



Urban Planning and Transportation Policy

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Agenda

- Urban transportation, air quality, and welfare
 - Mechanisms
 - Solutions
- The Los Angeles story
 - Regional development
 - Air pollution
 - Policy responses
- The Chinese story?

The engineering perspective: ICE-based traffic, local air pollution, & health

- Combustion
- Emissions
- Dispersion/transformation
- Concentration
- Exposure/intake
- Dose-response/impact/health end points

The system perspective: the role of human choice and its determinants

$$I = P \times A \times T$$

- Impact
- Population
- Affluence
- Technology

ASIF

- Activity
- Mode split
- Energy intensity
- Fuel mix

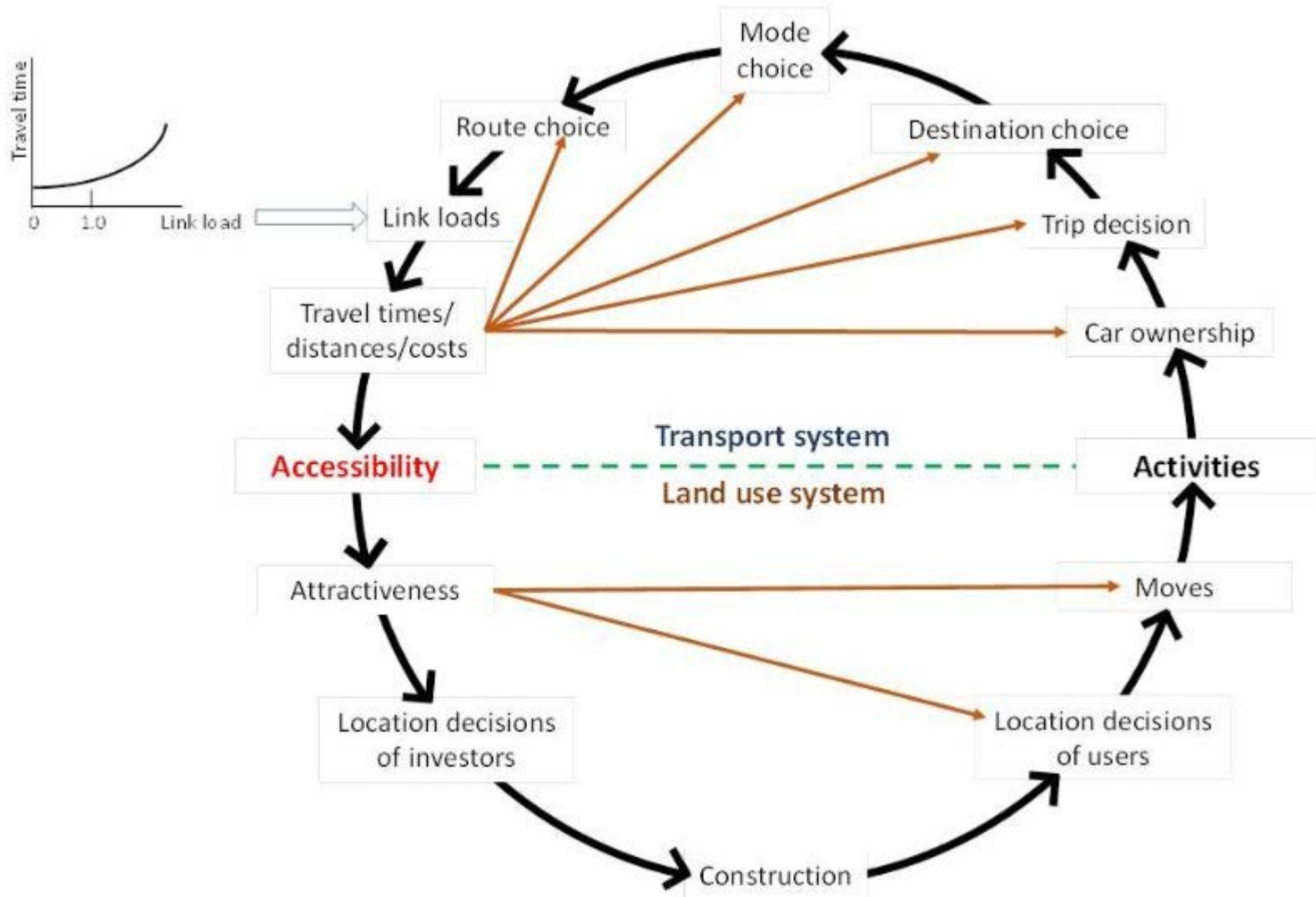
Transportation activities as human choices

- Transportation demand
- Technological choice
- Behavior choices

Human choices influenced by the built environment and policies

- Locations of origins and destinations (land use)
- Infrastructure and its efficiency (LOS)
- Out-of-pocket costs
- Policy constraints (command and controls)

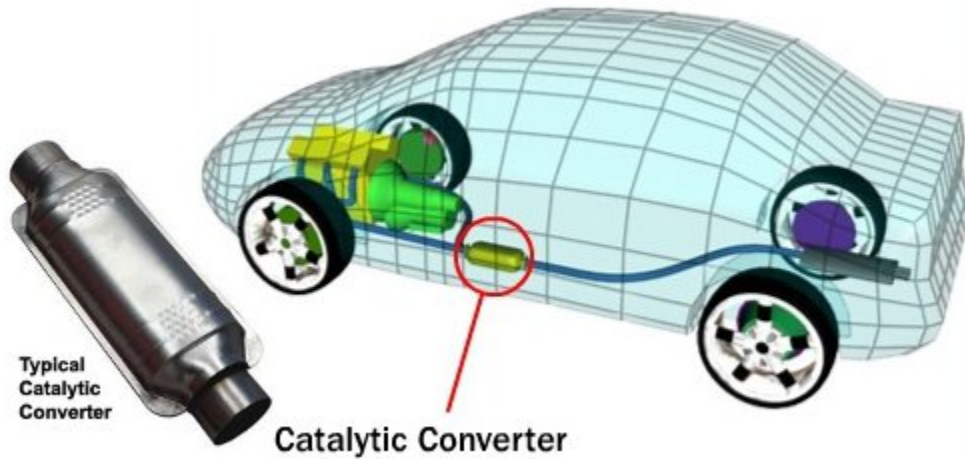
The human activity – land use – infrastructure system



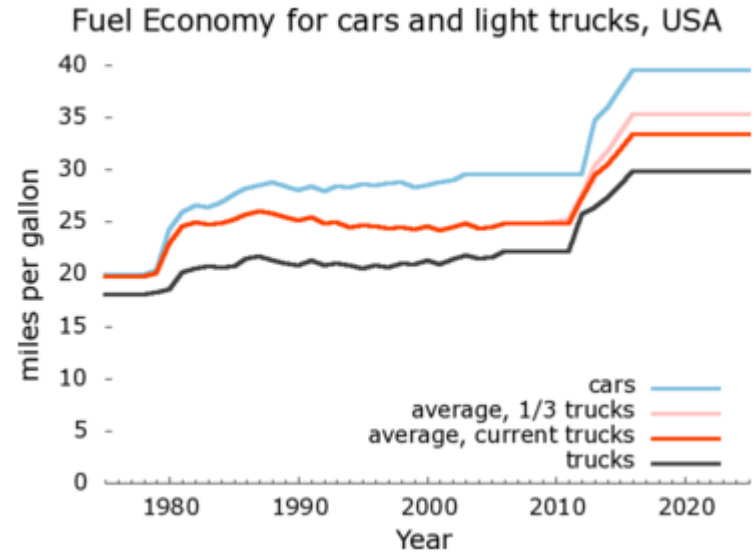
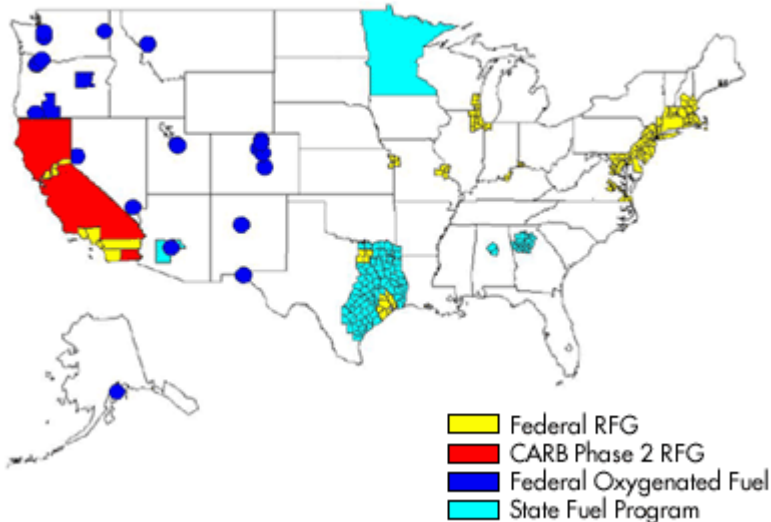
Solutions

- Technological standards/development
- Infrastructure supply/service
- Private behavior
- Land use planning

Technological standards/development

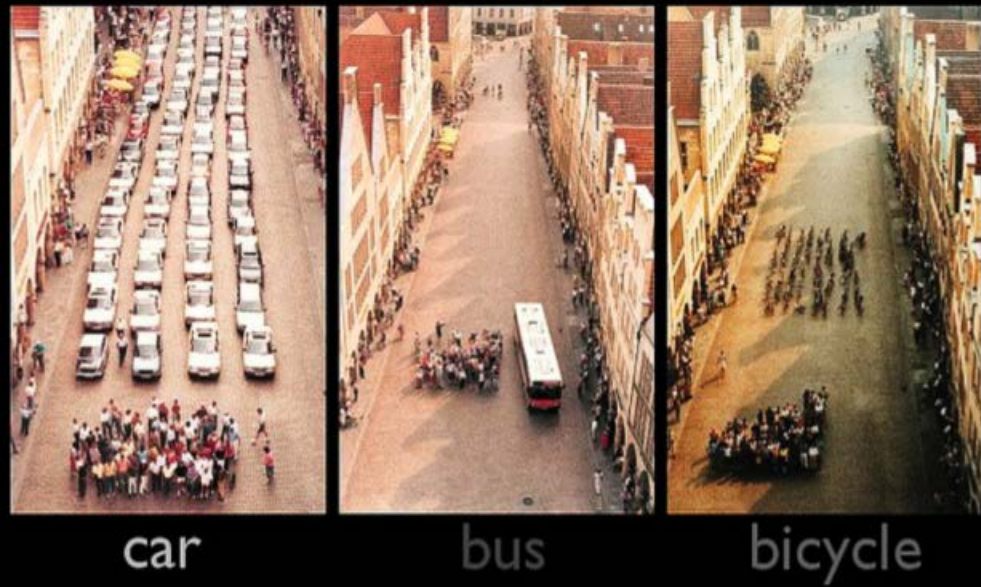


U.S. Clean Fuel Requirements



Infrastructure supply/service

space required
to transport 60 people





← big asphalt

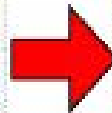
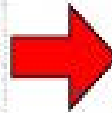
Big Asphalt at Tysons Corner, Virginia, near a new Metro station.

Automobile traffic calming,
infrastructure diet, and
multimodal sharing →



Brooklyn, NY

A thoroughfare with 10-foot lanes and safe, multimodal transportation.

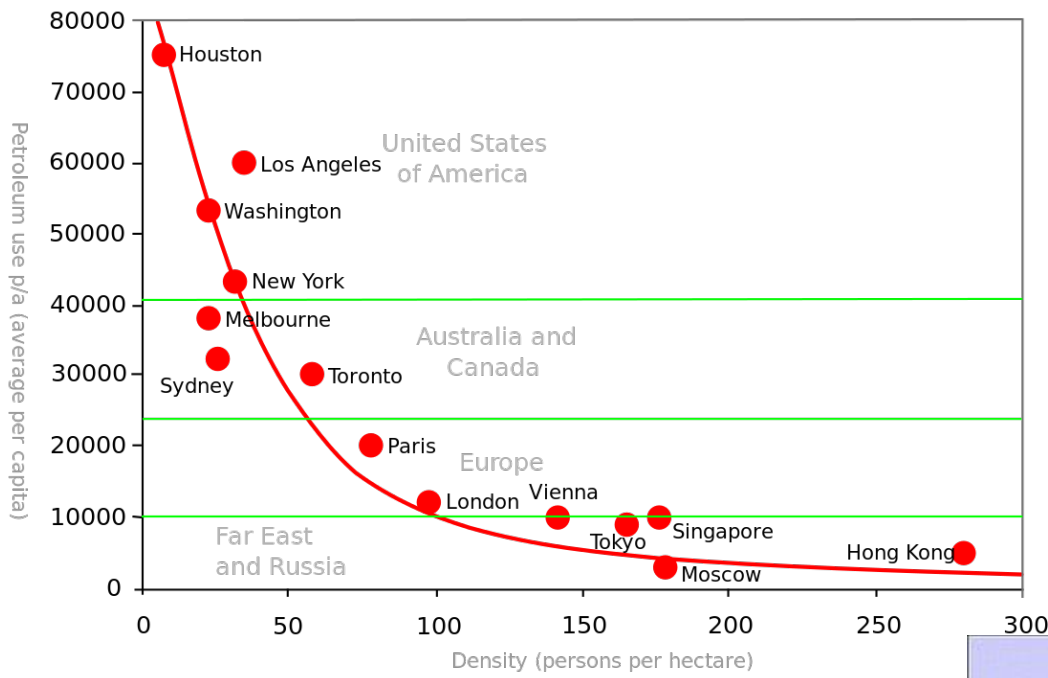


Private behavior

- Transit subsidies and car/van-pool assistance
- Vehicle/fuel taxes/quota
- Road/congestion/parking pricing
- Vehicle M&I/scrappage requirements
- Mandatory trip reduction (e.g. driving restrictions)
- Information/education

