Growing Cooler: The Evidence on Urban Development and Climate Change

Reid Ewing
Department of City and Metropolitan Planning
University of Utah
“The report confirms that warming in the climate system is unequivocal, with many of the observed changes unprecedented over decades to millenia: warming of the atmosphere and the ocean, diminishing snow and ice, rising sea levels and increasing concentrations of greenhouse gases.”
CO2 Build Up

Atmospheric CO$_2$ at Mauna Loa Observatory

Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
Global Mean Temperatures
Ten Hottest Years on Record

10 WARMEST YEARS ON RECORD GLOBALLY

* All Since 1998 *


1.2° 1.1° 1.0° 0.9°

Source: NOAA/NCDC
Record since 1880

CLIMATE CENTRAL

Departure from 20th century average (°F)
Global Warming Fingerprints

The rate of sea ice loss has increased in the past 20 years.
Global Warming Fingerprints

According to the Climate Change Impacts Report, since the 1980s hurricanes in North America have increased in frequency and strength.
Global Warming Fingerprints
Global Warming Fingerprints


Global Warming Fingerprints


Sources: NOAA/NCDC (1980 - 2011)
AON Benfield (2012, through October)
In Growing Cooler, you were very optimistic about the potential for smart growth and coordinated LU and transportation planning to achieve significant GHG reductions. But that was six years ago, and much (well some) has been published since calling that particular pathway into question. Or, even if it were technically possible, what with the rise of the tea party and all, it might be politically difficult. Are you still so favorably inclined toward smart growth-type solutions? Or, might technological improvements, fuel substitution, more renewables, and even carbon capture be a more productive GHG reduction pathway? I know you will do a great job revisiting your past work and conclusions and rethinking them for a new and different world.
Is It Too Late to Develop in a Different Way?
2/3rd of Development in 2050

- U.S. population will grow to 420 million by 2050
- 89 million new or replaced homes
- 60 billion square feet of new offices, institutions, stores, and other nonresidential + 130 billion of replaced space
Is the Market Ready for Compact Development?
Community A

There are only single-family houses on large lots

There are no sidewalks

Places such as shopping, restaurants, a library, and a school are within a few miles of your home and you have to drive most places

There is enough parking when you drive to local stores, restaurants, and other places

Public transportation, such as bus, subway, light rail, or commuter rail, is distant or unavailable

Community B

There is a mix of single-family detached houses, townhouses, apartments, and condominiums on various sized lots

Almost all of the streets have sidewalks

Places such as shopping, restaurants, a library, and a school are within a few blocks of your home and you can either walk or drive

Parking is limited when you decide to drive to local stores, restaurants, and other places

Public transportation, such as bus, subway, light rail, or commuter rail, is nearby
More than Half of Americans

56% of Americans select the smart growth community and 44% select the sprawl community.
Will the Market for Compact Development Continue to Grow?
Silver Tsunami

People Turning 65 in Year (in 1,000s)

Year

1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
## Decline in Households with Kids

<table>
<thead>
<tr>
<th>Household</th>
<th>1960</th>
<th>2000</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>With Children</td>
<td>48%</td>
<td>33%</td>
<td>28%</td>
</tr>
<tr>
<td>Without Children</td>
<td>52%</td>
<td>67%</td>
<td>72%</td>
</tr>
<tr>
<td>Single</td>
<td>13%</td>
<td>26%</td>
<td>28%</td>
</tr>
</tbody>
</table>

*Source: Census for 1960 and 2000, 2025 adapted from Martha Farnsworth Riche, How Changes in the Nation’s Age and Household Structure Will Reshape Housing Demand in the 21st Century, HUD (2003).*
Chapter 3
Aggressive Case: 50 mpg in 2030 & -20% Fuel GHG

Source: S. Winkelman based on EIA AEO 2008 (revised), HR6, stock model calculations and sources cited in Growing Cooler.
Chapter 4
Main Question Addressed

What reduction in vehicle miles traveled (VMT) is possible in the United States with compact development rather than continuing urban sprawl?
Portland vs. Raleigh
35% Less VMT with Compact Development

New York, NY  Providence, RI  San Francisco, CA  Honolulu, HI  Boston, MA  Portland, OR  New Orleans, LA  Dallas-Fort Worth, TX  Greenville-Spartanburg, SC  Knoxville, TN  Atlanta, GA  Raleigh-Durham, NC  Greensboro-Winston-Salem, NC  Riverside-San Bernardino, CA

