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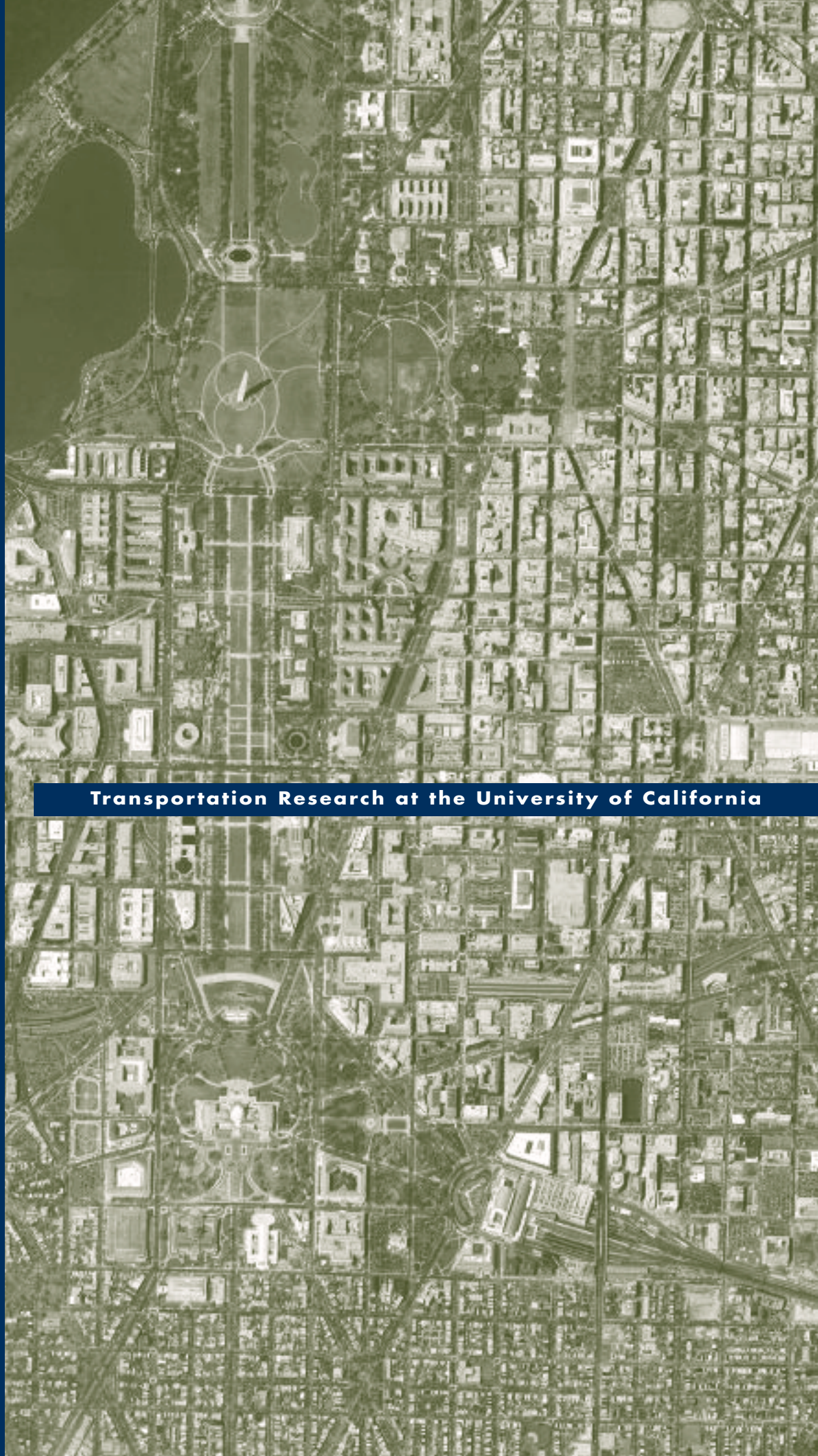

Transportation Research at the University of California

FALL 2008
NUMBER 33

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The University of California Transportation Center, founded in 1988, facilitates research, education, and public service for the entire UC system. Activities have centered on the Berkeley, Davis, Irvine, Los Angeles, Riverside, and Santa Barbara campuses.

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Cover image: Satellite view of Washington DC

Transportation Planning as an Integral Part of Urban Development: The Emerging Paradigm

TRANSPORTATION PLANNERS AND ENGINEERS OFTEN focus on specific areas of expertise, such as particular modes of transport, or air quality effects of transportation. Increasingly, however, Californians are reminded that such focused specializations, while valuable, are insufficient by themselves. Current efforts to meet stringent greenhouse gas reduction targets while accommodating growth and counteracting economic downturn show just how complex and interconnected urban development issues are. The emerging paradigm is one that integrates transportation planning into a broader metropolitan development strategy.

