



The Public Health Costs of Traffic Congestion

A Health Risk Assessment

By: Jonathan I. Levy, Jonathan J. Buonocore, & Katherine von Stackelberg

Traffic congestion is a significant issue in virtually every urban area in the United States and around the world. Anyone who spends any time commuting knows that the time and fuel wasted while sitting in traffic can not only be annoying, but can lead to real economic costs. An examination of the peer-reviewed literature shows that there are many previous analyses that estimate the economic costs of congestion based on fuel and time wasted, but that these studies don't include the costs of the potential public health impacts. Sitting in traffic leads to higher tailpipe emissions which everyone is exposed to, and the economic costs of those exposures have not been explored.

Motor vehicle emissions contain pollutants that contribute to outdoor air pollution. One in particular, fine particulate matter (referred to as $PM_{2.5}$) is strongly influenced by motor vehicle emissions. Studies that evaluate the sources of $PM_{2.5}$ in our environment find that vehicles contribute up to one-third of observed $PM_{2.5}$ in urban areas. $PM_{2.5}$ has been associated with premature deaths in many studies, and health impact assessments have shown $PM_{2.5}$ -related damages on the order of hundreds of billions of dollars per year. Recently, an expert committee convened by the Health Effects Institute in Boston, Massachusetts, summarized the available evidence on exposure to traffic-generated air pollution and negative health effects. They find strong evidence for a causative role for traffic related air pollution and premature death, particularly from heart attacks and strokes. $PM_{2.5}$ is emitted directly, and it is also produced by secondary formation, as sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions contribute to the formation of sulfate and nitrate particles. Exposure to $PM_{2.5}$ also causes other health effects such as asthma attacks, and other respiratory illnesses.

In this study, we evaluate the premature deaths resulting from people breathing primary $PM_{2.5}$ and secondarily-formed particles during periods of traffic congestion and compare that to the economic costs from time and fuel wasted. We do this analysis for 83 individual urban areas. We predict how much congestion to expect in each of the 83 urban areas over the period 2000 to 2030. We use several inter-linked models to predict how much of what people are breathing in each urban area is attributable to emissions from traffic congestion. The models predict how many people will die prematurely as a result of being exposed to these traffic conditions over the long term. We assign a dollar value to the predicted deaths using a "value of a statistical life" approach as is done for most regulatory impact analyses. The analysis explores the significance of public health impacts in assessments of predicted traffic congestion to identify information gaps to be addressed to better determine the ongoing public health burden of congestion in the United States, and to set the stage for evaluating potential strategies for relieving traffic congestion. Evaluating such strategies will require models and assumptions that take advantage of conditions and the context unique to each area.

We estimate traffic congestion-related PM_{2.5}, NOx and SO₂ emissions in these 83 cities caused approximately 4,000 premature deaths in the year 2000, with a monetized value of approximately \$31 billion (in 2007 dollars). This compares to the estimated \$60 billion congested-related cost of wasted time and fuel in these communities during the same year. This fuel and time loss is expected to continue to grow annually over the next 20 years. Across cities and years, the public health impacts of traffic congestion range from an order of magnitude less than the lost time/fuel economic impacts, to in excess of these impacts, with variation attributable to the extent of congestion, population density, and other factors.

We forecast the mortality and public health costs of congestion, however, will diminish slightly over time in most of the areas studied—until rising again toward the end of the modeling period, 2030. In 2005, for example, we estimate congestion-related premature mortality of 3,000 lives, with a monetized value of \$24 billion (in 2007 dollars). This reduction results from the continual turnover of the motor vehicle fleet to lower emission vehicles and the increased use of cleaner motor fuels.

Our estimates of the total public health cost of traffic congestion in the U.S. are likely conservative, in that they consider only the impacts in 83 urban areas and only the cost of related mortality and not the costs that could be associated with related morbidity, health care, insurance, accidents, and other factors. Our analyses indicate that the public health impacts of congestion are significant enough in magnitude, at least in some urban areas, to be considered in future evaluations of the benefits of policies to mitigate congestion.



Results

In total, across the 83 urban areas modeled, vehicle miles traveled (VMT) is projected to increase more than 30% from 2000 to 2030 (an increase from 2.97 billion daily VMT to 3.94 billion daily VMT), closely paralleling projected population growth in the urban areas of 32% (an increase from 133 million people to 176 million).

For 2005, nationwide estimates of traffic emissions attributable to time spent in congestion include approximately 1.2 million tons of NOx, 34,000 tons of SO₂, and 23,000 tons of PM_{2.5}. These emissions are associated with approximately 3,000 premature deaths in 2005 (Figure 1), with an economic valuation of \$24 billion (in 2007 dollars). Overall, nearly 48% of the impact over the 83 urban areas is attributable to NOx emissions, with 42% attributable

Nationwide estimates for 2005 of emissions attributable to congested traffic:

- **1.2 million tons of NOx**
- **34,000 tons of SO₂**
- **23,000 tons of PM_{2.5}**

These emissions are associated with approximately:

- **3,000 premature deaths**

The total social cost of these impacts:

- **\$24 billion**

By 2020, we predict:

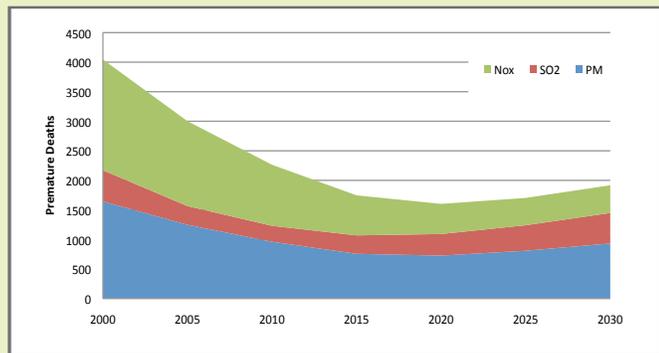
- **1,600 premature deaths**
- **\$13 billion in total social costs**