VMT per Capita

0 5 10 15 20 25 30 35 40

14.7 21.5 22.0 20.3 22.9 19.9 15.2 26.3 33.2 28.9 29.2 33.4 28.9 22.8
Disaggregate Travel Studies
Southern Village (40% lower)
Not True Today

- More than 200 Empirical Studies
- Collectively Relate All Aspects of Travel to All Aspects of Built Environment
- Vast Majority Control for Sociodemographic Differences
- Vast Majority Use Statistical Methods
- A Few Come Close to the Normative Model
### Weighted Average Elasticity of VMT

**Table 3. Weighted average elasticities of VMT with respect to built-environment variables.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total number of studies</th>
<th>Number of studies with controls for self-selection</th>
<th>Weighted average elasticity of VMT((\varepsilon))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Density</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household/population density</td>
<td>9</td>
<td>1</td>
<td>-0.04</td>
</tr>
<tr>
<td>Job density</td>
<td>6</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Diversity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use mix (entropy index)</td>
<td>10</td>
<td>0</td>
<td>-0.09</td>
</tr>
<tr>
<td>Jobs-housing balance</td>
<td>4</td>
<td>0</td>
<td>-0.02</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intersection/street density</td>
<td>6</td>
<td>0</td>
<td>-0.12</td>
</tr>
<tr>
<td>% 4-way intersections</td>
<td>3</td>
<td>1</td>
<td>-0.12</td>
</tr>
<tr>
<td><strong>Destination accessibility</strong></td>
<td>5</td>
<td>0</td>
<td>-0.20</td>
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<tr>
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<td>5</td>
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<td>0</td>
<td>-0.05</td>
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<td></td>
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</tr>
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</table>
Regional Simulations

**Basecase Scenario**

**Preferred Scenario**

- Areas of existing and future development
Simulation Results

26% reduction in VMT by 2050

15% reduction in CO$_2$ by 2050
Atlantic Station vs. Henry County
1/3 Savings Due to Regional Accessibility
Update
Actual Results Are Better

- 8 VMT per Day for Residents
- 11 VMT per Day for Employees
Answer to 1st Question

20-40% VMT Reduction for Each Increment of Compact Development
Doing the Math through 2050

\[
\text{60-90\% Compact} \times \text{67\% New Development} \times \text{30\% VMT Reduction} = \text{12-18\% Reduction in Metropolitan VMT}
\]
Add Smart Growth -15% VMT → 2030 CO$_2$ is 14% below 1990

Source: S. Winkelman based on EIA AEO 2008 (revised), HR6, stock model calculations and sources cited in Growing Cooler.
Chapter 8

The Combined Effect of Compact Development, Transportation Investments, and Road Pricing
What Would It Take?

- What would it take to reach the 2030 CO$_2$ reduction target of 33 percent below 1990 levels?
- Will compact development with supportive transportation policies be enough?
- If not, how much VMT reduction must be achieved through pricing, and what price changes would be required?
Table 9. Best-estimate elasticity values.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>pop</td>
<td>0.95</td>
<td>0.21</td>
<td>0.29</td>
<td>0.55</td>
<td>0.75</td>
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<td>0.12</td>
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<td>0.19</td>
<td>0.20</td>
<td>0.15</td>
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<td>olm</td>
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<td>0.42</td>
<td>0.04</td>
<td>0.01</td>
<td>0.20</td>
</tr>
<tr>
<td>trm</td>
<td>−0.06</td>
<td>0.016</td>
<td>−0.01</td>
<td>−0.03</td>
<td></td>
</tr>
<tr>
<td>fuel</td>
<td>−0.17</td>
<td>−0.45</td>
<td>−0.08</td>
<td>−0.20</td>
<td></td>
</tr>
<tr>
<td>den</td>
<td>−0.30</td>
<td>−0.38</td>
<td>−0.24</td>
<td>−0.08</td>
<td>−0.25</td>
</tr>
</tbody>
</table>
Compact Development + Transit + Road Pricing - Highway Expansion = 38% VMT reduction by 2030
Response to Special Report 298 Driving and the built environment: the effects of compact development on motorized travel, energy use, and \( \text{CO}_2 \) emissions
Both *Growing Cooler* and *NAS Report* agree that development needs to become more compact in order to address climate and energy goals.