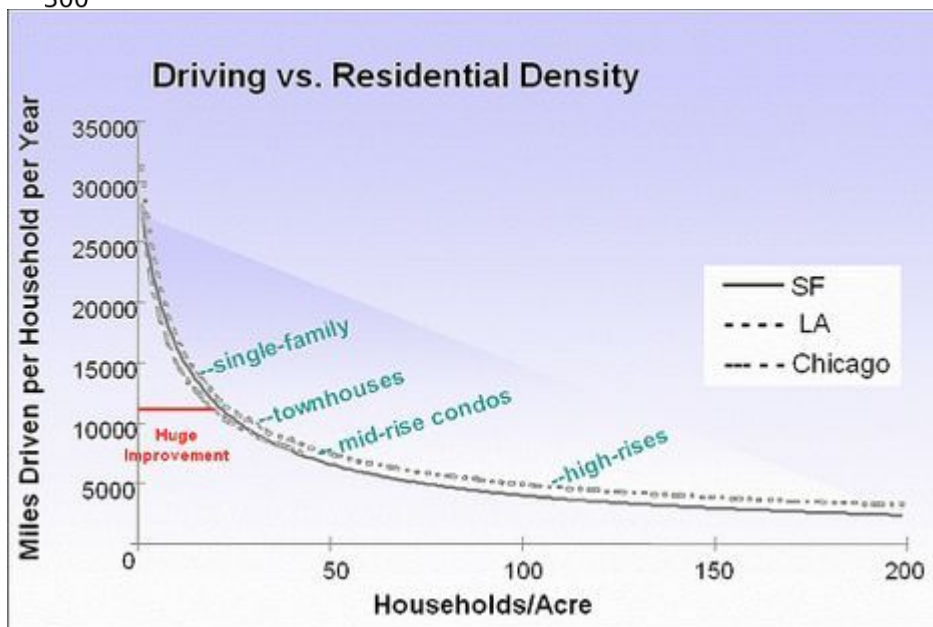
Relationship between Transport and Land Use

A commonly used study of 32 cities by Newman & Kenworthy in 1989 concluded that there was a strong link between urban development densities and petroleum consumption.



Annual petroleum use per capita adjusted to US MJ (1980)
 After Andrew Wright Associates, small section taken from 'Towards an Urban Renaissance',
 Urban Task Force Partnership, 1999, © DETR, 1999

Land use planning



RURAL

VILLAGE

SUBURB

CITY

METRO



PUSHING THE TRANSIT MODEL INTO LOWER DENSITIES CAN LEAD TO LACKING TICKET RECEIPTS AND ACCUSATION OF FAILING TRANSIT ACCEPTANCE

SUITED FOR AUTOMOBILES

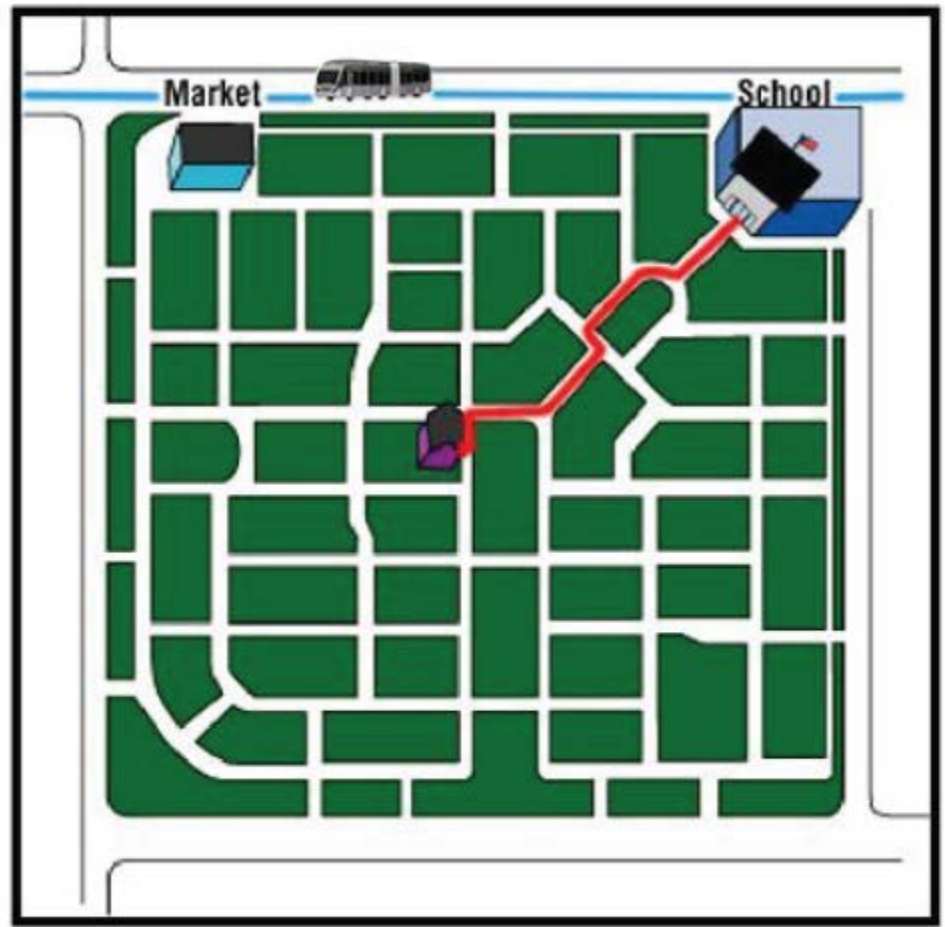
SUITED FOR TRANSIT

OVERALL DENSITY OF OUR BUILT ENVIRONMENT





Driving-only transportation pattern



Walkable connected transportation network

(Congress for New Urbanism (<https://www.cnu.org/sustainablestimulus>))



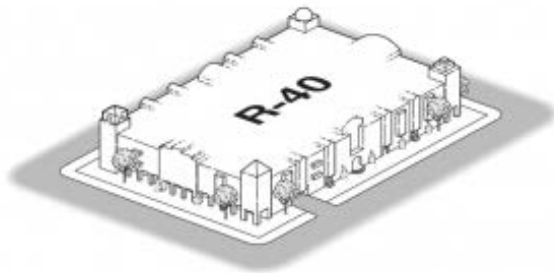
Conventional Zoning

Density use, FAR (floor area ratio), setbacks, parking requirements, maximum building heights specified



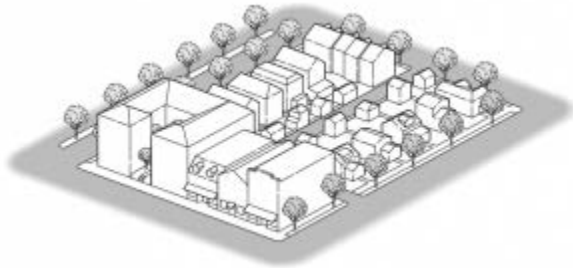
Zoning Design Guidelines

Conventional zoning requirements, plus frequency of openings and surface articulation specified



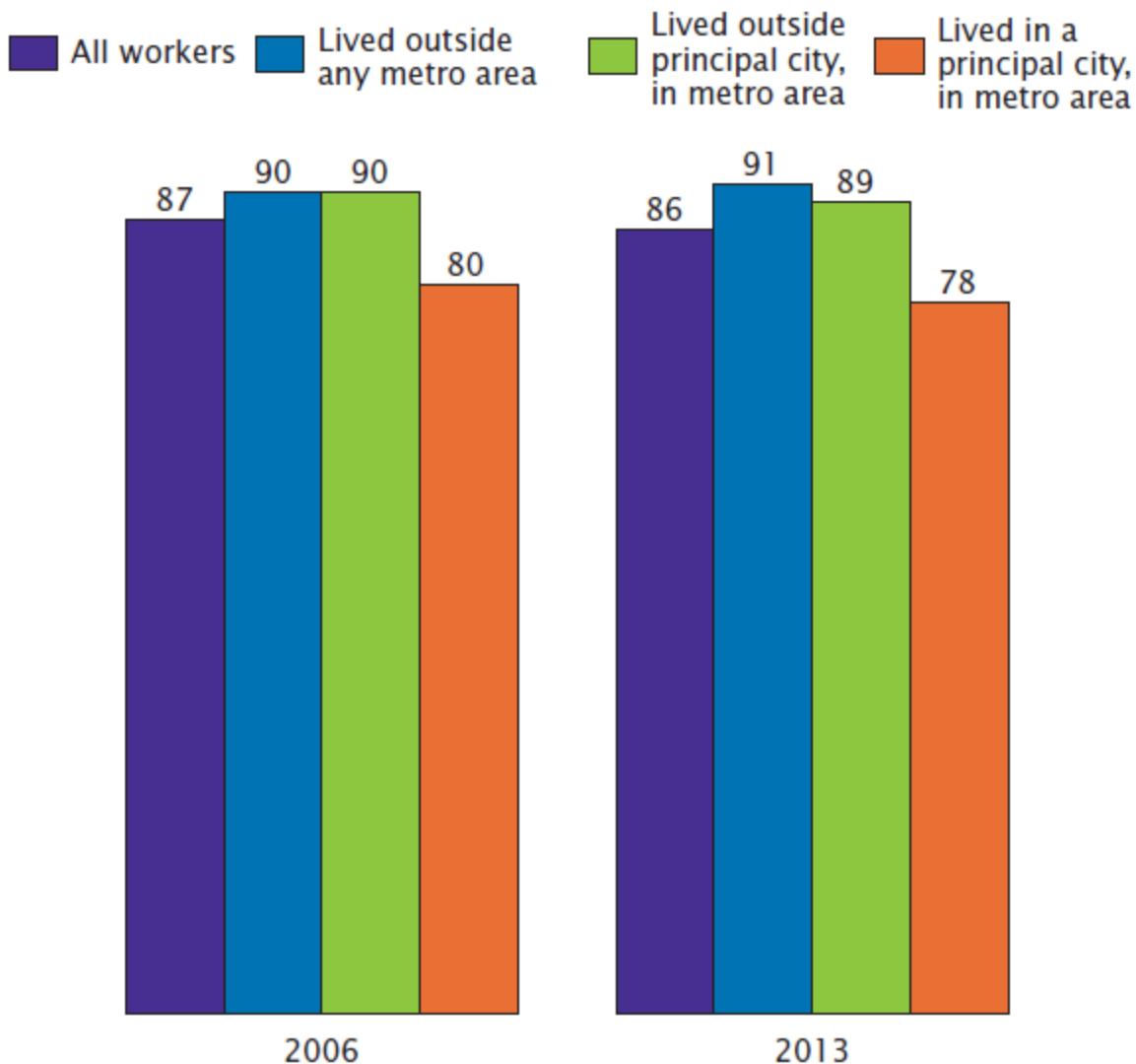
Form-Based Codes

Street and building types (or mix of types), build-to lines, number of floors, and percentage of built site frontage specified.



Automobile Commuting by Type of Community

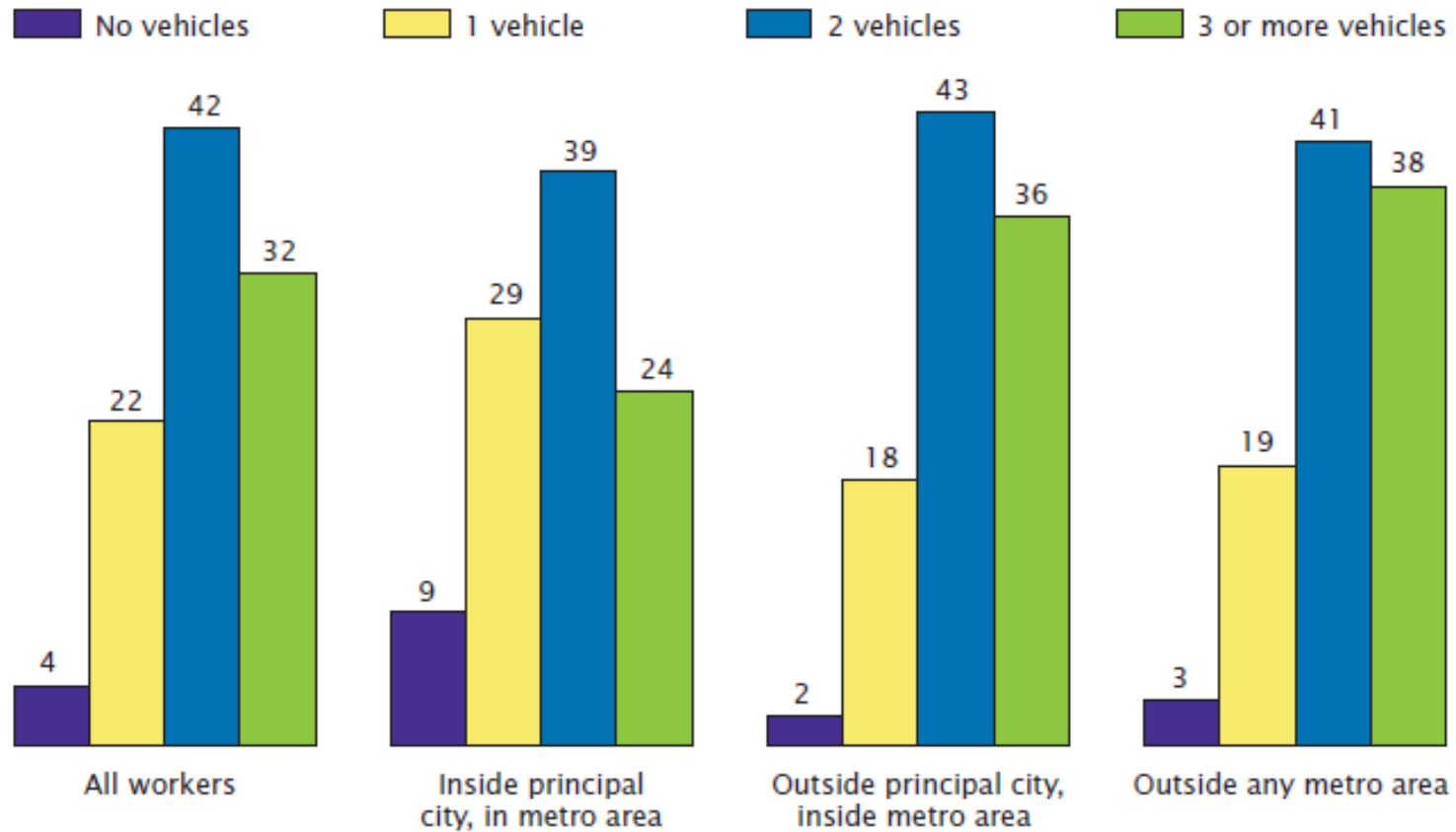
(In percent. Universe: workers 16 years and older. Data based on sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see www.census.gov/acs/www/)



Note: Numbers are rounded. See Appendix Table 1 for estimates and margins of error.
Source: U.S. Census Bureau, 2006 and 2013 American Community Survey.