By 2030, we predict:

- **1,900 premature deaths**
- **\$17 billion in total social costs**

Figure 1

Projected Nationwide Premature Deaths Attributable to Congested Traffic, 2000 - 2030



This graph represents the nationwide estimates for premature deaths attributable to congested traffic for 2000-2030. The colored sections indicate the portion of these premature deaths attributable to NO_x, primary PM_{2.5} and SO₂.

to primary PM_{2.5} and 11% attributable to SO₂. However, the relative proportion of the impact attributable to different pollutants varies significantly across urban areas. For example, the proportion due to NO_x ranges from 6% in multiple Northeast cities (Hartford, CT; Boston, MA; New Haven, CT; Springfield, MA) to over 70% in less densely populated areas of Texas (Brownsville, Austin) and Washington State (Spokane).

Similarly, the proportion of impact due to primary PM_{2.5} is highest in densely-populated urban areas of the Northeast (approximately 80%) and below 20% in Brownsville. The proportion attributable to SO₂ emissions is highest in California, with four urban areas in California constituting the only places with more than 20% of the mortality risk from SO₂ emissions. These relative proportions are

attributable in part to high ambient sulfate in the eastern United States, which tends to reduce particulate nitrate formation, and to conditions in California favoring the secondary formation of particulate sulfate.

Figure 2

The Monetized Health Impacts Attributable to Congestion for Selected Urban Areas, 2000 - 2030

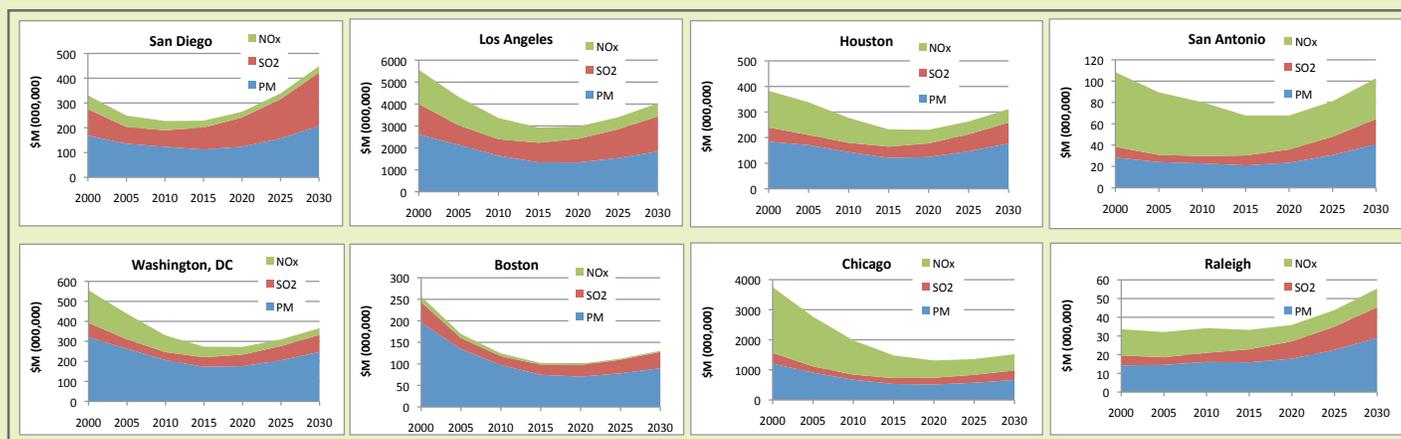
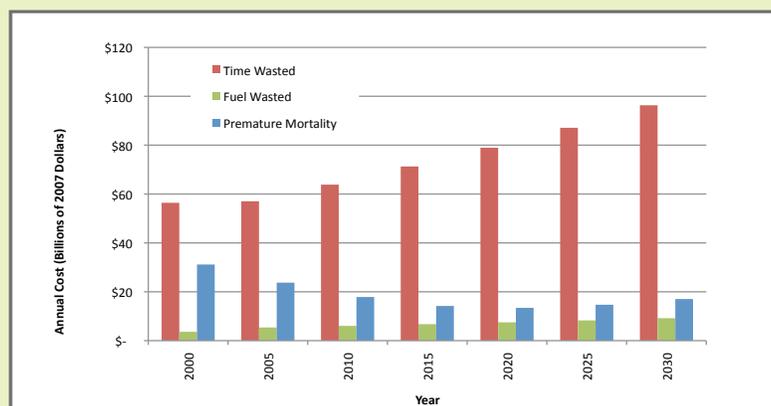


Figure 2 presents the monetized health impacts over time for selected urban areas. These trajectories differ as a function of differential population growth, congestion, population density and atmospheric chemistry. For example, monetized health impacts increase steadily over time in cities such as Raleigh NC and San Diego CA, in which VMT and population growth are significant and primary PM_{2.5} makes a substantial contribution to health risk. In contrast, Chicago and other cities in the Midwest are projected to have small VMT growth and have more substantial contributions to public health damages from NO_x emissions, and therefore show a steady decline in health risks over time given the larger decline in NO_x emissions per vehicle-mile.