However, the estimated VMT and greenhouse gas reductions from such development *differ* between these reports due to *different assumptions about the future.*
Different projected VMT, energy and CO2 outcomes

Projects reductions in VMT and associated energy use and CO2 emissions

<table>
<thead>
<tr>
<th>NAS report</th>
<th>Moderate scenario</th>
<th>Upper-bound scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>1%</td>
<td>7 – 8%</td>
</tr>
<tr>
<td>2050</td>
<td>1.3 – 1.7%</td>
<td>8 – 11%</td>
</tr>
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Growing Cooler 12 – 18%
Different rates of development and redevelopment

- Growing cooler and NAS report assume approximately the same number of new housing units will be required.
- But, ...

**Growing Cooler**

- Commercial and institutional:
  - 190 billion new square feet of non-residential space between 2005 to 2050

**NAS report**

- Commercial and institutional:
  - Not predicted

- Replacement housing:
  - Replacement rate - 0.6% per year, home lasts nearly 170 years (Nelson, 2004)

- Replacement housing:
  - Replacement rate - 0.2% per year, home lasts nearly 500 years (Pitkin & Myers, 2008)
Between 2010 and 2050, more single-person households will be added than households with children.

There is enough large lot single-family development on the ground today to meet the entire demand in 2025 (Nelson 2006).
Different travel patterns associated with compact development

Growing cooler

Compact development

Denser development, land use mix, population & job centers, and pedestrian-friendly design

NAS report

Compact development

Denser development

Table 1. Weighted average elasticities of VMT with respect to 5D variables (Ewing and Cervero 2010).

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Lack of progress on global agreements has pushed action down to the subnational level.
Portland Case Study
Timeline and Goals

1989
Oregon legislature first establishes carbon-reduction goal

1992
Rio Earth Summit (United Nations Framework Convention on Climate Change)

1993
City of Portland Carbon Dioxide Reduction Strategy

1997
Kyoto Protocol

2001
Portland/Multnomah Local Action Plan on Global Warming

2005
Oregon Strategy for Greenhouse Gas Reductions

2007
Multnomah County joins Cool Counties Initiative

2008
Metro resolution to develop regional climate change plan

2010
Portland/Multnomah goal: 10% below 1990 levels

2050
State of Oregon goal: 75% below 1990 levels

2009
Climate Action Plan

2030
Portland/Multnomah target: 40% below 1990 levels

2050
Portland/Multnomah goal: 80% below 1990 levels
Specifically in Climate Action

- 1993: first U.S. city to adopt a CO$_2$ Reduction Strategy
- 2001: adopted the *Local Action Plan on Global Warming*
- 2007: passed resolution that led to *Climate Action Plan 2009*
  - 2015 update ongoing
Local Action Plan on Global Warming 2001

10% reduction in carbon emissions below 1990 by 2010

150 items on “To Do” list in six focus areas

- Policy Research and Education
- Energy Efficiency and Green Building
- Transportation, Telecommunications, and Access
- Renewable Energy Resources
- Waste Reduction and Recycling
- Forestry and Carbon Offsets
Climate Action Plan 2009

- 2050 goal: 80% reduction in GHG emissions from 1990 levels
- 2030 interim goal: 40% reduction
Challenge

- **2050 goal**: 80% reduction in GHG emissions from 1990 levels
- **2030 interim goal**: 40% reduction
Implementation

- Implementation of the 2009 Climate Action Plan led by the Portland Bureau of Planning and Sustainability and Multnomah County Sustainability Initiative

- Action Plan contains 70 items in eight focus areas targeted for short-term completion
  - Action items updated (changed, added, removed) every three years
  - Data + progress updated yearly
Eight Action Areas

1. BUILDINGS AND ENERGY
2. LAND USE AND MOBILITY
3. CONSUMPTION AND SOLID WASTE
4. URBAN FORESTRY
5. FOOD AND AGRICULTURE
6. COMMUNITY ENGAGEMENT
7. CLIMATE CHANGE PREPARATION
8. LOCAL GOVERNMENT OPERATIONS
Outside Land Use and Transportation
Outside Land Use and Transportation

Since 2009:

- 45% of Multnomah County waste diverted to recycling & composting
- 1,000+ homes weatherized through Clean Energy Works Oregon
- 1,400+ homes/businesses installed solar panels
- Energy efficiency efforts save city $5.5 million / year
- Nearly 15,000 households have curbside composting for food scraps
- 7,000+ trees planted in 2011
Compared to the U.S.
## Budget for a Low-Carbon Future

