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Summer 2017

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Available at: <https://works.bepress.com/lewyn/129/>

Zoning and Land Use Planning

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THE ENVIRONMENTALIST CASE FOR SPRAWL— AND WHY IT FAILS

Environmentalists have generally criticized low-density, automobile-dependent suburban development (often referred to as “sprawl” or “suburban sprawl”), asserting that because residents of sprawl drive more than urbanites, the growth of sprawling suburbs impedes air quality. Defenders of the status quo have counterattacked, arguing that compact, walkable development actually leads to more pollution.¹ This article addresses both the conventional wisdom and pro-sprawl counterarguments, and concludes that the pro-sprawl arguments are unpersuasive.

I. The Dominant Environmentalist View

As Americans have moved to automobile-dependent suburbs, vehicle travel has exploded.² Since vehicle travel causes pollution, it logically follows that suburban growth increases pollution.³ By contrast, if Americans can reach a

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¹I note that arguments related to air quality are not the only environmentalist arguments against sprawl. See U.S. Environmental Protection Agency, *Our Built and Natural Environments: A Technical Review of the Interactions Among Land Use, Transportation, and Environmental Quality* 36 (sprawl reduces supply of wetlands), 128–30 (sprawl affects water quality) (2d ed. 2013), at <http://www2.epa.gov/sites/production/files/2014-03/documents/our-built-and-natural-environments.pdf>

However, this article focuses more narrowly on air pollution and greenhouse gases, primarily because defenders of sprawl seem to have addressed air quality issues in more detail than water quality issues.

²*Id.* at 26 (“While the population roughly doubled between 1950 and 2011 . . . vehicle travel during this same period increased nearly sixfold”).

³*Id.* at 67 (noting that transportation-related American greenhouse gas emissions increased by 19% between 1990 and 2010).

wide variety of destinations without driving, they will create less pollution than would otherwise be the case. According to one study sponsored by the Urban Land Institute, more compact, walkable development could reduce vehicle miles traveled by 20–40%, which in turn would reduce total transportation-related carbon dioxide emissions by seven–10% by 2050.⁴

Similarly, a study by Harvard economist Edward Glaeser and UCLA economist Matthew Kahn found that the most transit-oriented places had a smaller automobile-related carbon footprint than other large metropolitan regions. In particular, New York City, the metropolitan area with the highest use of public transit,⁵ had the lowest level of automobile-related carbon dioxide emissions among 66 regions surveyed.⁶ The United States has five other metropolitan areas where over 10% of commuters used public transit—Washington, Chicago, Boston, Philadelphia, and San Francisco.⁷ In each of these regions, automobile-related carbon dioxide emissions were higher than those of New York, but lower than the national median.⁸ By contrast, among the six regions surveyed where 1% or fewer of commuters used public transit,⁹ all had automobile-related carbon dioxide emissions higher than the national median.¹⁰

⁴Reid Ewing et. al., *Growing Cooler: The Evidence on Urban Development and Climate Change*, <http://www.smartgrowthamerica.org/document/s/growingcoolerCH1.pdf>.

⁵See Wendell Cox, *Major Metropolitan Commuting Trends: 2000–2010*, available at <http://www.newgeography.com/content/002500-major-metropolitan-commuting-trends-2000-2010>.

⁶See Edward L. Glaeser and Matthew Kahn, *The Greenness of Cities*, http://www.hks.harvard.edu/var/ezp_site/storage/fckeditor/file/pdfs/centers-programs/centers/taubman/working_papers/glaeser_08_greenness.pdf. Even when public transit-related carbon dioxide emissions are added to this figure, New York's per-household emissions level of 24,467 was below the national median for driving-related emissions alone (26,744).

⁷See Cox, *supra* note 5.