Number of Vehicles Available by Community Type: 2013

(Percentage of workers within group. Universe: workers 16 years and older in households. Data based on sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see www.census.gov/acs/www/)



Note: Numbers are rounded. See Appendix Table 6 for estimates and margins of error.
Source: U.S. Census Bureau, 2013 American Community Survey.

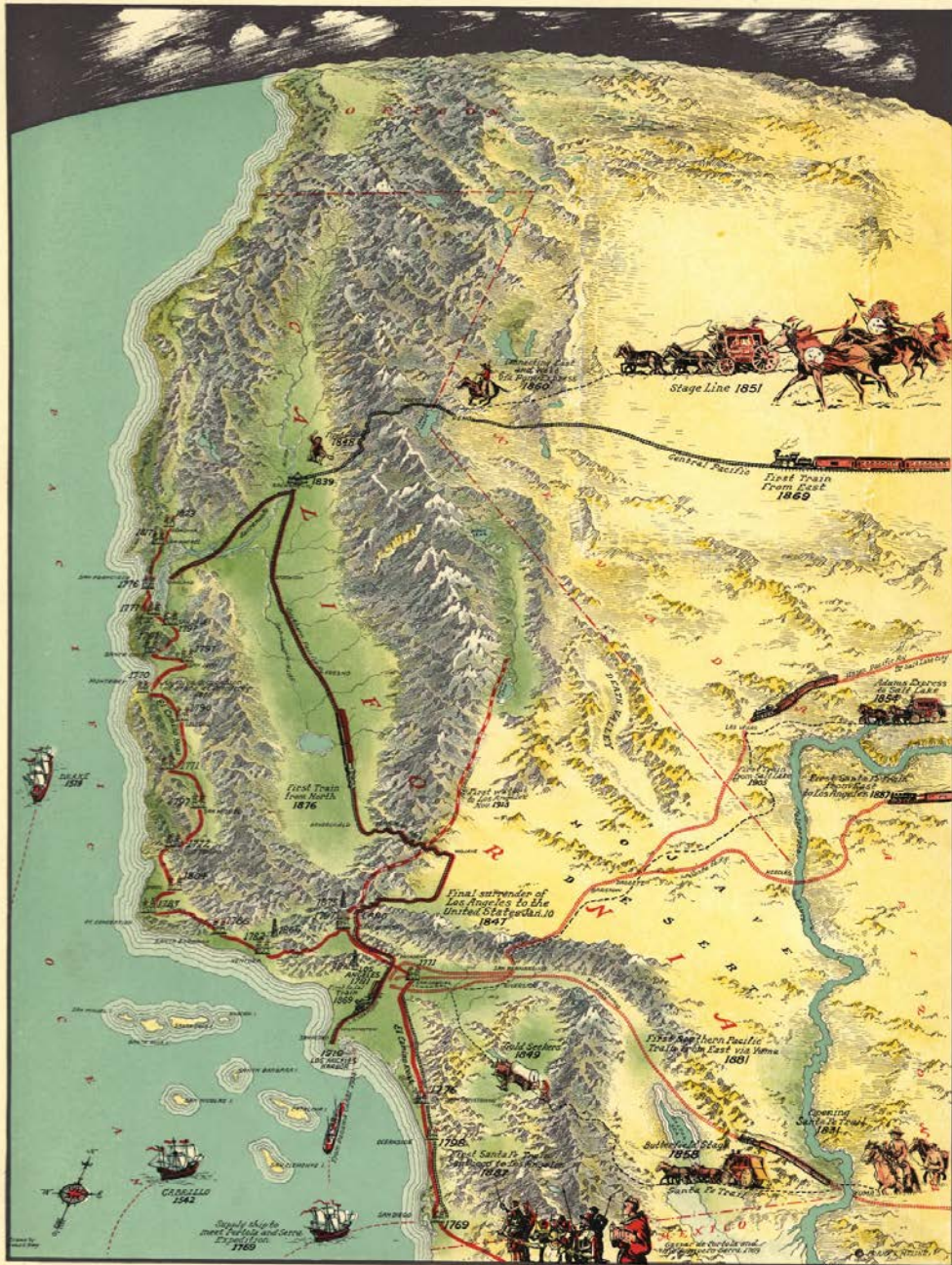
The Los Angeles Story

Regional development, air pollution,
and the pursuit of blue skies

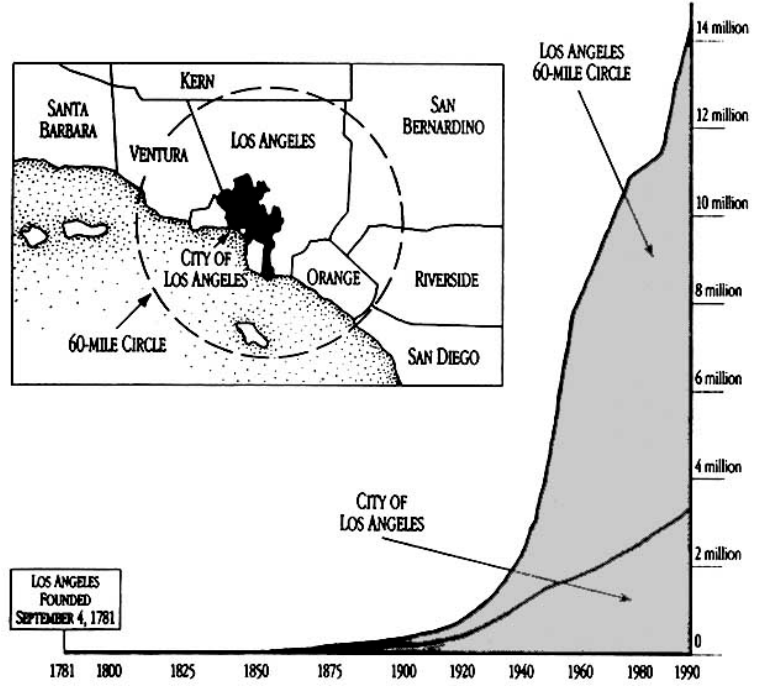
Aerial Photography of Southern California



Map credit to NASA JPL Shuttle Radar Topography Mission



Division of Maps
 JUL 31 1929
 Library of Congress
 Important Historical Events Which Have Made Los Angeles' Growth Possible
 HISTORICAL MAP OF LOS ANGELES
 © C I F 56792 JUN 24 1929



L.A. County population

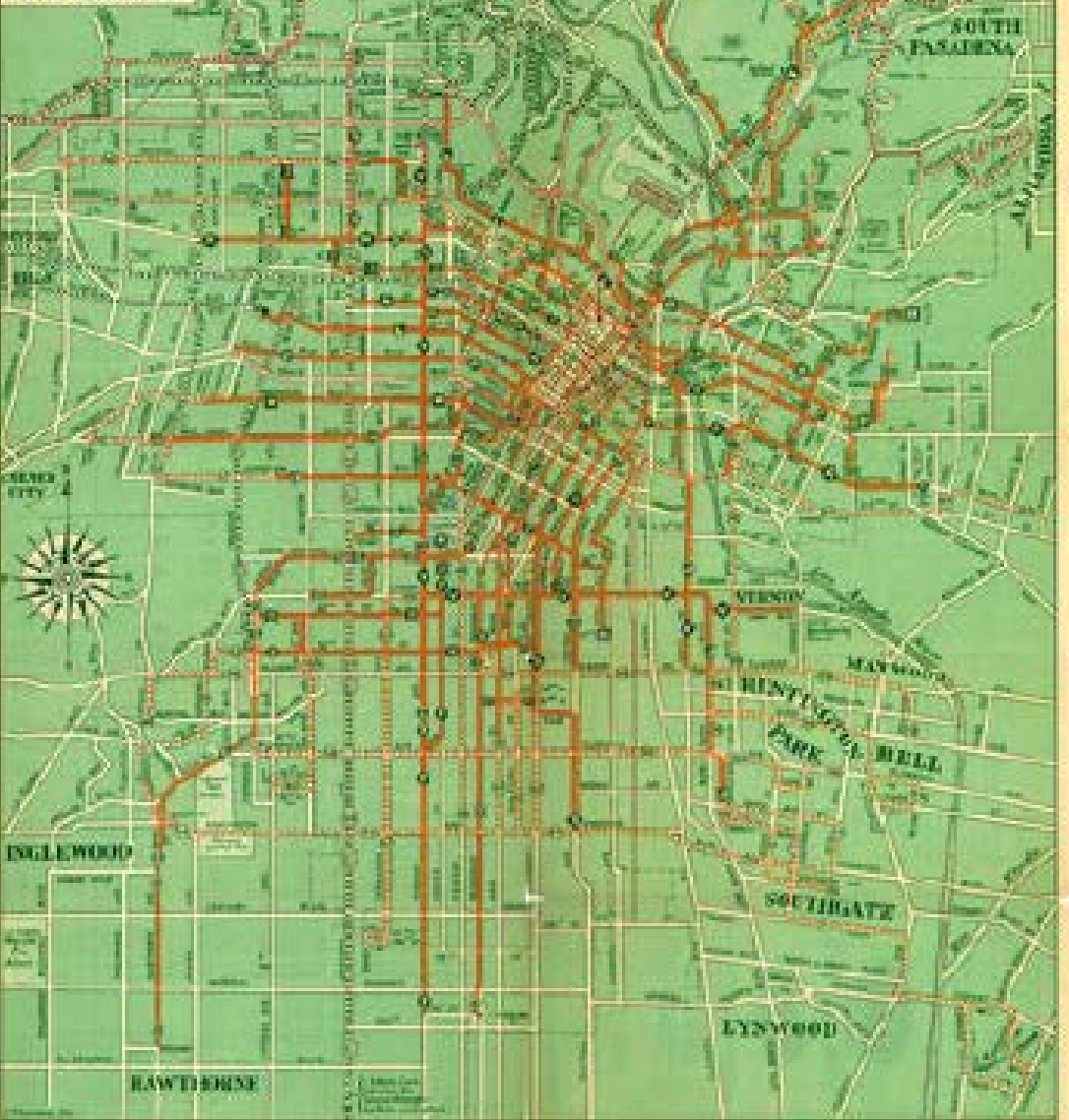
- 1900: <0.2 million
- 1920: ~1 million
- 1940: 2.8 million
- 1960: 6 million
- 1980: 7.5 million
- 2000: 9.5 million

ROUTE MAP
LOS ANGELES RAILWAY
ELECTRIC CAR and BUS ROUTES

THE RAILWAY OF LOS ANGELES
THE RAILWAY OF PASADENA
THE RAILWAY OF GLENDALE
THE RAILWAY OF INGLEWOOD
THE RAILWAY OF RAWLHORSE
THE RAILWAY OF SOUTH PASADENA
THE RAILWAY OF VERNON
THE RAILWAY OF WEST GLENDALE
THE RAILWAY OF WEST PASADENA
THE RAILWAY OF WEST WOODLAND
THE RAILWAY OF WEST WOODLAND
THE RAILWAY OF WEST WOODLAND

SCALE OF MILES
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

LEGEND
Electric Car Routes
Bus Routes



Transportation:
from streetcars to cars...

← 1930



Decommissioned streetcars awaiting destruction in Los Angeles, 1956. ([Los Angeles Times photographic archive \(http://en.wikipedia.org/wiki/File:Pacific-Electric-Red-Cars-Awaiting-Destruction.gif\)](http://en.wikipedia.org/wiki/File:Pacific-Electric-Red-Cars-Awaiting-Destruction.gif))

Automobiles in L.A. County

1915: 1/8 residents (1/43 nationally)

1918: 110,000

1923: 430,000

1925: 1/2 residents (1/6 nationally)

1956: 3,000,000 (5% of US)

1940s and 50s: smog town



Vast clouds of smoke boil into the sky from the



Glendale city dump in October 1946. Burning garbage in dumps was a common practice then.