Broader systems thinking could start with a statewide transportation strategy. Sustainable growth in California will require intercity transportation that links effectively with metropolitan transport systems, serving a wide variety of needs. Adib Kanafani notes in this issue of Access that currently the state lacks a true intermodal transport system. Both within and between cities, transport modes are planned and operated largely independently. As a result, opportunities for better services and cost savings are missed. One of the reasons for piecemeal planning and investment, says Kanafani, is that California has not yet developed the data nor the analysis tools needed to rigorously evaluate investments across modes. He advocates a new statewide interregional investment strategy integrating metropolitan blueprint plans and based on ongoing data collection and analysis.

Marlon Boarnet, also in this issue, points out that sustainable transportation also requires more context-sensitive plans: redeveloping cores, older suburbs, and growing outlying areas each require different kinds of transportation investments. In Boarnet's view, more funding should be directed toward serious congestion points in built-up areas and busy corridors, where congestion relief might be accomplished by encouraging mixed-use infill development and alternative modes, starting with walking. In newly developing areas, additional highways may be needed, but Boarnet also sees many opportunities to manage demand by coordinating neighborhood-scale transportation and land use planning. He argues that better measurement and data analysis could help decision makers identify the best sites and the best strategies for investment, moving away from opportunistic siting and a one-size-fits-all approach.

Yet as David Dowall and Robin Ried noted in the previous issue of Access, transportation is only one of many facilities and services demanded by expanding population and economic activity. Housing, discussed in ACCESS 32, as well as water and education—discussed in this issue—also require more coherent development strategies, and all have important linkages to transportation.

Water considerations will shape California's growth and pose challenges for its transportation systems. G. Mathias Kondolf and William Eisenstein note that California needs to invest in water storage, conveyance, and protection, and must deal with flooding risks. Design innovations, together with conservation strategies, could support growth while reducing environmental harm. Since flood risk could increase as the climate changes, California's new law banning development in the 200-year flood zone is an important step. However, massive amounts of housing, commercial development, and transportation facilities are already located on high-risk floodplains. Future transportation plans may need to address emergency evacuation more specifically than in the past.

California's schools also have direct and indirect links to transportation. As Deborah McKoy, Jeff Vincent, and Carrie Makarewicz point out, school quality has a significant influence on student achievement, and thus on economic competitiveness and growth. Schools also shape development patterns: school location, design, physical condition, and available services affect neighborhood quality, housing prices, developer decisions, and business and household location choices. Finally, school trips comprise five to ten percent of urban travel, and school location and design influence the travel modes chosen.

Links among infrastructure systems may well be the keys to sustainable development. Just as transportation planners must understand technological possibilities to effectively design new facilities and services, they must also understand changing and diverse patterns of urban growth and development, and develop transport options that fit into these larger urban systems. Making these connections will be necessary to support a robust economy, a vibrant society, and a healthy environment within uncertain times.

— Elizabeth A. Deakin

MULTIMODAL TRANSPORTATION IN CALIFORNIA

Connecting Planes, Trains, and Automobiles

BY ADIB KANAFANI

The continued population growth expected for California will bring increasing demand for mobility and pressure to expand the capacity of the transportation system, including intercity transportation. If historic trends are any indication, we know that no single mode—rail, air, or highway—by itself can meet this increasing demand. Making the best use of each mode and creating interconnections among them are key to coping with rising demand for transportation.

An integrated multimodal approach is a daunting institutional challenge today, because the current framework for transportation planning and investment assigns responsibility for air transport, rail transport, and highway transport to different and only loosely connected organizations—especially when it comes to intercity transport. But there are actions we can take to get started. First, we can develop a new framework for program planning and investment that covers all modes and considers social costs and benefits of alternative modes and combinations of modes. Second, we can re-evaluate transportation investment plans in light of changing economic conditions, public preferences, and expanding knowledge, especially regarding the environmental effects of transportation. Third, we can develop a new multimodal statewide transportation plan that balances the roles of different modes in a complementary manner and weaves them together into a comprehensive system. Fourth, as part of this plan, we can find more efficient ways to use existing capacity and available infrastructure. Finally, we can devise better financing and pricing mechanisms that seek economic efficiency and social effectiveness.

Transportation trends and new opportunities

It's no surprise that California traffic is increasing—even with higher fuel prices and economic difficulties, the state's expanding population is likely to keep traffic on the rise. However, while in past decades vehicle miles traveled have grown faster than the population, there is recent evidence of a slowing or even reversal of this trend. Meanwhile, while California is spending more on highways than ever before, construction costs have grown faster than spending, resulting in reduced purchasing power—and a decline in per capita lane-miles.