Figure 3 presents the economic costs from time and fuel wasted and monetized estimates of premature mortality attributable to traffic congestion across the 83 urban areas. Overall, time wasted accounts for the bulk of the economic cost associated with traffic congestion, and the cost of delay continues to increase between 2000 and 2030, as this is directly proportional to the extent of congestion. In contrast, reductions in per-vehicle emissions contribute to declines in economic costs associated with premature mortality between 2000 and 2025, with modest increases after that point.

Monetized Premature Mortality as Compared to Projected Time & Fuel Dollars Wasted Attributable to Congested Traffic



As a result, whereas the public health impacts contributed approximately 34% of the total cost of congestion in 2000, this decreases to 14% by 2030. However, the proportion of health impacts attributable to premature mortality varies substantially across urban areas. For example, in 2000, 17 urban areas had health impacts contributing less than 20% of the total cost of congestion, whereas 19 urban areas had contributions in excess of 50%. Those urban areas with relatively small contributions from public health had very high levels of congestion (near or at the 50% threshold) but did not have correspondingly high population density, including Laredo TX, Eugene OR, and Las Vegas NV. In contrast, those urban areas where public health impacts dominated had smaller percentage of time spent in congestion but greater public health benefits per ton of emissions.

Frequently Asked Questions

How was the analysis conducted?

The key components of the analysis include predicting emissions corresponding with traffic congestion for 83 individual urban areas based on travel demand models, which predict how many vehicle-miles people will be traveling in each area. We develop estimates of changes in air pollution (based on $PM_{2.5}$ concentration) associated with these emissions, and apply a concentration-response function that predicts how many people will be impacted by breathing this air pollution. Finally, we assign a dollar value to the predicted number of premature deaths.

Where did we get our data?

We develop estimates of vehicle miles traveled (VMT) based on data and methods from the Center for Urban Transportation Research (CUTR) at the University of Central Florida. We use a model developed by the US EPA called MOBILE6 to estimate city-specific emissions per VMT based on year, temperature profile, and average vehicle speed. We focus on emissions from the baseline year (2000) until 2030. The analysis is conducted for 83 individual urban areas that were previously evaluated by the Texas Transportation Institute (in order to directly compare our results with their estimates of economic costs of congestion) and are in the lower 48 states.

To estimate the changes in air pollution associated with congestion-related emissions from each urban area, we applied a source-receptor (S-R) matrix. S-R matrix is a reduced-form model containing county-to-county transfer factors across the United States, considering both primary $PM_{2.5}$ and secondary formation of sulfate and nitrate particles. To determine the health effects, we use the same studies that the US EPA uses based on a combination of published epidemiological studies and an expert elicitation study addressing the concentration-response function for $PM_{2.5}$ -related mortality. To monetize the resulting estimates of

mortality attributable to congestion, we applied a value of a statistical life (VSL) of approximately \$7.7M in 2007 dollars (for 2000 GDP), the central estimate used in recent EPA regulatory impact analyses.

What does it mean?

Our modeling illustrates that the public health impacts of traffic during periods of congestion, associated with premature mortality from primary and secondary PM_{2.5} concentrations, are appreciable, with thousands of deaths per year and a monetized value of tens of billions of dollars per year. While the monetized public health damages are smaller than the economic value of time wasted, with the differential anticipated to grow over time, there are some geographic areas where public health damages represent a significant proportion of the total damages, even in future years when per-vehicle emissions are expected to be substantially less. Prior analyses of population exposure per unit emissions from motor vehicles demonstrated that these values were highest in dense urban areas for primary PM_{2.5} and secondary sulfate, especially in California, the mid-Atlantic states, and the industrial Midwest, and were highest in the Southeast and Midwest for secondary nitrate. The urban areas with the greatest proportion of damages from public health were often found in parts of California and the Midwest, where the damages per ton of emissions were greater and the projected future population growth was lower. These findings provide an indication that considering only the direct economic costs of congestion will underestimate societal benefits of mitigating congestion, significantly so in certain urban areas.

What did we leave out?

There are clearly numerous other health endpoints or pollutants that may contribute to the public health burden of congestion, including morbidity endpoints associated with PM_{2.5}, mortality and morbidity from ozone, and effects of multiple air toxics. This analysis assumed no change to road infrastructure from 2005 levels, and the models, out of necessity, do not use individualized models of traffic congestion in each urban area (that is, although population and traffic demand are specific to each area, the analysis does not consider road closures, construction, or other area-specific factors that might contribute to increases or decreases in congestion over particular time periods). It is important to note that these are not traffic planning models specific to each area. These are models that predict emissions of pollutants associated with congested conditions on broader scales. Therefore, the results are approximations and represent order-of-magnitude predictions. In addition, the relative proportions across pollutants and urban areas are more robust than the specific numeric estimates.

Where do we go from here?

These results indicate that public health impacts of traffic congestion exist and should be considered when evaluating long-term policy alternatives for addressing congestion such as traffic management through congestion pricing, traffic light synchronization and more efficient response to traffic incidents, and adding new highway and public transit capacity. This analysis represents a first step, and future analyses could incorporate more sophisticated approaches for predicting expected emissions under location-specific conditions as opposed to the generalized case presented here. This exploratory study was designed to evaluate the scope of the issue; more refined estimates are possible that would address urban-area specific alternatives and impacts.



The following tables provide supporting information for our analyses that did not appear in the published paper. Note that the estimates for individual urban areas are more uncertain than the overall estimates for all 83 urban areas combined, and should be interpreted with caution. The model does not capture the nuances and dynamics of each individual urban area. Traffic demand, for example, is based on a national model, not individual models specific to each location.