Scientific quests: measurements, impacts and sources



Public and policy responses



Early Smog Control Efforts

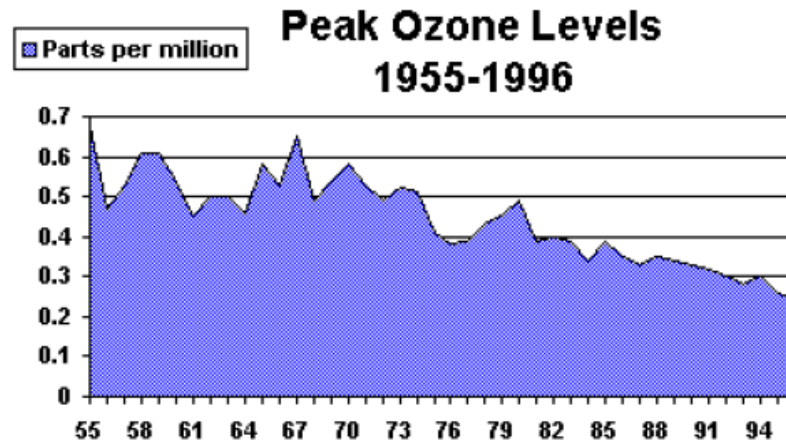
In the late 1940s and early 1950s, air pollution officials made significant strides in reducing smoke and fumes by regulating open burning in garbage dumps, reducing smoke from factories and cutting sulfur dioxide emissions from oil refineries.

In the 1950s, automobile exhaust became a prime suspect: The birth of modern air pollution control

A burgeoning number



of cars in the Southland helped create the highest smog levels ever recorded in the 1950s.



In 1955, when modern ozone monitoring began, Southland residents suffered the highest ozone level ever recorded -- 0.68 parts per million in downtown Los Angeles - nearly three times the highest level in 1996.

Clean up cars

- 1959: CA Motor Vehicle Pollution Control Board
- 1963: Reduce HC emissions/evaporation
- 1975: catalytic converter required
- Later 1970s: I/M law --> SmogCheck program

1960s

Cleaning Up Fuels

In the 1960s, regulators took the first step in cleaning up motor vehicle fuels by reducing the amount of highly photochemically reactive olefins in gasoline.

Starting in 1970, the federal government also phased out the use of lead in gasoline, a toxic pollutant that in high levels can cause behavioral problems, learning disabilities and even brain damage in children. Due to the phaseout, lead levels in the Southland have not exceeded state or federal health standards since 1982.

In the early 1980s, ARCO introduced the first reformulated gasoline with fewer smog-forming and toxic ingredients. The California Air Resources Board and the U.S. Environmental Protection Agency have since required all oil companies to develop and sell even cleaner gasoline.

Starting in 1970s: energy efficiency/independence jointly pursued

During the 1970s and 1980s, California environmental agencies advocated the use of methanol and natural gas instead of gasoline, which could cut a vehicle's smog-forming emissions in half. "Flex-fuel" vehicles could burn any combination of gasoline and methanol, so drivers never had to worry about availability of fuel.

Beyond technology

Seeking new areas for pollution reductions -- and cheaper ways to accomplish it -- air quality officials in the late 1980s and early 1990s moved beyond traditional factory smokestack and vehicle tailpipe controls to transportation and market incentive programs.

AQMD's Governing Board adopted a landmark rideshare program in 1987. It required employers with more than 100 employees to offer tangible incentives to employees to carpool and ride public transit to work. For eight years, the program achieved marked success, reducing 272,000 trips per day. But businesses chafed at trying to change employee behavior. They also perceived the program's cost, estimated at \$110 per employee per year, as excessive and its administration as overly burdensome.

Half a century later (1980s-90s)



Targeting the Total Package: Clean Fuels and Vehicles

In 1990, CARB adopted a landmark regulation targeting both vehicles and the fuels used in them. The agency launched its Low Emission/Zero Emission Vehicle program, requiring auto manufacturers to develop incrementally cleaner cars, culminating with the mandate for an electric, zero-emission vehicle by 1998. CARB officials subsequently delayed the mandate until 2003 after oil and auto manufacturers argued that introducing electric vehicles too soon, before the technology was perfected, could alienate consumers.

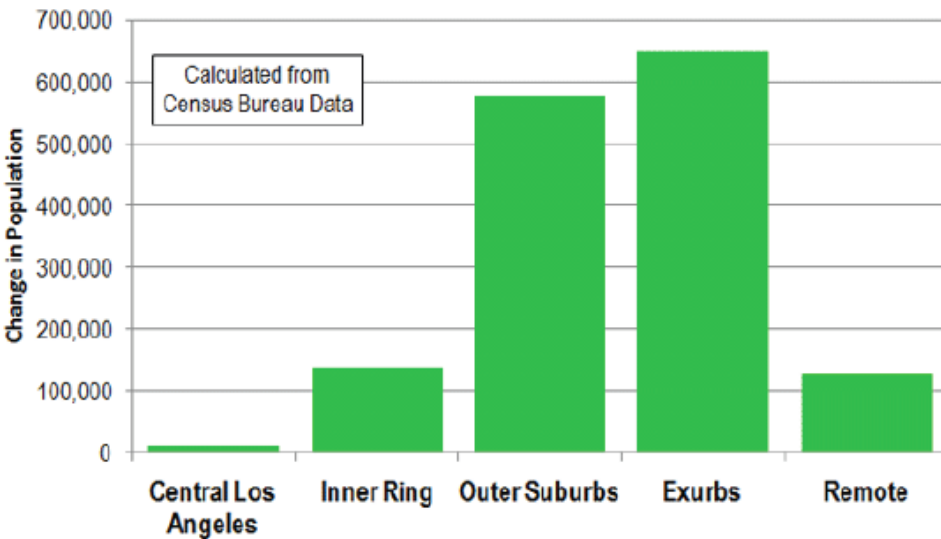


1970s-90s: significant improvement

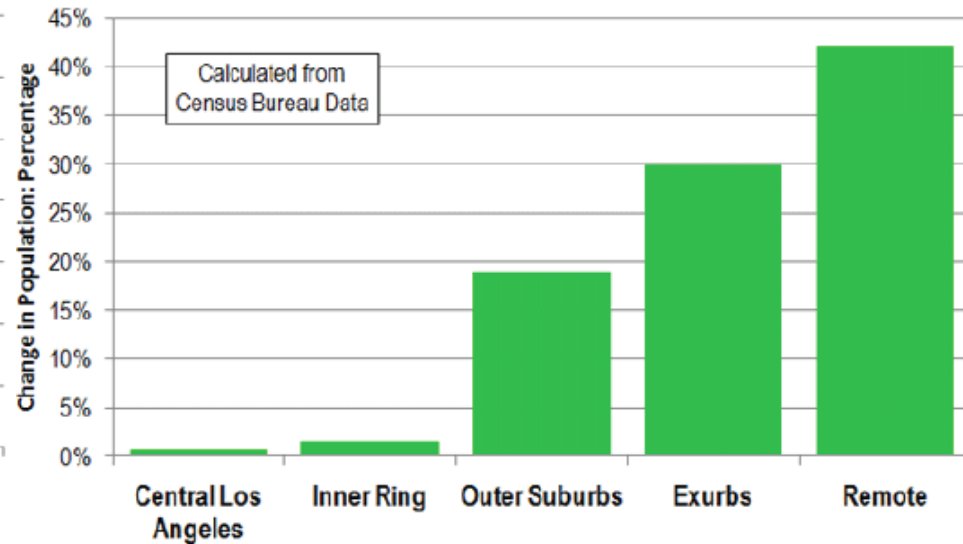
1995	Total registered vehicles reached 26 million and vehicle miles traveled is 271 billion. Cumulative California auto emissions for NOx and HC are about 1.1 million tons/year a 31% reduction compared to 1970 levels, despite a 137% increase in vehicle miles traveled from 1970 levels. Statewide averaged for NOx and HC emissions per vehicle reduced respectively by 58% and 80% from 1970 levels.
1996	The SCAQMD's maximum one-hour ozone concentration recorded is 0.24 ppm 59% improvement from 1965. The area exceeded Stage 1 Smog Alerts (0.20 ppm ozone) on 7 days this year. This is an improvement of 111 days or a 94% reduction as compared to 1975.
	Big seven automakers commit to manufacture and sell Zero Emission Vehicles.
	CA's Phase II Cleaner Burning Gasoline (CBG) came to market. CBG reduces lung-damaging ozone and ozone precursors by 300 tons/day, as well as reducing airborne toxic chemicals like benzene that can cause cancer. This is equivalent to taking 3.5 million cars off the road.
2000	California's population grows to 34 million with 23.4 million registered vehicles in the state. Annual vehicle miles traveled (VMT) reaches 280 billion miles. Cumulative California vehicle emissions for nitrogen oxides and hydrocarbons are about 1.2 million tons per year. This is 200,000 tons/year less than 1990 despite an increase in VMT of 40 billion miles per year.
	The South Coast Air Quality Management District's maximum one-hour ozone concentration recorded is 0.18 parts per million. The area has no Stage 1 Smog Alerts (0.20 ppm ozone) this year, down from 42 Alerts in 1990.

The never-stop sprawl

Los Angeles CSA Population Growth
2000-2010 BY SECTOR



Los Angeles CSA Population Growth
2000-2010 BY SECTOR



Sector	2000	2010	Change	% Change
Central Los Angeles	1,752,024	1,763,967	11,943	0.7%
Inner Ring	9,093,756	9,231,513	137,757	1.5%
Outer Suburbs	3,053,615	3,630,273	576,658	18.9%
Exurbs	2,173,459	2,822,884	649,425	29.9%
Remote	301,331	428,369	127,038	42.2%
Total	16,374,185	17,877,006	1,502,821	9.2%

Deal with sprawl

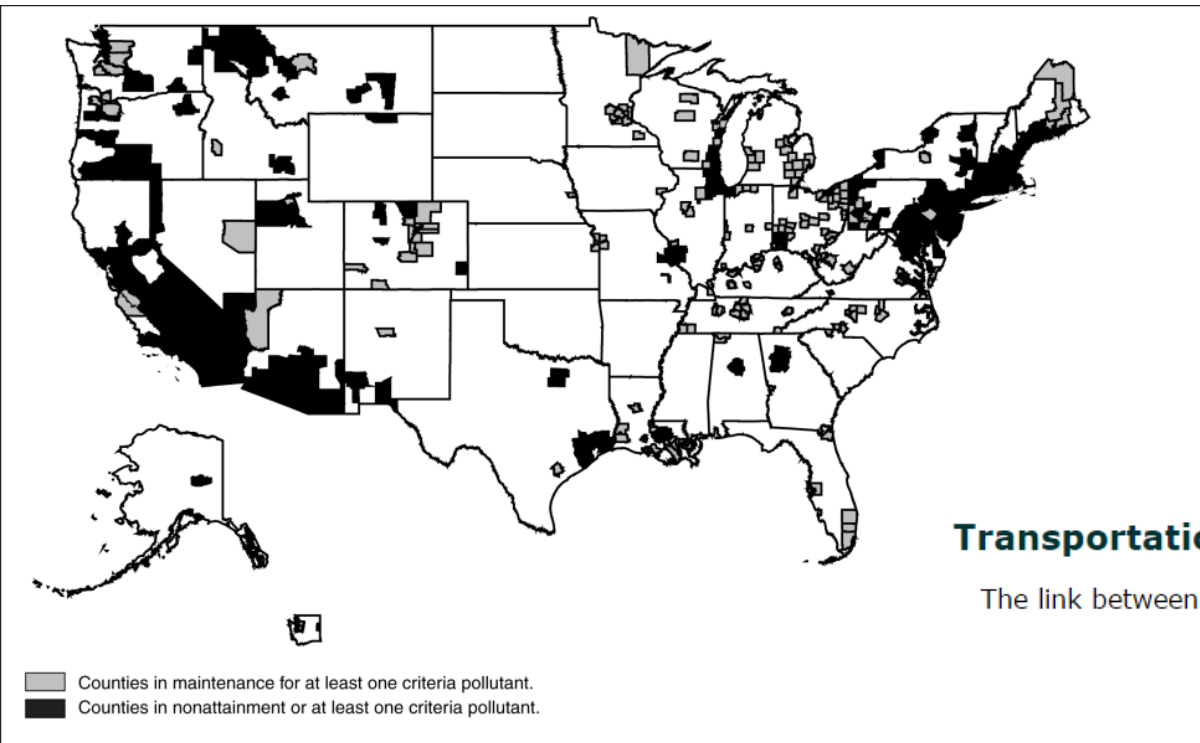
Controlling mobile emissions in urban regions through regional planning

- Air quality (policy) is regional
 - 1976: SCAQMD
- Transportation (policy) is regional too
 - Federal action since CAAA 1990 and ISTEA 1991
 - Regional air quality conformity
 - Air quality and metropolitan planning organization's regional transportation plan

Transportation conformity is...

A process required by the Clean Air Act (CAA) Section 176(c) which establishes the framework for improving air quality to protect public health and the environment. The goal of transportation conformity is to ensure that Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) funding and approvals are given to highway and transit activities that are consistent with air quality goals.