Population growth is also pushing up the use of other transport modes. Per capita trips by air went up by fifty percent over the last two decades, with intrastate trips a large share of the total. Rail transportation, the mode that carries the smallest share of overall trips in the state, has actually shown the largest percent increase in passenger trips, doubling over the past twenty years.

The strong growth in air and rail travel shows that these modes are playing an increasingly important role in meeting mobility demand within California. However, most of the funds available for these modes are used to maintain existing facilities, and not much investment is going towards expanding capacity. Their ability to continue absorbing growth is therefore far from certain, and would require major shifts in policy and in operations.

A true multimodal transportation system does not yet exist in California.

The case for modal integration

While trips by rail and air are increasing in California, a true multimodal system does not yet exist here. Transportation planners have always accepted the integration of modes as a sound principle, but daunting challenges prevent its realization. Yet integrating the modes could produce better service at lower cost than the current mode-by-mode approach.

For example, consider the problem of providing intermetropolitan passenger transportation in California. The distances between major Californian cities are large, so driving is time consuming even in the best of circumstances. Congestion on many of the routes increasingly makes driving long distances unpredictable and tedious. Airplanes provide an important alternative to car use between the largest and farthest apart of the state's intercity markets, especially between Los Angeles and San Francisco. But because of strong economies of scale, air transport services concentrate in the major airports that can sustain them efficiently. This leaves vast intermediary regions with only limited—and costly—air transport options.

Integrating rail and air transportation effectively could remedy the intercity access problem for smaller cities. Rail transportation could be used to connect smaller cities to each other and to major airports, where passengers could find flights at far lower cost than the local airports can offer. With good planning, a single intermodal ticket could be purchased, transfers could be effortless and quick, and luggage could be checked through to destinations regardless of modes used. But currently no agency has responsibility for stitching together these modes, and few opportunities exist for private sector action. As a result, integrated multimodal services are not available. ➢

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Multimodal planning and priority setting

The lack of multimodal planning also reduces our ability to discuss investment priorities and trade-offs among modes. For example, the state is considering a major investment in high speed rail to connect its cities and link to airports and urban transit systems. In evaluating this proposed investment, we ought to be comparing high speed rail's costs—dollar and other—to the costs of expanding congested airports or highway systems. We should consider capital outlay, operating costs to public and private parties, environmental costs, energy impacts, social equity, and public acceptability. The different modes offer different advantages in travel time and cost, community and environmental impacts, economic development effects, safety, comfort, and convenience; investment decisions should weigh these factors across modes.

Existing institutional arrangements provide neither the authority nor the funding to conduct such a broad analysis. No current transportation organization has the authority to plan across modes or prioritize investments. The large number of organizations responsible for individual modes are as likely to compete for resources as to join together to rationalize their use. Intercity transport programs thus suffer from insufficient attention to institutional design, and the result is insufficient attention to planning and budgeting. Lacking both the information and the wherewithal to capture intermodal opportunities, many actions that could be highly beneficial and cost-effective are not pursued.

No current transportation organization has the authority to plan across modes or prioritize investments.

Better use of existing resources

Most transportation technologies offer economies of scale that can improve performance and lower costs, if properly managed. These same technologies can also suffer from diseconomies and rising costs, if mismanaged or subjected to excessive congestion. For example, we know we can increase highway capacity if we deploy effective traffic management schemes to monitor and optimize speeds, flows, and safety, and if we use pricing to manage demand. Yet most California roads are unpriced, and the use of advanced management technologies, such as ITS, is spotty.

