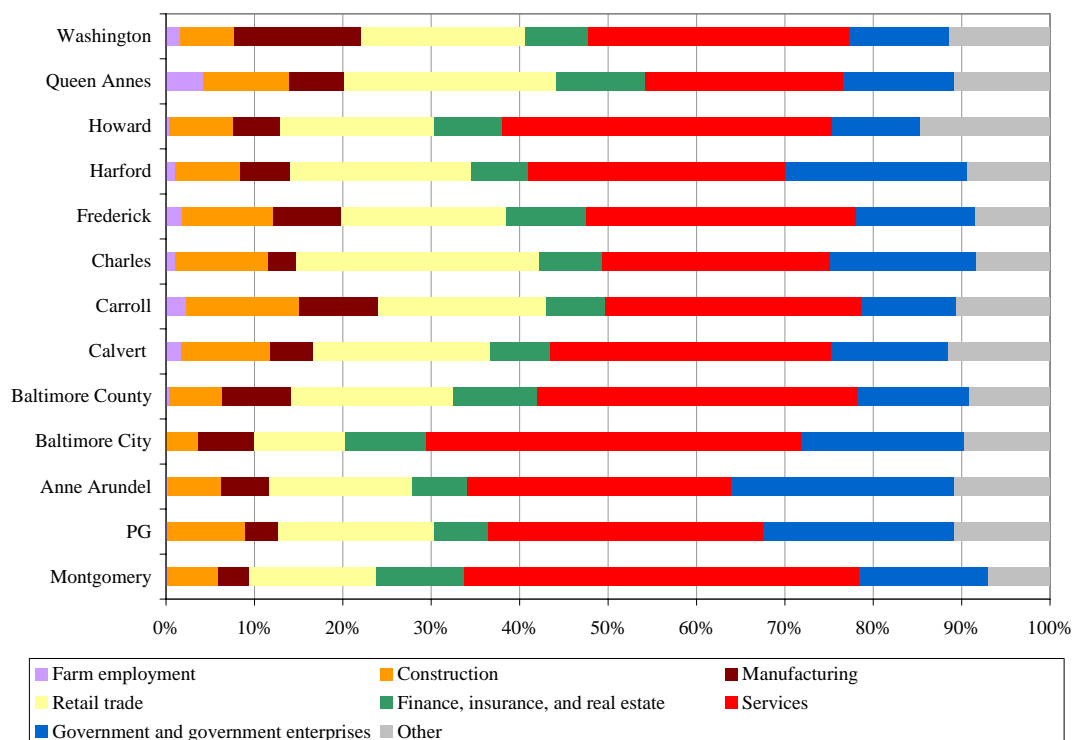


Figure 4.5 Employment by industry within metropolitan counties, 2000

Nine percent of the workforce of Montgomery County and eight percent of the workforce of Prince George's County were employed in construction in 1969. Prince George's County experienced a slight increase—one percent—in construction employment by 2000; Montgomery County, on the other hand, experienced a decline to six percent of total employment in 2000.

In 2000, fourteen percent of Washington County's workforce was employed in the manufacturing sector, the highest percentage rate for manufacturing employment among metropolitan counties in the state. However, this represents a decline in manufacturing employment from 30 percent of total employment in Washington County in 1969. In both Montgomery and Prince George's counties, about four percent of the workforce was in manufacturing in both 2000 and 1969. Three percent of Charles County's workforce is in manufacturing, a slight decline from four percent in 1969. Frederick and Howard counties once relied heavily on the manufacturing sector. This contrasts with Baltimore city where 20 percent of the workforce was in manufacturing in 1969, declining to six percent of the workforce by 2000. Sixteen percent of Frederick County's workforce was employed in manufacturing in 1969, declining to seven percent by 2000. There were even larger declines in Howard County where 23 percent of the workforce was employed in manufacturing in 1969 compared to five percent in 2000. Both Howard and Frederick counties shifted from rural, manufacturing counties to more service-based local economies in recent decades.

The retail trade sector has grown in every metropolitan county in Maryland. In 2000, almost a quarter of the workforce of Queen Anne's County was employed in the retail trade sector, and increase from 14 percent of the workforce in 1969. This sector is the most important source of employment for the county. In both Calvert and Harford counties, retail workers comprised 20 percent of total employment, an increase from 15 percent and 11 percent of respective workers. In both Montgomery and Prince George's counties, employment in retail trade declined as a percentage of total employment. In Montgomery County, 18 percent of the workforce was employed in the retail trade sector in 1969, declining to 14 percent of the workforce in 2000. In Prince George's County, 21 percent of the workforce was employed in the retail trade sector in 1969, declining to 17 percent of the workforce in 2000. Typically, the more "rural" metropolitan counties rely more heavily on the retail trade sector than those counties that have better adapted to the high-technology, service-based economy. The exception to this is Howard County – home to the Columbia Mall and other retail outlets – where retail trade employment increased from 13 percent in 1969 to 17 percent in 2000.

Among metropolitan counties, Prince George's and Anne Arundel counties had the lowest percentage of FIRE workers – six percent in both counties – among their employment pool in 2000. Queen Anne's and Montgomery counties, on the other hand, had the highest percentage of FIRE workers – ten percent in both counties – in 2000. This was an increase from four percent of the workforce in Queen Anne's County and nine percent of the workforce in Montgomery County in 1969.

Many metropolitan counties rely heavily on the service sector. Almost half of all workers in Montgomery County were employed in services in 2000, an increase from 29 percent of the workforce in 1969. In Baltimore City, 42 percent of workforce was in the service sector in 2000, an increase from 21 percent of total employment in 1969. Queen Anne's local economy is the least service-oriented with 23 percent of the workforce in service employment in 2000, an increase from 17 percent in 1969. Employment among metropolitan counties in Maryland, across the board, has become more service-based in the last three decades.

Metropolitan counties in Maryland experienced declines in government employment, in some cases quite dramatic decreases. For instance, in Hartford County, government services employment decreased from more than half of the workforce in 1969 to 21 percent of the workforce in 2000. In Anne Arundel, a similar decline occurred as government services employment declined by 25 percent from 1969 to 2000. In Charles County, government services comprised 37 percent of total employment in 1969, declining to only eight percent of the workforce by 2000. There is definite evidence of a shrinking of government service employment, although in counties such as Anne Arundel and Prince Georges' counties, this sector is still an important element of the local economy.

Employment growth and change in non-metropolitan counties

Non-metropolitan counties experienced an increase of almost 125,000 jobs between 1969 and 2000. As with metropolitan counties, the industrial sector that witnessed the largest

employment growth was the service sector, increasing by more than 230 percent or more than 60,000 jobs from 1969 to 2000 (see Figure 4.6).

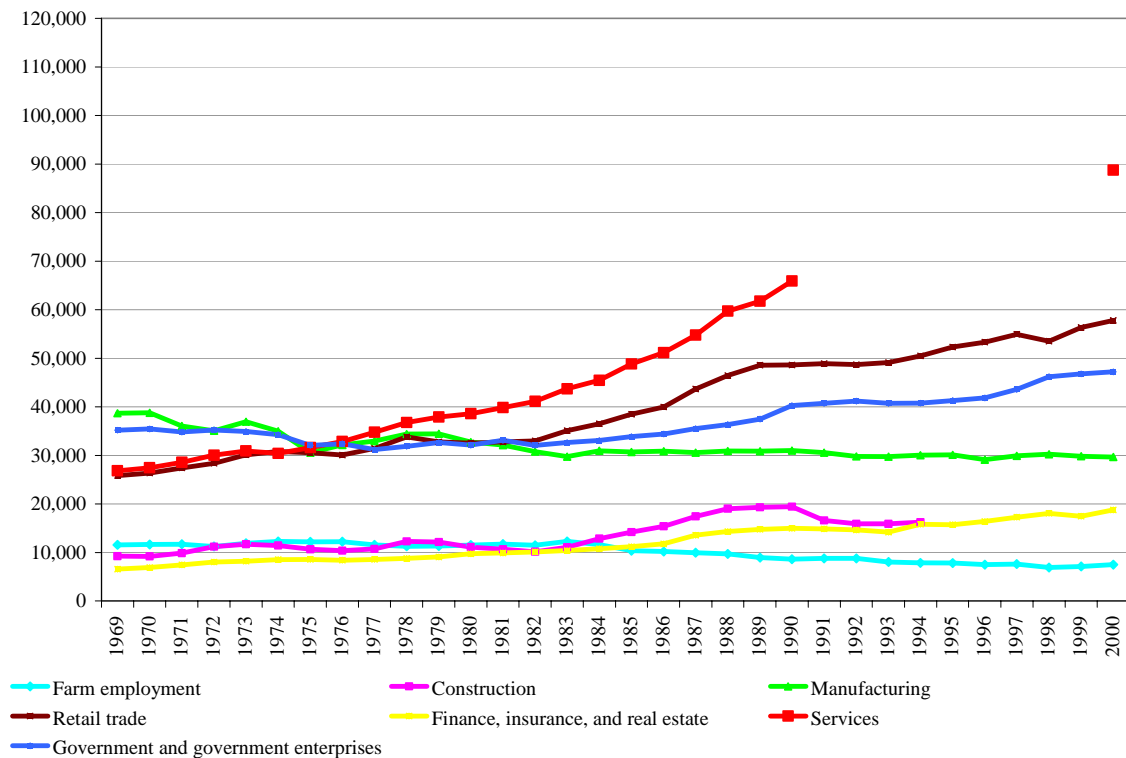


Figure 4.6 Employment by industry in non-metropolitan Maryland, 1969 to 2000

Employment growth in the retail sector of non-metropolitan counties was also substantial with the addition of almost 32,000 retail jobs from 1969 to 2000, a growth rate of 123 percent. Both the government sector and the FIRE sector experienced an addition of more than 12,000 jobs from 1969 to 2000, with the largest percentage increase of more than 185 percent in the FIRE sector. Both agricultural and manufacturing employment declined from 1969 to 2000 in non-metropolitan counties in Maryland. Manufacturing employment declined by more than 9,000 jobs, 23 percent of total employment; and farm employment decreased by more than 4,000 workers, 35 percent of total employment.

Despite this decline, farming employment in the non-metropolitan counties accounts for 39 percent of statewide farm employment.

Table 4.2 Employment in Non-Metropolitan Maryland, 2000

	Non Metropolitan Counties, 2000	Percent of Non- Metropolitan County Employment in 2000	Percent of State Employment in 2000
Total employment	297,786	100%	10%
Farm employment	7,494	3%	39%
Construction	16,197	6%	10%
Manufacturing	29,648	10%	16%
Retail trade	57,786	19%	11%
FIRE	18,768	6%	8%
Services	88,747	30%	8%
Government	47,197	16%	9%

As with metropolitan counties in Maryland in 2000, the most important employment sector in non-metropolitan counties of Maryland was the service sector, accounting for 30 percent of non-metropolitan county employment. Retail trade, another important industrial sector for both metropolitan and non-metropolitan counties, was 19 percent of non-metropolitan employment, 11 percent of the state employment. While manufacturing employment declined in the non-metropolitan counties of Maryland, this sector accounted for 10 percent of non-metropolitan county employment in 2000. This compares to six percent of metropolitan employment that same year. Farming accounts for only three percent of total employment in non-metropolitan counties in 2000.

Examining within non-metropolitan counties, we find some interesting features. As Figure 4.7 demonstrates, St. Mary's County had the largest increase in jobs, adding more

than 30,000 new jobs from 1969 to 2001. The main sectors of employment growth in this county during this period were retail trade, manufacturing, FIRE and services. The only sector to decline was farming with a loss of almost a quarter of farm workers.

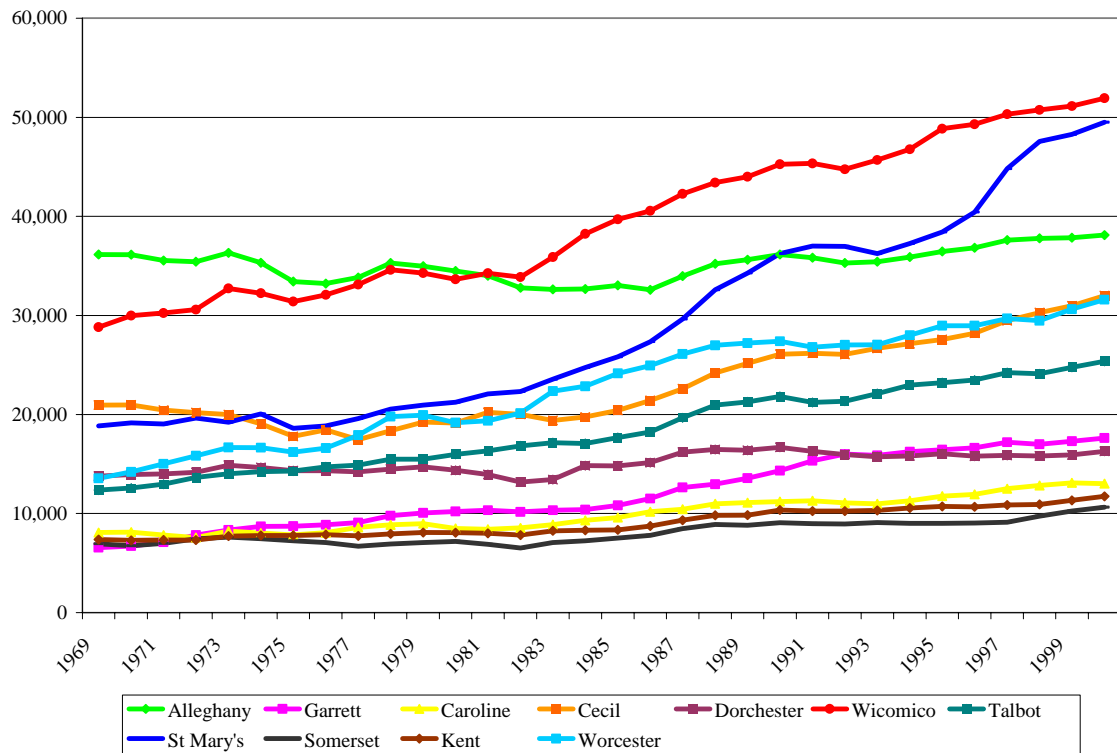


Figure 4.7 Total employment by non-metropolitan county, 2000

Second among non-metropolitan counties in employment growth during this time period was Wicomico County. By 2000, this county had the highest number of workers – almost 52,000. Wicomico County's workforce grew by almost 25,000 workers from 1969 to 2000. The major growth sectors were FIRE, services and government. FIRE and government employment more than doubled while service employment more than tripled during this time period.

The lowest gains in employment were in Allegany County. From 1969 to 2000, total employment in this county grew by less than 2,000 workers. The sectors to lose workers include farming, construction and manufacturing. The manufacturing sector declined by almost 65 percent, a loss of almost 8,000 workers. A growth sector is services. The number of workers in this sector more than doubled from 1969 to 2000.

Worcester, Garrett and Cecil counties experienced similar levels of increase in employment. The number of employed workers increased from 13,000 to more than 31,000 in Worcester County from 1969 to 2000; in Cecil County total employment increased from more than 20,000 to almost 32,000 over this same time period; and in Garrett County, total employment grew by more than 11,000 workers. In Cecil and Worcester counties, there was a decline in farm and manufacturing employment, and in Cecil County, employment in the government sector also declined. In Garrett County, farm employment remained the same with a slight increase by nine workers; and manufacturing employment grew from 650 workers in 1969 to more than 1,500 workers in 2000. During this period, the number of service and retail trade workers increased counties, with larger increases in these sectors in Worcester County.

Total employment in Talbot County more than doubled from 1969 to 2000. As with other non-metropolitan counties, the growth rate was highest in the service sector which almost tripled over the three decades. The construction and retail sectors in Talbot County grew by more than 120 percent and 150 percent, respectively. Manufacturing

employment barely grew and farm employment declined. Government services employment grew by more than 73 percent.

Caroline, Kent and Somerset counties had similar levels of total employment in 2000, and similar rates of employment growth from 1969 to 2000. In Caroline County, total employment increased by 60 percent, in Kent County there was an increase in employment of 58 percent and in Somerset County, employment grew by 53 percent over the thirty year period. In each case, farm employment declined, and in the case of Somerset and Kent counties, manufacturing employment declined. In Kent County, manufacturing employment grew slightly. Meanwhile, service employment more than tripled in Caroline County and almost tripled in Somerset and Kent counties.

Industrial structure varies within the non-metropolitan counties as indicated by Figure 4.8. In 2000, close to seven percent of Kent and Caroline counties' workforce was employed in farming compared to only one percent of Talbot County's workforce. Construction employment is highest at in Talbot County seven percent of the workforce and lowest at five percent in both Allegany and St. Mary's counties.

Manufacturing employment is substantial in some non-metropolitan counties. For instance, 23 percent of the workforce in Dorchester County and 14 percent of Wicomico and Caroline counties was employed in the manufacturing sector in 2000. Typically, the workforce in non-metropolitan counties was employed in either retail trade or services that year. For instance, almost 60 percent of the workforce of Worcester County was

employed in both sectors. In Allegany County, 22 percent of the workforce was employed in the retail and 31 percent was employed in services sector.