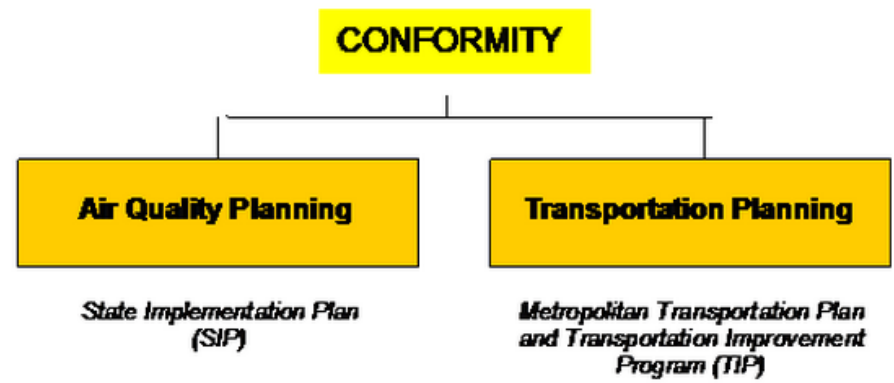
The CAA requires that metropolitan transportation plans, metropolitan transportation improvement programs (TIPs) and Federal projects conform to the purpose of the State Implementation Plan (SIP). Conformity to a SIP means that such activities will not cause or contribute to any new violations of the National Ambient Air Quality Standards (NAAQS); increase the frequency or severity of NAAQS violations; or delay timely attainment of the NAAQS or any required interim milestone.



Source: GAO analysis of EPA data.

Transportation Conformity:

The link between air quality and transportation planning.



What pollution does transportation conformity address?

Air pollution comes from a variety of sources. Transportation conformity only addresses air pollution from on-road mobile sources which include emissions created by cars, trucks, buses, commuter rail, and motorcycles.



Transportation conformity applies in...

All nonattainment and maintenance areas for ozone (O₃), particulate matter (PM₁₀ and PM_{2.5}), nitrogen dioxide (NO₂), and carbon monoxide (CO), and their appropriate precursors (precursor pollutants are those pollutants which contribute to the formation of other pollutants).

Precursor Emissions*

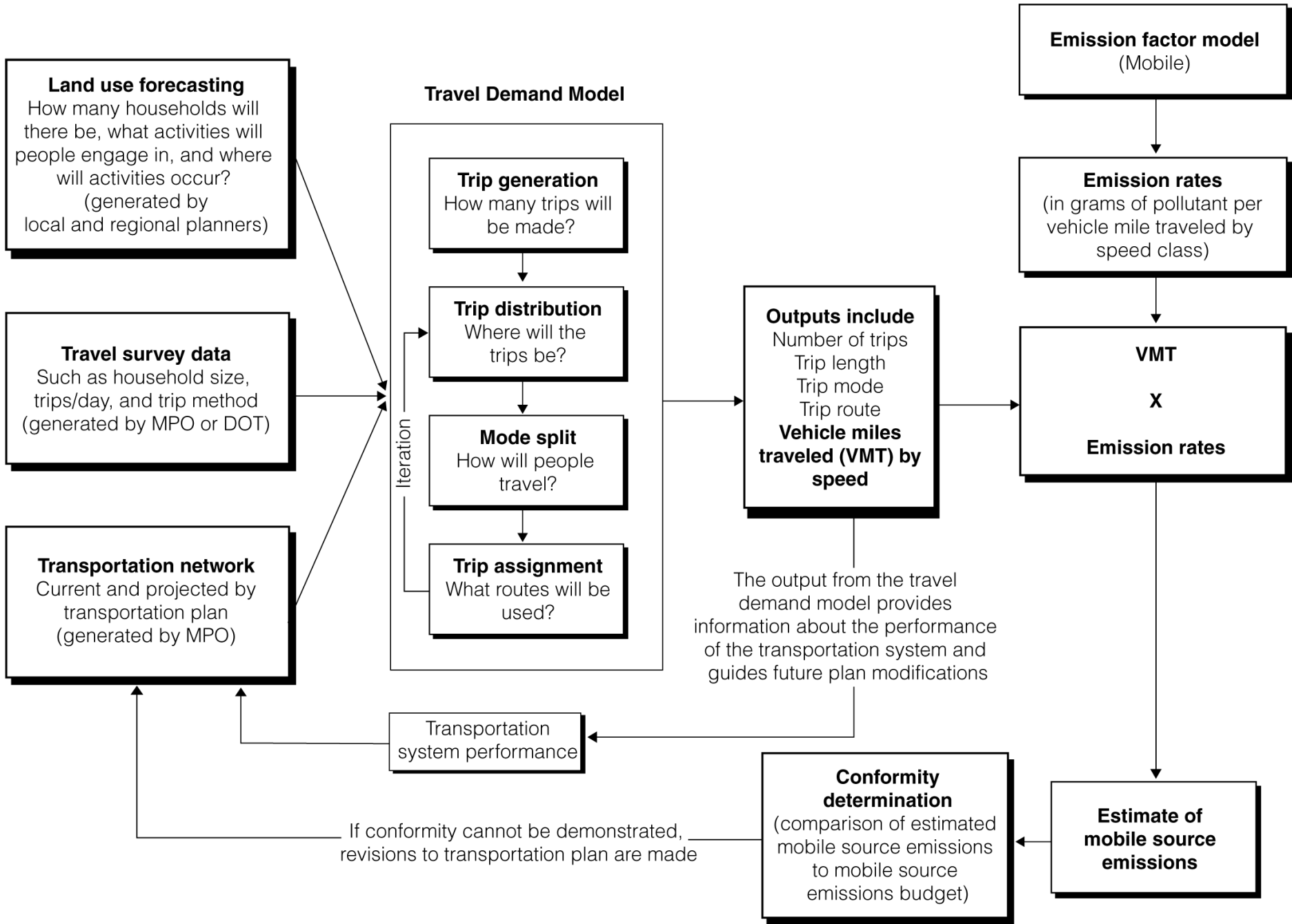
	Direct Emissions	NOx	VOC	Ammonia (NH ₃)	Sulfur Dioxide (SO ₂)
Ozone (O ₃)		X	X		
PM ₁₀	X	X	X		
PM _{2.5}	X	X	X	X	X
NO ₂		X			
CO	X				

Precursor Emissions

* Not all precursors are required to be analyzed in every area.

What transportation activities are subject to transportation conformity?

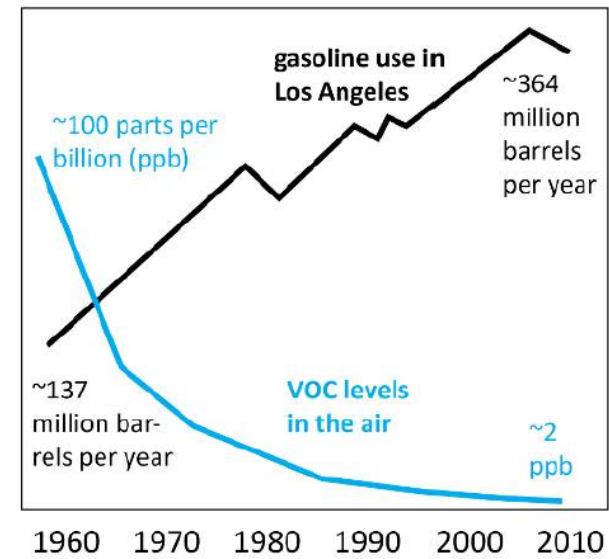
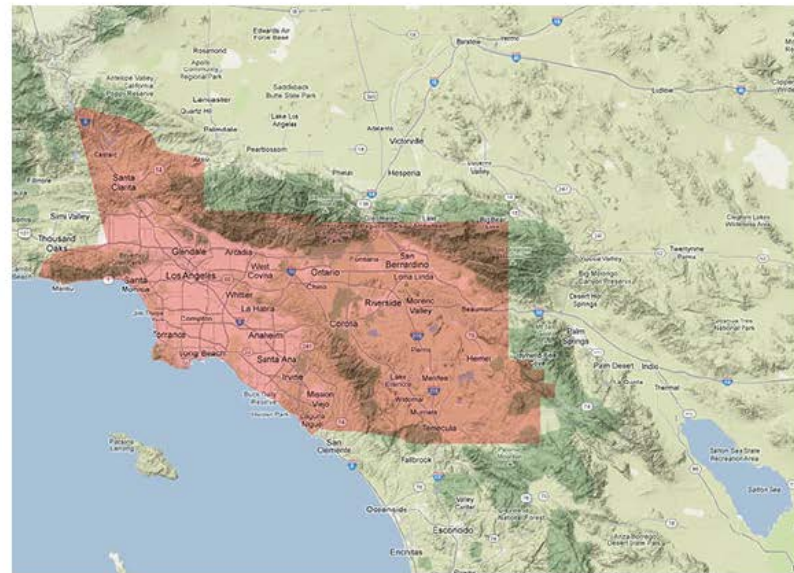
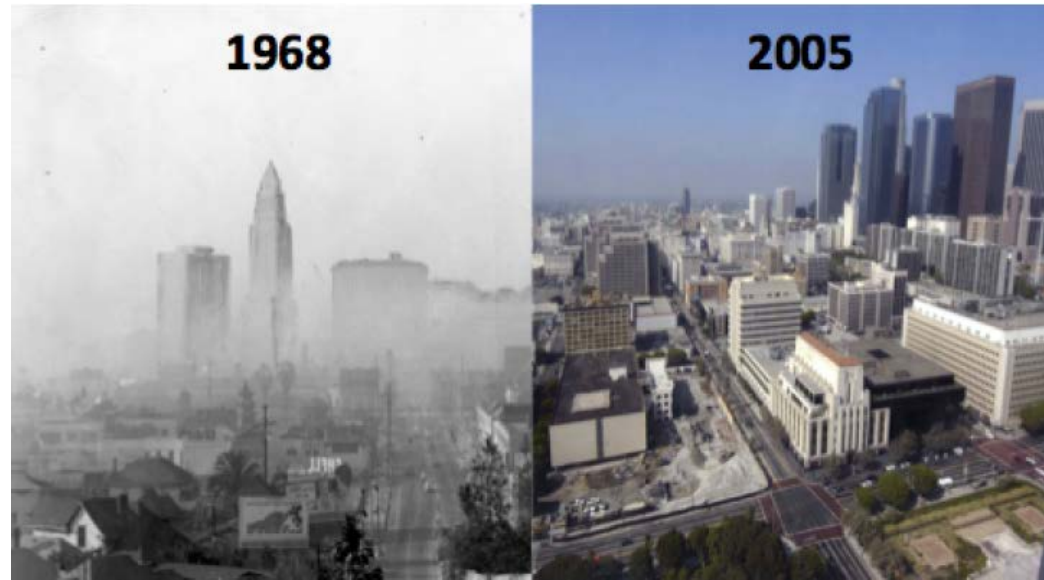
- Metropolitan transportation plans
- Metropolitan transportation improvement programs (TIPs)
- Federal projects
 - Projects receiving FHWA/FTA funding
 - Projects receiving FHWA/FTA approval



21st Century

June 4, 2013

Los Angeles air pollution declining, losing its sting



South Coast Air Basin. The air in the Los Angeles region has lost some of its “sting,” according to a new CIRES-led study. Regulations to reduce emissions have affected chemical processes in the atmosphere, decreasing levels of an eye irritant called peroxyacetyl nitrate. Credit: CIRES and Google Maps.


Although gasoline consumption in Los Angeles has nearly tripled since 1960, levels of vehicle-related pollutants called volatile organic compounds (VOCs) have plummeted. NOAA illustration.

2000s: GHG emissions reduction jointly pursued

2006	AB 32 signed. The California Global Warming Solutions Act of 2006 establishes the first-in-the-world comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions in greenhouse gases (GHG). It makes the ARB responsible for monitoring and reducing GHG emissions.
	AB 1811, directed the ARB to develop a joint plan with the CA Energy Commission to spend \$25 million to provide incentives for the use and production of alternative fuels.
	California switched to new ultra low sulfur diesel fuel.
	The ports of Long Beach and Los Angeles, in cooperation with the United States Environmental Protection Agency (USEPA), the ARB, and the South Coast Air Quality Management District (AQMD), developed the most comprehensive plan in the US seaport history to reduce air pollution and associated health risks generated from port-related operations.
	ARB implemented the Lower Emission School Bus Program to reduce children's exposure to both cancer-causing and smog forming pollution.
2010	ARB makes changes to diesel regulations that protect public health, provide relief and flexibility to California business owners of on-road and off-road equipment.
	ARB approves the cap-and-trade regulation, marking a significant milestone toward reducing California's greenhouse gas emissions under AB 32. The regulation helps drive the development of green jobs and set the state on track to a clean energy future.
	California regulations reduce air pollution from 11 categories of consumer products including bug sprays and a variety of household and professionally-used cleaners.
	California adopts the Renewable Energy Standard. One-third of the electricity sold in the state in 2020 will come from clean, green sources of energy.
	California adopts goals of SB 375 for more healthy and sustainable communities that improve the way we plan and promote transportation choices.