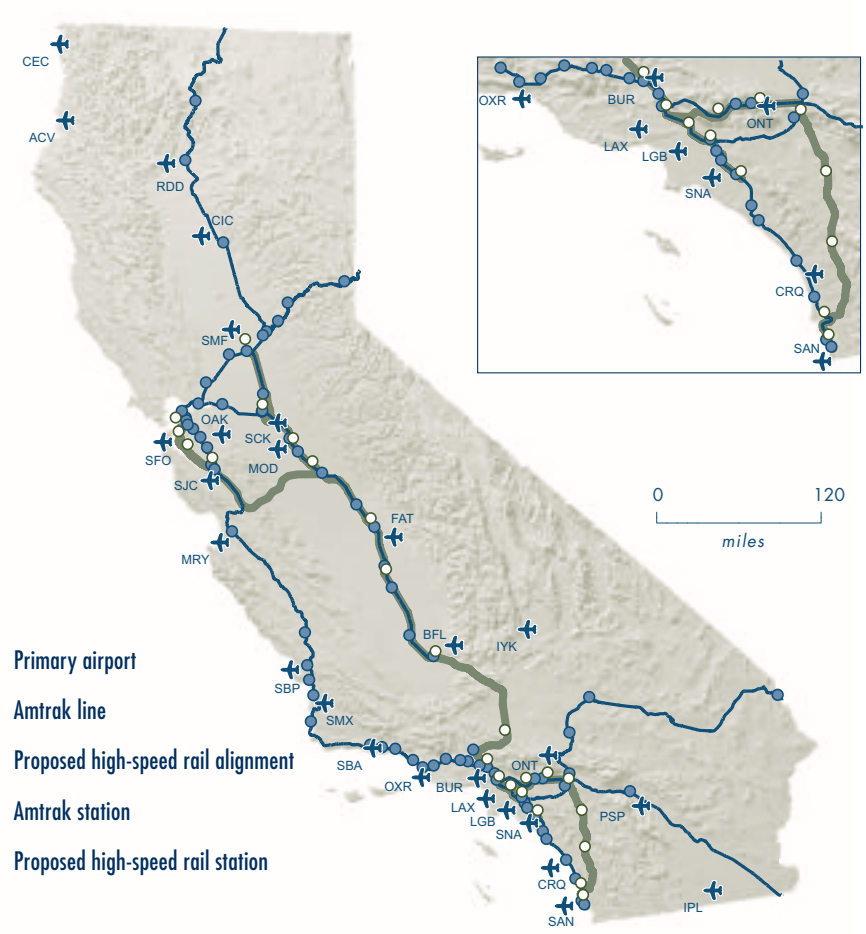
Similar opportunities exist in air and rail transportation but remain underutilized. The air transportation system continues to struggle for profitability, which forces airlines and airports to focus on near-term actions and individual interests. Really significant opportunities exist for increasing air transportation capacity, but only if the parameters that drive the system can be revised.

Consider the shuttle system that connects the San Francisco Bay Area with the Los Angeles basin. Airlines currently operate seventy flights a day in that corridor, using airplanes that can seat between 100 and 140 people. The passenger capacity of this system could be doubled without increasing air traffic by switching to bigger aircraft. Capacity could be used more effectively by reallocating traffic among airports in each region, and constraints could be relieved further by shifting short-haul traffic to rail or bus transportation. What stands in the way of these patently obvious solutions?

A big part of the problem is that the many different actors are each optimizing their own objectives, with no one looking after the whole system. Airlines know that frequency of service is a matter of importance in attracting market share, so they insist on high frequency with smaller planes. They will do so as long as airlines and passengers are not paying the true marginal cost of flight operations. Airports consider maintaining and growing their market share a necessity for revenue enhancement, and revenue enhancement is a primary

FIGURE 1

Primary airports and HSR/Amtrak network



AIRPORT DESIGNATIONS AND NAMES

ACV	Arcata
BUR	Bob Hope, Burbank
CIC	Chico Municipal
FAT	Fresno Yosemite International
IPL	Imperial County
IYK	Inyokern
CEC	Jack McNamara Field, Crescent City
SNA	John Wayne Airport, Orange County
LGB	Daugherty Field, Long Beach
LAX	Los Angeles International
CRQ	McClellan-Palomar, Carlsbad
BFL	Meadows Field, Bakersfield
OAK	Metropolitan Oakland International
MOD	Harry Sham Field, Modesto City County
MRY	Monterey Peninsula
SJC	Norman Y. Mineta San Jose International
ONT	Ontario International
OXR	Oxnard
PSP	Palm Springs International
RDD	Redding Municipal
SMF	Sacramento International
SAN	San Diego International
SFO	San Francisco International
SBP	San Luis County Regional
SBA	Santa Barbara Municipal
SMX	Capt. G. Allan Hancock Field, Santa Maria Public
SCK	Stockton Metropolitan

goal for airports, given their ongoing need for huge infrastructure investments. Airports compete with each other for more flights even when congestion builds up. Consolidating flights in larger aircraft and shifting flights among airports and modes might make sense for the system, but not for the individual competing airlines and airports. Without institutions in place that can change the incentives and revenue consequences resulting from cooperation and coordination, little change is likely. Airport plans are insufficient; they can scarcely influence the distribution of traffic among airports of the same metropolitan area, much less allocate traffic across modes so that each can play its role efficiently. In the absence of a comprehensive multimodal planning and decision-making structure with a say over operations and finance—and without a pricing structure that reflects marginal costs—none of the individual actors will want to seek overall system optimization.

An improved framework for evaluation

Transportation experts have long recognized that the palette of transportation technologies available to California shows wide variations in direct and indirect costs. Some technologies appear self-sufficient financially—if analysts consider only narrowly defined user-paid costs, leaving out relatively high environmental costs. Other technologies with ➢

Californians are increasingly aware of the importance of considering all of a transportation system's costs, including its external costs.

lower external costs look financially infeasible when evaluated on direct costs alone. Currently, we fail to consider the full range of costs and benefits in many of our evaluations, but we can and must do better.