Table A: Forecasted Increase in Vehicle Miles Traveled (VMT) in 83 U.S. Urban Areas: 2000-2030

| Urban Area | Percent VMT Increase | | | | | |
|-----------------------------------|----------------------|-----------|-----------|-----------|-----------|-----------|
| | 2000-2005 | 2000-2010 | 2000-2015 | 2005-2020 | 2000-2025 | 2000-2030 |
| Akron, OH | 1% | 1% | 2% | 3% | 4% | 6% |
| Albany, NY | 3% | 4% | 4% | 5% | 6% | 7% |
| Albuquerque, NM | 2% | 8% | 14% | 19% | 23% | 28% |
| Allentown--Bethlehem, PA--NJ | -3% | 3% | 6% | 10% | 13% | 16% |
| Atlanta, GA | 7% | 14% | 19% | 22% | 24% | 27% |
| Austin, TX | 6% | 12% | 17% | 21% | 25% | 29% |
| Bakersfield, CA | 9% | 16% | 21% | 26% | 30% | 33% |
| Baltimore, MD | 1% | 4% | 9% | 13% | 17% | 20% |
| Beaumont, TX | -4% | -3% | -1% | 2% | 4% | 7% |
| Birmingham, AL | 1% | 4% | 6% | 9% | 12% | 15% |
| Boston, MA--NH--RI | -5% | -3% | -2% | 0% | 1% | 3% |
| Boulder, CO | 0% | 6% | 11% | 14% | 17% | 20% |
| Bridgeport--Stamford, CT--NY | 0% | 2% | 3% | 4% | 5% | 7% |
| Brownsville, TX | 6% | 10% | 14% | 17% | 20% | 23% |
| Buffalo, NY | -3% | -3% | -3% | -2% | -1% | 0% |
| Cape Coral, FL | 8% | 20% | 25% | 30% | 34% | 38% |
| Charleston--North Charleston, SC | 3% | 11% | 18% | 25% | 28% | 32% |
| Charlotte, NC--SC | 4% | 13% | 17% | 21% | 25% | 28% |
| Chicago, IL--IN | 1% | 3% | 5% | 6% | 8% | 10% |
| Cincinnati, OH--KY--IN | -4% | -3% | -1% | 0% | 2% | 3% |
| Cleveland, OH | -6% | -8% | -9% | -10% | -11% | -12% |
| Colorado Springs, CO | -2% | 6% | 12% | 17% | 22% | 27% |
| Columbia, SC | -2% | 7% | 15% | 23% | 31% | 36% |
| Columbus, OH | -1% | 2% | 6% | 10% | 13% | 17% |
| Corpus Christi, TX | 1% | 6% | 12% | 19% | 25% | 29% |
| Dallas--Fort Worth--Arlington, TX | 8% | 15% | 18% | 21% | 24% | 27% |
| Dayton, OH | -8% | -8% | -8% | -8% | -7% | -6% |
| Denver--Aurora, CO | 0% | 7% | 10% | 13% | 16% | 19% |
| Detroit, MI | -3% | -3% | -2% | -2% | -1% | 0% |
| El Paso, TX--NM | 3% | 7% | 11% | 15% | 19% | 22% |
| Eugene, OR | 1% | 7% | 12% | 16% | 19% | 22% |
| Fresno, CA | 3% | 9% | 14% | 19% | 22% | 25% |
| Grand Rapids, MI | -15% | -9% | -3% | 2% | 8% | 14% |
| Hartford, CT | -2% | -1% | 0% | 2% | 4% | 5% |
| Houston, TX | 8% | 12% | 15% | 17% | 20% | 23% |
| Indianapolis, IN | 4% | 8% | 12% | 15% | 19% | 22% |
| Jacksonville, FL | 5% | 15% | 19% | 23% | 28% | 32% |
| Kansas City, MO--KS | 0% | 8% | 15% | 21% | 28% | 35% |

