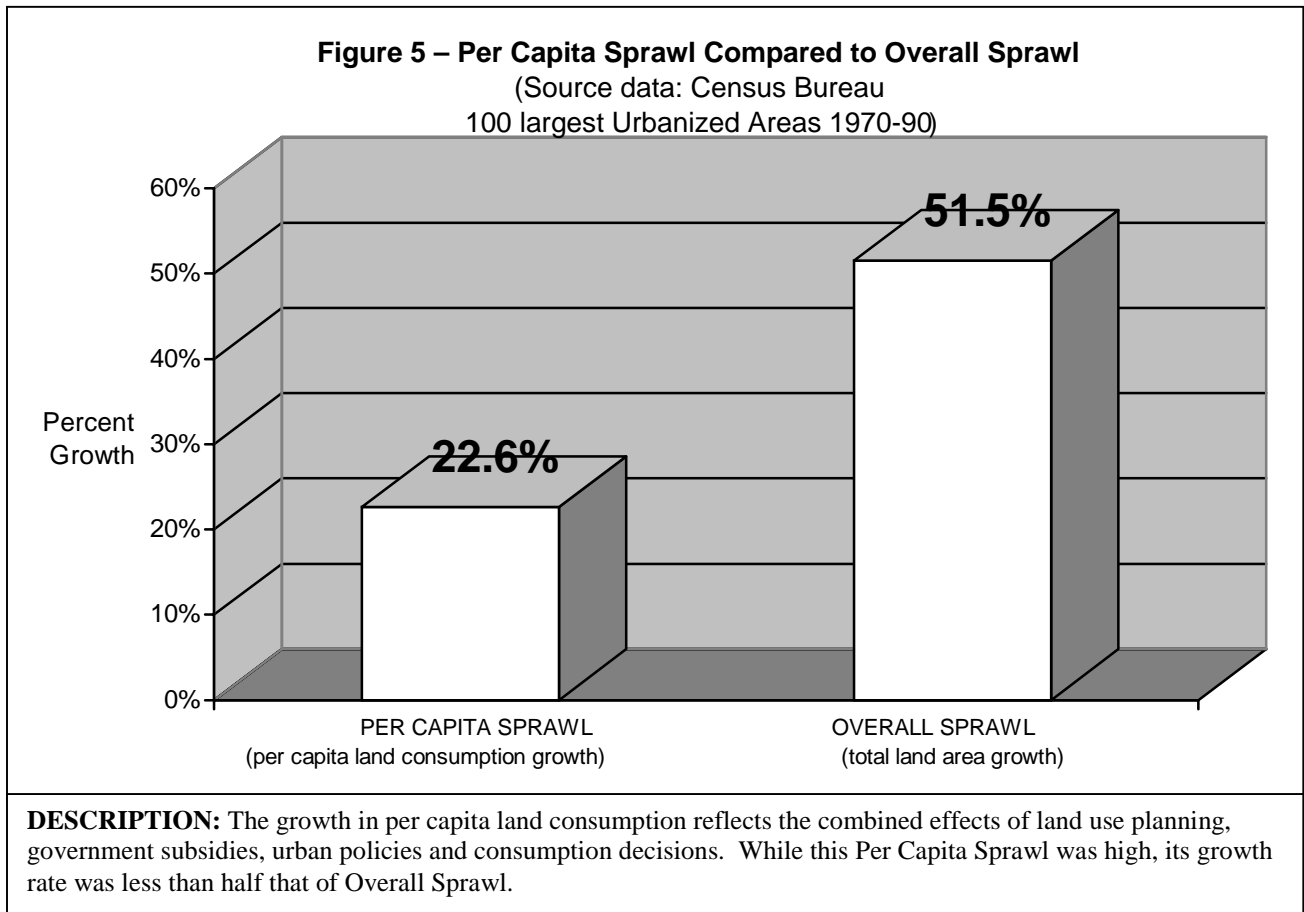


#### 4. APPORTIONING RELATIVE CONTRIBUTIONS OF EACH FACTOR TO OVERALL SPRAWL

Despite the considerable complexity of sprawl in an urban area, nearly all of the complexity can be boiled down to what ends up being a rather simple equation:

[The amount of land covered by an Urbanized Area]  
is equal to  
[the average amount of urban land per resident]  
multiplied by  
[the number of residents].

Overall Sprawl then is the change in that amount of total urban land and can be calculated using the change in per capita land consumption and the change in population.