⁸See Glaeser & Kahn, *supra* note 6, at 41. The most-polluting region of the five, Washington, emitted 25,918 pounds of automobile-related carbon dioxide per household; 28 of the 66 metropolitan areas created less pollution. *Id.*

⁹See Cox, *supra* note 5 (listing Memphis, Raleigh, Birmingham, Nashville, Oklahoma City and Indianapolis as regions with transit shares

Moreover, cities consistently created less carbon dioxide than suburbs: in every single one of the 66 metropolitan areas surveyed, transportation-related carbon dioxide emissions (including both emissions from automobiles *and* emissions from public transit) were higher in suburbs than in cities. For example, in New York, the city's per-household transportation emissions were 3783 pounds fewer than those of the suburbs.¹¹

Environmental benefits from walkable development are not limited to greenhouse gases. A study by the Environmental Protection Agency concluded that if five to 10% of regional housing and employment was shifted from to walkable, transit-accessible locations, several forms of pollution would be reduced.¹² For example, if 17% of Boston's development was shifted to such locations, emissions of carbon monoxide, volatile organic compounds, and nitrogen oxide would all be reduced by between 4.8 and 8.1%,¹³ primarily because many trips would be shorter.¹⁴

In turn, reduced pollution would improve human health. One study by several scholars found if vehicle miles traveled in the 11 largest Midwestern regions decreased by 10%, the

of 1% or lower). Cox's tables also mention that only 1% of Jacksonville commuters used transit to get to work. *Id.* However, Glaeser and Kahn did not include emissions data for that region.

¹⁰See Glaeser & Kahn, *supra* note 6, at 41. The lowest-emission region of this group, Memphis, produced more automobile-related emissions (28,440 pounds of carbon dioxide per household) than all but 16 of the 66 areas surveyed. The other five were Raleigh (29,922), Indianapolis (29,222), Birmingham (30,041), Nashville (30,495) and Oklahoma City (28,953). Glaeser and Kahn did not include statistics for Jacksonville, a seventh major metropolitan area where only 1% of commuters used transit to get to work. See Cox, *supra* note 5.

¹¹See Glaeser & Kahn, *supra* note 6, at 44.

¹²See U.S. Environmental Protection Agency, Measuring the Air Quality and Transportation Impacts of Infill Development 11, at https://www.epa.gov/sites/production/files/2014-01/documents/transp_impacts_infill.pdf.

¹³*Id.* at 19.

¹⁴*Id.* at 22. See also Todd Litman, *Can Smart Growth Policies Conserve Energy and Reduce Emissions?* 5–8, at <http://vtpi.org/REQJ.pdf> (discussing numerous other studies).

resulting decline in particulate matter¹⁵ pollution would lead to 525 fewer pollution-related deaths and an even larger reduction in the number of hospital admissions, thus creating a societal savings of over \$4.2 billion per year.¹⁶ Another study found that the least compact American regions have 60% more high-ozone days than the most compact regions.¹⁷ Thus, it seems clear at first glance that the most compact, walkable regions are the most environmentally friendly.

II. On The Other Hand . . .

Some commentators argue that suburbs actually generate less pollution than cities, because (1) even if suburbs create more transportation-related pollution, cities create more overall pollution, and (2) a compact city's high population density leads to increased congestion and pollution.

A. Non-Transportation Pollution

Some commentators argue that even if suburbanites create more transportation-related pollution, city residents create more overall greenhouse gas (GHG) emissions- for example, through common areas in urban apartment buildings.¹⁸ For example, journalist Joel Kotkin relies on a newspaper article asserting that residents of downtown Halifax, Nova Scotia, have carbon footprints compara-

¹⁵See *American Trucking Associations, Inc. v. E.P.A.*, 283 F.3d 355, 359, 54 Env't. Rep. Cas. (BNA) 1001, 32 Env'tl. L. Rep. 20568 (D.C. Cir. 2002) (particulate matter is "all solid particles and liquid droplets found in air" and is "associated with a range of adverse health effects such as coughing, shortness of breath, aggravation of existing respiratory conditions like asthma and chronic bronchitis, increased susceptibility to respiratory infections and heightened risk of premature death").

¹⁶See Maggie L. Grabow et. al., *Air Quality and Exercise-Related Health Benefits from Reduced Car Travel in the Midwestern United States*, <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3261937/>.