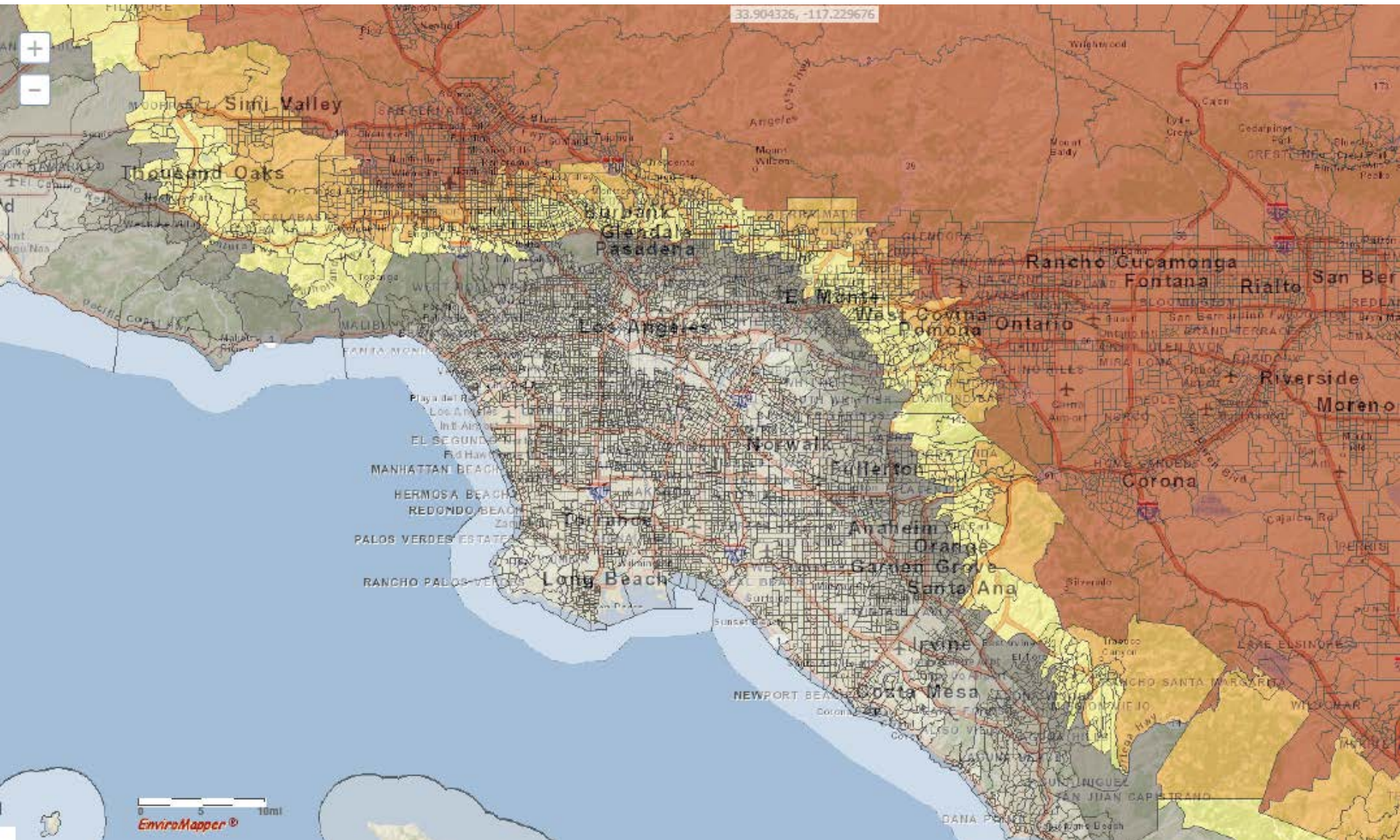
The right to breathe for everyone

The problems of hot spots and
vulnerable population

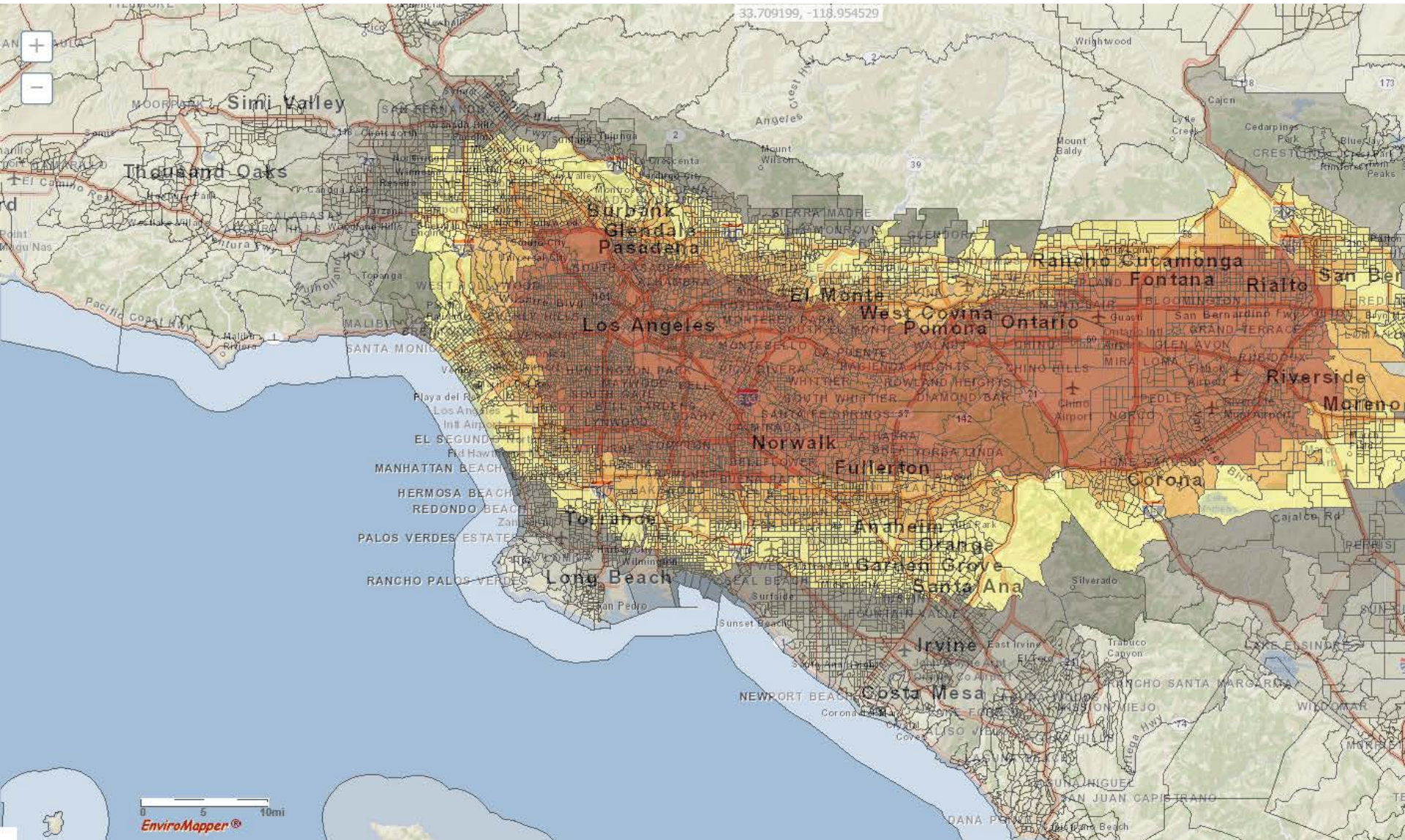


Everyone in this family has health problems

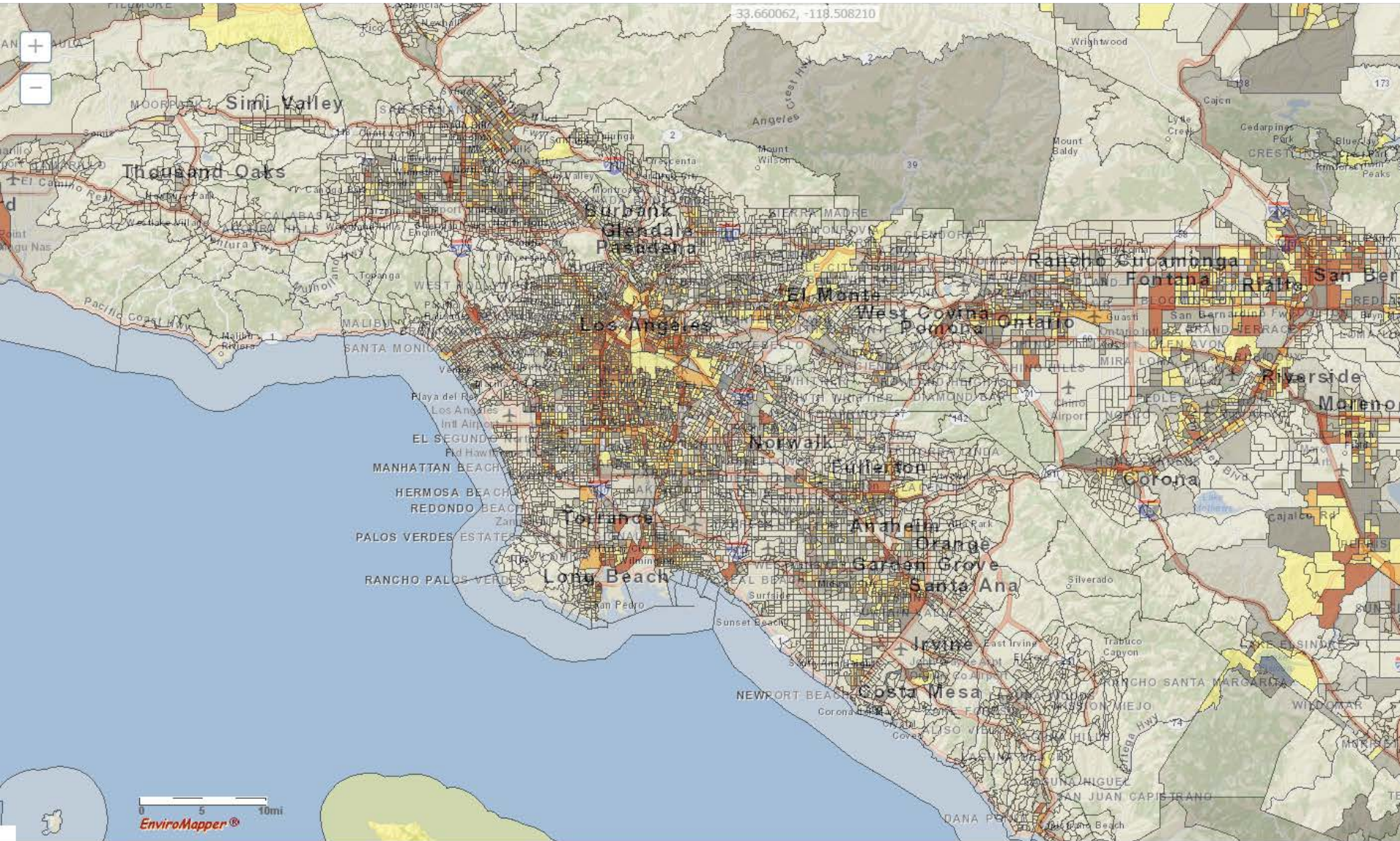
Ozone



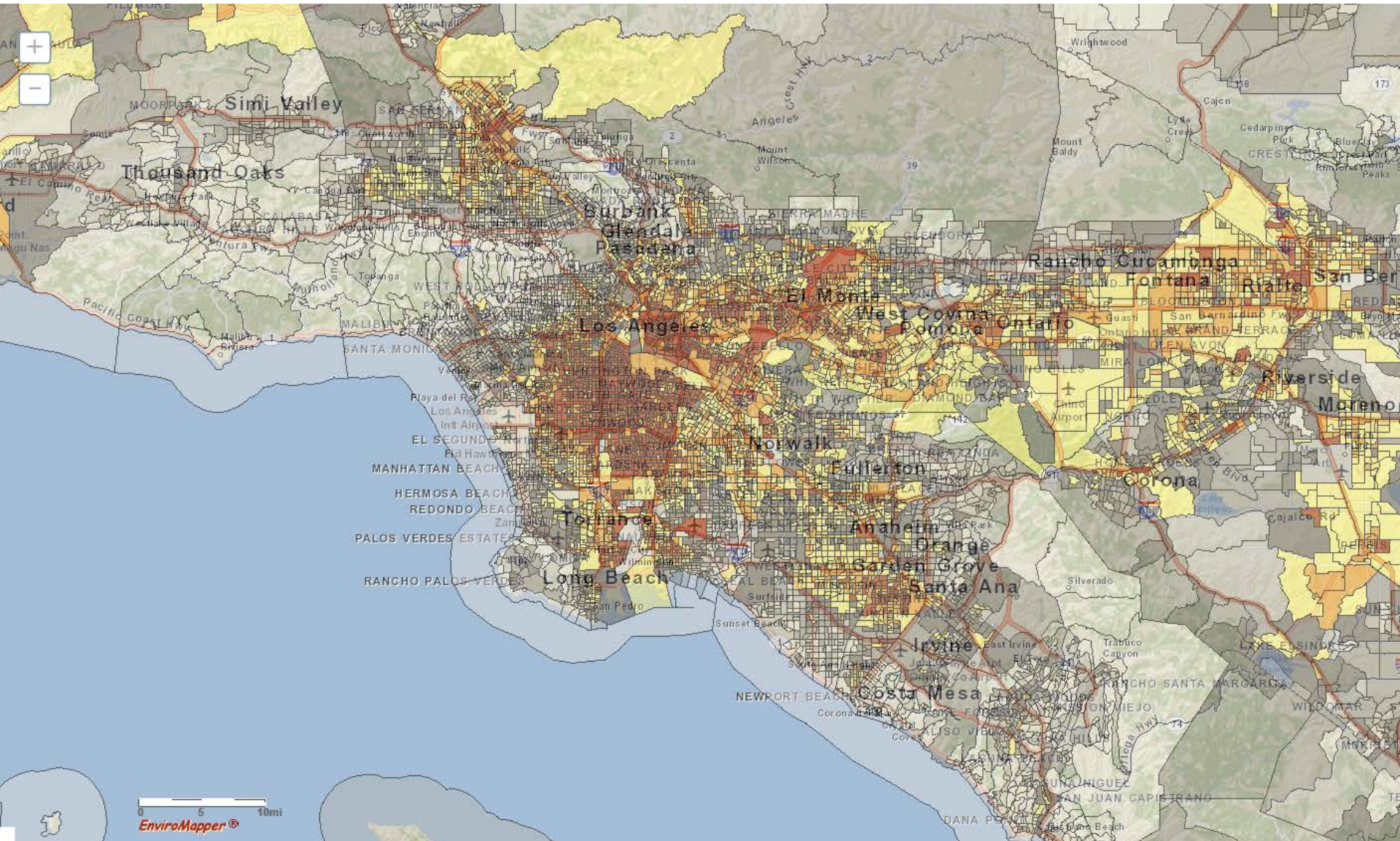
PM2.5



Income

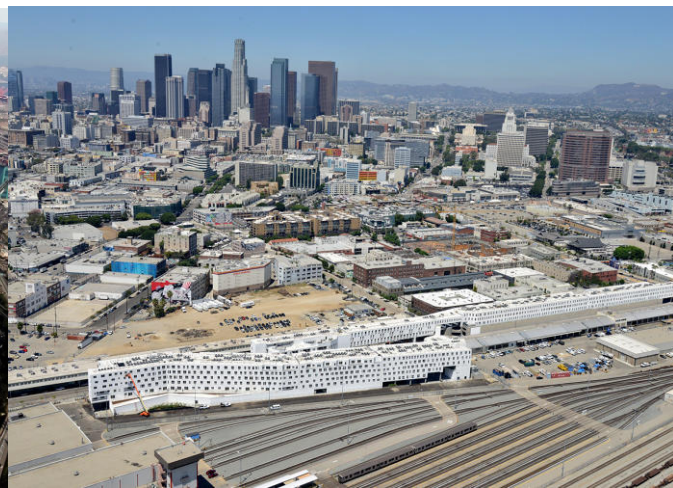


Race



Ports and freight hubs/corridors

- The San Pedro Bay ports are the largest single source of air pollution in Southern California, generating about 10% of the region's smog-forming emissions
- Diesel emissions from the ports have the greatest health consequences for harbor area neighborhoods, where residents have higher rates of asthma and face the region's highest cancer risk from air pollution
- The ports' 2006 Clean Air Action Plan includes
 - A ban on old, dirty diesel trucks
 - Docked vessels need turn off engines and plug into the electrical grid