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Urban Area

Percent VMT Increase

| | 2000-2005 | 2000-2010 | 2000-2015 | 2005-2020 | 2000-2025 | 2000-2030 |
|--|-----------|-----------|-----------|-----------|-----------|-----------|
| Laredo, TX | 8% | 16% | 22% | 28% | 33% | 38% |
| Las Vegas, NV | 15% | 25% | 32% | 37% | 42% | 46% |
| Little Rock, AR | -8% | -5% | -3% | 0% | 3% | 6% |
| Los Angeles--Long Beach--Santa Ana, CA | 2% | 4% | 5% | 7% | 8% | 10% |
| Louisville, KY--IN | 0% | 2% | 4% | 6% | 8% | 10% |
| Memphis, TN--MS--AR | -3% | -1% | 1% | 3% | 5% | 8% |
| Miami, FL | 4% | 8% | 13% | 18% | 22% | 26% |
| Milwaukee, WI | -5% | -4% | -3% | -1% | 0% | 2% |
| Minneapolis--St. Paul, MN | 0% | 5% | 9% | 14% | 17% | 20% |
| Nashville-Davidson, TN | -12% | -3% | 4% | 11% | 17% | 24% |
| New Haven, CT | -2% | 1% | 4% | 7% | 9% | 12% |
| New Orleans, LA | -3% | -36% | -25% | -15% | -8% | -2% |
| New York--Newark, NY--NJ--CT | 1% | 2% | 3% | 5% | 6% | 8% |
| Oklahoma City, OK | 3% | 9% | 13% | 16% | 19% | 23% |
| Omaha, NE--IA | 5% | 10% | 14% | 19% | 23% | 27% |
| Orlando, FL | 6% | 18% | 27% | 32% | 37% | 41% |
| Oxnard, CA | 5% | 15% | 25% | 34% | 42% | 47% |
| Pensacola, FL--AL | -7% | 4% | 12% | 19% | 26% | 31% |
| Philadelphia, PA--NJ--DE--MD | 0% | 2% | 3% | 4% | 5% | 7% |
| Phoenix--Mesa, AZ | 8% | 15% | 20% | 24% | 29% | 33% |
| Pittsburgh, PA | -6% | -6% | -4% | -2% | 0% | 3% |
| Portland, OR--WA | 4% | 7% | 10% | 13% | 16% | 19% |
| Providence, RI--MA | -1% | 1% | 4% | 7% | 10% | 13% |
| Raleigh, NC | 11% | 28% | 37% | 43% | 49% | 54% |
| Richmond, VA | -4% | 5% | 14% | 22% | 31% | 36% |
| Riverside--San Bernardino, CA | 9% | 15% | 19% | 24% | 28% | 31% |
| Rochester, NY | 0% | 0% | 0% | 0% | 1% | 3% |
| Sacramento, CA | 6% | 10% | 14% | 18% | 22% | 25% |
| St. Louis, MO--IL | 1% | 1% | 1% | 2% | 2% | 3% |
| Salem, OR | 5% | 11% | 15% | 20% | 25% | 29% |
| Salt Lake City, UT | 6% | 17% | 27% | 35% | 40% | 45% |
| San Antonio, TX | 5% | 15% | 22% | 28% | 35% | 42% |
| San Diego, CA | 1% | 10% | 15% | 20% | 26% | 31% |
| San Francisco--Oakland, CA | 0% | 1% | 2% | 3% | 5% | 6% |
| San Jose, CA | 1% | 2% | 3% | 4% | 5% | 6% |
| Sarasota--Bradenton, FL | 8% | 17% | 25% | 33% | 39% | 45% |
| Seattle, WA | 2% | 6% | 8% | 11% | 14% | 17% |
| Spokane, WA--ID | 2% | 8% | 14% | 20% | 25% | 30% |
| Springfield, MA--CT | -6% | -5% | -5% | -4% | -2% | -1% |
| Tampa--St. Petersburg, FL | 4% | 7% | 10% | 13% | 15% | 18% |
| Toledo, OH--MI | -5% | -6% | -5% | -5% | -4% | -2% |
| Tucson, AZ | 5% | 12% | 19% | 23% | 26% | 29% |
| Tulsa, OK | -8% | -2% | 4% | 10% | 16% | 22% |
| Virginia Beach, VA | -1% | 3% | 7% | 10% | 14% | 17% |
| Washington, DC--VA--MD | 3% | 5% | 7% | 9% | 11% | 13% |

Table B provides estimates of premature mortality and associated social costs across selected years to 2030 for each of the 83 urban areas. While estimates in all individual urban areas were not reported in the published paper, they are included below to provide perspective on the relative proportion of expected impacts across the 83 modeled areas. Given the underlying uncertainties and simplifications in the modeling approach, although the values are listed below with multiple significant figures for ease of comparison, the values in this table should be interpreted as order of magnitude estimates of the potential public health impacts.

Table B: Estimated Selective Public Health Impacts of Traffic Congestion With Status Quo Infrastructure & Mobility Options in 83 U.S. Urban Areas: 2000 - 2030