¹⁷See *Built and Natural*, *supra* note 1, at 90-93 (noting study, but adding that within regions, high-ozone areas sometimes more compact due to proximity to polluting industry).

¹⁸See Wendell Cox, *Reducing Greenhouse Gases from Personal Mobility: Opportunities and Possibilities* 20, at http://reason.org/files/reducing_greenhouse_gases_mobility_development.pdf ("Common energy is used for elevators, air conditioning, heating, water heating, building lighting, and commonly provided heating, cooling and water heating.").

ble to those of suburbanites.¹⁹ However, the author of the study stated “part of the reason for the higher than expected carbon footprint in the core is that Halifax is not as dense as other cities, where assumptions about people living outside of the downtown core tend to have higher carbon footprints may hold true . . . [in Halifax] the square footage [per person] is very similar between the suburbs and downtown.”²⁰ In other words, if downtown Halifax was significantly more dense than the suburbs, downtown might have a *smaller* carbon footprint. Thus, the Halifax study actually supports compact development.

Kotkin also cites a document by an Australian environmental group (the Australian Conservation Foundation)²¹ stating that urban cores have higher environmental impacts than suburbs or rural areas.²² However, the study goes on to state that the reason for this was that “the opportunities for relatively efficient, compact living appear to be overwhelmed by the energy and water demands of modern urban living, such as air conditioning, spa baths, down lighting and luxury electronics and appliances These trends in are closely correlated with wealth. Higher incomes in the inner cities are associated with higher levels of consumption across the board.”²³ In other words, Australian cities are more carbon-intensive than their suburbs not because of the evils of density, but because those cities are richer and thus buy and use more goods. In fact, the Foundation has *rejected* the use of its report to defend sprawl, stating, “Eco-footprints in

¹⁹See Joel Kotkin, *The Human City: Urbanism for the Rest of Us* 11 (2016), citing CBC News, *Carbon footprint assumptions do not hold true for Halifax*, at <http://www.cbc.ca/news/canada/nova-scotia/carbon-footprint-assumptions-do-not-hold-true-for-halifax-1.1371095>.

²⁰*Id.*

²¹Although the link referred to in Kotkin’s book, *id.* at 264, is broken, I suspect he is referring to Australian Conservation Foundation, *Consuming Australia: Main Findings*, at https://d3n8a8pro7vhmx.cloudfront.net/auscon/pages/1433/attachments/original/1477284331/res_Atlas_Main_Findings.pdf?1477284331.

²²*Id.* at 10.

²³*Id.*

suburban areas in Australia are lower than in the urban core in spite of, not because of, lower residential densities.”²⁴

Wendell Cox cites another Australian study asserting that multifamily housing produces more GHG gas emissions per capita than townhouses or detached single-family housing, because of the emissions necessary for elevators and other features of apartment common areas, and because multifamily dwellings tend to use concrete and steel, which are more GHG-intensive than the wood often used in houses.²⁵ This argument fails to support sprawl, for several reasons.

First, Cox seems to equate walkable urban development with large apartment buildings. But in fact, low-rise urban areas can be quite dense. For example, Brooklyn, New York’s Park Slope neighborhood has just over 64,000 people per