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>2008</th>
<th>2030</th>
<th>Percent change from 2008</th>
<th>2050</th>
<th>Percent change from 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total carbon emissions (metric tons)</td>
<td>8,599,508</td>
<td>8,495,319</td>
<td>5,134,000</td>
<td>-40%</td>
<td>1,704,000</td>
<td>-80%</td>
</tr>
<tr>
<td>Population</td>
<td>584,000</td>
<td>715,000</td>
<td>999,000</td>
<td>+40%</td>
<td>1,355,000</td>
<td>+90%</td>
</tr>
<tr>
<td>Per person carbon emissions (metric tons)</td>
<td>14.7</td>
<td>11.9</td>
<td>5.1</td>
<td>-57%</td>
<td>1.3</td>
<td>-89%</td>
</tr>
<tr>
<td>Passenger miles per day per person</td>
<td>17.4</td>
<td>18.5</td>
<td>13.4</td>
<td>-28%</td>
<td>6.8</td>
<td>-63%</td>
</tr>
<tr>
<td>Electricity (kWh per person)</td>
<td>13,049</td>
<td>12,081</td>
<td>7,869</td>
<td>-35%</td>
<td>3,815</td>
<td>-68%</td>
</tr>
<tr>
<td>Natural gas (Therms per person)</td>
<td>391</td>
<td>382</td>
<td>302</td>
<td>-21%</td>
<td>98</td>
<td>-74%</td>
</tr>
</tbody>
</table>

Source: Portland Bureau of Planning and Sustainability, Climate Action Plan 2009
Multnomah County CO₂ Emissions (2010)

- Transportation: 38%
- Residential: 21%
- Commercial: 25%
- Industrial: 16%
- Waste disposal: 1%

Source: Portland Bureau of Planning and Sustainability, Climate Action Plan 2009 -- Year Two Progress Report
Daily VMT per person (private vehicles)

<table>
<thead>
<tr>
<th>Year</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>17.4</td>
</tr>
<tr>
<td>1995</td>
<td>19.3</td>
</tr>
<tr>
<td>2007</td>
<td>18.5</td>
</tr>
<tr>
<td>2030</td>
<td>13.2</td>
</tr>
<tr>
<td>2050</td>
<td>6.7</td>
</tr>
</tbody>
</table>
“Even the Portland version of business-as-usual won’t cut it.”

Michael Armstrong
Senior Sustainability Manager
Land Use and Mobility
Accomplishments

■ TriMet ridership has doubled since 1990, with increases every year. The regional light-rail system continues to expand; the new Orange Line will connect Portland’s city center with Milwaukie in September 2015.

■ Portland has a higher percentage of bicycle commuters than any other major U.S. city with a bicycle commute rate that is eight times the national average. The number of riders crossing bridges into downtown Portland has increased by double-digit percentages in each of the past four years.

■ The Portland Streetcar now connects the new South Waterfront neighborhood with the central city and will reach east across the river to the Convention Center in September 2015; ridership on the streetcar line continues to grow faster than anticipated.

■ Each new person moving into the Portland metro area uses one-fourth the amount of living space that is used by each new person moving into the Washington, D.C metro area.
Regional Growth Management
Policy Tools

- Urban Growth Boundary
- Density Targets (10/8/6)
- Multifamily Targets
- Transportation Investments
- Open Space Acquisition
Urban Growth Boundary
Density Targets/Multifamily Targets
Transportation Investments
Open Space Acquisition
Transit and Transit-Oriented Development
Planned Expansions

A new transit bridge under construction will connect SE & SW Portland with new streetcar and MAX lines.
TOD Map
Centers
Land-Use Impacts

Transit Oriented Communities
Next to Westside MAX

Nearly 7,000 new homes
Streetcar Loop
High-Potential Streetcar Corridors
Pedestrian- and Bike-Friendly Design
Streetscape Improvements
Complete Streets

Regional Bicycle Network
Bicycle Commute Mode Split 1990
Bicycle Commute Mode Split 2000

Portland Oregon Bicycle Commute Mode Split by Census Tract

Legend
- Existing Bikeway

Bicycle Commute Mode Split
- 0 to 1.5
- 1.51 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- 10.1 to 12
- 12.1 to 15
- 15.1 to 20
- 20.1 to 25

2000
It is a Choice
“The task of holding global emissions constant would be out of reach, were it not for the fact that all the driving and flying in 2056 will be in vehicles not yet designed, most of the buildings that will be around then are not yet built, the locations of many of the communities that will contain these buildings and determine their inhabitants’ commuting patterns have not yet been chosen”

Socolow and Pacala 2006
Climate in Its Proper Perspective