With global warming and energy prices prominent in the news, Californians are increasingly aware of the importance of considering all of a transportation system's costs, including its external costs. In turn, increased attention to the environmental effects of transportation systems could change how we rank transportation alternatives; comparing full costs and benefits across modes would let us choose the best package of investments overall. But the processes we use to evaluate policies and investment decisions will have to be redesigned to incorporate external costs and benefits more rigorously.

The need for a new evaluation framework is illustrated, once again, by comparisons between highway and rail transportation. Much of the debate over high speed rail has centered on the price tag for the investment and whether projected ticket sales and other sources of revenue will be able to cover construction, operation, and maintenance costs. Yet the benefits high speed rail can offer by reducing external costs—such as reduced energy use per passenger, lower personal financial and safety costs, and airport and highway congestion relief—are less frequently included in the debate. A well-documented and publicly scrutinized analysis of both direct and indirect costs of the alternatives—acknowledging the risks and uncertainties as well as what we know about likely effects—could change the evaluation of available choices.

The evaluation framework should not only consider modal alternatives but an expanded set of choices for pricing and finance. California seems poised to consider both pricing and finance reforms in the coming months and years. State and local officials and the public have shown increased willingness to try congestion pricing in various forms, and there has been recent interest and some success in extending public-private partnerships, common in airport planning and finance, to the rail and highway modes. These approaches hold considerable promise for improving transportation efficiency.

However, enthusiasm for partnerships and for pricing must be tempered with two realities. First, while public-private partnerships can produce real advantages, including cost savings and risk sharing, private sector involvement will rarely alter a system's fundamental financial feasibility. Certain transportation systems simply do not pay for themselves and will require subsidy, direct or indirect. This fact has to be confronted head-on; bringing in

the private sector will not change that reality. Second, a pricing approach that accounts for total costs and benefits is likely to be more efficient and fairer than the prices we have today, and full-cost accounting may well justify subsidy for some transport services whose indirect benefits are important. But not every transport service currently subsidized today would be likely to fare well in a rigorous, full-cost evaluation, and some politically favored projects could be among those that do not. There will be a need for considerable public discussion and debate on these issues as we move forward.

Research needs

There is sufficient current knowledge to improve planning processes now. At the same time, there is more research to be done. We need a better handle on how to assess and quantify external benefits, and how to plan transportation investment within the context of social welfare. This calls for an aggressive research agenda.

In particular, we need a sound basis for weighing carbon emissions against increased mobility, for this type of trade-off will have to be faced to evaluate alternatives fully. At some point we also have to be able to put a price tag on carbon emissions. What we know now is that such a price tag is likely to be higher than we thought at first, and that integrating it into transportation decision making may well be a rather painful exercise. But better information on transport costs and benefits could also help us address transport financing problems more effectively. For example, the carbon performance of various modes could justify the addition of some subsidies and the removal of others, in order to move the transportation system towards a more environmentally and socially optimal configuration. Finally, the cost of not addressing the carbon issue also needs evaluating, since inaction will also have serious costs. For example, a sea rise could flood many coastal facilities, including airports and roads, requiring costly investments in protective infrastructure or relocation.

Research is also needed on how to best communicate research findings to decision makers and the public. For example, it is widely accepted among transportation researchers that transportation pricing is efficient, but it is far less clear that California consumers or decision makers understand why the researchers have concluded this is so, or accept their reasoning. Thus, research not only on pricing strategies but also on attitudes concerning pricing would be valuable.

Recommendations

To provide Californians with the transportation systems they need and deserve, we should immediately fund an integrated multimodal plan for intercity transport needs for the next thirty or even fifty years. The plan should anticipate the expected demand for air, rail, and highway intercity transport and its linkages to multimodal metropolitan transportation systems, current and proposed.

Such a plan should address the need for ongoing maintenance as well as new investment, and should consider how demand management, including pricing, might alter investment needs. The plan should evaluate the full social, environmental, and economic costs of the alternatives, including possible costs due to climate change, and should identify preferred alternatives and priority actions based on this evaluation, putting forward a specific and fundable set of actions for implementation. Finally, the plan should identify needed legislative changes, management approaches, and investment practices to make such planning an ongoing feature of California transportation decision making. ◆

FURTHER READING

California State Transportation Plan 2025, California Department of Transportation. http://www.dot.ca.gov/hq/tpp/offices/osp/ctp2025.html

Regional Airport System Plan, Update 2000, Metropolitan Transportation Commission. 2000.

Regional Aviation Plan for the 2004 Regional Transportation Plan, Southern California Association of Governments, 2004.

California High Speed Rail Authority. http://www.cahighspeedrail.ca.gov/

Planning Water Use in California

BY WILLIAM EISENSTEIN AND G. MATHIAS KONDOLF

As California's population grows, so will its demand for a full range of infrastructure and services. An efficient transportation system, for example, is crucial for the state's economy and people. So is a system for storing water and moving it to where it's needed.