²⁴Tim Halbur, *Smart Growth and Australia*, at <http://www.planetizen.com/node/42941> (quoting Charles Berger, Director of Strategic Ideas at Australian Conservation Foundation). Kotkin also cites a study pointing out that residents of the New York metropolitan area use more energy than do Los Angeles residents. See Kotkin, *supra* note 19, at 264, citing Christopher A. Kennedy et. al, *Energy and material flows of megacities*, at <http://www.pnas.org/content/112/19/5985.full.pdf>. But this statement, is oversimplified for three reasons. First, the study refers to the entire New York region, *id.* at 5986, which in fact is less dense by some measures than Los Angeles. Cf. Wendell Cox, *America’s Densest Cities*, at http://www.huffingtonpost.com/wendell-cox/americas-densest-cities_b_5888424.html (Los Angeles suburbs twice as dense as those of New York, and as a result the Los Angeles region more dense) (“Densest Cities”); Kyle Magnum, *The Role of Housing in Urban Carbon Emissions* 9 at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2863168 (similarly pointing out that metro New York less dense than metro Los Angeles). Second, New York’s higher energy use is at least partially caused by its climate, which is less temperate than that of Los Angeles and thus requires more heating and cooling. *Id.* at 11 (California cities less carbon-intensive due to temperate weather); See also Kennedy et. al., *supra*, at 5987 (noting that the “majority of megacities are in warm to hot climates where demands for heating are relatively low” and that New York, but not Los Angeles, is an exception to this rule). Third, New York’s housing-related carbon emissions, although higher than that of temperate Southern California, are lower than that of most of the United States. See Magnum, *supra* at 15 (of 49 regions listed, New York has 13th lowest level of emissions; the six “best” are all in California, and two of the other regions with fewer emissions than New York are in the also-temperate Pacific Northwest).

²⁵See Cox, *supra* note 18, at 20–21.

square mile²⁶ (more than 10 times the density of most urban areas)²⁷ and only 27% of its residents drive to work²⁸ even though less than 15% of its housing structures have five or more units.²⁹

Second, the Australian study is flawed because of its miniscule sample size. It studied only 17 high-rise buildings, 12 mid-rise buildings and 10 low-rise buildings.³⁰ As a result, the authors wrote that their study's results "are not statistically representative of . . . multi-unit residential buildings"³¹ even in Sydney, Australia where the study was conducted,³² let alone in the United States.

Third, evidence from Australia may not be tremendously relevant to the United States, because personal vehicles account for only 10% of Australian GHG emissions, as opposed to 25% of U.S. GHG emissions.³³ As a result, development patterns that reduce driving are likely to reduce overall per-household emissions to a greater extent in the United States than in Australia.

Fourth, because the study focuses on per-capita emissions its findings are only valid as long as household sizes do not change- that is, as long as apartments are more likely than houses to be dominated by single people. But if development becomes more compact and multifamily dwellings become

²⁶See Park Slope Neighborhood in Brooklyn, New York (NY), 11215, 11217 *Detailed Profile*, at <http://www.city-data.com/neighborhood/Park-Slope-Brooklyn-NY.html> ("Park Slope").

²⁷See Cox, *supra* note 18, at 21 (only two large U.S. urban areas have over 6000 people per square mile).

²⁸See AllTransit, at <http://alltransit.cnt.org/metrics/?addr=park+slope%2C+brooklyn+ny> (Park Slope inserted into search engine).

²⁹See Park Slope, *supra* note 26.

³⁰See Paul Myors, et. al., Multi Unit Residential Buildings Energy and Peak Demand Study 4, at http://www.ausgrid.com.au/Common/Our-network/Demand-management-and-energy-efficiency/Energy-use-facts-and-figures/~media/Files/Network/Demand%20Management/Energy%20use%20resources/Networks_multi_unit_sumrep_Oct08.pdf.

³¹*Id.* at 3.

³²*Id.* (study not representative of "Sydney multi-unit residential buildings") (emphasis added).

³³See Michael D. Setty, *Wendell Cox Distorts Australian Data*, at http://www.publictransit.us/index.php?option=com_content&task=view&id=161.

more popular with families, per-capita emissions for apartments will decline, because each new resident does not significantly increase the overall emissions for a unit. For example, if a two-bedroom apartment is occupied by a family of three instead of by one person, their apartment building is unlikely to need additional elevators or hallway lighting.

B. Density, Congestion and Pollution

The most dense cities tend to be those most friendly to walking and public transit. If a neighborhood has only a couple of houses per block, very few people can walk to the nearest bus stop. By contrast, more compact neighborhoods tend to have higher transit ridership.³⁴ As noted above, such compact places tended to produce less pollution than sprawling suburbs.³⁵

Nevertheless, pro-sprawl commentators argue that low-density suburbia is good for air quality because (1) density leads to traffic congestion, which in turn increases pollution, and (2) dense areas tend to be more polluted.