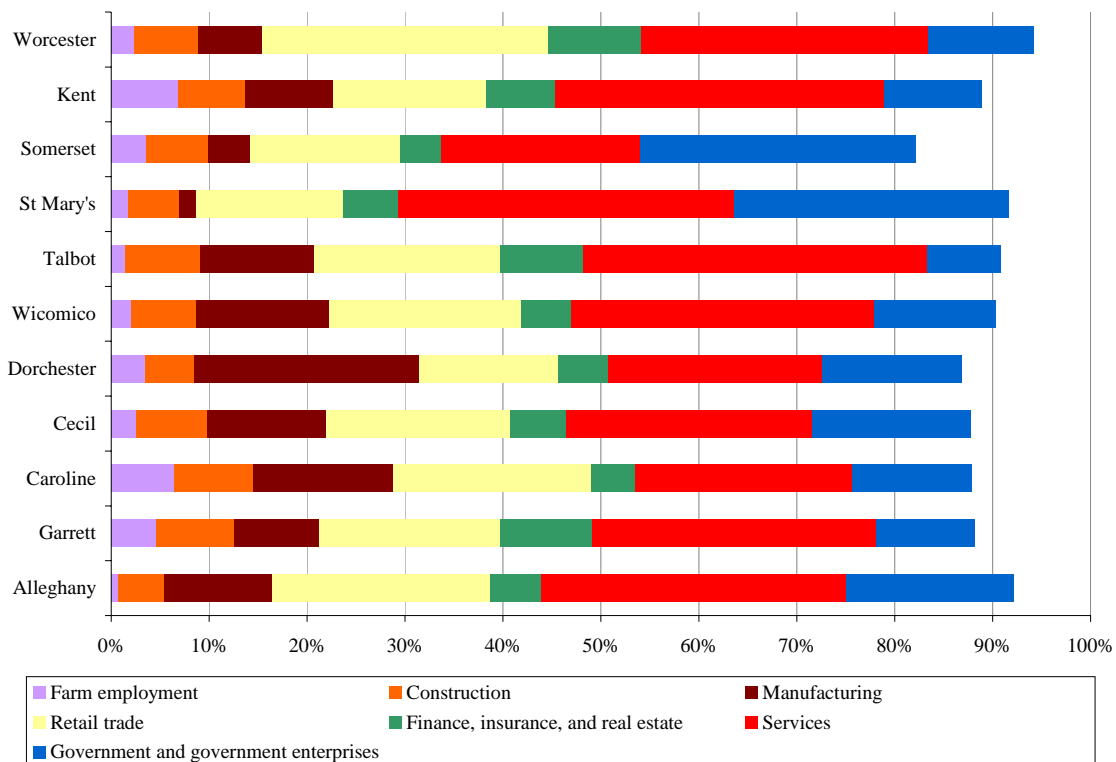


Figure 4.8 Employment by industry within non-metropolitan counties, 2000³

The highest rate of service employment was in Talbot County where 35 percent of the workforce is employed in this sector in 2000. The lowest rate was 20 percent of Somerset County's workforce. St. Mary's County and Somerset County shared the highest ranking for government employment at 28 percent of the workforce in both jurisdictions in 2000. Construction employment was highest in Garrett and Talbot counties. Eight percent of the workforce in both counties was employed in this sector in 2000. In terms of FIRE

³ Data excludes some employment sectors

employment, ten percent of Wicomico County's workforce was employed in this sector in 2000, the highest rate among non-metropolitan counties that year.

Industry advantage and concentrations of employment in Maryland

To determine industry specialization in Maryland, we employed a location quotient (LQ) analysis comparing Maryland's economy to the national economy. The LQ technique identifies areas of specialization and industry advantage in the state economy. When the LQ score is greater than one, it is likely that the state specializes in that particular industrial activity. In contrast, when the LQ score is less than one, the state does not specialize in that activity, and it is possible that the state must import that industry. The results of the LQ analysis for Maryland are outlined in Figure 4.9.

We found that Maryland outpaces the nation (i.e. LQ greater than one) in services but under performs in agriculture and manufacturing. Maryland scored an LQ of 1.6 for the professional, scientific and technical services sector, 1.3 for construction, more than 1.2 for real estate, 1.2 for educational services and more than one for public administration services. The LQ results for the construction and real estate industries indicate that the Maryland economy has benefited from the growth in population. The high LQ score for professional, scientific and technical services sector is likely the result of closeness to defense and research industries close to Washington DC. This booming sector will attract more people to the state as evidenced by recent decisions on military base realignment. Meanwhile, producing industries such as agriculture and manufacturing are not areas of

specialization for the Maryland economy, and the LQ results suggest the state must import from these sectors.

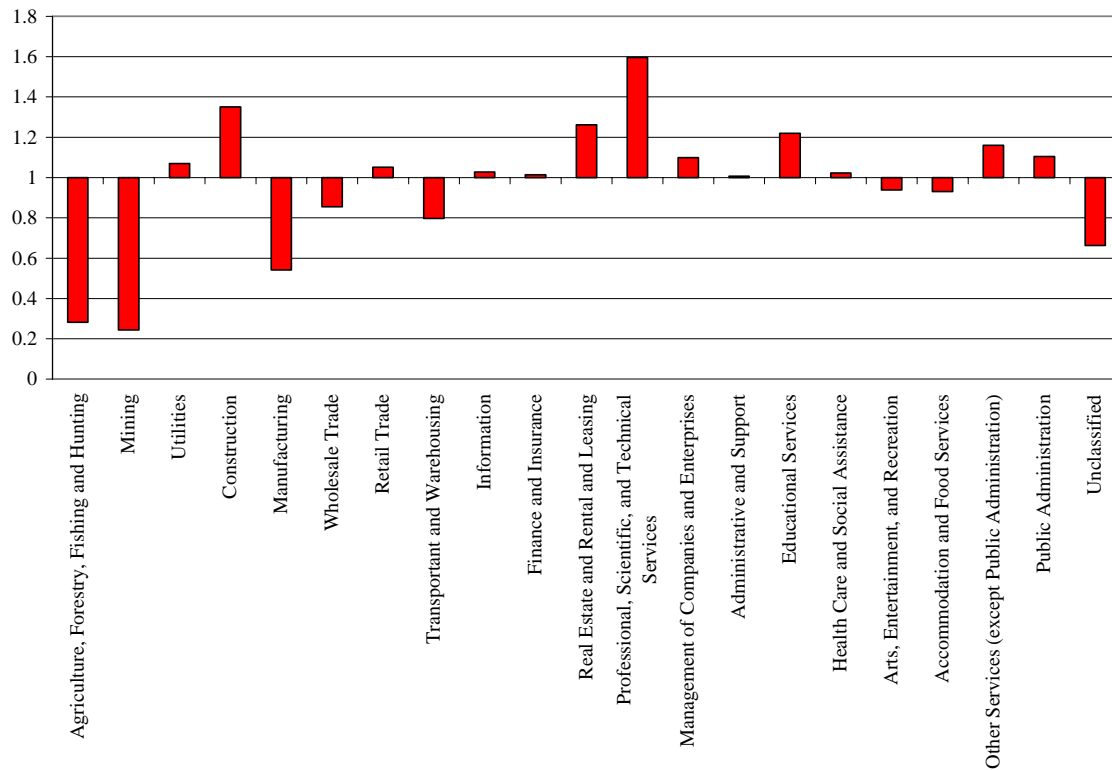


Figure 4.9 Location quotients for different industries in Maryland, 2001

In looking more closely at Maryland's area of specialization within the professional, scientific, and technical services sector, in recent years the state has developed a niche in the technology sector. As Figure 4.10 indicates, this industrial advantage plays out spatially with concentrations of high technology establishments primarily along the I-270 corridor in Montgomery County, outside Washington DC, and in outer suburbs of the Baltimore region.

The presence of important federal research agencies, particularly in the suburbs of Washington DC, is crucial to high technology growth. These agencies include such government bodies as the National Institutes of Health, the Food and Drug Administration, National Security Agency (NSA), NASA Goddard Space Flight Center, Army Research Laboratory, and National Geospatial-Intelligence Agency (NGA). These agencies, coupled with such major research developments as the Human Genome Project, have put Maryland at the forefront in terms of biotechnology, bioscience, defense and aerospace.

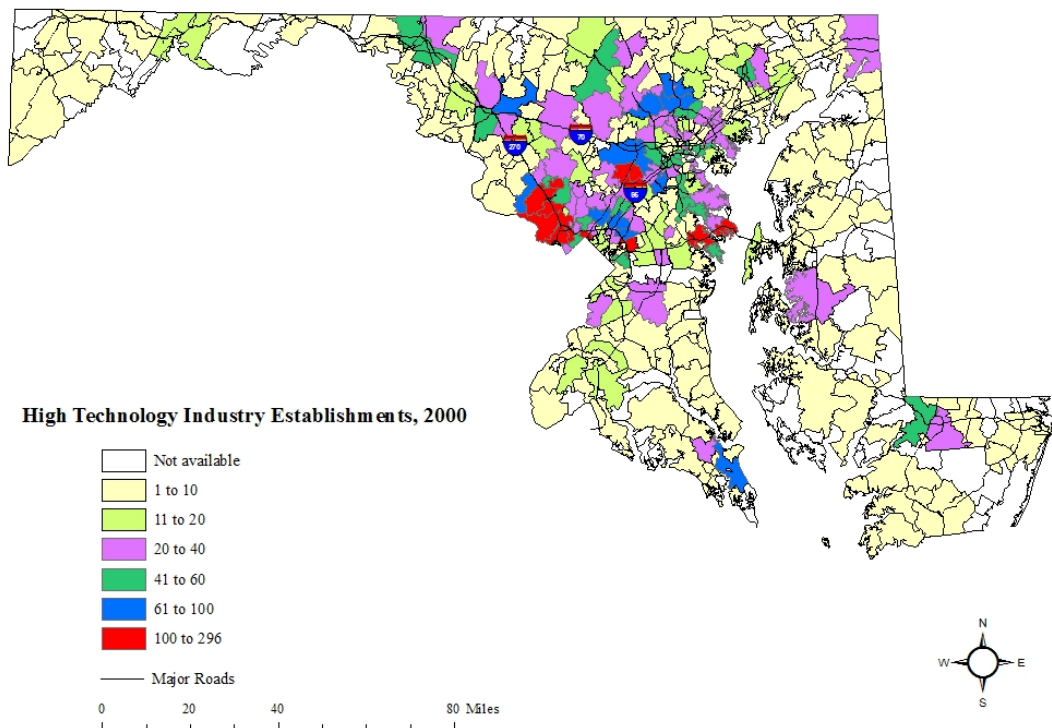


Figure 4.10 High technology establishments by zip code, 2000

Central Maryland is a focus for much employment throughout the state. Figure 4.11 illustrates the major centers of employment. Examining data on employment in

transportation analysis zones, we found that I-270 corridor in the Rockville and Gaithersburg area, north of Baltimore City along I-83, in Frederick City, and along I-95 between Baltimore and Washington DC are important centers of employment for Maryland. Transportation routes are essential for location of both industry and employees in the state.

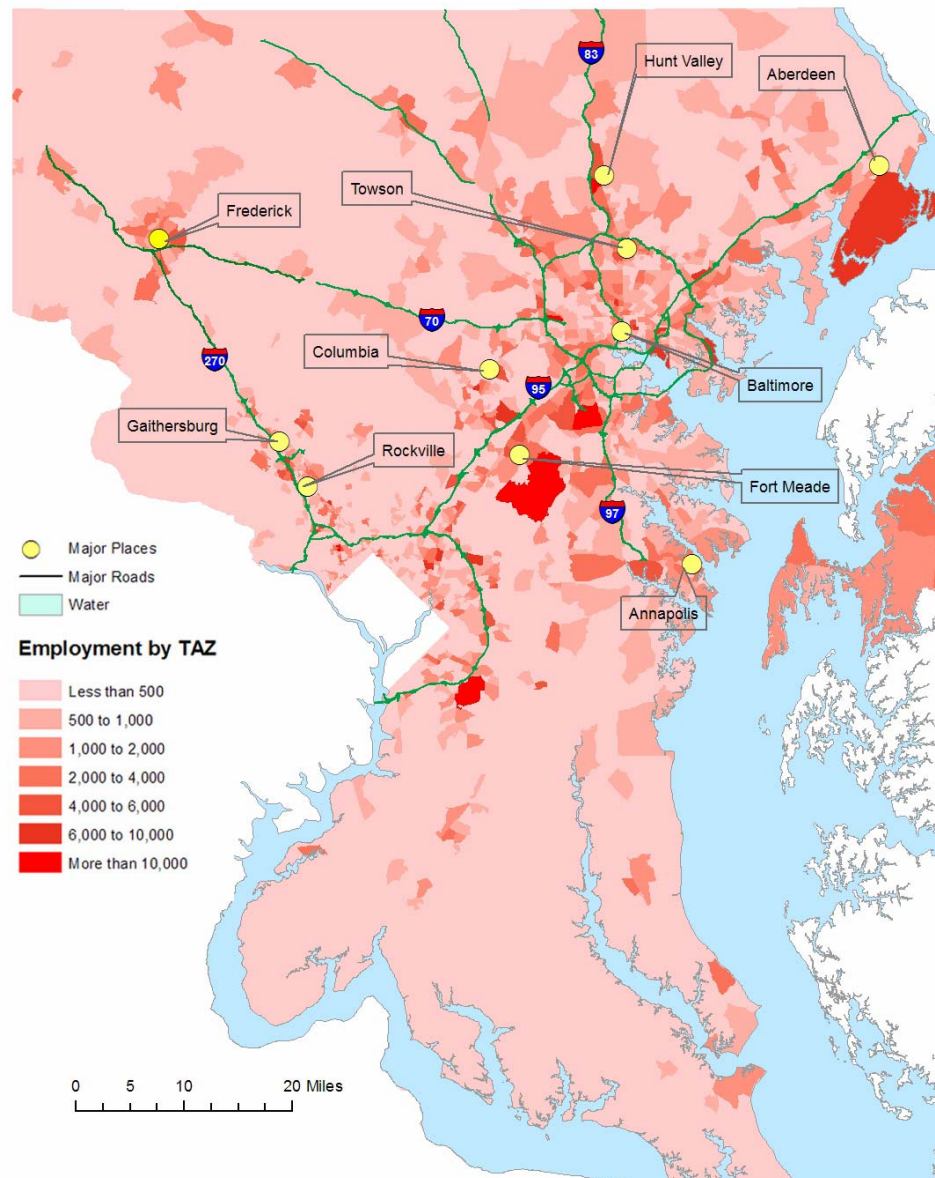


Figure 4.11 Employment centers in Central Maryland

Summary of analysis of employment

There have been massive shifts in the economy of Maryland that both reflect and drive population growth throughout the state. Job growth, as with population growth, has occurred at a tremendous pace with the workforce expanding from 1.6 million in 1969 to 3.1 million in 2001, a growth rate of 86 percent. During these thirty years, there has been a shift away from farm and manufacturing employment to a more service-based, high-technology economy. Employment has shifted location, dispersing away from central cities to employment centers primarily in the Central Maryland region.

Metropolitan counties are important sources of employment for the state. Employment in the Washington suburban counties of Montgomery, Frederick and Prince George's combined increased from almost 450,000 workers in 1969 to more than 1.1 million workers in 2001, a job growth rate of 147 percent. The Baltimore region has more workers – 1.5 million in 2001 – but the workforce in the region is growing at a slower pace than the suburban counties of Washington DC. The Washington DC area, in particular, is the site for many professional jobs in industries located along I-270 and I-70.

Employment structure in both metropolitan and non-metropolitan counties has change dramatically in recent decades. Farming is less important as a source of employment; and manufacturing employment has taken a sharp decline in recent decades. Among rural counties, the effects are quite devastating. For instance, in 2001, fourteen percent of Washington County's workforce was employed in the manufacturing sector, the highest

percentage rate for manufacturing employment among metropolitan counties in the state. However, this represents a decline in manufacturing employment from 30 percent of total employment in Washington County in 1969.

Many rural counties have turned to the retail trade and service sectors as sources of employment in the new economy. Employment growth in the retail sector of non-metropolitan counties was substantial with the addition of almost 32,000 retail jobs from 1969 to 2001, a growth rate of 123 percent. In 2001, the service sector accounted for 30 percent of non-metropolitan county employment. At the same time, farming accounts for three percent of employment in non-metropolitan counties. The local economies of rural counties rely less on the land or manufacturing sector and more on consumer growth and service. This reliance encourages further urban growth.

CHAPTER FIVE

MARYLAND'S AGRICULTURE

Population growth, housing development and changes in the regional economy have greatly impacted the extent of Maryland's farmland. In 1978, 2.6 million acres or 42 percent of land in the state was in farms⁴. By 2002, this number had declined to about 2 million acres of land in farms, a third of the land area of the state. Every county in the state experienced a decline in farmed land during this period, with dramatic decline in some cases.

More than half of the land area of the Upper Eastern Shore counties – the most farmed region in Maryland – was comprised of farms in 2002, a decline from more than 65 percent of the land area in 1978. As Figure 5.1 indicates, the Eastern Shore counties of Queen Anne's and Kent, 65 percent of the land area was in farms in 2002. However, in 1978, in both counties more than three quarters of the land area was in farming. In Talbot County, 61 percent of the land area was farmed in 2002, a decline from 68 percent in 1978. Caroline County witnessed a similar trend with 56 percent county in farming in 2002, a decline from 65 percent in 1978.

⁴ A census farm is defined as an agricultural operation that produces crop, poultry, animal products or other agricultural products intended for sale. For the 1981 and 1986 Censuses, a census farm was defined as a farm, ranch or other agricultural holding with sales of agricultural products of \$250 or more during the previous 12 months. For the 1976 Census, a census farm was defined as a farm, ranch or other agricultural holding of one acre or over with sales of agricultural products of \$1,200 or more during 1975.