Water is a perennial problem in California, but it is not the problem most people think it is. Viewed strictly as a matter of quantity, California does not have a water shortage, nor will it anytime soon. The state's water is plentiful, but it is inconvenient for human use; distributed unevenly across time and space, it is rarely where we want it when we want it. About three quarters of the potential water supply in the state of California originates north of the city of Sacramento, while about three quarters of the demand is south of the city. During flood times, the state's most pressing water problem is getting rid of it, while in dry times the problem lies in storing and moving it.

Traditionally, governments have resolved this mismatch between the location and timing of supply and demand by building dams and canals—or "storage and conveyance" in the water planning lexicon. Today these are only two among many tools in California's water supply and flood control infrastructure—its "waterscape." However, our approaches to water management strategies must evolve substantially in the future. California's population continues to grow; the state's Department of Finance projects that in 2030 California will have twelve million more people than today. Also, intense development of California's water resources has already exacted a huge cost to the state's natural environment. Dam construction has inundated hundreds of valleys, populations of salmon and many other fish are a small fraction of what they once were, and water quality has suffered from industrialized agriculture and urbanization. Climate change promises to complicate matters still further. California must diversify its water management strategies and place a premium on consumption efficiency and management flexibility. ➢

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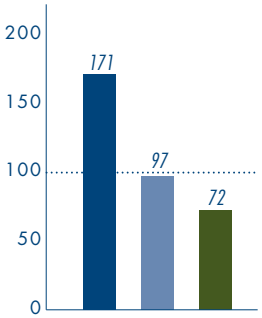
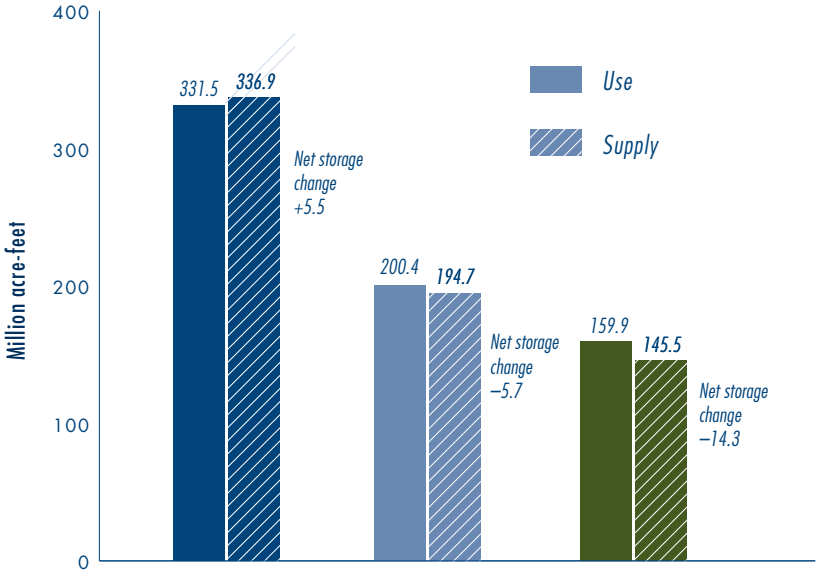
FIGURE 1