##### 4.1. A sample village illustrates how growth factors work

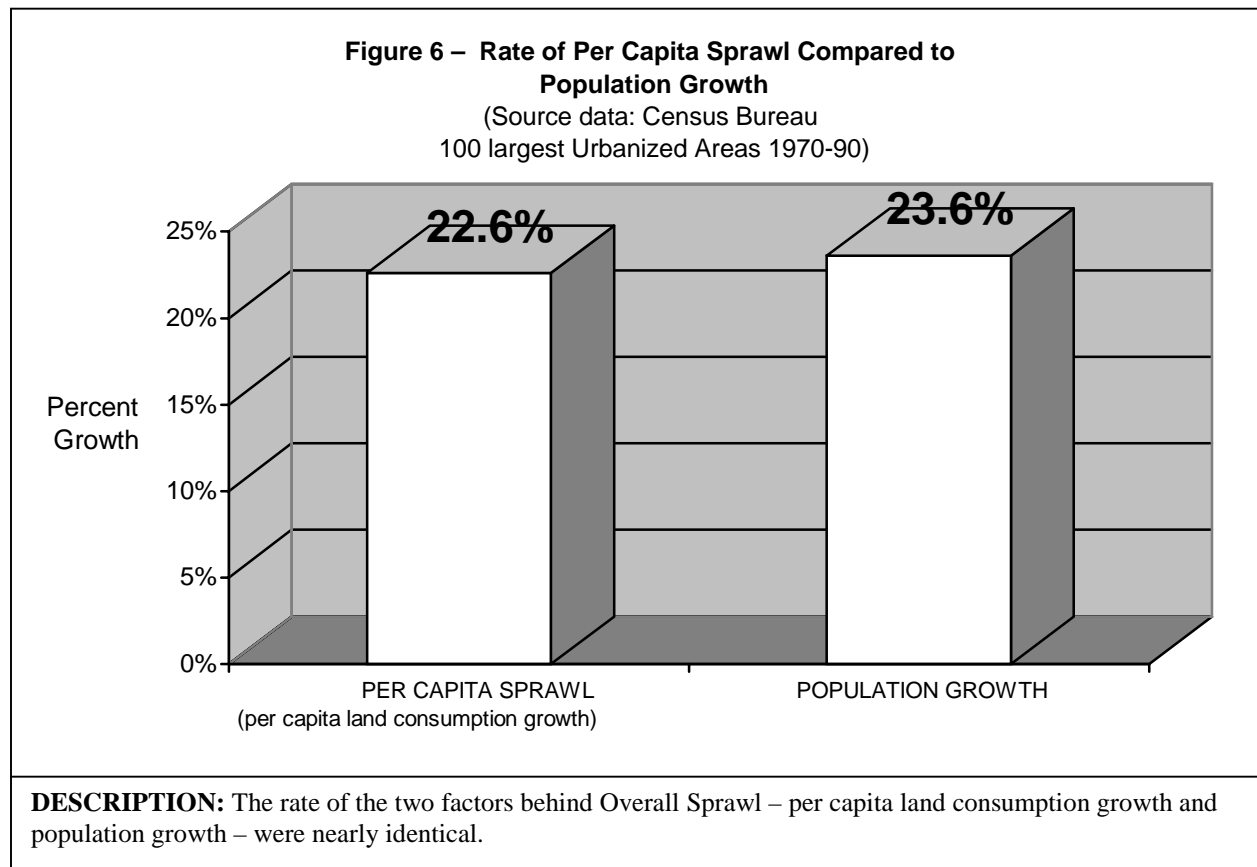
We can see this equation at work by visualizing a small village with:

- 400 residents
- an average of 0.200 acre land consumption per resident for all housing work, retail, recreational, transportation and other needs
- a fully developed area of the village of 80 acres (400 X 0.200 acre)

Let's say we revisit this village a few years later and find that the fully developed area has expanded 50% to 120 acres. There can be only three types of explanation:

1. The 400 villagers may have expanded their per capita land consumption by 50% from 0.200 acre to 0.300 acre ( $400 \times 0.300 \text{ acre} = 120 \text{ acres}$ ). This could have happened by households dividing by divorce or children leaving home and the departees starting new households, by people expanding the size of their houses and yards, by constructing additional public and business buildings, and by abandoning homes and stores within the old boundaries to move just outside those boundaries, perhaps adding a shopping mall and large parking lot on the town's edge.
2. OR the per capita land consumption may not have risen at all while 200 additional people moved into the village, causing a 50% increase in population to 600 ( $600 \times 0.200 \text{ acre} = 120 \text{ acres}$ ).
3. OR there may have been some combination of both population growth and per capita land consumption growth. One example would be that population grew 25% to 500 and per capita land use grew 20% to 0.240 acre ( $500 \times 0.240 \text{ acre} = 120 \text{ acres}$ ).