The most dramatic decline in the percentage of land area in farms occurred in the Southern counties of Calvert and St. Mary's. In Calvert County, the percentage of land in farms was 37 percent in 1978, declining to 21 percent by 2002. In St. Mary's County, 45 percent of the land area was in farms in 1978, declining to 29 percent of land area in 2002.

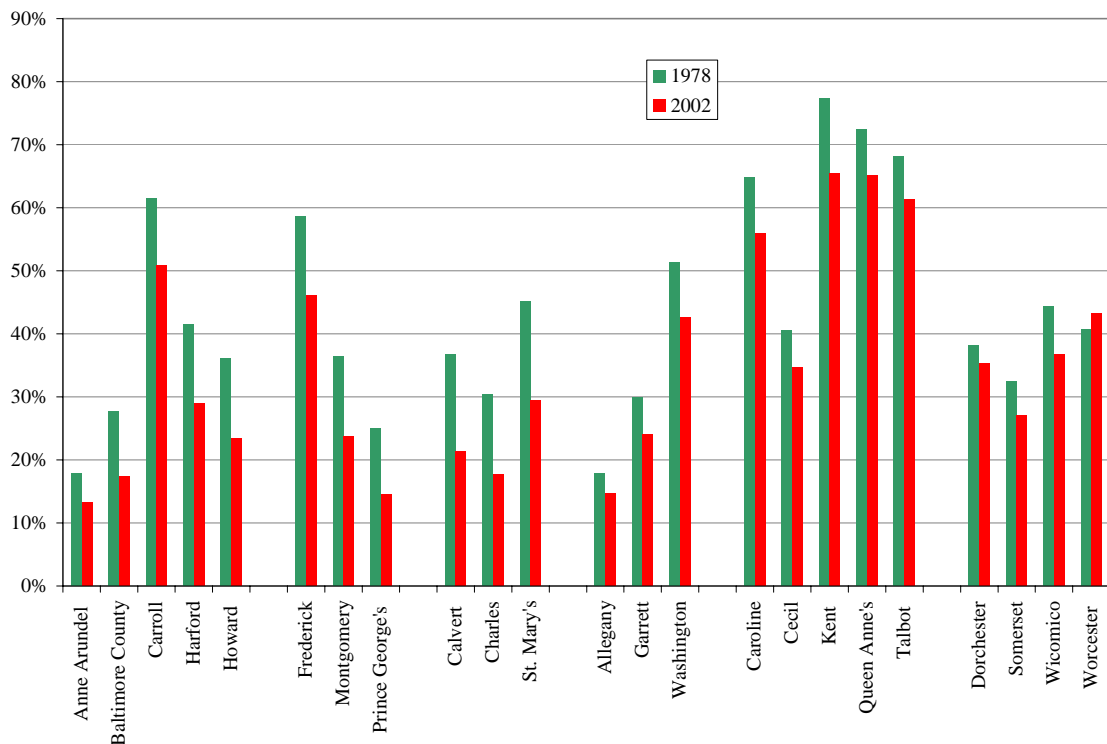


Figure 5.1 Percent of land area in farms by county, 1978 and 2002

Metropolitan counties in both the Washington DC and Baltimore areas also experienced decline in the percentage of land area in farming from 1978 to 2002. The most extreme cases were Harford, Howard, Frederick and Montgomery counties. In each county, the land area in farming declined by around 13 percent from 1978 to 2002. Carroll County also witnessed substantial decline in the percent of land in farms. In 1978, 62 percent of

the county was in farming compared to 51 percent in 2002. In Frederick County, 59 percent of the land area was in farming in 1978, declining to 46 percent by 2002.

Maryland has lost almost 537,000 acres of land in farms since 1978, and farm acreage declined in almost every county. As Figure 5.2 indicates, Frederick County witnessed the largest decline in farm acreage among all Maryland counties, losing more than 53,000 acres of land in farms over a thirty year period. As the largest county in the state, Frederick had the largest number of acres in farming with more than 195,000 acres in 2002 compared to 248,000 acres in 1978.

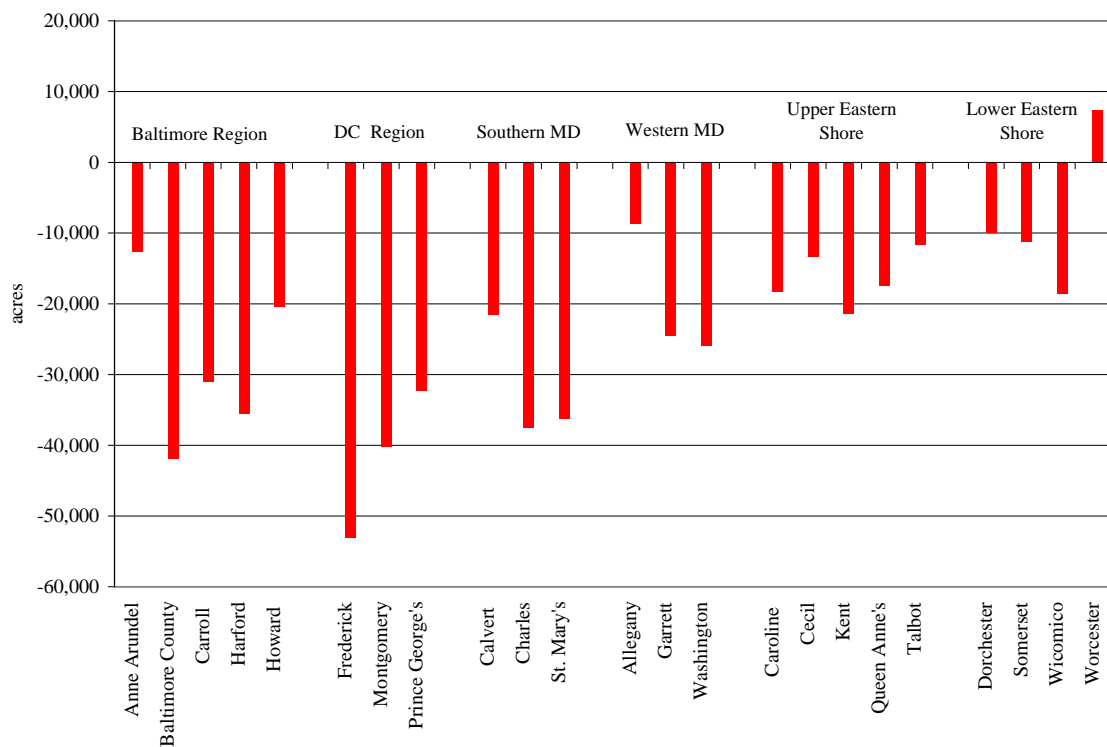


Figure 5.2 Farm acres by county, 1978 to 2002

Overall, the suburban counties of the Washington DC region lost more than 125,000 acres of land in farms, almost a quarter of statewide losses in land area in farms.

Montgomery County lost more than 40,000 acres of farmland from 1978 to 2002. Prince George's County also experienced a substantial decline in farmland, losing more than 32,000 acres in the three decades.

The land in farms declined in the Baltimore region by more than 141,000 acres from 1978 to 2002. Despite the growth boundary of the Urban Rural Demarcation Line (URDL) in Baltimore County, this county still lost almost 42,000 acres of land in farms from 1978 to 2002. In Howard County, the number of farm acres declined by more than 20,000 acres during this same period, and in Hartford County, farm acreage declined from more than 116,000 acres in 1978 to more than 81,000 in 2002.

Southern Maryland lost a total of 95,000 acres of land in farms from 1978 to 2002. The largest decline in acreage was in Charles County with a decline of more than 37,500 acres over this time period. St. Mary's also experienced substantial decline as the number of farms acres declined from more than 104,000 in 1978 to a little over 68,000 in 2002.

The rural counties in Maryland also experienced a loss of land in farms. The Eastern Shore as a whole had more than 1 million acres of land in farms in 1978, declining to less than 973,000 acres by 2002, a loss of 114,707 acres. The largest loss of acres in farms from 1978 to 2002 occurred in Kent County with the loss of more than 21,000 acres of land in farms during this time period. Wicomico County also experienced substantial

losses as the land in farming declined by more than 18,600 acres over the 24-year period. Caroline County was not far behind with a loss of more than 18,300 acres. Queen Anne's County witnessed substantial decreases, with the number of farms acres declining from more than 173,000 acres in 1978 to about 155,000 acres in 2002.

Western Maryland lost almost 60,000 acres of land in farms over the three decades. The largest decline was in Washington County as land in farms declined from more than 151,000 acres in 1978 to 125,000 acres in 2002.

The total number of farms in Maryland also declined in recent decades. In 1987, there were 14,776 farms, declining to 12,198 by 2002. Every county, with the exception of Talbot and Allegany counties, experienced a decline in the number of farms during this time period.

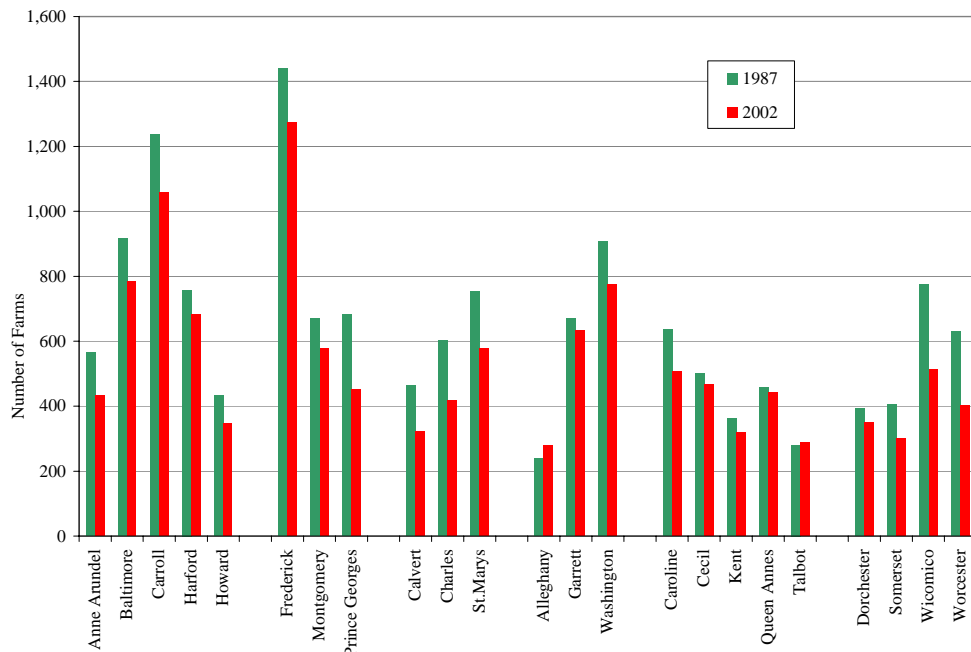


Figure 5.3 Number of farms by county, 1987 to 2002

The number of farms in the Baltimore region declined by 609 farms from 1987 to 2002, and the suburban Washington DC counties lost 489 farms during this same period.

Among regions in the state, the Lower Eastern Shore experienced the largest decline, with the number of farms in this region dropping from a high of 2,203 in 1987 to 1,567 in 2002, a loss of 636 farms. Southern Maryland also witnessed substantial decline in the number of farms. This region had 1,819 farms in 1987, declining to 1,316 farms by 2002.

Among counties, the most significant decline occurred in Wicomico County where the number of farms dropped from 774 in 1987 to 512 in 2002. This was followed closely behind by Worcester and Prince George's counties. In Worcester County, there were 631 farms in 1987, declining to 403 farms by 2002. In Prince George's County, there was a loss of 231 farms during this same period. The county with the largest number of farms in 2002 was Frederick County with 1,273 farms. Frederick lost 166 farms from 1987 to 2002. Carroll County had 1,058 farms in 2002, a decline from 1,238 farms in 1987.

To provide a more detailed analysis, we examined the loss of farms by zip code. As Figure 5.4 demonstrates, many zip codes lost a substantial number of farms with at least four large zip codes in the Lower Eastern Shore losing more than 100 farms from 1987 to 2002. One zip code in Carroll County experienced a loss of more than 101 farms. A similar pattern exists for a zip code in Washington County. Also zip codes particularly around Frederick City experienced a decline in the number of farms from 1987 to 2002. Areas of Southern Maryland and south Prince George's County lost farms, with many zip codes losing more than 50 farms from 1987 to 2002.

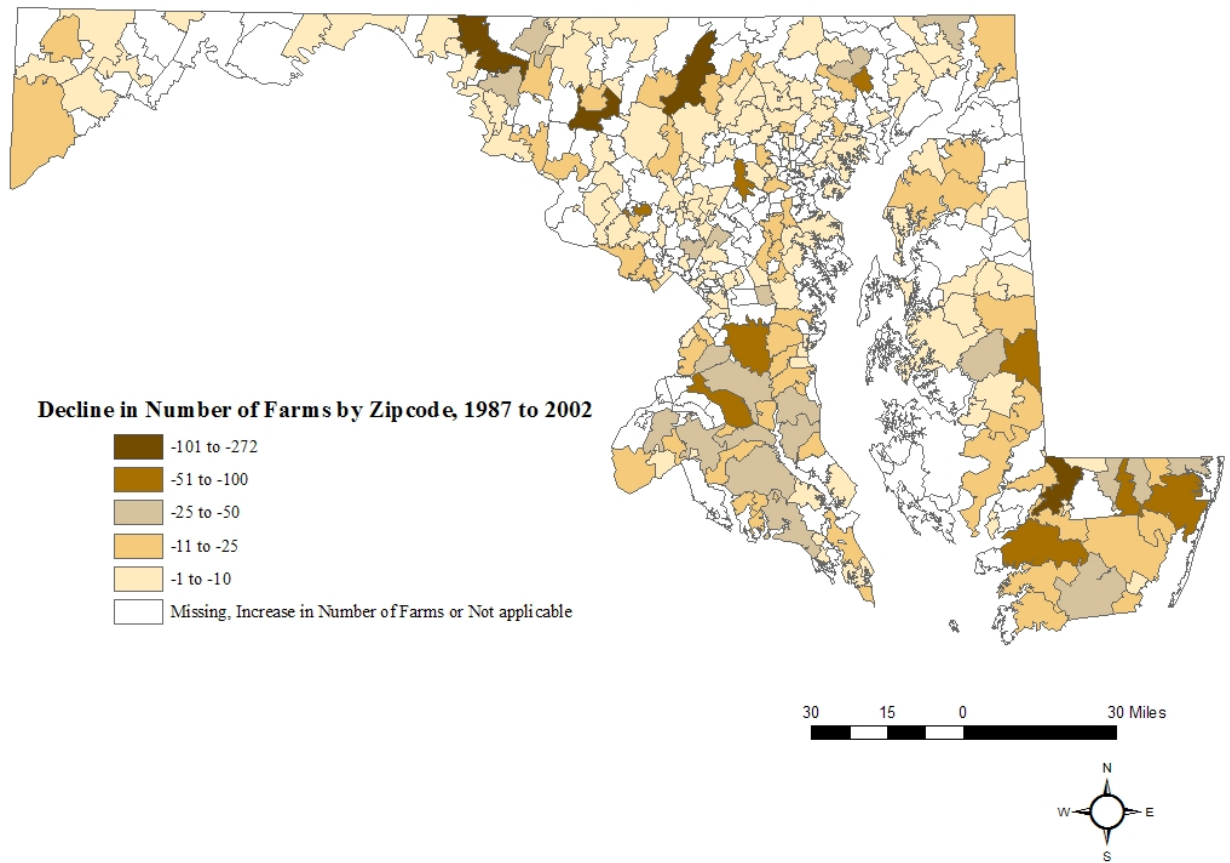


Figure 5.4 Change in the number of farms by zip code, 1987 to 2002

The decline in the number of farms has different meanings for different counties. For instance, the loss of a farm in Queen Anne’s County compared to, say, Anne Arundel County is more significant in terms of lost acreage because of the larger farm size in Queen Anne’s compared to Anne Arundel.

The average size of farms varied among counties and across decades throughout the state. In 1978, the average farm size in Maryland as a whole was 168 acres. This figure

fluctuated over the next three decades and the average farm size was 170 acres in 2002.

As to be expected, the average farm size in the non-metropolitan counties of Maryland was generally larger than the average farm size in the metropolitan counties. In most cases, the average farm size increased among the more traditionally rural counties in Maryland from 1978 to 2002, and, in general, the average farm size among metropolitan counties declined or remained similar over the period.

Table 5.1 Average size of farms in acres by county, 1978 to 2002

	1978	1982	1987	1992	1997	2002	78-02
MARYLAND	168	158	162	171	178	170	2
Metropolitan Counties	1978	1982	1987	1992	1997	2002	
Anne Arundel	83	74	75	91	84	82	1
Baltimore County	126	98	101	99	97	91	-35
Calvert	81	74	89	93	96	94	13
Carroll	146	133	135	146	154	139	7
Charles	121	112	113	120	136	125	4
Frederick	178	167	164	166	166	154	-24
Harford	160	148	132	140	145	119	-41
Howard	140	117	125	117	125	109	-31
Montgomery	173	157	155	147	147	130	-43
Prince George's	103	98	91	99	101	101	2
Queen Anne's	352	343	373	400	401	351	-1
Washington	172	152	152	153	164	161	-11
Non Metropolitan Counties	1978	1982	1987	1992	1997	2002	
Allegany	208	190	204	173	175	142	-66
Caroline	183	180	209	216	212	227	44
Cecil	198	188	173	176	185	165	-33
Dorchester	303	318	319	357	414	357	54
Garrett	198	183	181	175	166	154	-44
Kent	377	360	370	413	374	369	-8
Somerset	162	149	158	161	190	188	26
St. Mary's	120	107	107	115	116	118	-2
Talbot	332	342	389	436	457	367	35
Wicomico	116	132	123	133	156	173	57
Worcester	176	185	196	227	269	326	150

In terms of metropolitan counties, an exception is Queen Anne's County where the average farm size remained relatively stable at about 350 acres over the 24 year period.