 - Near the shore, ocean vessels are also required to burn low-sulfur fuel



L.A.'s fight for blue skies: key takeaways

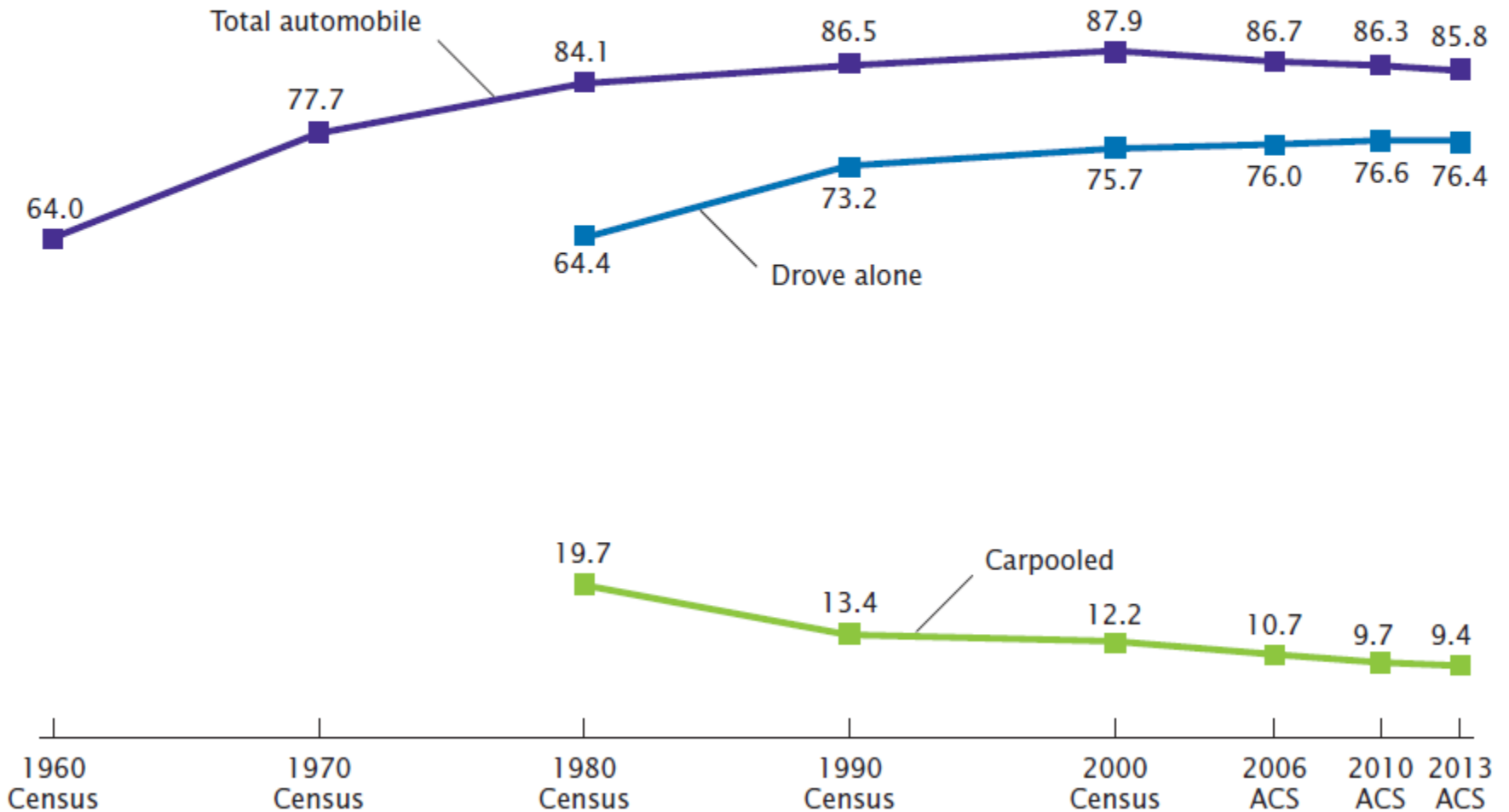
- Fundamental demand for air quality
 - Crises and policy agenda
 - Policy synergies
 - Mega events
- Globalization
 - Deindustrialization
 - Freight transportation
- Technology has been the key
 - Scientific research: what technologies are needed?
 - Development: mandatory/voluntary improvements
 - Adoption: market/consumer buy-in
- Hard to change land use or lifestyle (in U.S.)

How fast can a socioeconomic-
environmental system change?



Commuting by Automobile: 1960 to 2013

(Percentage of workers. Universe: workers 16 years and older. Data based on sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see www.census.gov/acs/www/)



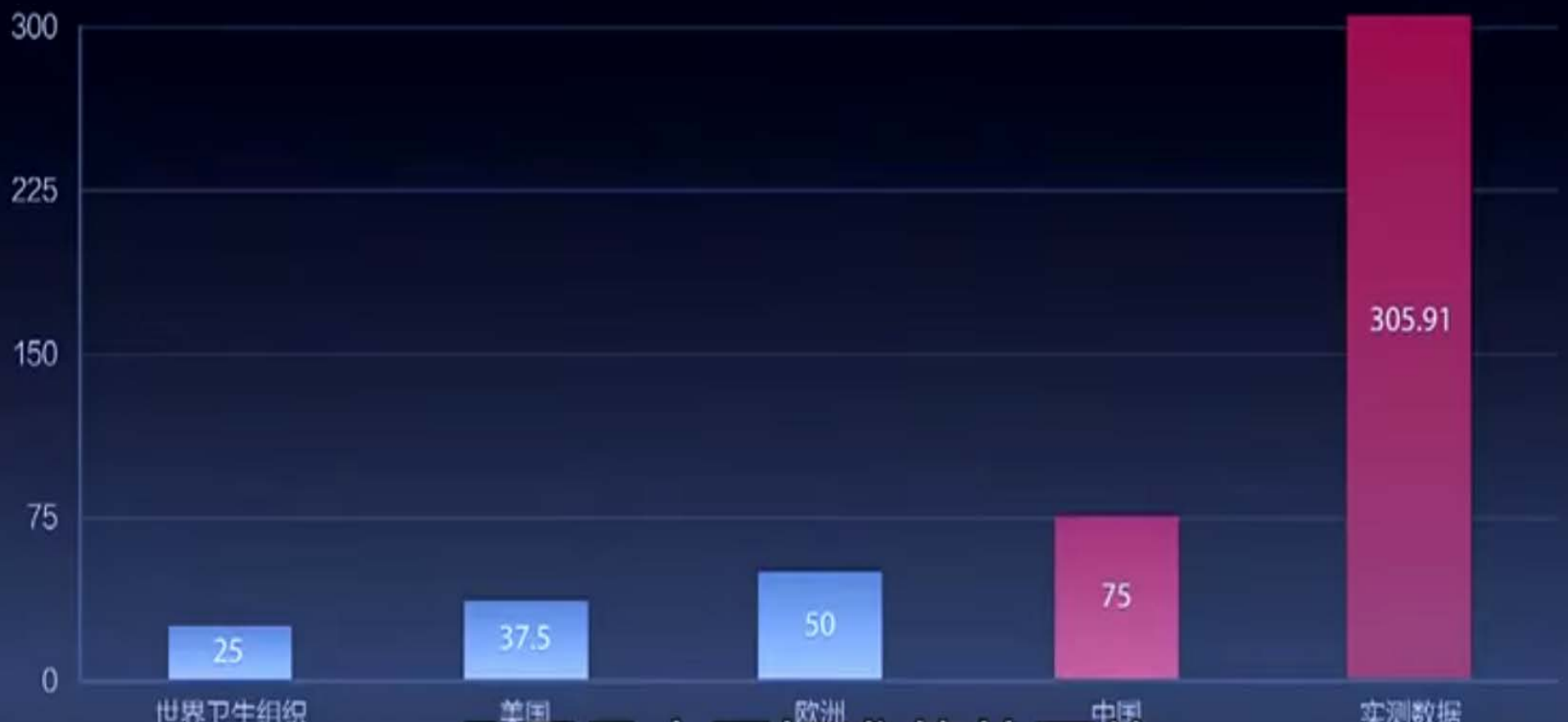
Sources: U.S. Census Bureau, 1960, 1970, 1980, 1990, 2000 Census; 2006, 2010, 2013 American Community Survey.