Water supply and use in three recent California water years

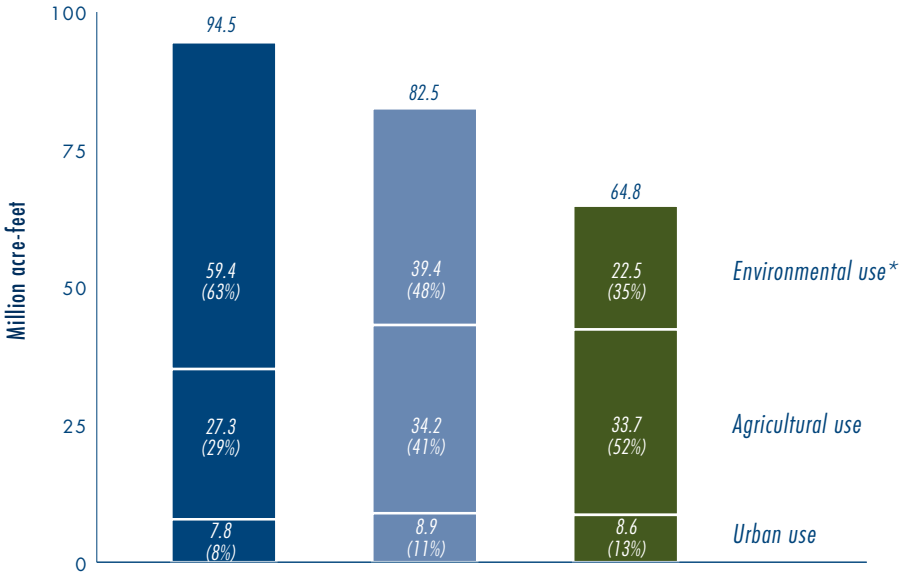
PERCENT OF NORMAL



TOTAL USE AND TOTAL SUPPLY



TOTAL DEDICATED SUPPLY



*managed by humans and specifically dedicated to environmental purposes

California water use in context

Despite a widespread perception to the contrary, California is blessed with substantial annual precipitation in most years. The annual average rainfall in Sonoma County, which is far from the wettest part of the state, is about the same as central Indiana—yet we do not think of Indiana as dry, and indeed Indiana has a long history of non-irrigated agriculture. California differs from Indiana in the pronounced seasonality of its precipitation, its long summer drought, and its greater year-to-year variability in precipitation. The state also has large variations in the amount of precipitation that falls in the north and south, and at high elevations and low.

It's also important to recognize that water is water. We tend to think of flood control and water supply as different problems that require different organizations and planning approaches. We also tend to think of groundwater and surface water as different resources, and we adjudicate them in different ways. But in fact floods, droughts, surface flows, and groundwater aquifers are all part of the same hydrological cycle, and our institutions and infrastructure should reflect that.

Data from three recent years (one wet, one average, one dry) in Figure 1, sketch the outlines of the water cycle in California. "Total use" includes large flows (such as rivers flowing to the ocean) that are not "used" by people in the normal sense of the word, whereas the "total dedicated supply" (the last graph) consists of the water that human institutions explicitly decide how to allocate. Perhaps unsurprisingly, the environmental portion of the dedicated supply (i.e. the water dedicated to maintaining environmental quality in rivers, lakes, and wetlands) varies much more than the relatively inflexible urban and agricultural uses. Because urban demands change little from year to year, and because agricultural demands are greater in dry years (when there is less "free" irrigation from rain falling directly on fields), those uses take up a much larger percentage of the pie in the dry years. ➢

Groundwater aquifers may be the only place to find the quantities of storage likely to be needed as California's population grows.

Much more water is used for agriculture than is used in urban areas. In the dry year of 2001, for example, agriculture used 34 million acre-feet (maf) of water, while urban uses accounted for 9 maf, a nearly four-to-one ratio. Even in the wet year of 1998, farms used well over three times as much water as urban areas. Any effort to address water management problems in California therefore needs to carefully consider how to handle agricultural needs.

Surface and groundwater storage have historically been the backbone of the state's water system, allowing managers and landowners to retain and access water at moments of their choosing. In a Mediterranean climate that is dry all summer, it could scarcely be otherwise. State, federal, and local agencies have made massive investments in surface storage throughout the state for decades, to the point that there are few practical and economical sites remaining to develop. But, as large as our reservoirs are, groundwater aquifers are still by far the largest potential storage areas. Indeed, groundwater banks may be the only place to find the quantities of storage that will likely be necessary to meet growing demand in the coming decades. To transport water from storage sites to point of use has required construction of a network of canals, some of which bring water westward from high elevations in the Sierra Nevada to urban centers along the coast, then move water southward to meet agricultural and urban demand. Much of this water transport crosses active faults, and some crosses the Sacramento Delta, a region that is extraordinarily vulnerable to disruption by earthquakes and flooding.

The tenuous situation of the Delta

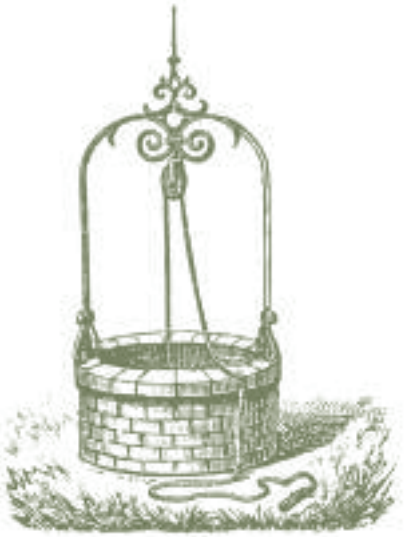
The fate of the Sacramento-San Joaquin Delta (at the north end of which sits the city of Sacramento) looms large in the state's water policy debates, because getting water from areas of origin to areas of use requires moving it from north to south, and that means somehow conveying water through the Delta. But the Delta is ecologically and geologically unstable, and because of that, the water supply for most Californians is unreliable.

The Delta is the hub of the two largest conveyance systems in the state, the State Water Project and the Central Valley Project, which together carry roughly one fourth of the state's developed water supply from the Sacramento River system to the south. While political debates about Delta management have often focused on the quantity of water these systems export to southern California, the Bay Area is actually more dependent on the Delta than is urban southern California. Moreover, upstream diversions remove more water from the Delta system than do the two water projects. As a result, the environmental sustainability and supply reliability of the Delta require policies that directly affect most of the state's residents, not just those in southern California or the San Joaquin Valley.