The metropolitan county with the smallest farms is Baltimore County with the average

farm size at 91 acres in 2002, a decline from 126 acres in 1978. In Harford County, the average farm size declined from 160 acres in 1978 to 119 acres in 2002. Farms in Howard County also became smaller with farm size declining to an average of 109 acres by 2002. Frederick and Washington counties both experienced a decline in the average size of farms. In the case of Frederick, the average size of the farm declined from 178 to 154 acres from 1978 to 2002. In the case of Washington County, the average farms size declined by 11 acres during this period.

Montgomery County, of all metropolitan counties, experienced the most profound decline in average farm size, with farm size declining from 173 acres in 1978 to 130 acres in 2002.

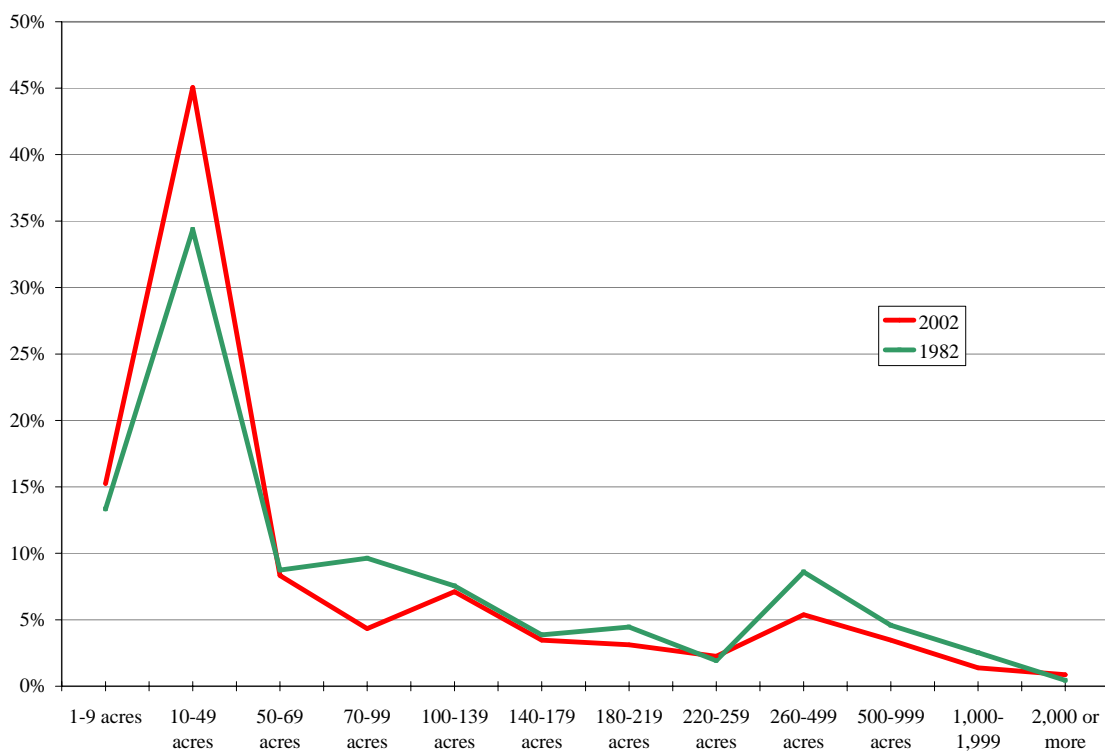


Figure 5.5 Farm size in Montgomery County, 1982 to 2002

As Figure 5.6 demonstrates, between the years from 1982 to 2002, Montgomery County witnessed a sharp increase in the percentage of farms between ten and 50 acres in size. In general, during this same period, the percent of farms more than 500 acres declined. Increased development and urban growth has encouraged the proliferation of small farms and the loss of large farms in the county. Many small farmers benefit from closeness to urban markets.

Examining more traditionally rural counties, farm size increased in a number of counties. For instance, in Wicomico County, the average farm size increased from 116 acres in 1978 to 173 acres by 2002. Similarly, in Caroline County, the average farm size increased from 183 to 227 from 1978 to 2002. In some cases, there was a decrease in average farm size among non-metropolitan counties. In Allegany, the average farm size declined from 208 acres in 1978 to 142 acres in 2002.

The most profound case of a change in the structure of farmland among rural counties occurred in Worcester County where the average size of farms increased by 150 acres from 1978 to 2002. A closer examination of changes in farm size in Worcester County indicates, on the one hand, the proliferation of very large farms (i.e. more than 1,000 acres) and, on the other hand, a decline in the percentage of very small farms (i.e. less than 10 acres). As Figure 5.5 indicates, there has been an increase in the percentage of farms between 10 and 50 acres in size as well as an increased in the percentage of farms 1,000 acres or more in size. Small farm producers are important in Worcester County. However, the county has also witnessed increased importance of large farm production as

the percent of farms over 1,000 acres increased from 4 percent in 1982 to 10 percent in 2002.

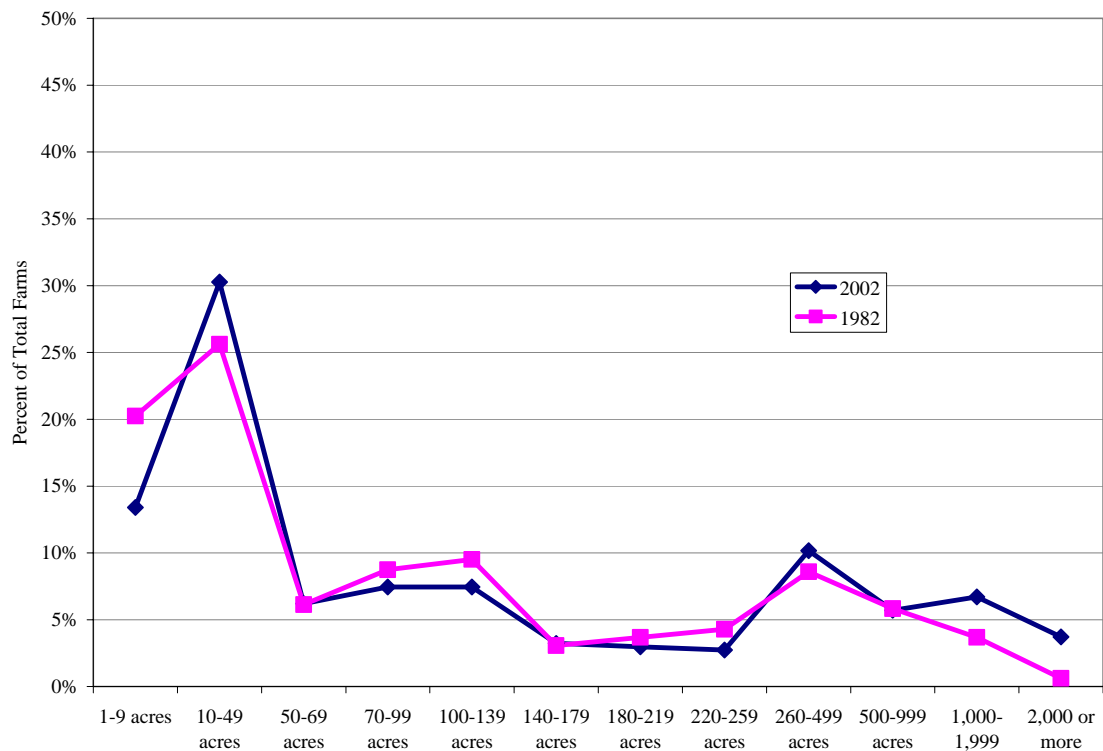
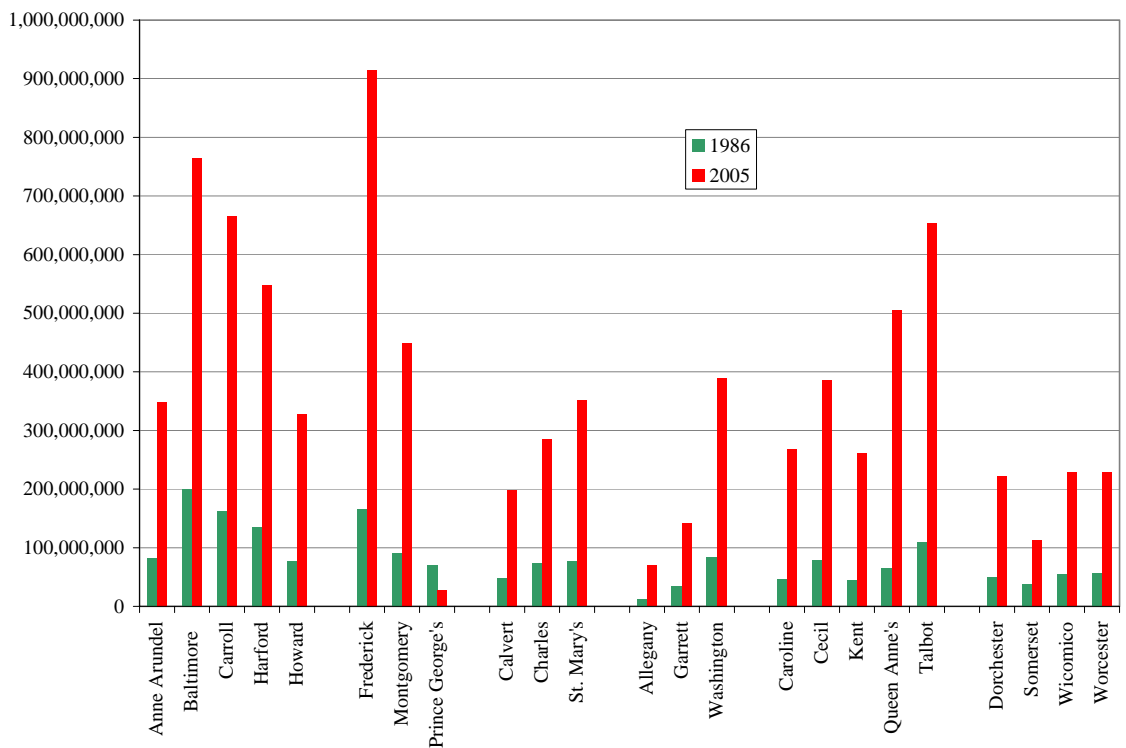


Figure 5.6 Farm size in Worcester County, 1982 to 2002

These changes in farm size indicate more profound changes in the nature of farming in Maryland. On the one hand, there is increased importance in large farm production while, on the other hand, farming is adapting to urban development with the increased reliance on small farm production and recreational farming that supplies the urban consumer.

Among other forces, urban development has greatly impacted the value of agricultural property in Maryland. Statewide, agricultural real property value totaled around \$8.3 billion in 2005, an increase from \$1.9 billion in 1986.

In some counties, agricultural property values have increased dramatically in recent decades, and in only one case – Prince George’s County – has agricultural property values declined.



**Figure 5.7 Real agricultural property values by county, 1986 to 2005
(in 2005 dollars)**

These changes in agricultural property values offer farmers profound incentives to sell their farms for urban development. It also puts additional strain on local governments and land conservation groups aiming to purchase agricultural easements since they are forced to compete with high market values for agricultural land.

CHAPTER SIX

LAND COVER CHANGE IN TRANSITIONING COUNTIES

To analyze the impacts of the population and employment changes identified in Chapters Two through Five on agricultural land, we used Landsat data to perform an analysis of changes in land coverage for Montgomery and Frederick counties at multiple time periods. In this analysis, we fused remote sensing data and tax assessment data to obtain a more accurate assessment of the extent of developed land over time. For this purpose a generalized land use and land cover consisting of classes for developed, agriculture/open, and forested lands was created for the years 1986, 1995, and 2001. The classification methodology used to generate this data can be found in Appendix 1.

Results

Figure 6.2 through to Figure 6.4 show the resulting classification of Montgomery and Frederick Counties for 1986, 1995, and 2001. Figure 6.5 depicts a progression of development for Montgomery and Frederick Counties. We describe the results for Montgomery County and then the results for Frederick County.

Montgomery County

Figure 6.5 shows that some areas of the county remained highly developed from 1986 to 2001. These are areas that border Washington DC, typically extending to about 10 kilometers outside the central city. Some areas within this 10 kilometer radius of the city remained low density over the time period, specifically in the Potomac area outside Washington DC. Other areas in Montgomery County remained untouched or

agricultural/open and forested from 1986 to 2001. These areas are in the northwest of the county, areas bordering Frederick County, and the agricultural reserve in Montgomery County.

Other areas of Montgomery, however, witnessed dramatic change. Intense urbanization extends northwest towards Germantown, and development is clearly evident around particular towns and places. For instance, examining immediately around Germantown, there is substantially more developed land in 2001 than in 1995 and 1986 as indicated by the growth in red and orange on the map. Similarly, the surrounding environs of Damascus and Poolesville witnessed similar growth over this time period.

There is evidence of in-fill development, particularly south of North Damascus and around Montgomery Village. These areas moved from low density development to high density development. However, there was also an increase in low density development, joining areas south of Damascus with northern areas of Montgomery Village. Also, low density development increased areas along the Potomac River.

Figure 6.6 shows a graph depicting the number of acres in each class for Montgomery County. It is evident from this figure that developed land has increased over the time period. According to our analysis, Montgomery County lost a total of 20,884 acres of agricultural/open land and 15,003 acres of forested land from 1986 to 2001. During this same period, the amount to developed land grew by 32,122 acres, 11,509 acres of low density development and 20,613 acres of high-to-medium density development.