Each of the nation's sprawling Urbanized Areas has been expanding in one of those three ways.



#### 4.2. FINDING: Per Capita Sprawl alone cannot explain Overall Sprawl

Our literature search found that most media stories, advocacy programs, governmental reports and political statements about sprawl have focused almost entirely on the land-use and consumption factors that cause per capita

land growth. This would suggest that Per Capita Sprawl explains most, if not all, of the Overall Sprawl in the nation's Urbanized Areas.

One way to determine the accuracy of that supposition is to compare the percentage growth of per capita consumption with the percentage growth of Overall Sprawl. For example, if Per Capita Sprawl were responsible for all of the 50% increase of our sample village above, then Per Capita Sprawl would have to have been at least 50%. When we line up the percentages for those kinds of growth for the 100 largest Urbanized Areas, we find that very few of the Per Capita Sprawl percentages are even close to as high as the Overall Sprawl percentage. [See Table 1 on Page 10 and Appendix A.] For example, Chattanooga's per capita consumption rose by 65.7%, but it sprawled by almost twice as much: 120.1%. And the difference in growth rates was far wider in many cities such as Denver, where per capita consumption rose by 8.1% while its overall land consumption rose by 56.7% – seven times as much.

**Figure 5** (on page 22) shows that for all the cities, Per Capita Sprawl was a significant 22.6%. But overall land consumption increased by more than twice as much – by 51.5%.

Clearly per capita land consumption growth was a major factor – but not the overwhelming factor – in America's urban sprawl. Though the statistics for some of the Urbanized Areas seem to justify a single-factor anti-sprawl approach dealing with land use issues, most of the cities clearly fit into the third explanation about our sample village in which both Per Capita Sprawl and Population Growth are significant factors of Overall Sprawl.

### **4.3. FINDING: Comparing the two growth factors reveals national parity**

Since all of Overall Sprawl is explained by the combination of population change and per capita consumption change, we can learn much about their relative roles by simply lining up those percentage changes side by side. Those comparisons are available on Table 1 (on page 11) and in Appendix A.

**Figure 6** (on the previous page) lumps all 100 Urbanized Areas together and finds that their population change was 23.6% and their per capita land change was 22.6%. Thus, we easily see that the roles of the two growth factors are nearly identical in urban sprawl nationwide.

### **4.4. FINDING: Calculating ratios with a scientific method reinforces general findings**

To test the foregoing very simple exercise, we can run the numbers through a more complex scientific method that is commonly applied to total consumption of various resources. Harvard physicist John Holdren – internationally honored in 2000 for his achievements in environmental science – has particularly developed, described and worked with this method.<sup>15</sup> It can be applied to virtually any type of resource use. Perhaps its best-known application has been in understanding how total U.S. energy use has risen in recent decades. The method has enabled analysts to apportion shares of the total increase of energy in a country to (1) the change in per capita energy use and (2) the change in population.

A unique contribution of this study is that it appears to be the first to apply this method to sprawl. As in the case of looking at energy consumption, the question here was how much of the increased total consumption of rural land

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<sup>15</sup> John P. Holdren. 1991. "Population and the Energy Problem." *Population and Environment*, Vol. 12, No. 3, Spring 1991. Holdren is Teresa and John Heinz Professor of Environmental Policy and Director of the Program on Science, Technology, and Public Policy at Harvard University's Kennedy School of Government, as well as Professor of Environmental Science and Public Policy in the Department of Earth and Planetary Sciences at Harvard University. Trained in aeronautics/astronautics and plasma physics at MIT and Stanford, he previously co-founded and co-led for 23 years the campus-wide interdisciplinary graduate degree program in energy and resources at the University of California, Berkeley. On April 12, 2000 he was awarded the Tyler Prize for Environmental Achievement at the University of Southern California, which administers the award. The Tyler Prize is the premier international award honoring achievements in environmental science, energy, and medical discoveries of world-wide importance.

(Overall Sprawl) was related to per capita change in land consumption (Per Capita Sprawl) and how much was related to the increase in number of land consumers (Population Growth). [See Appendix E for further description.]