1. The Density-Congestion Link

The dominant environmentalist view is that even if more compact development makes some places more congested, on balance shorter travel distances and increased use of non-automotive commuting would decrease both traffic congestion and air pollution. Kotkin argues, by contrast, that compact development increases pollution by increasing traf-

³⁴See Joanna D. Malaczynski and Timothy P. Duane, Reducing Greenhouse Gas Emissions from Vehicle Miles Traveled: Integrating the California Environmental Quality Act with the California Global Warming Solutions Act, 36 Ecology L.Q. 71, 80 n. 44 (2009) (raising average density to nine units per acre could reduce vehicle miles traveled by 30% nationwide); See Robert H. Freilich, The Land Use Implications of Transit-Oriented Development: Controlling the Demand Side of Transportation Congestion and Urban Sprawl, 30 Urb. Law. 547, 552 & n. 18 (2009) (neighborhood must have at least seven units per acre to support regular transit service); Jed Kolko, Making the Most of Transit: Density, Employment Growth, and Ridership Around New Stations 16, available at <http://www.ppic.org/main/publication.asp?i=947> (“transit ridership falls considerably at distances beyond just one quarter-mile from a transit station”).

³⁵See *supra* notes 5–11 and accompanying text.

fic congestion, which in turn increases fuel consumption.³⁶ But if this argument supported suburbanization, congestion-related fuel consumption would have decreased as low-density suburbia grew. This failed to occur: since 1982, the amount of fuel wasted due to American traffic congestion grew from 4 gallons per driver to 19.³⁷ Moreover, congestion increased even in rapidly decentralizing regions. For example:

- * Detroit lost over 40% of its central city population between 1980 and 2014³⁸ yet the amount of fuel wasted due to regional traffic congestion nearly doubled.³⁹
- * Similarly, St. Louis lost 30% of its central city population between 1980 and 2014,⁴⁰ but the amount of lost fuel lost per driver more than quadrupled.⁴¹
- * Similarly, Buffalo lost about a quarter of its central city population between 1980 and 2014⁴² yet its congestion-

³⁶See Kotkin, *supra* note 19, at 191 (“Increased densities, for example, increase congestion and create more ‘stop and go’ conditions that ultimately add to emissions . . . fuel consumption per kilometer (and thus GHG emissions) rises nearly 50 percent as arterial street traffic conditions deteriorate”); Cox, *supra* note 18, at 11–12.

³⁷See David Schrank et. al., *2015 Urban Mobility Scorecard* 1, at <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/mobility-scorecard-2015.pdf>. The only period during which fuel loss due to congestion decreased was between 2006 and 2009, presumably due to the American economic downturn during that period.

³⁸See Sarah Janssen, ed., *The World Almanac and Book of Facts 2016*, at 614 (decrease from over 1.2 million in 1980 to just under 700,000).

³⁹See Texas Transportation Institute, *Performance Measure Summary-Detroit MI*, at <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/ums/congestion-data/detroit.pdf> (fuel losses per auto commuter increased from 14 in 1982 to 25 in 2014).

⁴⁰See Janssen, *supra* note 38, at 614 (decrease from over 450,000 million in 1980 to just over 317,000).

⁴¹See Texas Transportation Institute, *Performance Measure Summary-St. Louis, MO* at <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/ums/congestion-data/st-louis.pdf> (fuel losses increased from 5 gallons per driver in 1982 to 21 in 2014).