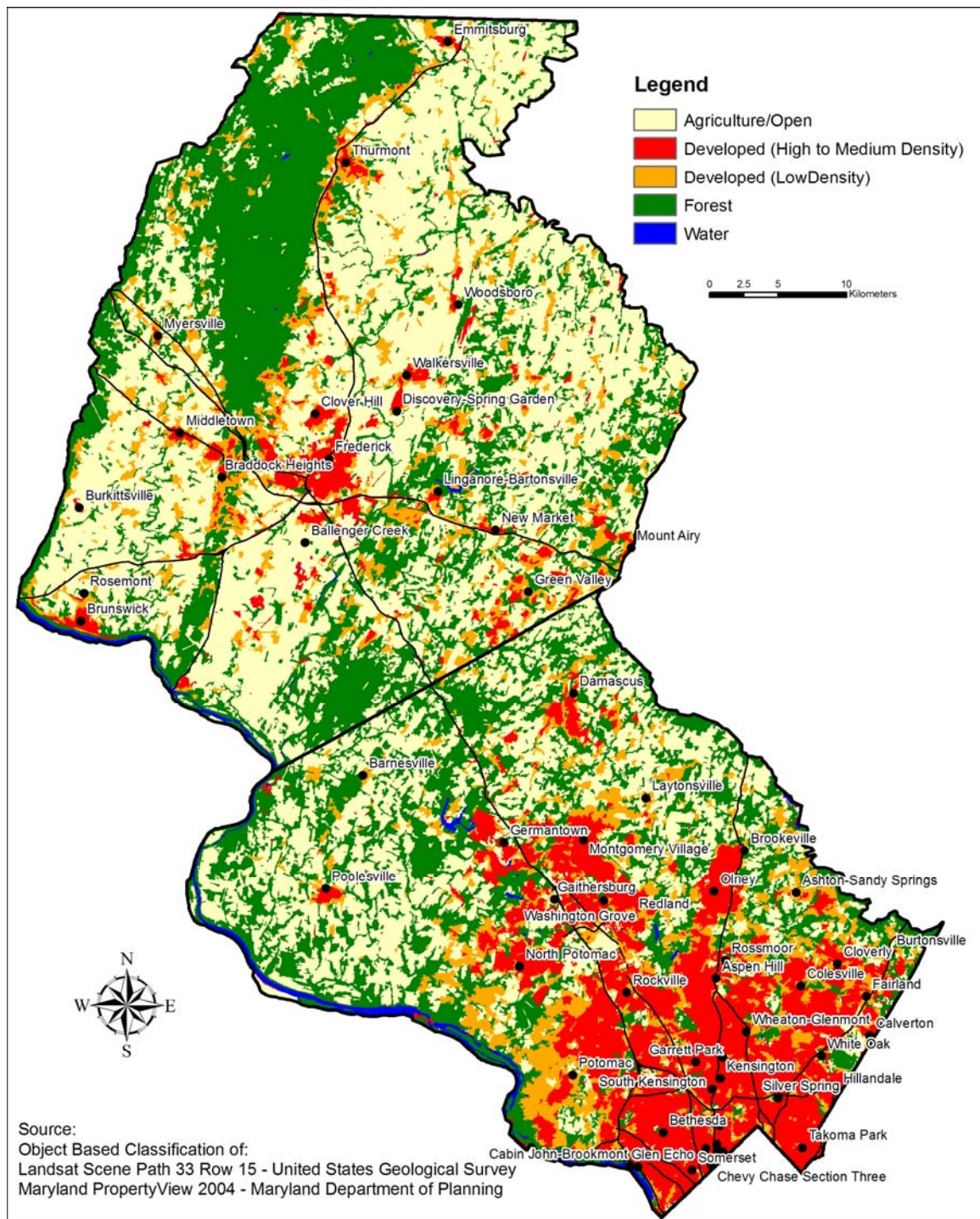
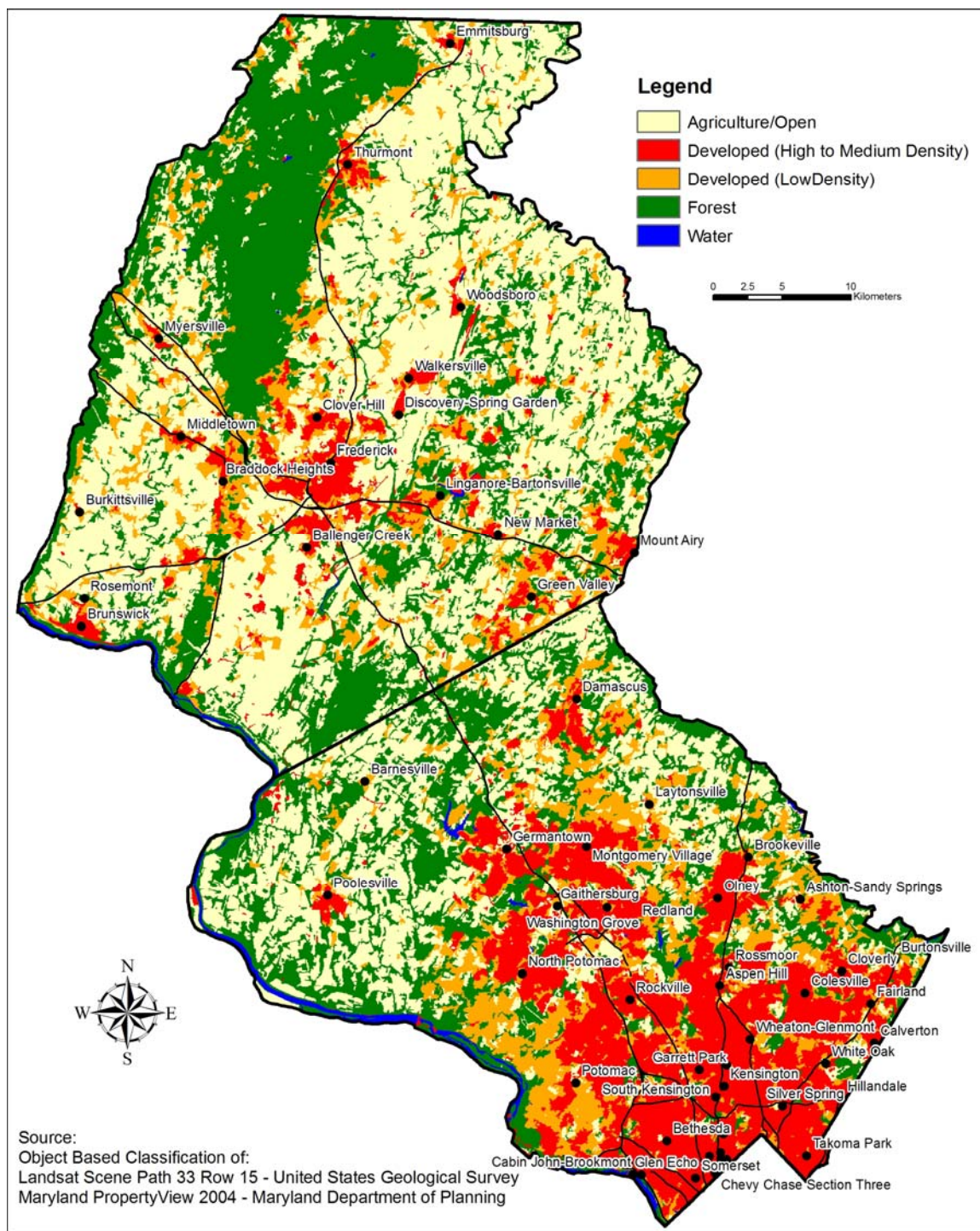


Figure 6.2 1986 classification for Montgomery and Frederick counties



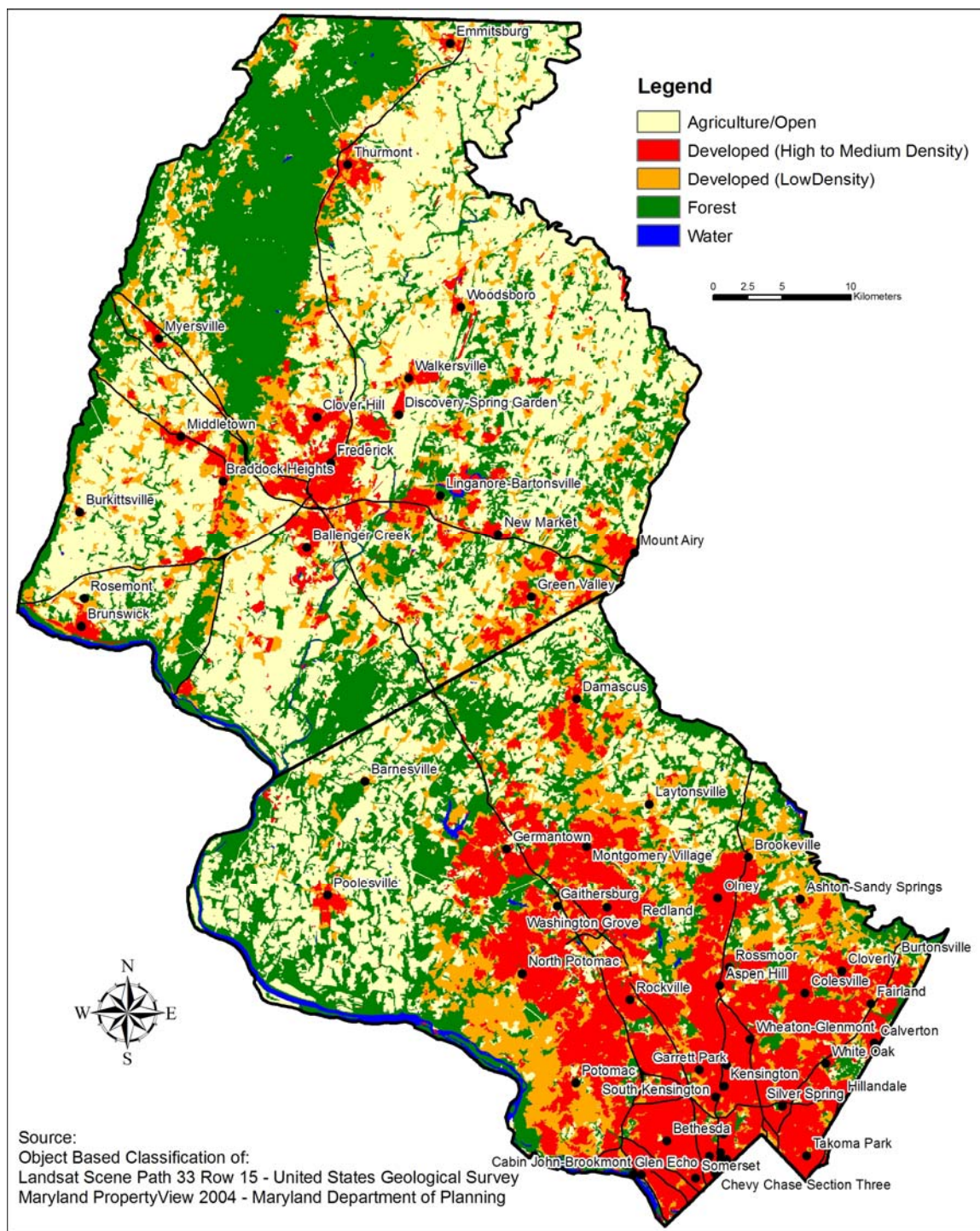


Figure 6.4 2001 classification for Frederick and Montgomery counties

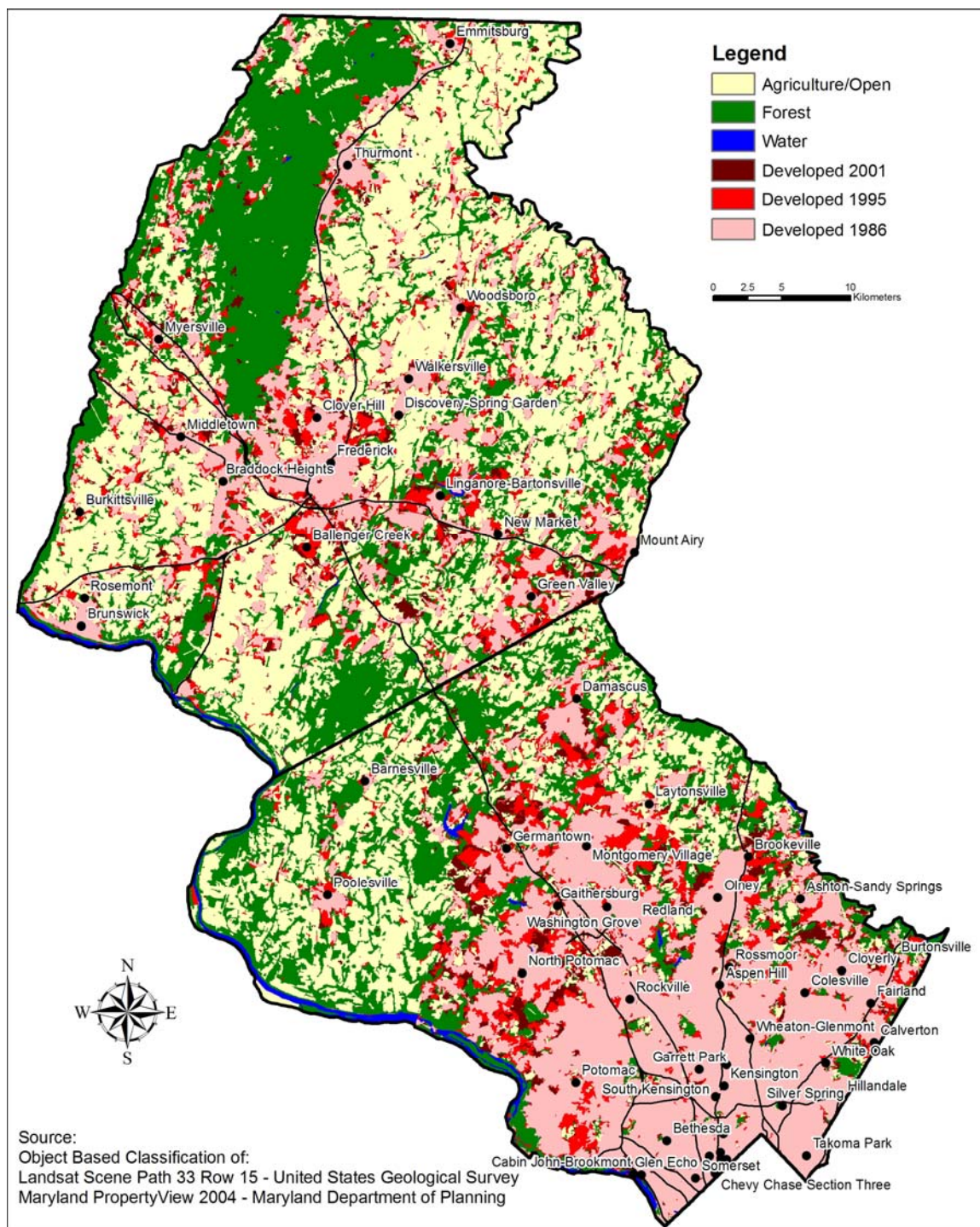


Figure 6.5 Progression of Urbanization for Frederick and Montgomery counties (1986, 1995, and 2001)

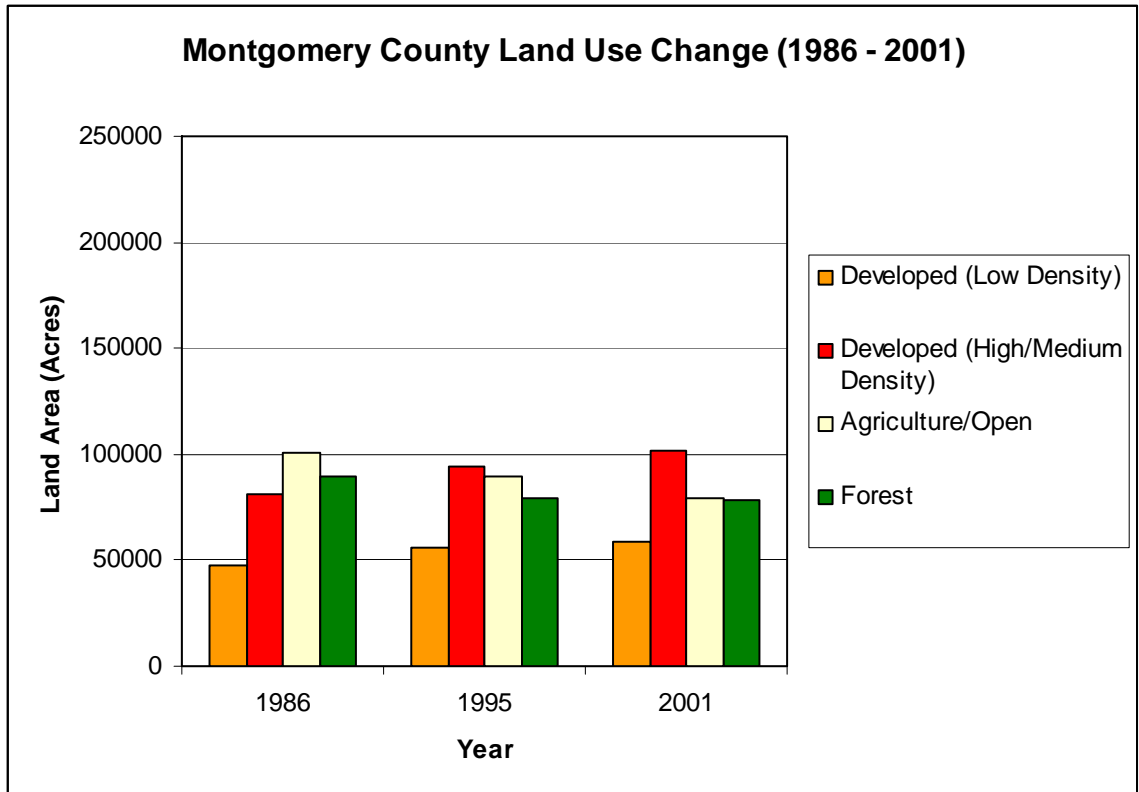


Figure 6.6 Montgomery County Classification Totals

Examining *within* multiple years, we found that Montgomery County gained 7,960 acres of low-density development at an average rate of 884 acres per year between 1986 and 1995. Low density development slowed somewhat with the county gaining 3,549 acres of this type of development at an average rate of 592 acres per year between 1995 and 2001. Montgomery County gained 13,394 acres of high-to-medium density development at an average rate of 1,488 acres per year between 1986 and 1995. Again, high-to-medium density development slowed with the county gaining 7,219 acres of this type of development at an average rate of 592 acres per year between 1995 and 2001.

According to these results, high-to-medium density development is occurring at a faster rate than low density development in Montgomery County. This is good news for the county since it suggests in-fill development. Theoretically, high-to-medium density development is encroaching or changing low-density to high-to-medium density development. However, low-density development is simultaneously expanding. This places importance on the spatial configuration of zoning within the county. The optimal results for land conservation purposes would be to encourage infill in what are currently low density developed areas while at the same time minimizing their expansion.

Land in the agricultural/open class decreased between 1986 and 2001. Montgomery County lost 10,526 acres of agricultural/open land at an average rate of -1,170 acres per year between 1986 and 1995. There was evidence that the loss of agricultural land intensified between 1995 and 2001. During this period, the county lost 10,358 acres of agricultural/open land at an average rate of -1,726 acres per year.

Land in the forested class also showed a general decline over this time period totaling a loss of 10,653 forested acres at an average rate of -1,184 acres per year between 1986 and 1995; and 4,350 acres at an average rate of -161 acres per year between 1995 and 2001. As these findings point out, the rate of loss of forested land slowed in the latter part of the 1990s. Comparing the loss of both agricultural/open and forested lands, our analysis suggests that there was a shift from the development of forested land to the development of agricultural land between 1995 and 2001.

Frederick County

Frederick County, in many ways, is the infant child of Montgomery County in terms of urban development in the sense that development has not occurred on as large a scale. However, there is evidence of urban encroachment on agricultural/open and forested lands in Frederick County between 1986 and 2001.

As Figure 6.5 indicates, most of urban development is focused around Frederick city, Thurmont, the southeast area along I-70, and around the Lake Linganore area. A great deal of development appears to be low density. Much of the development that has occurred in Frederick between 1986 and 2001 is largely focused around already existing population centers (e.g. Frederick city) and along major roads. Also, areas in the south eastern portion of the County, particularly along the I-70 corridor, developed at low densities, with a smattering of high density development in New Market and Mount Airy.