| | 2000 | | 2005 | | 2010 | | 2015 | | 2020 | | 2025 | | 2030 | |
|--|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|
| | EPD | \$M |
| Akron, OH | 8 | 63 | 6 | 47 | 4 | 34 | 3 | 27 | 3 | 26 | 3 | 28 | 4 | 32 |
| Albany, NY | <2 | 9 | <2 | 7 | <2 | 5 | <2 | 4 | <1 | 4 | <2 | 4 | <2 | 5 |
| Albuquerque, NM | 4 | 32 | 3 | 25 | 3 | 21 | 2 | 17 | 2 | 17 | 2 | 19 | 3 | 23 |
| Allentown--Bethlehem, PA--NJ | 6 | 44 | 4 | 31 | 3 | 25 | 3 | 21 | 3 | 21 | 3 | 24 | 3 | 29 |
| Atlanta, GA | 93 | 717 | 80 | 633 | 70 | 549 | 56 | 454 | 52 | 431 | 55 | 476 | 62 | 549 |
| Austin, TX | 17 | 129 | 14 | 110 | 12 | 92 | 9 | 73 | 8 | 67 | 8 | 73 | 10 | 85 |
| Bakersfield, CA | 2 | 17 | 2 | 15 | 2 | 13 | <2 | 11 | <2 | 11 | 2 | 13 | 2 | 16 |
| Baltimore, MD | 65 | 499 | 45 | 354 | 32 | 252 | 24 | 195 | 22 | 183 | 23 | 200 | 26 | 228 |
| Beaumont, TX | <1 | 2 | <1 | 2 | <1 | <2 | <1 | <2 | <1 | <2 | <1 | <2 | <1 | <2 |
| Birmingham, AL | 9 | 66 | 6 | 48 | 5 | 36 | 4 | 29 | 3 | 27 | 3 | 29 | 4 | 33 |
| Boston, MA--NH--RI | 33 | 257 | 21 | 169 | 16 | 125 | 13 | 102 | 12 | 100 | 13 | 112 | 15 | 130 |
| Boulder, CO | <2 | 8 | <2 | 6 | <2 | 5 | <2 | 4 | <2 | 4 | <2 | 4 | <2 | 5 |
| Bridgeport--Stamford, CT--NY | 11 | 83 | 8 | 62 | 6 | 47 | 5 | 38 | 4 | 37 | 5 | 40 | 5 | 46 |
| Brownsville, TX | 4 | 28 | 3 | 25 | 3 | 20 | 2 | 15 | 2 | 13 | 2 | 14 | 2 | 16 |
| Buffalo, NY | 4 | 34 | 3 | 23 | 2 | 16 | 2 | 13 | <2 | 12 | 2 | 14 | 2 | 16 |
| Cape Coral, FL | 10 | 78 | 9 | 75 | 10 | 76 | 8 | 65 | 8 | 64 | 8 | 73 | 10 | 91 |
| Charleston--North Charleston, SC | 2 | 18 | 2 | 14 | 2 | 13 | 2 | 12 | 2 | 14 | 2 | 17 | 2 | 21 |
| Charlotte, NC--SC | 16 | 120 | 13 | 102 | 12 | 92 | 10 | 78 | 9 | 78 | 10 | 89 | 12 | 105 |
| Chicago, IL--IN | 487 | 3,751 | 350 | 2,770 | 251 | 1,982 | 182 | 1,481 | 157 | 1,313 | 158 | 1,361 | 171 | 1,520 |
| Cincinnati, OH--KY--IN | 60 | 460 | 41 | 321 | 28 | 220 | 19 | 154 | 15 | 129 | 15 | 129 | 16 | 139 |
| Cleveland, OH | 34 | 262 | 21 | 165 | 14 | 111 | 10 | 84 | 9 | 77 | 9 | 79 | 10 | 86 |
| Colorado Springs, CO | 4 | 29 | 3 | 21 | 2 | 18 | 2 | 15 | 2 | 14 | 2 | 15 | 2 | 18 |
| Columbia, SC | 2 | 17 | 2 | 12 | <2 | 11 | <2 | 10 | <2 | 11 | 2 | 14 | 2 | 18 |
| Columbus, OH | 19 | 150 | 14 | 109 | 11 | 83 | 8 | 69 | 8 | 68 | 9 | 76 | 10 | 89 |
| Corpus Christi, TX | 2 | 18 | 2 | 13 | <2 | 11 | <2 | 9 | <2 | 9 | <2 | 10 | <2 | 12 |
| Dallas--Fort Worth--Arlington, TX | 122 | 941 | 103 | 816 | 85 | 671 | 62 | 507 | 54 | 455 | 56 | 483 | 62 | 547 |
| Dayton, OH | 21 | 161 | 13 | 103 | 9 | 70 | 6 | 48 | 5 | 40 | 5 | 39 | 5 | 42 |
| Denver--Aurora, CO | 41 | 319 | 31 | 245 | 24 | 192 | 18 | 144 | 15 | 126 | 15 | 132 | 17 | 148 |
| Detroit, MI | 173 | 1,333 | 116 | 918 | 76 | 603 | 52 | 421 | 43 | 357 | 41 | 355 | 43 | 381 |
| El Paso, TX--NM | 9 | 69 | 7 | 56 | 6 | 47 | 5 | 40 | 5 | 40 | 5 | 47 | 7 | 58 |
| Eugene, OR | <2 | 5 | <2 | 4 | <1 | 4 | <1 | 3 | <1 | 3 | <1 | 4 | <2 | 5 |
| Fresno, CA | 9 | 70 | 7 | 58 | 6 | 49 | 5 | 42 | 5 | 42 | 5 | 47 | 6 | 56 |
| Grand Rapids, MI | 8 | 62 | 5 | 36 | 4 | 28 | 3 | 22 | 2 | 21 | 3 | 23 | 3 | 27 |
| Hartford, CT | 7 | 54 | 5 | 38 | 4 | 29 | 3 | 24 | 3 | 23 | 3 | 26 | 3 | 30 |
| Houston, TX | 50 | 383 | 43 | 338 | 35 | 277 | 29 | 232 | 28 | 231 | 30 | 263 | 35 | 311 |
| Indianapolis, IN | 34 | 264 | 27 | 210 | 19 | 153 | 14 | 113 | 12 | 100 | 12 | 103 | 13 | 112 |
| Jacksonville, FL | 5 | 39 | 4 | 32 | 4 | 29 | 3 | 25 | 3 | 26 | 3 | 30 | 4 | 36 |
| Kansas City, MO--KS | 18 | 142 | 14 | 108 | 11 | 88 | 8 | 67 | 7 | 62 | 8 | 69 | 9 | 84 |
| Laredo, TX | <2 | 4 | <1 | 4 | <1 | 3 | <1 | 3 | <1 | 3 | <1 | 4 | <2 | 5 |
| Las Vegas, NV | 4 | 34 | 5 | 36 | 4 | 34 | 4 | 33 | 4 | 37 | 5 | 46 | 7 | 61 |
| Little Rock, AR | 3 | 22 | 2 | 14 | <2 | 10 | <2 | 8 | <2 | 7 | <2 | 7 | <2 | 7 |
| Los Angeles--Long Beach--Santa Ana, CA | 722 | 5,564 | 547 | 4,324 | 426 | 3,362 | 360 | 2,924 | 355 | 2,974 | 394 | 3,396 | 454 | 4,038 |

EPD = Estimated Premature Deaths

\$M = Estimated Cost in Millions of U.S. Dollars (2007 \$)

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Table B Continued:

Estimated Selective Public Health Impacts of Traffic Congestion With Status Quo Infrastructure & Mobility Options in 83 U.S. Urban Areas: 2000 - 2030

| | 2000 | | 2005 | | 2010 | | 2015 | | 2020 | | 2025 | | 2030 | |
|-------------------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|
| | EPD | \$M |
| Louisville, KY--IN | 34 | 265 | 24 | 192 | 17 | 138 | 12 | 101 | 11 | 89 | 11 | 91 | 11 | 99 |
| Memphis, TN--MS--AR | 16 | 123 | 11 | 84 | 8 | 62 | 6 | 48 | 5 | 44 | 5 | 47 | 6 | 52 |
| Miami, FL | 62 | 474 | 47 | 370 | 40 | 316 | 36 | 293 | 38 | 316 | 44 | 379 | 53 | 473 |
| Milwaukee, WI | 40 | 308 | 26 | 205 | 18 | 142 | 13 | 102 | 11 | 88 | 10 | 90 | 11 | 99 |
| Minneapolis--St. Paul, MN | 66 | 505 | 48 | 380 | 37 | 295 | 29 | 236 | 27 | 225 | 28 | 245 | 32 | 282 |
| Nashville-Davidson, TN | 11 | 84 | 6 | 50 | 5 | 42 | 4 | 34 | 4 | 32 | 4 | 36 | 5 | 43 |
| New Haven, CT | 5 | 35 | 3 | 25 | 2 | 19 | 2 | 17 | 2 | 17 | 2 | 19 | 3 | 22 |
| New Orleans, LA | 10 | 76 | 6 | 51 | 2 | 17 | 2 | 16 | 2 | 19 | 3 | 23 | 3 | 29 |
| New York--Newark, NY--NJ--CT | 644 | 4,962 | 477 | 3,768 | 337 | 2,658 | 244 | 1,981 | 212 | 1,772 | 215 | 1,859 | 234 | 2,079 |
| Oklahoma City, OK | 16 | 120 | 12 | 94 | 9 | 73 | 6 | 52 | 5 | 44 | 5 | 44 | 5 | 48 |
| Omaha, NE--IA | 7 | 53 | 6 | 45 | 4 | 34 | 3 | 26 | 3 | 23 | 3 | 25 | 3 | 28 |
| Orlando, FL | 25 | 196 | 21 | 169 | 21 | 166 | 19 | 157 | 19 | 161 | 22 | 191 | 27 | 236 |
| Oxnard, CA | 4 | 29 | 3 | 24 | 3 | 22 | 3 | 24 | 3 | 29 | 5 | 39 | 6 | 51 |
| Pensacola, FL--AL | 3 | 23 | 2 | 15 | 2 | 14 | 2 | 12 | <2 | 12 | 2 | 14 | 2 | 17 |
| Philadelphia, PA--NJ--DE--MD | 149 | 1,145 | 102 | 806 | 71 | 561 | 51 | 416 | 45 | 374 | 46 | 395 | 50 | 441 |
| Phoenix--Mesa, AZ | 19 | 148 | 17 | 134 | 15 | 116 | 13 | 102 | 12 | 104 | 14 | 123 | 17 | 152 |
| Pittsburgh, PA | 18 | 137 | 11 | 87 | 8 | 63 | 6 | 51 | 6 | 51 | 7 | 57 | 8 | 69 |
| Portland, OR--WA | 20 | 154 | 16 | 129 | 13 | 101 | 10 | 81 | 9 | 75 | 9 | 81 | 11 | 94 |
| Providence, RI--MA | 11 | 81 | 7 | 59 | 6 | 44 | 5 | 38 | 5 | 39 | 5 | 45 | 6 | 55 |
| Raleigh, NC | 4 | 34 | 4 | 32 | 4 | 34 | 4 | 33 | 4 | 36 | 5 | 44 | 6 | 55 |
| Richmond, VA | 6 | 45 | 4 | 30 | 3 | 27 | 3 | 25 | 3 | 29 | 4 | 38 | 5 | 49 |
| Riverside--San Bernardino, CA | 13 | 98 | 11 | 90 | 10 | 80 | 10 | 79 | 11 | 89 | 13 | 111 | 16 | 144 |
| Rochester, NY | 3 | 24 | 2 | 17 | <2 | 13 | <2 | 10 | <2 | 9 | <2 | 10 | <2 | 12 |
| Sacramento, CA | 69 | 533 | 60 | 471 | 48 | 378 | 39 | 316 | 36 | 305 | 40 | 343 | 46 | 412 |
| St. Louis, MO--IL | 103 | 797 | 74 | 589 | 51 | 399 | 34 | 273 | 27 | 224 | 25 | 218 | 26 | 227 |
| Salem, OR | <1 | 3 | <1 | 2 | <1 | 2 | <1 | 2 | <1 | 2 | <1 | 2 | <1 | 2 |
| Salt Lake City, UT | 5 | 42 | 5 | 37 | 4 | 34 | 4 | 31 | 4 | 34 | 5 | 39 | 6 | 49 |
| San Antonio, TX | 14 | 108 | 11 | 89 | 10 | 80 | 8 | 68 | 8 | 68 | 9 | 81 | 12 | 103 |
| San Diego, CA | 43 | 331 | 31 | 249 | 29 | 227 | 28 | 229 | 32 | 265 | 39 | 339 | 50 | 449 |
| San Francisco--Oakland, CA | 235 | 1,813 | 170 | 1,345 | 124 | 981 | 90 | 733 | 77 | 649 | 78 | 675 | 85 | 751 |
| San Jose, CA | 42 | 323 | 31 | 248 | 24 | 191 | 19 | 156 | 18 | 149 | 19 | 163 | 21 | 188 |
| Sarasota--Bradenton, FL | 2 | 12 | <2 | 11 | <2 | 9 | <2 | 8 | <2 | 8 | <2 | 9 | <2 | 12 |
| Seattle, WA | 32 | 246 | 26 | 203 | 21 | 162 | 16 | 128 | 14 | 119 | 15 | 128 | 17 | 149 |
| Spokane, WA--ID | <2 | 7 | <2 | 5 | <2 | 5 | <1 | 4 | <1 | 4 | <1 | 4 | <2 | 5 |
| Springfield, MA--CT | <2 | 5 | <1 | 3 | <1 | 2 | <1 | 2 | <1 | 2 | <1 | 2 | <1 | 2 |
| Tampa--St. Petersburg, FL | 80 | 619 | 61 | 482 | 45 | 357 | 33 | 265 | 28 | 233 | 28 | 238 | 29 | 260 |
| Toledo, OH--MI | 12 | 91 | 8 | 60 | 5 | 40 | 3 | 28 | 3 | 24 | 3 | 24 | 3 | 26 |
| Tucson, AZ | 4 | 31 | 3 | 26 | 3 | 23 | 3 | 21 | 2 | 21 | 3 | 24 | 3 | 29 |
| Tulsa, OK | 9 | 68 | 5 | 43 | 4 | 35 | 3 | 26 | 3 | 24 | 3 | 25 | 3 | 29 |
| Virginia Beach, VA | 13 | 102 | 9 | 74 | 7 | 59 | 6 | 53 | 7 | 56 | 8 | 67 | 9 | 82 |
| Washington, DC--VA--MD | 72 | 556 | 55 | 438 | 42 | 330 | 34 | 273 | 33 | 272 | 36 | 310 | 41 | 366 |
| Total | 4,045 | 31,161 | 3,001 | 23,736 | 2,264 | 17,861 | 1,746 | 14,192 | 1,602 | 13,412 | 1,703 | 14,690 | 1,917 | 17,034 |