**Table 5** (on the next page) applies the Holdren method to the 10 largest sprawlers. For Atlanta, we see that 36% of Atlanta's Overall Sprawl was related to, or explained by, increases in per capita land consumption – and that 64% was related to Atlanta's massive population growth of the last two decades.

With these proportional percentages, opponents of sprawl in the nation's worst sprawling Urbanized Area, for example, can know that roughly two-thirds of their problem has been the inability to stabilize the Atlanta Area's population. And a very significant minority of the problem (36%) has been the inability to stabilize the per capita land use of the area.

Figure 8 (on the back cover) illustrates the results of applying the Holdren method to the entire population and land area of the 100 largest Urbanized Areas. Of the 14,545.2 square miles of sprawl, 49.1% of the lost rural land was related to the growth in per capita land consumption by the residents of those cities. And 50.9% of the lost rural land was related to the fact that 24.1 million additional people moved into those cities.

For all the sophistication of the Holdren method, with its use of logarithms and the like, it produces results that are little different from a simple equation that one can do on the back of a napkin. A common way to calculate the ratio of any two figures to each other is to add them together to obtain a sum, which can then be divided into each figure to yield a percentage. The two percentages will add up to 100%.

In the case of the Atlanta Urbanized Area, we add the per capita consumption growth percentage of 42 to the population growth percentage of 84, yielding a sum of 126. When we divide 126 into each growth figure we find that:

- per capita land consumption growth is 33.3% of the combined power of the two growth factors, in Atlanta.

- population growth is 66.7% of the combined power of the two growth factors, in Atlanta.

These numbers – as all numbers coming from this simple calculation – are quite close to the percentages produced by the Holdren method of 36.5% and 63.5% respectively. The importance of these proportioning exercises is in general approximations, not mathematical precision. The Holdren method – with its more sophisticated accounting of the relationship between factors – tends to move the percentages slightly toward the middle from the figures yielded by the simple ratio calculation.

**4.5. FINDING: Other data are consistent with the conclusion that both sprawl factors are roughly equal**

<b>Urbanized Area</b>	<b>% of Total Sprawl related to GROWTH IN PER CAPITA LAND CONSUMPTION was:</b>	<b>% of Total Sprawl related to POPULATION GROWTH was:</b>
1. Atlanta, GA	36%	64%
2. Houston, TX	30%	70%
3. New York City, NY-NJ	100%	0%
4. Washington, DC-MD-VA	53%	47%
5. Philadelphia, PA-NJ	89%	11%
6. Los Angeles, CA	0%	100%
7. Dallas-Fort Worth, TX	0%	100%
8. Tampa-Saint Petersburg-Clearwater, FL	15%	85%
9. Phoenix, AZ	0%	91% *
10. Minneapolis-St. Paul, MN	49%	51%

*Source: U.S. Census Bureau data*  
*\*Adjusted from 100%: see Appendix F for explanation.*