Figure 6.7 is a graph depicting the number of acres in each class for Frederick County. As this graph illustrates, Frederick County is dominated by agricultural/open and forested classes. This is largely due to the historical importance of agriculture in the local economy and the presence of mountainous, government-owned forested land in the northwestern portion of the County. Despite this, Frederick County still experienced growth in developed land between 1986 and 2001. Frederick County lost a total of 14,744 acres of agricultural/open land and 11,243 acres of forested land from 1986 to 2001. During this same period, the county gained 25,809 acres of developed land, 12,475

acres of low density development and 13,334 acres of high-to-medium density development.

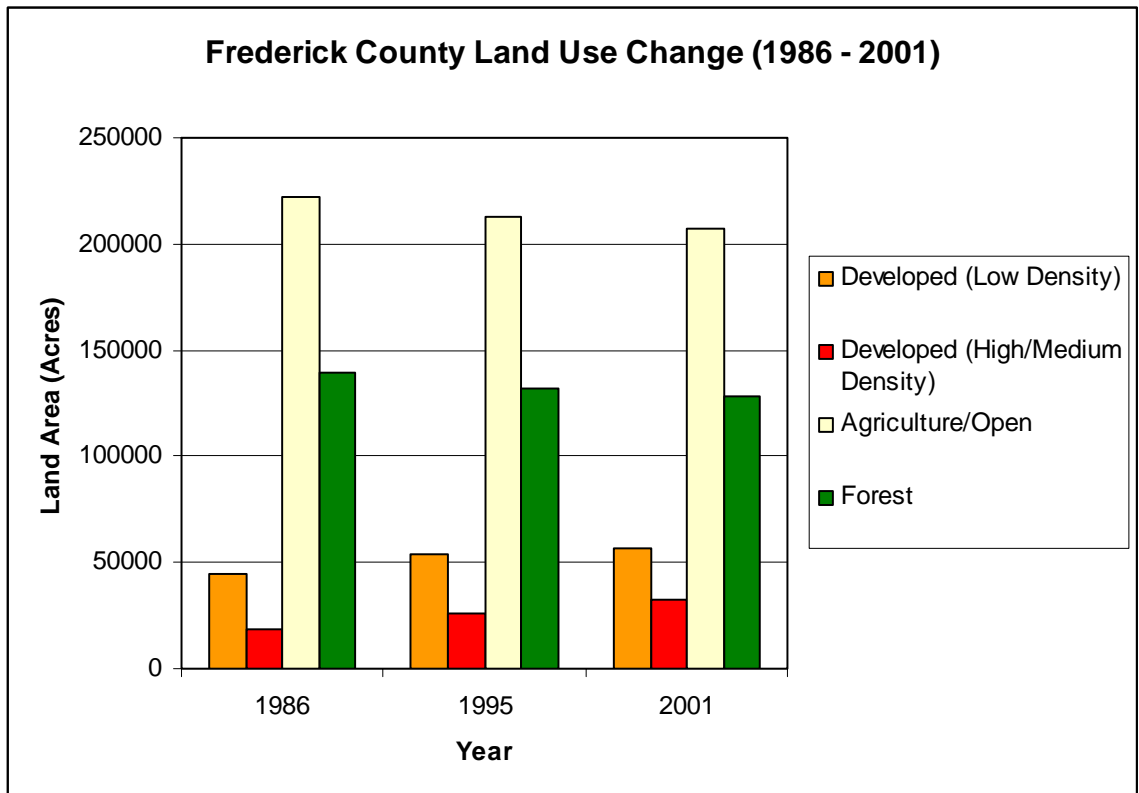


Figure 6.7 Frederick County Classification Totals

Examining *within* multiple years, we found that Frederick County gained 9,075 acres of low density development at an average rate of 1,008 acres per year between 1986 and 1995; and gained 3,400 acres at an average rate of 567 acres per year between 1995 and 2001. As with Montgomery County, the rate of low-density development slowed somewhat in the latter part of the 1990s.

Frederick County gained 7,103 acres of high-to-medium density at an average rate of 789 acres per year between 1986 and 1995; and 6,231 acres at an average rate of 1,038 acres per year between 1995 and 2001. The rate of high-to-medium density development increased in the latter part of the 1990s. Our analysis suggests that Frederick County experienced a large amount of low density growth between 1986 and 1995; and an increased amount of high to medium density development between 1995 and 2001. This could signify that infill occurred; converting what was defined as low density development between 1986 and 1995 to high-to-medium density development by 2001.

Land in the agricultural/open class decreased between 1986 and 2000. Frederick County lost 8,573 acres of agricultural/open land at an average rate of -973 acres per year between 1986 and 1995; and lost 6,171 acres at an average rate of -1,029 acres per year between 1995 and 2001. This suggests a slight increase in the rate of consumption of agricultural/open land for development at the end of the 1990s. Land in the forested class also showed a general decline over this time period totaling a loss of 7,307 acres at an average rate of -812 acres per year between 1986 and 1995; and 4,036 acres at an average rate of -673 acres per year between 1995 and 2001. As with Montgomery County, the rate of consumption of forested land for development slowed somewhat between 1995 and 2001, although Frederick County lost a lot more forested land than Montgomery County during this period.

In conclusion, both Montgomery and Frederick Counties experienced an increase in development from 1986 to 2001. Development largely occurred around population

centers and along transportation corridors. The balance between agriculture/open and forested land and developed land in Montgomery County tipped to favor developed land during this time period. Frederick County still has a large amount of forested and agricultural/open land. However, an increase in development pressure on agricultural land could put this balance in jeopardy.

To quantify and visualize different aspects of land cover change, we used the classifications for each year to analyze change in patch consolidation and patch fragmentation using the largest patch index (LPI) statistic. LPI quantifies the percentage of the total landscape area that is comprised by the largest patch in a certain class. The LPI is calculated as the area of the largest patch of a certain type divided by the total landscape area multiplied by 100. A LPI that equals 100 shows that the largest patch dominates 100% of the landscape. As the LPI decreases the landscape is less dominated by a particular class and patches are likely to become more fragmented.

We calculated LPI in a hexagonal grid covering Montgomery and Frederick Counties using the Patch Analyst 3 (<http://flash.lakeheadu.ca/~rrempe/p/patch/index.html>) extension for ArcView 3.2. Using this software, we created a hexagonal grid to analyze fragmentation within each hexagon. The size of each hexagonal cell is 400 hectares. We grouped the developed classes into one class and calculated the LPI for developed, forest, and agriculture/open classes within each hexagon for 1986 and 2001. We then calculated the change of LPI between 1986 and 2001. The results of the change in LPI for each class are shown in Figure 6.8, Figure 6.9, and Figure 6.10.

Figure 6.8 is a map of the LPI change for developed classes from 1986 to 2001. Darker hexagons on this map show where a decrease in LPI for developed classes. This signifies that the size of the largest developed patch has increased within these polygons. This growth is caused largely by new development. However, an increase in LPI could also indicate consolidation of an existing development resulting from infill. It is evident that there is significant increase in the LPI occurring in areas that showed a large amount of growth in Montgomery County including the area around North Potomac, Germantown, between Olney and Montgomery Village, and south of Damascus. In Frederick County LPI is increasing near Braddock Heights, Clover Hill, Ballenger Creek, to the northeast of Frederick, Linganore–Bartonsville, Green Valley, and along the southeastern border along Interstate 70 near Mount Airy, in and in around the city center of Frederick.

Figure 6.9 shows the change in LPI for forest classes. The darker hexagons on this map represent where the LPI of forested classes has decreased between 1986 and 2001. This signifies that forested patches within these hexagons are becoming more fragmented. The fragmentation of forest patches is largely taking place where land is being developed. In Montgomery County, this includes areas around Ashton-Sandy Springs, Brookeville, south of North Potomac, west of Germantown, and South of Damascus. In Frederick County forested patches are becoming more fragmented in Linganore-Bartonsville, just southwest of New Market, and about 10 miles north of Mount Airy. One cause for this is the increase of smaller low density developments in areas with large contiguous forested patches.

Figure 6.10 shows change in LPI for agricultural/open classes between 1986 and 2001. Darker hexagons represent larger values and signify that the Agricultural/Open patches are becoming more fragmented. Agricultural/Open classes are becoming fragmented in areas where development has increased during this time period. In Montgomery County, the hexagons form sort demarcation line that runs south of Damascus, just west of Germantown and stops immediately west of the Potomac River. There is also fragmentation occurring around Latonsville, south of Montgomery Village, and east of North Potomac. Frederick is experiencing fragmentation of agricultural/open classes near Mount Airy, Ballenger Creek, Clover Hill, Myersville, and just northwest of Middletown.

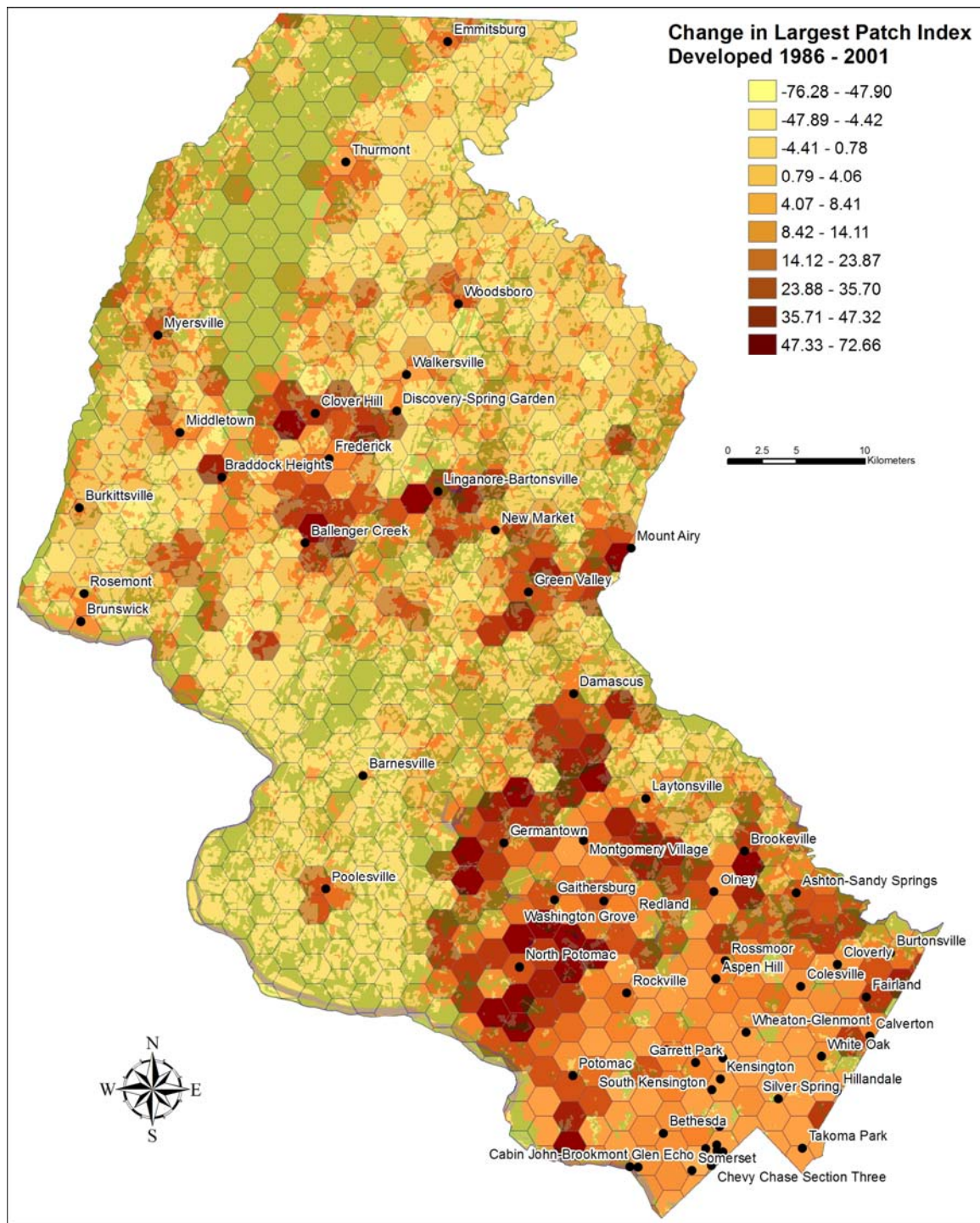
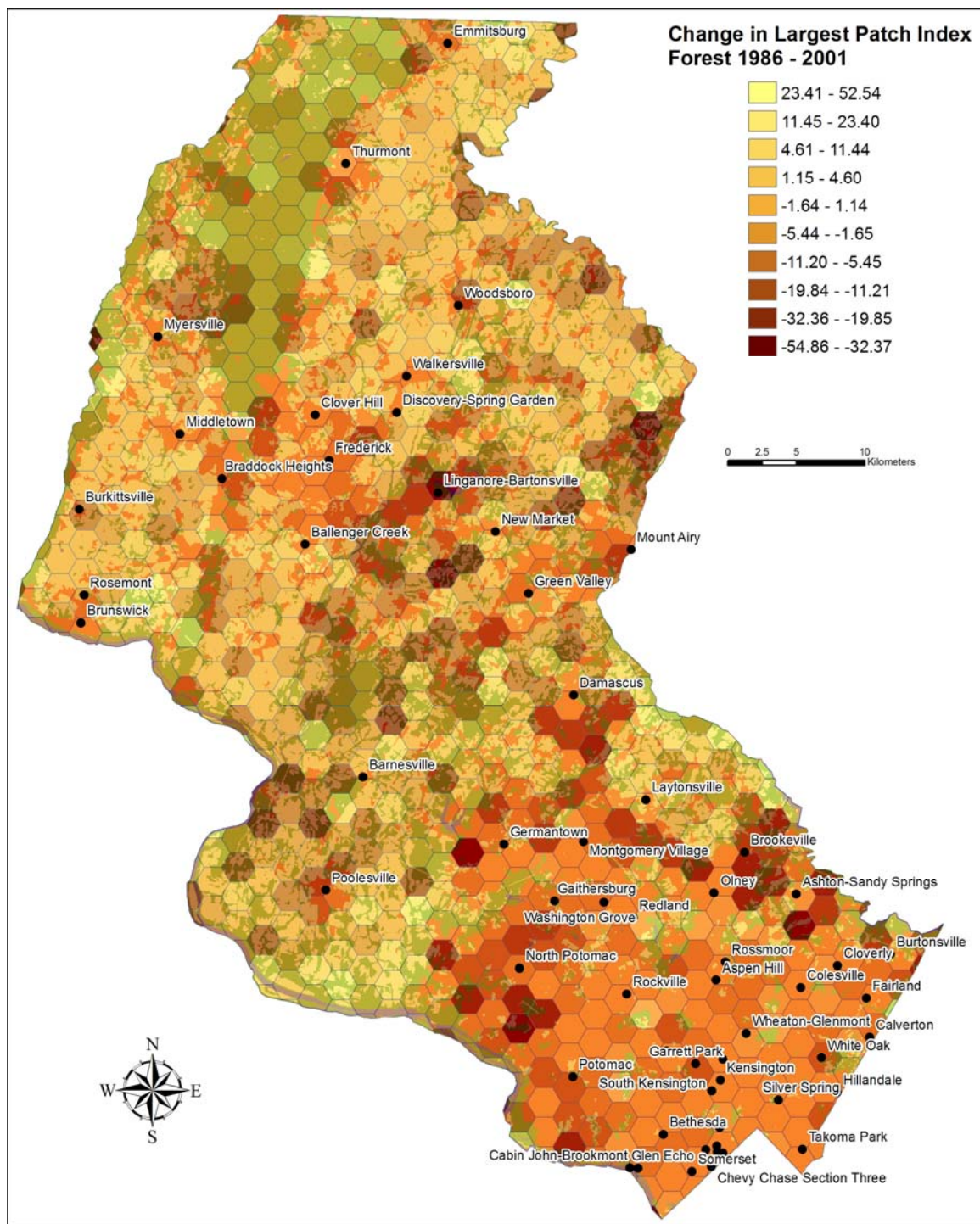