⁴²See Janssen, *supra* note 38, at 614 (decrease from just over 357,000 in 1980 to just over 258,000).

related wasted fuel per driver also more than quadrupled.⁴³

And if density led to congestion and pollution, dense central cities would be more polluting than sprawling suburbs. But as noted above, suburbs emit more transportation-related greenhouse gases than cities,⁴⁴ and the most car-dependent cities emit more greenhouse gases than the most transit-oriented, walkable cities.⁴⁵

2. But Aren't Cities More Polluted than Suburbs?

Cox writes that "overall traffic volumes increase as population densities rise."⁴⁶ He does not deny that the most dense places have lower per-household car use than the least dense places.⁴⁷ So he seems to be arguing that even if per-household vehicle use is lower in more compact neighborhoods, the larger number of households per acre means that there are more cars per acre, leading to more pollution in that acre.⁴⁸ Therefore, reasons Cox, lower density means less pollution.

This argument has a few weaknesses. First, higher traffic volumes in cities are in part created by suburbanites commuting to a city. So if population spreads to suburbs, traffic volume may actually increase, as former transit users move

⁴³See Texas Transportation Institute, *Performance Measure Summary-Buffalo, NY* at <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/ums/congestion-data/buffalo.pdf> (fuel losses increased from 5 gallons per driver in 1982 to 21 in 2014). I note that congestion did not increase any more rapidly in regions with growing cities. For example, New York fuel waste increased from 10 gallons per commuter to 35. See Texas Transportation Institute, *Mobility Data for New York-Newark NY-NJ-CT*, at <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/ums/congestion-data/new-york-city.pdf>.

⁴⁴See Glaeser and Kahn, *supra* note 6, at 44 (suburbs generated more transportation-related emissions in every single region surveyed, and generated more overall emissions in all but two of 50-plus regions surveyed).

⁴⁵See *supra* notes 6–10 and accompanying text.

⁴⁶Cox, *supra* note 18, at 10.

⁴⁷*Id.* at 20 (quoting study stating that "The threshold value at which density seems to have a meaningful impact upon [vehicle miles traveled], or trips, is somewhere probably between 6,000 and 7,000 persons per square mile," thus implying that car trips less frequent at higher levels of density).

⁴⁸See Kotkin, *supra* note 15, at 66.

to suburbia and become drivers. Imagine, for example, that in the city of Rustbeltiana, 50 of the city's 100 residents move to suburbia, where all of them must use a vehicle to drive to work. Before the shift to suburbia, 20% of the city's residents (20 of 100) drove to work, causing 20 vehicles to congest the city during rush hour. If even half of the suburbanites drive to jobs in the city, there are now 35 car commuters in the city- 25 of the 50 suburbanites and 20% (or 10) of the remaining city residents. And if jobs shift to the suburbs, many of the remaining city residents may drive to suburban worksites, causing additional congestion. In other words, suburbanization may actually increase urban traffic to the extent that suburbanites drive into the city.

Second, it is not always the case that dense urban areas have the highest traffic volumes. The Environmental Protection Agency has created a set of maps showing traffic volumes and pollutant levels in individual neighborhoods. In Washington, D.C. and its suburbs, the highest traffic volumes (over 4000 vehicles per day) are along interstate highways, mostly in the suburbs. By contrast, some blocks surrounding George Washington University (less than a mile from the White House) have 850-1300 vehicles per day, and the area near Catholic University (a few miles away but still in the city of Washington and served by the city's Metro Rail system) has about 100 vehicles per day, a level comparable to that of suburban Potomac⁴⁹ despite the fact that the Catholic University neighborhood has more than three times the population density of Potomac.⁵⁰ Pollution levels are also no higher in the city; particulate matter in the city is roughly comparable to that of its northern suburbs, and ozone levels are higher in the eastern suburbs than in the city's urban core.⁵¹

In cities (such as Philadelphia) where interstate highways go near the heart of downtown, urban traffic volumes are higher. For example, Philadelphia's downtown Vine Street

⁴⁹See U.S. Environmental Protection Agency, *EPA EJScreen*, at <https://ejscreen.epa.gov/mapper/comparemapper.html> ("EJ Screen.").

⁵⁰See City-Data.com, at <http://www.city-data.com> (internal search engine reveals that Potomac has 1786 persons per square mile, while North Michigan Park, which includes the university, has over 8000) ("City Data").

⁵¹See EJ Screen, *supra* note 49.