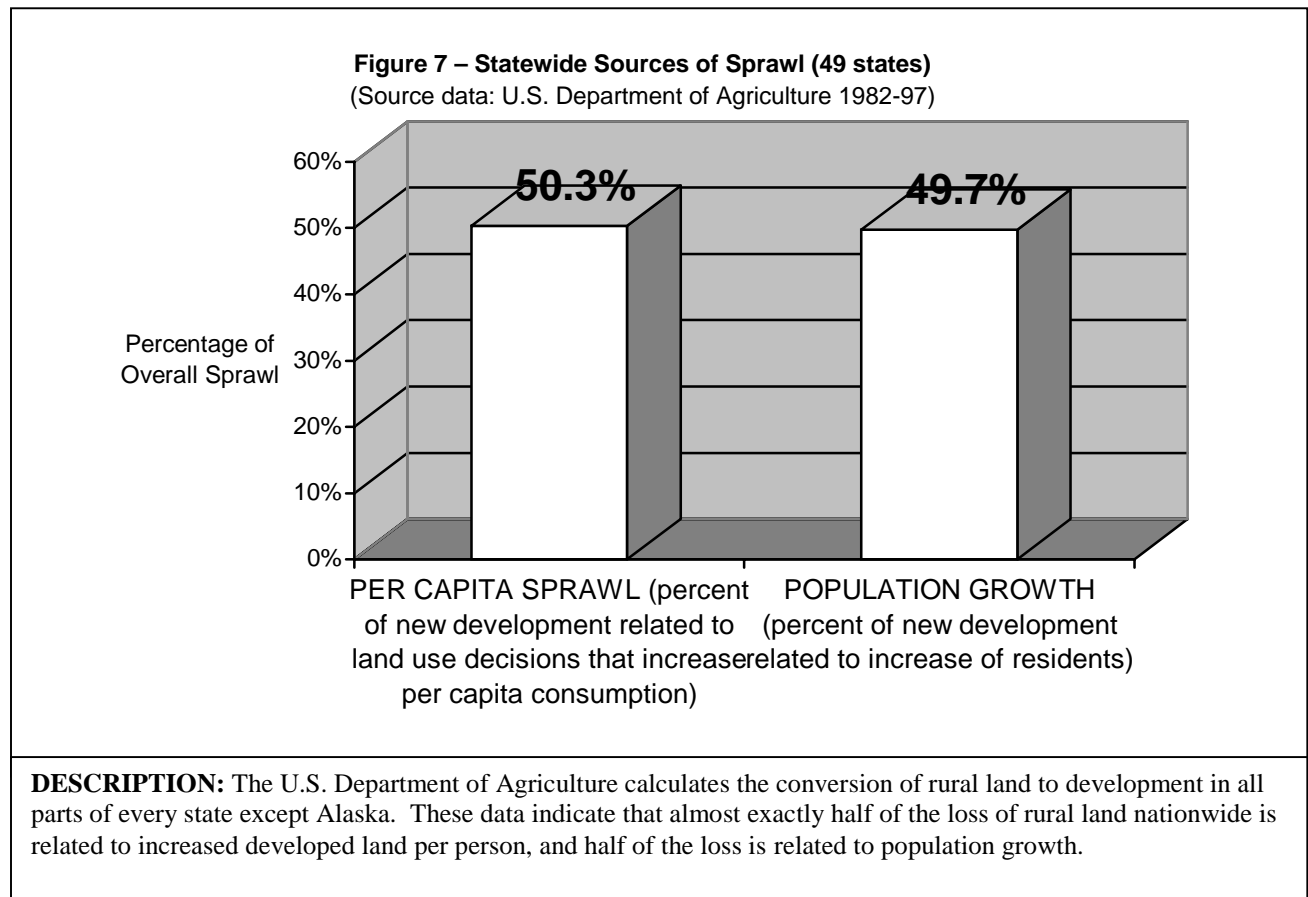
Four other studies on rural land loss provide for conclusions that are consistent with this study's finding that population growth and per capita land growth are nearly equal in their sprawl roles. (The four – by the U.S. Department of Agriculture, the U.S. Department of Housing and Urban Development, the University of Illinois Great Cities Institute and private consultant David Rusk – are described on Page 13.)

While this study relied on the Census Bureau's calculations on rural land loss around the 100 largest Urbanized Areas, the others looked at fewer and larger numbers of Areas. This study covered the 1970 to 1990 period while the others covered 1950-1990, 1960-1990, 1982-1997 and 1994-97.

Interestingly, all five studies provide for the same general conclusion: about half the rural land loss is explained by population growth and about half is explained by growth in per capita land consumption. This suggests a certain consistency to the nature of sprawl among broad regions and over a broad period of time. There appear to be long-standing built-in cultural and economic trends in America that drive a certain amount of Per Capita Sprawl, while a constant high level of Population Growth has typically doubled the overall rural land loss.

The fact that the two most recent studies ending in 1997 provide for about the same aggregate conclusion as ours suggests that the eventual Census data on the 1990s won't show a markedly different national picture than its data for 1970-90.

Of particular importance to this study is the survey by the U.S. Natural Resources Conservation Service (NRCS) of the Department of Agriculture. If the Census Bureau Urbanized Areas data were giving us a false reading on the real pace of sprawl by overstating or undercounting, the NRCS results would likely give us a significantly different figure.



The NRCS has conducted inventories of the nation's ecologically productive land every five years since 1982. It provides statewide data rather than assigning development to specific cities. The NRCS survey picks up

development such as weekend cottages and second homes that are built by city residents far enough into the country that they don't get included in the data on expanding Urbanized Areas. The NRCS survey also notes all the rural land lost each year to the development of recreational areas, resorts, roads, manufacturing, parking areas and sprawling small cities under 50,000 residents.

When we applied the Holdren apportioning method to the NRCS data, the results were nearly identical to those of our study of the 100 largest Urbanized Areas using Census data.

**Figure 7** illustrates that 50.3% of the rural land loss nationwide (minus Alaska) was related to increased acres of development per resident – and that 49.7% was related to the nation's population growth.