Figure 6.8 Change in developed LPI 1986 – 2001



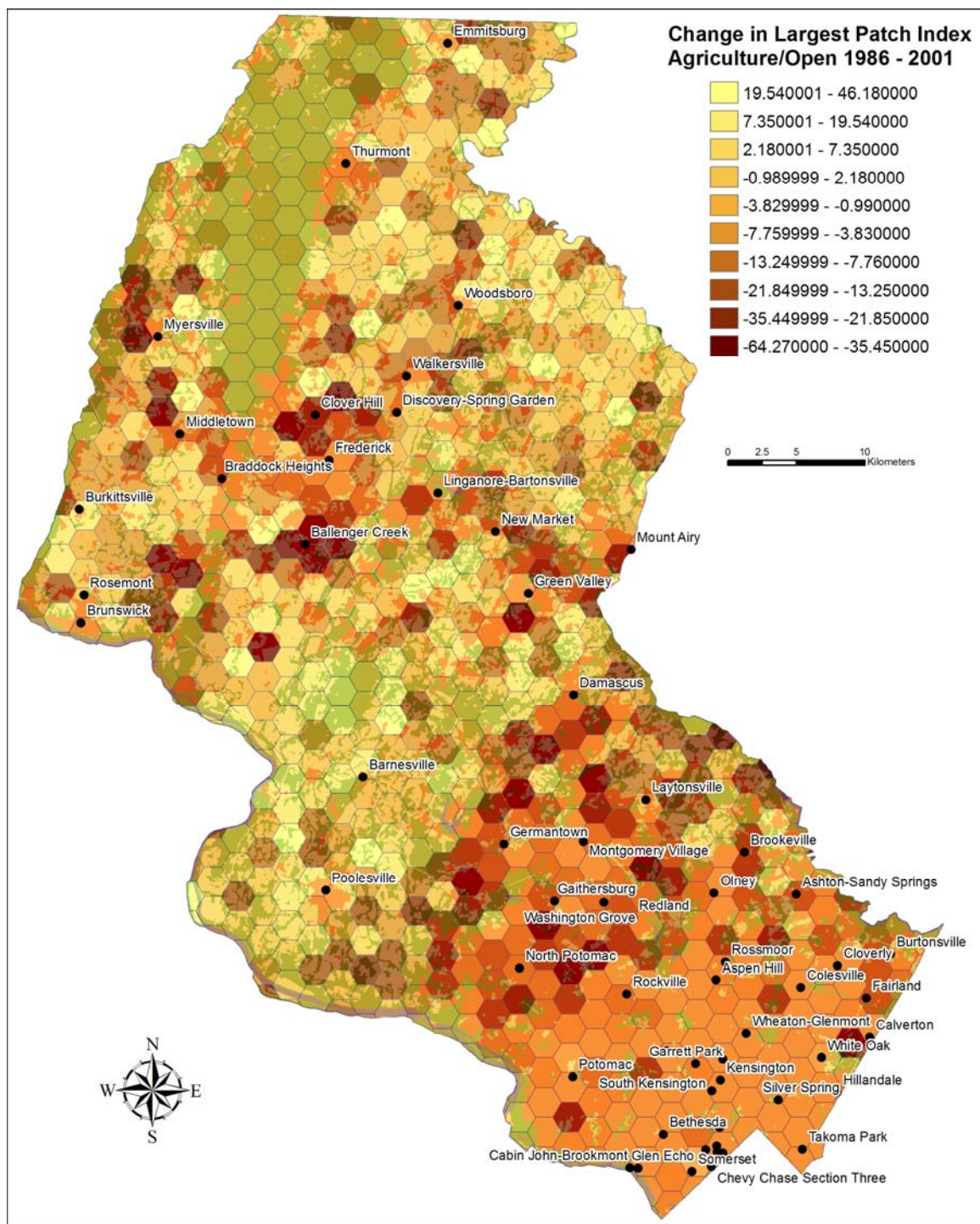


Figure 6.10 Change in agriculture/open LPI 1986 – 2001

CHAPTER SEVEN

INFLUENCES ON GROWTH AND POLICY AND PLANNING IMPLICATIONS

Using Frederick County as a pilot study, we developed a statistical model to determine the conditions that influence a parcel's change from agriculture to residential use. Before giving the results and policy implications of this model, there are six reasons why we chose Frederick County as our case study.

First, the population of Frederick County has grown tremendously, particularly in recent decades. Historically, Frederick was a rural county with a population of less than 52,000 at the turn of the last century, only increasing to a little over 72,000 by 1970. Since this time, however, the population has increased dramatically. By 2000, the population had more than doubled in three decades to more than 195,000. Projections indicate that this population increase is likely to continue. According to Frederick County's

Comprehensive Plan (1995), the county is projected to grow at a faster rate than any of the other Maryland counties contained within the Washington or Baltimore regions.

Most recent figures, taking into consideration BRAC, suggest that the population will reach almost 340,000 people by 2030.

Second, despite this population growth, farming remains an important aspect of the landscape of Frederick. Among Maryland counties, Frederick had the largest number of farms in 2002. Frederick also had the largest percentage of land area in farms – 46 percent – in 2002 among all metropolitan counties.

Third, farming is important to the economy of Frederick. We employed a location quotient (LQ) analysis, comparing Frederick County's economic activity with the state of Maryland (see Table 7.1). The results of the LQ analysis indicate that Frederick County, compared to other counties in the state, still relies heavily on the farming sector. The LQ score was 3.06 in 2000, indicating that the level of farming employment is 3.06 times more than the average percent in the Maryland economy as a whole. Frederick specializes primarily in dairy farming, and is an important exporter of this industry, particularly to the state of Pennsylvania.

Table 7.1 Location quotients for Frederick County (compared to Maryland economy)

Industry	1969	2000
	LQ	LQ
Farm employment	4.76	3.06
Non-farm employment	0.94	0.99
<i>Private employment</i>	0.98	1.02
Construction	1.32	1.56
Manufacturing	0.98	1.28
Transportation and public utilities	0.99	0.62
Wholesale trade	0.70	0.99
Retail trade	0.95	1.13
Finance, insurance, and real estate	0.81	1.12
Services	0.98	0.85
<i>Government and enterprises</i>	0.80	0.81
Federal, civilian	0.79	0.58
Military	0.63	1.22
State and local government	0.89	0.85

Four, despite its importance, farming has been greatly impacted by urban growth in the county in a number of ways. First, the percentage of land area in farms in Frederick declined by more than 53,000 acres from 1987 to 2002, the largest decline in land in farms among the counties of Maryland. Second, while farming continues to be an

important contributor to the Frederick economy, this industry is not a major source of employment for the newly established population. Farm employment has declined in recent decades, and Frederick lost more farm workers than any other metropolitan county in the state. Third, the LQ for farming declined from a high of 4.76 in 1990 to 3.06 in 2000, indicating a decline in farming as an export industry. This decline, combined with the growth in LQ scores for other sectors of the local economy, demonstrates a decreasing specialization in agricultural activities and the growing importance of industries that respond to new urban growth (see Table 7.1). Four, the estimated market value of all agricultural property throughout the county has grown tremendously in recent decades from almost \$2.5 million in 1983 to \$7.1 million in 2003. This increased value provides added incentive for farmers to sell to speculators and developers, putting pressure on the farming industry in the county.

Five, the city of Frederick is a major hub of commercial and industrial activity that provides a springboard for urban growth in the county. A well-established historic, urban core, Frederick City expanded greatly in recent decades. The population was 28,086 in 1980 and climbed to 52,767 by 2000, a growth rate of almost 90 percent. This growth can be attributed to Frederick city's central location and attributes as an historic urban core. The city offers a wide-range of natural amenities, art houses, restaurants and other leisure activities. It has maintained its original, historic architecture. Much of the housing in the core of Frederick City is historically preserved, and there are cultural and historical points of interest in many locations nearby. Frederick City, once a market town devoted to agriculture, now contains almost half of all jobs in the county, with employment

concentrations in health care and biotechnology. Specialization in biodefense, for instance, is primarily associated with the Fort Detrick army base located in the city.

Six, the road transportation network connects Frederick County (via Frederick City) to the Central Maryland regional economy, and is an important driver of growth. There is a convergence of two interstate highways – I-270 and I-70 – within the Frederick City limits. This road network links residents of Frederick County with employment centers in the greater Washington-Baltimore region. More than 30 percent of workers residing in Frederick County commute mostly to the Washington DC region, specifically to centers of employment along the I-270 corridor. In 2000, 42,046 workers out-commuted from Frederick County. Almost 55 percent of all out-commuters and, as Table 7.2 indicates, 22 percent of all Frederick County workers traveled to Montgomery County, home to many high-tech firms along the I-270 highway.

Table 7.2 Commuting from Frederick County

Out-Commuting Labor Force		
To	Workers	Percent of All Workers
Montgomery County	22,867	22%
Other Eastern MD Counties	4,117	4%
Virginia	4,011	4%
Washington, DC	3,025	3%
Washington County	2,153	2%

I-270, which connects Frederick County to Washington DC, and I-70, which connects the county to Baltimore City were built in 1956 and 1968, respectively. Their continued

expansion caters to the growing population and can lead to the conversion of agricultural properties in the County.

Based on growth pressures in Frederick, we conducted a logit probability model to statistically identify major determinants of future growth location in the county. We also used this model to map the probability a parcel would change from agricultural to a residential use over the next four years – 2004 to 2008 – assuming conditions such as road infrastructure remains constant.

The variables we expected to influence the probability of a parcel remaining in agriculture rather than changing to residential, and their expected sign are as follows: distance from non-agricultural parcels (+) , distance from the inner state highway quality (+), the distance from the nearest town center (+), the distance from Frederick city center (+) and the quality of the land in agricultural production (+). We deemed distance from non-agricultural parcels important based partly on the notion of impermanency. A sense of impermanence in the agricultural industry is enhanced if farmers witness the development of neighboring farms. Farmers are more likely to sell when they observe the loss of surrounding farms. Similarly, agricultural land will be attractive to developers if adjacent land use is residential since roads, schools and other services are already established for potential incoming residents.

The parcel size was included in the model as a control variable. We expected the following relationships. The further the property is from residential parcels the more

likely the parcel is to stay in agriculture; the greater the distance from the entrance and exits on interstates I-70 and I-270 the less likely to change to residential; the greater the distance from the nearest town the more likely the parcel will stay in agriculture; the greater the distance from the town of Frederick the more likely the parcel is to stay in agriculture; and the greater the potential yield from local soils the more likely the property is to stay in agriculture. We also expected larger parcels were more likely to stay in agriculture because of the cost of subdividing.

We used land use change data from the Maryland Property View dataset from 2000 to 2004. Matching land uses between 2000 and 2004, we were able to identify parcels that changed from agricultural to residential land uses over that period. We also identified those properties that remained in agriculture over the same time period. When an agricultural parcel was subdivided into residential parcels, we captured each residential parcel as a separate transaction. There were 4,897 parcels in the County of Frederick in our data set. The model dropped only 88 parcels because of missing data.

The distance variables were calculated as euclidean distance, rather than distance by road. Distance is measured in meters. The parcel size is measured in meters squared. The quality of the land was measured by examining non-irrigated yield for pasture. We chose pasture since Frederick County is heavily focused on dairy farming. The measurement unit is animal units per month (AUM) – the amount of forage required by one mature cow of approximately 1,000 pounds weight per month. The value of land improvement was tested, but found not significant, and therefore dropped from the final model.

The statistical results of the model are reported in Table 7.3. The statistically significant variables are bolded. These include the land area, distance from non-agricultural properties, distance from the interstate exits, and non-irrigated agricultural yield (a proxy for quality of land for agricultural production). The two variables which were not statistically significant are the distance from the nearest town and the distance from the City of Frederick. The distance from the city of Frederick turns up non-significant because the importance of this distance is captured in our variable measuring distance to the interstate. Distance from the nearest town may be insignificant for similar reasons of because some are too small to encourage surrounding urbanization. The distance measures reported below are in meters, the area is measured in meters.

Table 7.3 Logistic model results (the probability a parcel remains in agriculture)

Variables	Estimate	Standard Error	Wald Chi-Square	Pr >Chi Square
Intercept	1.17	.226	27.05	<.0001
Land Area	-.002	.0002	129.69	<.0001
Dist_Nonag	.004	.0005	52.77	<.0001
Dist_Inter State	.00007	.00002	14.36	.0002
Dist_Town	-.00002	.00001	2.49	.1143
Dist_Fred	.00001	.000004	1.42	.2331
Non_Irryiel	.065	.017	15.15	<.0001
N = 4795				

Figure 7.1 illustrates the impact that distance from the closest non-agricultural parcel; Figure 7.2, the impact of the distance from the interstates nearest I-70 and I-270 entrance or exit; and Figure 7.3, the impact of the quality of land in agricultural production on the probability a parcel will change from agricultural to residential use.

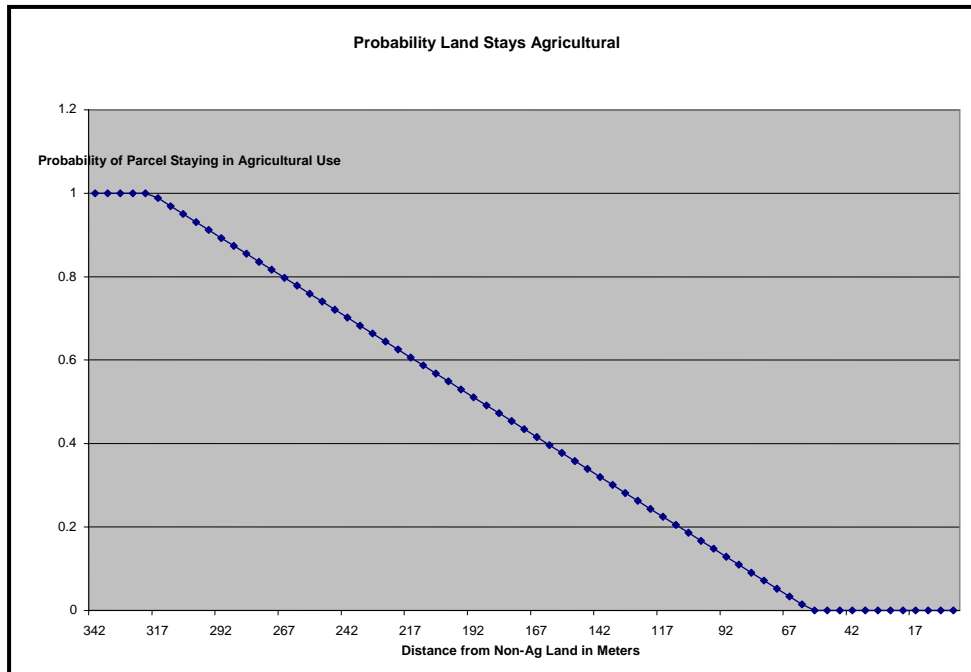


Figure 7.1 Distance from non-agricultural parcel

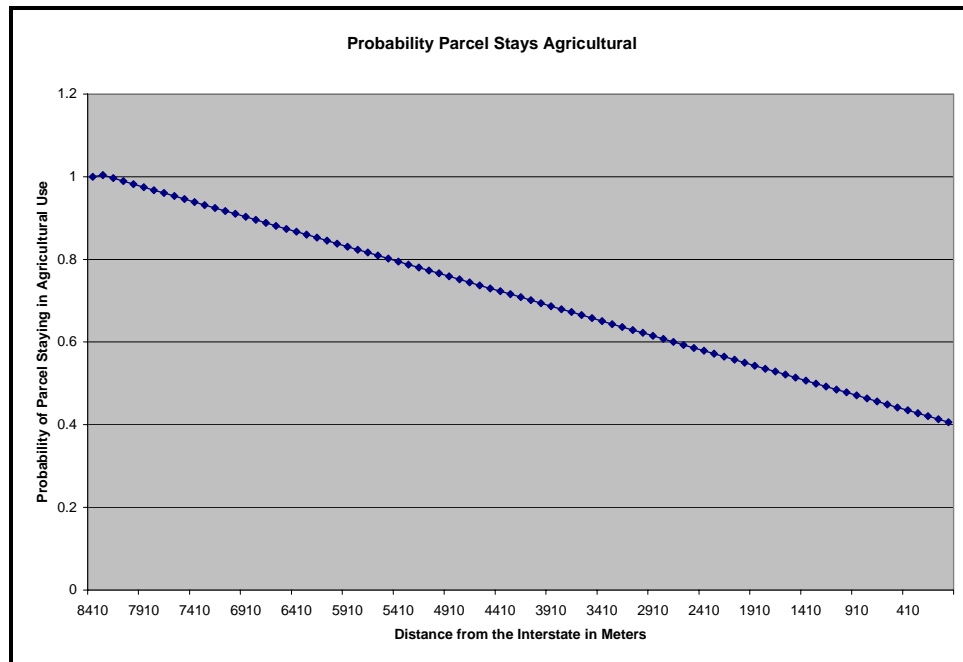


Figure 7.2 Distance from the interstate highway

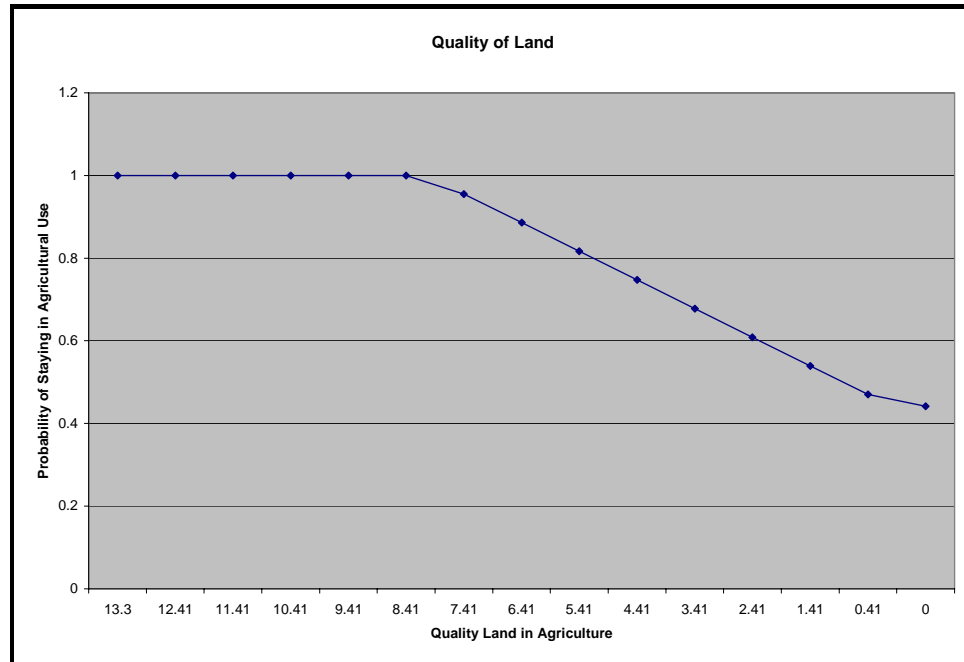


Figure 7.3 Quality of land in agricultural production

The probabilities reported in these figures hold all other variables in the model constant at the mean values as shown in Table 7.4.