EPD = Estimated Premature Deaths

\$M = Estimated Cost in Millions of U.S. Dollars (2007 \$)



The Harvard Center for Risk Analysis (HCRA), founded in 1989, is recognized as a world-leader in applying decision theory, environmental and health science, and economics to a broad range of important environmental and public health issues. HCRA is a research institute within the Harvard School of Public Health, which has the objective of using a variety of analytic methods to inform public policy decisions relevant to public health. Our researchers enjoy successful collaborations across disciplines, and a hallmark of our work is synthesizing and integrating basic environmental sciences with social sciences to better inform decision making. We regularly host interdisciplinary seminars. Since 1993, HCRA has been publishing *Risk in Perspective*, a periodic publication available from our website (www.hcra.harvard.edu). Currently, HCRA hosts the Research Translation Core for a Superfund Basic Research program grant focused on gene-environment interactions (www.srphsph.harvard.edu) and is responsible for developing and communicating policy-relevant research based on the results of studies from partners across the University and MIT.

Authors



Jonathan I. Levy is a Professor of Environmental Health in the Department of Environmental Health at Boston University School of Public Health. He received his Sc.D. from the Harvard School of Public Health in Environmental Science and Risk Management, with a B.A. in Applied Mathematics from Harvard College. His primary research interests involve methods and applications related to air pollution exposure assessment and health risk assessment, including multiple studies of exposures and health risks for fine particulate matter, ozone, and other criteria air pollutants. Dr. Levy was the recipient of the Walter A. Rosenblith New Investigator Award from the Health Effects Institute in 2005. He served on the NRC Committee on the Effects of Changes in New Source Review Programs for Stationary Sources of Air Pollutants, the NRC Committee on Improving Risk Analysis Methods Used by the U.S. EPA, and currently serves on the NRC/IOM Committee to Develop Framework and Guidance for Health Impact Assessment. He is currently a member of the Advisory Council on Clean Air Compliance Analysis, which provides guidance to U.S. EPA on its evaluations of the benefits and costs of the Clean Air Act Amendments (CAAA) of 1990. Dr. Levy was an associate professor at the Harvard School of Public Health when this work was conducted.



Jonathan Buonocore is a doctoral student in the Environmental Science and Risk Management program at the Department of Environmental Health at Harvard School of Public Health and is a member of the Harvard University Graduate Consortium on Energy & Environment. His research interests are in risk assessment and life cycle assessment on topics relevant to both public health and climate change. His thesis work is on the full life cycle benefits of electrical efficiency and alternative energy.



Katherine von Stackelberg is a Research Manager at the Harvard Center for Risk Analysis at the Harvard School of Public Health and a Principal at E Risk Sciences, LLP. She received her Sc.D. and Sc.M. from the Harvard School of Public Health in Environmental Science and Risk Management, and an A.B. from Harvard College. She specializes in developing risk-based tools and methods to support sustainable approaches to environmental decision-making. Much of her work has focused on incorporating quantitative uncertainty analysis (e.g., analytical, probabilistic, and fuzzy methods) into the environmental management process, and she has been at the forefront of the effort to explore methods for effectively communicating and interpreting scientific uncertainty to support environmental decision-making. Dr. von Stackelberg serves on the US EPA Board of Scientific Counselors and is leading an effort to explore the use of decision analytic tools and methods to support environmental decision making within the Office of Research and Development, and is a member of the Scientific Advisors on Risk Assessment for the European Commission in Brussels. She is also a Co-Director of the Research Translation Core under a Superfund Basic Research Program grant at the Harvard School of Public Health.

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