China's air quality challenge

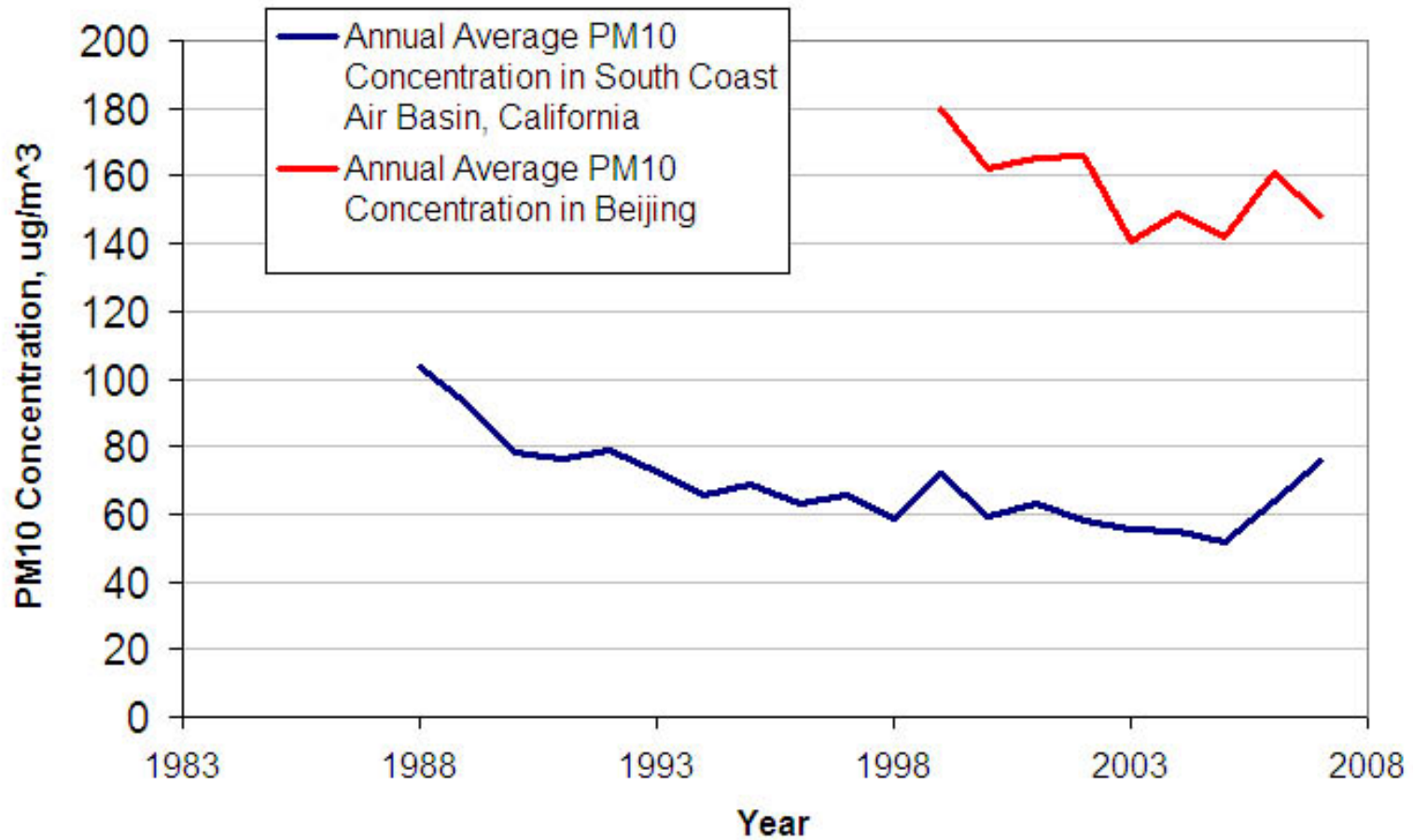
PM_{2.5} 24小时平均浓度限值

计量单位: $\mu\text{g}/\text{m}^3$

数据来源: 《环境空气质量标准》GB 3095-2012



PM₁₀ concentration in L.A. vs. Beijing



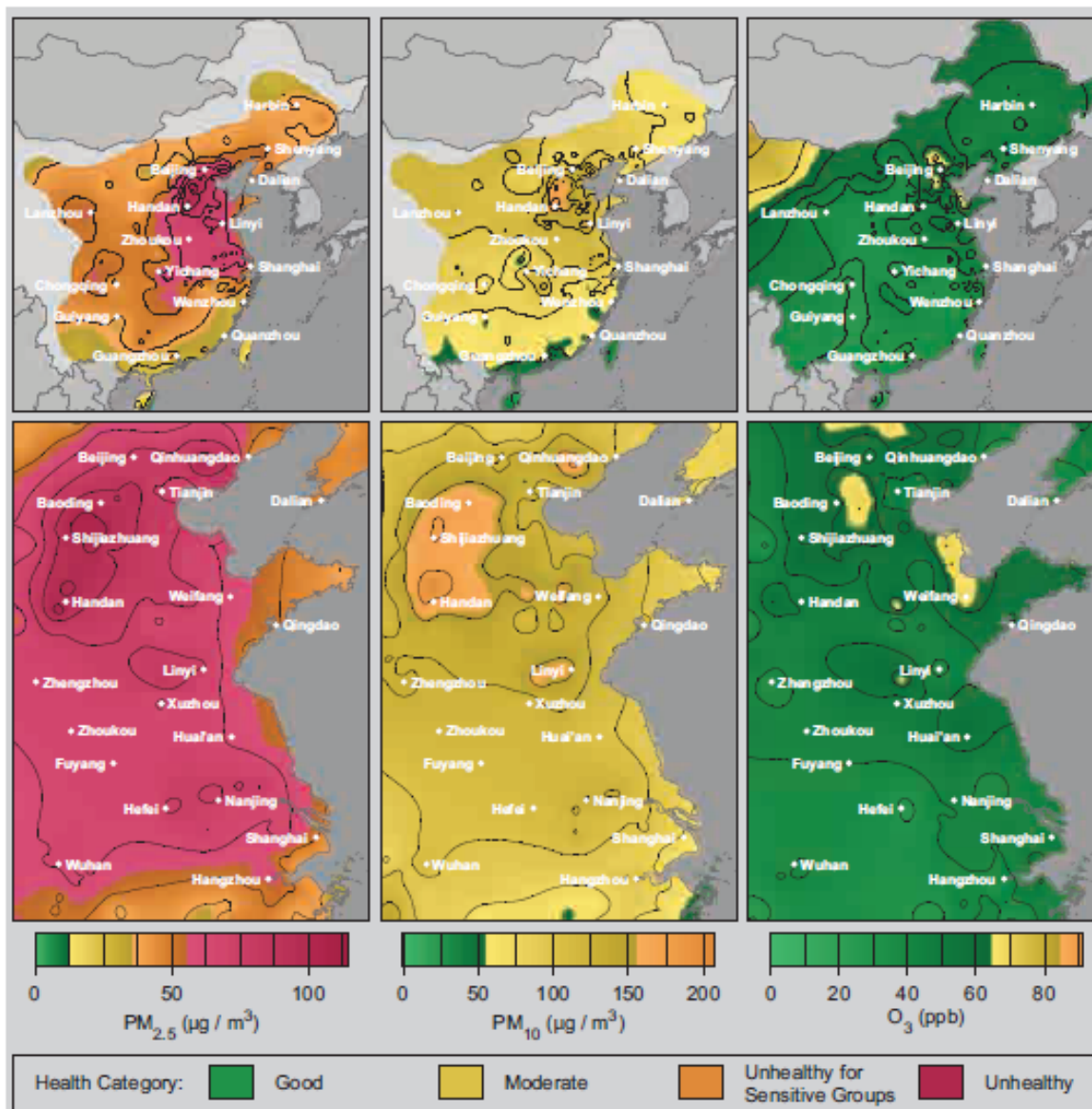


Figure 3. Average air pollution maps. Maps of average pollutant concentration for $PM_{2.5}$, PM_{10} , and O_3 for eastern China (top row) and the Beijing to Shanghai corridor (bottom row). Concentrations are shown using color gradients and contour lines; the colors (green, yellow, etc.) represent US EPA qualitative health impacts. Pollution concentrations were computed as described in the text using hourly data and then the hourly concentration fields were averaged over the four month study duration.

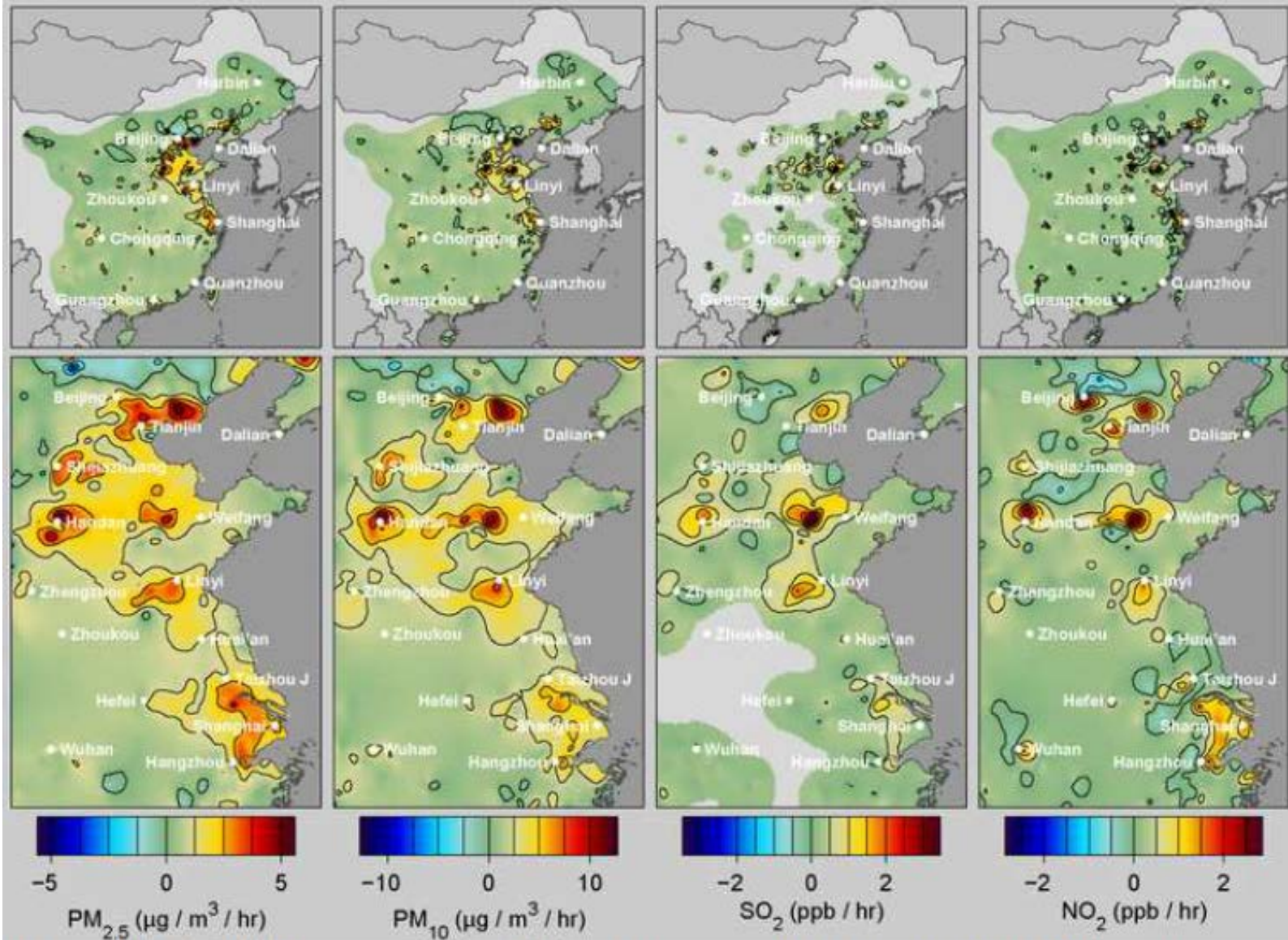
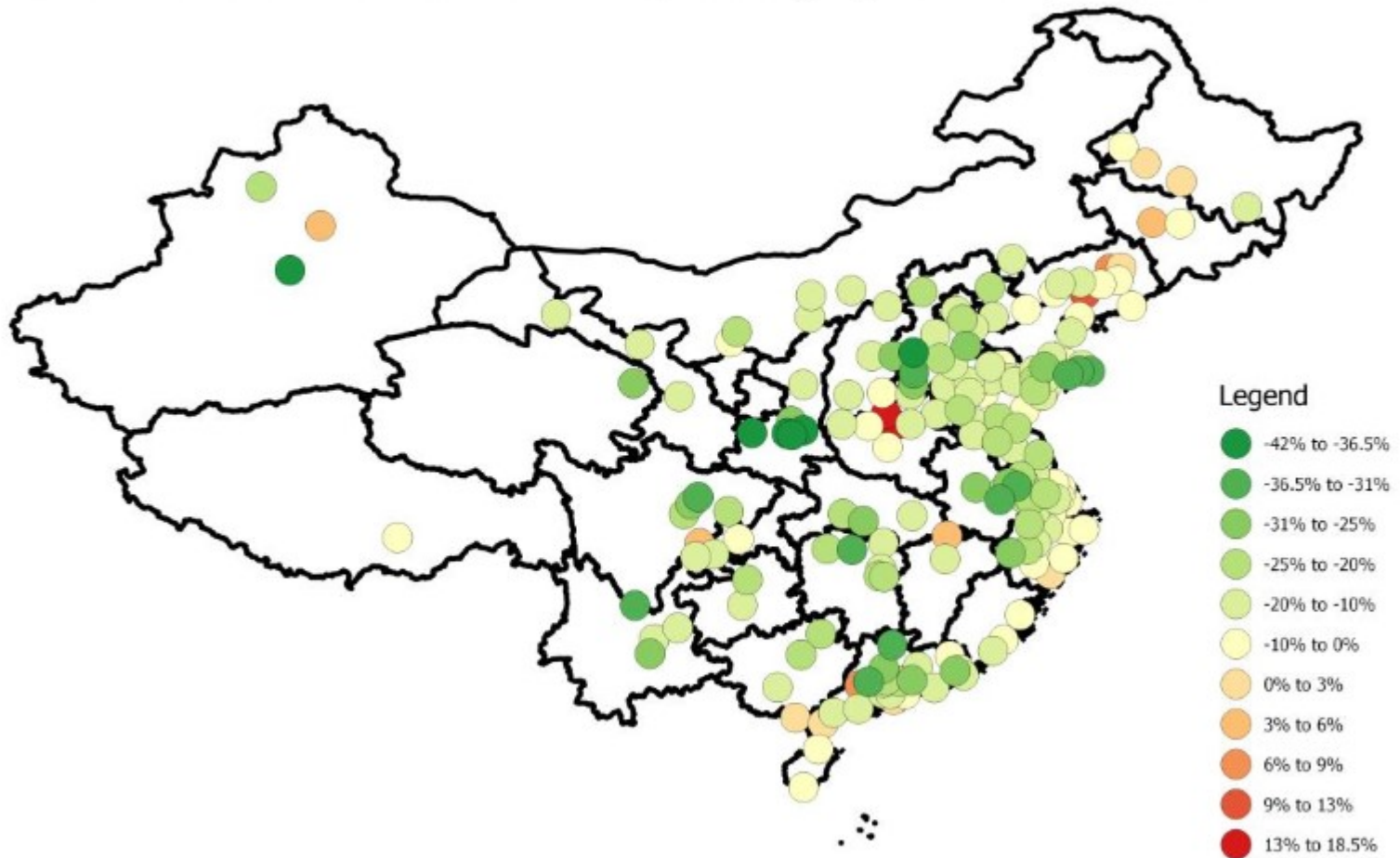


Figure 4. Air pollution source maps. Maps of average pollutant flux for $\text{PM}_{2.5}$, PM_{10} , SO_2 , and NO_2 for eastern China (top row) and the Beijing to Shanghai corridor (bottom row). Pollutant fluxes were computed as described in the text from changes in the interpolated hourly pollution fields along with contemporaneous wind and weather data. Due to sparse sampling and secondary transformations of pollutants in the atmosphere, apparent source fluxes are likely to appear more diffuse than the true emissions source.

Are we at a turning point?

PM2.5 levels: First half of 2015, change year-on-year, %



Questions to consider

- What are the systematic drivers of urban air quality in China?
- Are they changing? How fast?

To enable a socioeconomic- environmental system change

- Set expectations
- Make efforts
- Be prepared for disappointments
- Learn from others but your solution might be very different

Questions/comments?

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