Table 7.4 Mean values for variables

Variable	Mean Value
Land Area	446.18 sq. meters
Dist_Nonag	.27 Kilometers
Dist_Interstate	5.71 Kilometers
Dist_Town	8.14 Kilometers
Dist_Fred	18.19 Kilometers
NonIrryiel	5.41
N = 4897	

So for example, in Figure 7.1, when all other variables are at their mean value the probability a parcel will stay in agriculture reaches zero when the nearest developed

parcel is 50 meters (.03 miles) or less, and reaches 100% when residential parcels are 300 meters (0.19 miles) away or more.

Figure 7.2 indicates that when a parcel is 8,310 meters (5.16 miles) or more from the interstate entrance or exit, the probability is nearly 100% that the parcel will remain agricultural. But when a parcel is 10 meters or less from the interstate exit or entrance, and all other variables are at their mean value, the probability falls to .40 that the parcel will remain agricultural.

Figure 7.3 demonstrates that when a parcel reaches 8.41 AUM (i.e. forage for cows for a month) the probability that it will remain in agriculture equals 100 percent. But when a parcel reaches 0 AUM and all other variables are at their mean value, the probability falls to .40 that the parcel will remain agricultural.

The results of our statistical analysis provided a probability score for each parcel. Figure 7.4 is a map of the resulting probability scores. This figure displays those areas where agricultural parcels are most likely to stay agricultural or change to urban use over the next five years, assuming all external conditions remain constant. The predicted values are based on the results in the model reported in Table 7.3. The external conditions which would have to remain constant are for example, no new investments in road infrastructure; similar demand for agricultural output; and constant oil prices. For example, if oil prices rise, as they have over the past several years, urban uses are less likely to spread into rural areas, since the cost of commuting is rising.

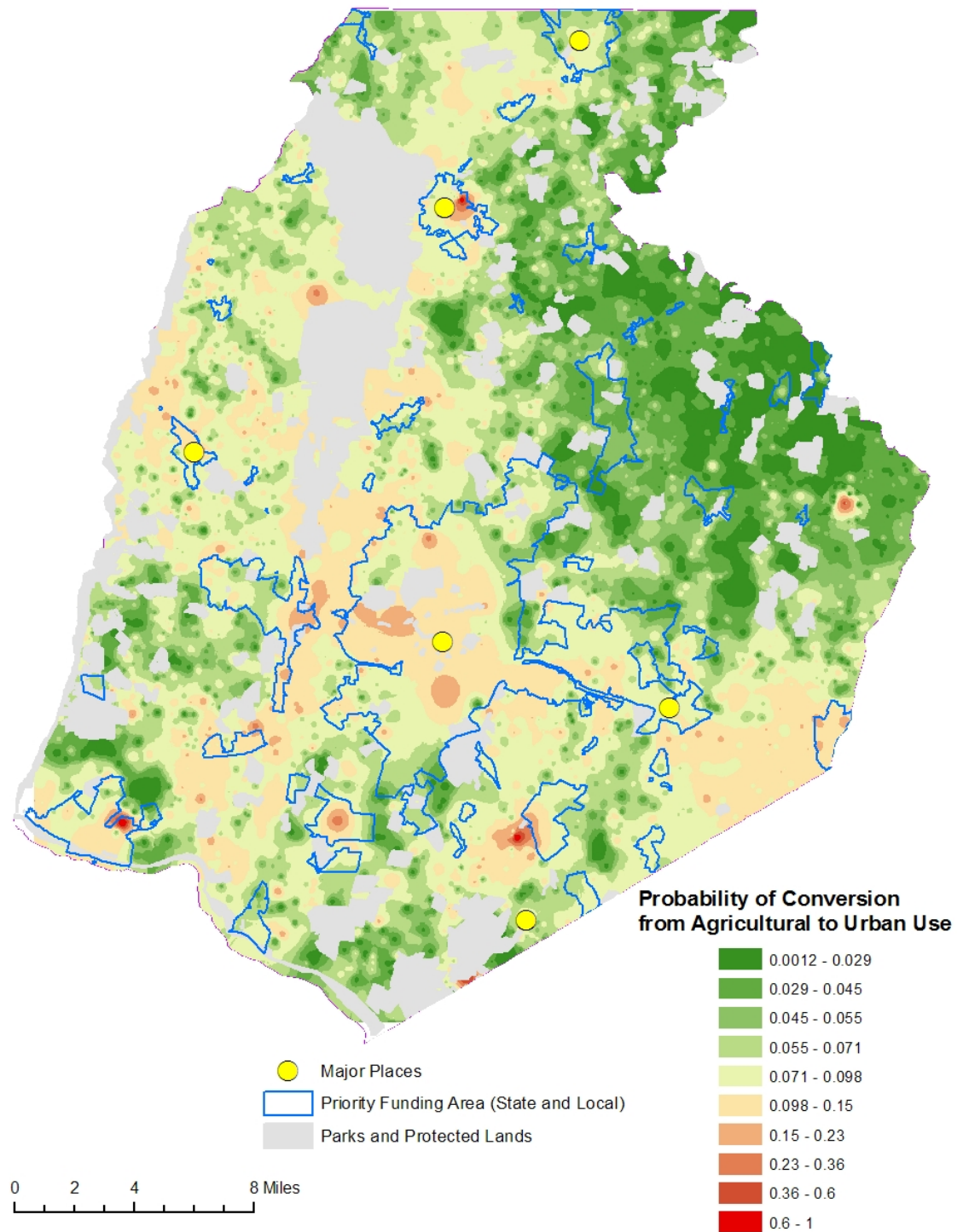


Figure 7.4 Map of probability land will change from agricultural to urban use

In this map, areas that are already in urban land use are ignored and, as indicated by the grey areas on the map, parks and protected lands are identified. This map indicates that areas most likely to stay in agricultural production are in the northeastern and southwestern portions of the county. The several reddish-orange pockets spread throughout the middle of the county are most likely to shift to urban land uses. There are a number of 'hotspots' for growth as indicated by the areas of red or deep pink.

The value of this map for land use policy is threefold. First, where reddish areas fall into Priority Funding Areas, market forces will encourage development where the county government wants this growth to go. Much of this land area is around Frederick City and around some smaller towns or rural villages in the county. We predict that the agricultural properties within these areas will continue to be developed.

Second, in those locations of high probability that fall *outside* the Priority Funding Areas, government intervention will be required to keep such areas in agricultural use. As this map indicates, there are such areas, particularly in the southern part of the county. These parcels, if not already protected, need appropriate land use controls such as agricultural easements to prevent continued urban encroachment.

Thirdly, when the red colored parcels fall in areas deemed environmentally sensitive, the County should pay attention to be sure the appropriate land use controls are in place to keep these areas from turning to residential developments. The results of our analysis

indicate that left to market forces, all these reddish areas will transition from agriculture to residential use.

To conclude, since a change in the status of an agricultural parcel is a function of its closeness to highway exits, it is important that land conservation policy and transportation policy work together to optimize the preservation of valuable farmland. Also, since a shift in land use is likely for agricultural parcels near residential parcels or for small agricultural properties, preventing farm fragmentation by residential development is paramount. Maintaining a consolidation of valuable agricultural parcels is the best strategy for preservation of this farmland.

CHAPTER EIGHT

CONCLUSION

Rapid population growth in Maryland, in both rural and urban counties is straining both the State's natural environment and agricultural sectors. US Census reports that from 1970 to 2000, nearly 1.4 million residents were added to the Maryland population. The Census estimates that another 1.4 million new residents will be added between 2000 and 2030. While the metropolitan counties surrounding Washington, D.C. and Baltimore are projected to receive the highest rates of growth, the traditionally rural counties of Southern Maryland are also experiencing population pressure.

To keep in step with population growth and change, 900,000 houses were added to the State's housing stock between 1970 and 2000. The number of housing units in the metropolitan counties grew by 777,000 and the number in rural counties grew by 121,000. Household formation of this magnitude results in a loss of acreage in farmland and open space, added pressure on the public school systems, and a need for public expenditures and land for infrastructure.

Foreign immigration is the major driver of the state's population growth, although domestic migration is significant for specific counties. Foreign immigration added a net gain of 147,307 people to the state between 1995 and 2000, while domestic migration from the surrounding states added 9,500 people over the same period. Within the state, rural to urban migration is overshadowed by the movement of urban residents to the rural

counties. Central county to suburban county migration overshadows movement into the state's most urban counties, such as the central county of Baltimore. Rural counties also experienced a positive net migration from abroad and other states. This decentralization of population puts added pressures on farmland, forested areas, and open space in the state.

The majority of the added housing stock of 900,000 over the 30-year period, 1970 to 2000, went into the metropolitan counties, but specific areas in rural Maryland also witnessed large increases, specifically Ocean City. Housing expansion in small urban centers of the state is important since these centers act as a springboard from where further development occurs. This adds to the pressures on farmland and open space surrounding these once small rural towns.

Job growth in the State both reflects and drives population growth. The workforce expanded from 1.6 million in 1969 to 2001. During these 30 years there has been a shift from farming and manufacturing to a more service-based, high-technology economy. While statewide employment grew by 86 percent, growth in the Washington, D.C. suburban counties grew by 147 percent, outpacing growth in the Baltimore region.

Services, primarily in retail trade, exhibited the most growth in non-agricultural economies. The service sector now comprises about 30 percent of the non-metropolitan county workforce. Manufacturing has continued to decline and farming only accounts for 3 percent of the workforce in the State's non-metropolitan counties.

The decline in the farming related workforce is not just due to mechanization. Statewide, the acreage in farms has declined from 2.6 million in 1978 to about 2 million acres in 2002. Similarly, the number of farms dropped from 14,776 in 1987 to 12,198 in 2002. Not surprisingly, the largest declines in farmland occurred in the suburban counties experiencing the greatest population and employment pressures, the suburban counties surrounding Washington, D.C. and Baltimore. However, non-metropolitan counties also experienced a loss in farmland over the past thirty years. The farming that remains has changed its structure. In the most rural counties, farm size is growing. Closer to the urban areas, farming is adapting to urban development with an increased reliance on small farm production and recreational farming that supplies the urban consumer.

Chapters 6 and 7 examined the impact of the population and employment changes, identified in Chapters 2 through 5, on agricultural land in more detail. In chapter 6, we used Landsat data to perform an analysis of changes in land use coverage for Montgomery and Frederick counties at multiple time periods, 1986 to 2001. As mentioned above, these are two counties experiencing the most development pressure. We found that Montgomery County lost 20,884 acres of agriculture and open space land and 15,003 acres of forested land between 1986 and 2001. During the same period, developed land grew by 32,122 acres, 20,613 acres in high density development and 11,509 acres in low density development. In short, development was more likely to infringe on farms than forests, and in-fill absorbed some of the growth. In closer examination of these maps, we found evidence of the fragmentation of both farmland and

forests on the fringe, but on a positive note, we found evidence of infill and the consolidation of developed areas within the core.

In chapter 7, we developed a statistical model for Frederick County to examine at a micro-level the factors that affect the likelihood that residential developments will replace agriculture. We selected Frederick County because it witnessed the largest decline in farm acreage among all Maryland counties. Our findings suggest that the smaller the original parcel, the closer it is located to a non-agricultural parcel, the closer to the interstate, and the less agriculturally productive, the more likely the parcel is to change from farming and open space to an urban use.

Two implications of these findings are obvious. First, in locations where the public policy is to preserve agricultural land, this is easier to accomplish where there are no major interstates and highway exits. Where interstate exits already exist, perhaps the best policy is to rezone for residential use. Where interstate exits do not exist and the desirable land use is agriculture, the best option is to avoid adding or expanding highways. When they are necessary, it is best to route them through areas where the land is less productive and already more likely to become residential.

Second, since parcels closer to urban uses are more likely to flip from agriculture or residential developments, public policy should avoid the fragmentation of agriculture land. Maintaining the consolidation of valuable agricultural parcels is the best strategy for preservation of farmland.

The value of this model for policy makers is threefold. Hotspots are defined as agricultural parcels most likely to shift to urban use because they are near highway exits, the parcel is small, neighbors have already shifted to residential urban use, and the land's productivity in agriculture is low. First, where these hotspots fall outside of Priority Funding Areas, county officials should evaluate whether to keep the parcel in agriculture. If the answer is yes, then the county should take additional measures to preserve the current agriculture use. Agricultural easements, transfer development rights, or county land purchases will be necessary. If a shift to an urban use is acceptable, the Priority Funding Area boundaries should be expanded.

Second, where these hotspots fall into the Priority Funding areas, this is an indication that growth will go where the county wants it to occur. Many of the hotspots we identified fall in the area around Frederick City and rural towns.

Finally, when the hotspots fall in areas deemed environmentally sensitive, the County should pay attention to be sure the appropriate land use measures are in place to keep these areas from turning to residential developments. Our analysis indicates that left to market forces, these hotspots will likely transition from open space to residential use.

This report has documented Maryland's on-going population, housing, and employment pressures and the tendencies for this growth to decentralize and sprawl. County and state efforts to restrict development to "Priority Funding Areas", put acreage threatened by development in easements and land trusts, promote development infill, and evaluate the

land use implications before investing in infrastructure are all critical components to maintaining agriculture and open space and a high quality of life for Maryland residents.

Appendix 1

Figure A.1 shows a workflow consisting of the steps that were used in this classification.

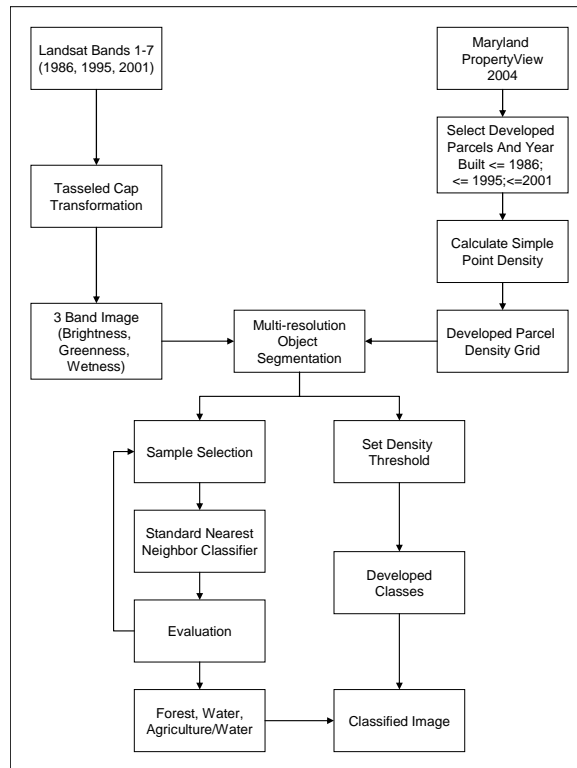


Figure A.1 Classification Workflow

The primary data sources in this methodology were Landsat 5 and 7 multispectral data and spatially explicit tax assessment data from Maryland Property View, a product produced by the Maryland Department of Planning. Precision corrected Landsat 5 data was obtained for the dates October 20, 1986 and October 13, 1995 and precision corrected Landsat 7 ETM+ data was obtained for the date October 5, 2001.

The Landsat bands were merged into one multi-band image and a tasseled cap transformation was performed on the imagery. The tasseled cap transformation is a spectral enhancement method which is optimized for vegetation studies.⁵ The transformation uses a series of coefficients to the Landsat bands to create a resulting image with three channels representing brightness, greenness, and wetness. Through trial and error in testing a number of spectral enhancement methods, it was concluded that this transformation gave us the best results in differentiating between forested and agricultural land covers.

⁵ E.P. Crist and R.J. Kauth, "The tasseled Cap De-Mystified," in *Photogrammetric Engineering and Remote Sensing*, Vol. 52, No. 1, January 1986, pp. 81-86.

Maryland Property View data was first subsetted to include all parcel centroids that had a land use that was residential, commercial, or industrial. Queries were then performed on the “yearbuilt” field to select parcel centroids that were developed in or before 1986, in or before 1995, and in or before 2001. This resulted in three separate GIS layers that represented the spatial configuration of development for the years matching the Landsat data.

We then used the ArcGIS Spatial Analyst to create point density grids for each year. The cell size for each grid was 64 meters by 64 meters which roughly equals 1 acre. The Landsat data and parcel density grids were then brought into the eCognition[®] software (www.definiens-imaging.com) where the images were segmented into image objects which represent heterogeneous features of the landscape. Rules were then applied to the image objects to classify any object with a mean parcel density over a threshold of 0.5 parcels per acre as developed.

After evaluating this threshold, it was determined that low density development was under represented. Because of this, an iterative approach was taken using high resolution orthophotography to determine a proper density threshold to use to make sure that low density development was included in the classification. As a result it was decided that the proper threshold to use for low density development in this analysis is 0.1 parcels per acre.

Forest and agricultural/open classes were also classified using an iterative process. First samples were selected representing each class. Then a nearest neighbor classification was applied on the entire image using the three channels created by the tasseled cap

transformation. The resulting classification was evaluated and re-sampled and classified until all covers associated with each class were included in the sample set.