Expressway attracts 9000 vehicles per day. But City Hall just half a dozen blocks south has only 1600 vehicles per day, and Rittenhouse Square (less than two-thirds of a mile away) has less than 200.⁵²

Third, even if the most dense neighborhoods are the most congested and polluted, this fact is irrelevant to regionwide air pollution. Table 2 shows that density and high levels of emissions do not always go together.

Table 1: Density and Transportation-Related Emissions in U.S. Metropolitan Areas

	Density (in Persons per square mile) ⁵³	Emissions (thousands of pounds of carbon dioxide per household) ⁵⁴
Most Dense		
Los Angeles	6999	24.6
San Francisco	6266	25.6
San Jose	5820	23.7
New York	5319	24.4
Miami	4442	28.7
San Diego	4037	25.4
Sacramento	3660	25.9
New Orleans	3579	25.5
Denver	3554	26.5
Riverside	3546	26.4
Least dense		
Birmingham	1414	30.2
Charlotte	1685	31.8

⁵²See City Data, *supra* note 50. I note that the Rittenhouse neighborhood has over 33,000 people per square mile, about three times the citywide average. *Id.*

⁵³Although there are numerous ways to measure regional density, I have used Cox's own measurements. See Densest Cities, *supra* note 24, at http://new.www.huffingtonpost.com/wendell-cox/americas-densest-cities_b_5888424.html. I note that I have excluded two regions for which inadequate emissions data exists- Las Vegas (one of the most dense) and Jacksonville (one of the least dense).

⁵⁴See Glaeser and Kahn, *supra* note 6, at 41 (including both public transit emissions and auto emissions).

Atlanta	1707	30.5
Raleigh	1708	30.4
Nashville	1721	30.9
Hartford	1792	24.5
Pittsburgh	1916	27.6
Richmond	1937	30.2
Grand Rapids	2031	29.8
Louisville	2040	29.6

Table 1 shows that high density in fact correlates with low levels of GHG emissions. Among the 10 most dense regions, the most polluting is Miami (with 28,676 pounds of transportation-related carbon dioxide per household).⁵⁵ All of the five least dense regions have higher emissions than Miami, as do eight of the 10 least dense regions. Thus, low density equals more pollution, not less.

C. But Won't Rising Fuel Economy End The Problem?

Cox argues that increased fuel efficiency is likely to lead to emissions reductions to a significantly greater extent than more compact development.⁵⁶ But there is little historical basis for the notion that fuel efficiency consistently improves. The overall fuel efficiency of American vehicles stagnated during the 1990s (increasing only from 19.5 miles per gallon in 1991 to 19.6 in 1999), increased briefly for a couple of years (to 20.2 in 2001), then decreased (back to 19.6 in 2004).⁵⁷ More recently, fuel efficiency decreased from 21.8 miles per gallon in 2008 to 21.4 in 2014.⁵⁸ Thus, the long-term trend is unclear.

And if technological developments do cause cars to become more fuel-efficient, the same trends could cause buses to

⁵⁵*Id.*

⁵⁶See Cox, *supra* note —, at 31.

⁵⁷See United States Department of Transportation, Bureau of Transportation Statistics, Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicles, at https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/national_transportation_statistics/html/table_04_23.html.

⁵⁸*Id.* It could be argued that the long-run trend is towards increased efficiency. But the Department of Transportation notes that “data from 1960-2006 are not comparable to the data from 2007-14,” *id.*, so this may not be the case.

become more fuel-efficient as well. So on balance, it may be that high reliance on automobiles will continue to make society more polluting than would otherwise be the case.

III. Conclusion

Although numerous studies suggests that compact, walkable growth reduces air pollution, some commentators argue that the higher population density caused by such compact growth may actually increase environmental harm from vehicles, either by increasing traffic congestion or by concentrating pollution in a few places. But this argument does not seem to be supported by the evidence: as American cities have sprawled, their vehicle congestion has continued to grow, and the most dense places seem to have lower vehicle emissions than the least dense places.