The primary risk to the Delta is flooding. The Delta is not unique in this regard—the lower Sacramento and San Joaquin Valleys, for instance, are basically huge floodplains. Earthquakes and wildfires capture the California imagination, but few people realize how dramatic and damaging Central Valley floods have been at numerous points in the state's history. In 1997, for example, flooding on the San Joaquin River caused over $2 billion in damage. But the Delta is particularly vulnerable to flooding—far more so than New Orleans or any other part of the United States. The Delta has been spared a devastating inundation in recent decades because upstream reservoirs and flood bypasses have been sufficient to control the floods we have experienced, but there is no reason to think our luck will last forever.

In fact, the risk of a levee failure disaster in the Delta is extraordinarily high. Two members of the CalFed Independent Science Board estimate that there is a more than 66 percent chance of mass levee failure in the Delta before 2050, due to earthquake or flooding. Because most Delta "islands" are actually basins below sea level, a mass levee failure would result in a large intrusion of saltwater from Suisun Bay into the central Delta, potentially spoiling the freshwater supplies that millions of agricultural and urban users depend upon. Levee failure would also disrupt transportation and infrastructure corridors that cross the Delta.

The rapid urbanization of the Delta's edges exacerbates these flood threats and makes their long-term mitigation more difficult. This urbanization is driven, in part, by powerful perverse incentives that encourage people to move into harm's way. Since the early 1970s, federal flood control policy has decreed that property owners living in a natural floodplain behind levees certified to provide 100-year flood protection need not obtain flood insurance. The clear implication of this policy is that the levees make these floodplains safe places to build. But many people misunderstand the risks they face. A 100-year flood protection levee does not guarantee protection for 100 years. Even if they are protected against a 100-year flood (with its one percent chance of occurring in any given year), they are not protected against the inevitable larger floods. A 200-year flood has a one-half percent chance of occurring in any given year, and a 500-year flood a one-fifth percent chance. When we add up these individual risks, we obtain a "residual ➢



Many property owners would consider their residual flood risk intolerable if they were fully aware of it.

risk" of being flooded by a greater-than-100-year flood: this is a 26 percent risk of levees being overtopped sometime during the life of a 30-year mortgage. Many property owners would consider that risk intolerable if they were fully aware of it. Residual risk remains surprisingly high—still well over ten percent—even for the 200-year levels of flood protection recently mandated for the Central Valley.

The risk of flooding will likely be exacerbated by climate change. Climate models generally predict that California will continue to receive the same amount of average annual precipitation, but that less of that precipitation will arrive as snow. Snowpack in the Sierras is immensely important to the state's water system, since it is a form of storage, allowing water to be retained in the mountains, free of charge, until well into the spring. In addition, snow melts more gradually than rain runs off, so flood peaks are lower and management of the flows is easier.

The state predicts that climate change could reduce Sierra snowpack storage by as much as five million acre-feet. Once this occurs, flood peaks in Central Valley rivers will be higher and more frequent, placing all people and resources in the floodplains, including the Delta, at greater risk. In addition, a larger proportion of potentially usable water in the state will be "lost" in uncontrolled high flows, rather than stored for later use. Sea level rise will also make it more difficult to manage salinity in the Delta, potentially compromising water quality at certain times of the year. Finally, climate change will also increase temperatures (and therefore evaporation pressure) throughout most of the state, increasing irrigation demands for agriculture. Unless we make significant changes to our water management strategies and infrastructure, these changes will be quite damaging to the California waterscape.

Finally, the Delta is in a precarious position environmentally. High levels of upstream diversions, historically high levels of water exports, water pollution, invasive species, continued land subsidence, and aging levees all threaten the Delta's environment (not to mention the water resources it provides). The Delta smelt is probably approaching extinction, but is only one of several fish species that are in sharp decline. There are likely to be more endangered species listings, and more conflicts between habitat needs and water diversions, in the future.

The oversubscription of the Delta, and of California's water supplies generally, means that there is little slack in the current system to absorb expected future demand. Alternative means of supply development and demand reduction, such as water conservation and recycling, efficiency investments, rethinking reservoir operation (modifying the rules of reservoir storage and release to meet multiple objectives) and managing surface and groundwater together as one cycle, are the only ways California will be able to meet this increased demand.

Many parts of California, especially southern California, have already made significant strides in water efficiency and recycling. According to the Department of Water Resources, California's urban areas use about the same amount of water as they did in the mid-1990s, although their populations have grown by 3.5 million people. California agriculture also increased crop yield per water use by forty percent between 1980 and 2000. Despite these impressive gains, further efficiency improvements are still the largest potential source of "new" water in the state.

Recommendations for creating a sustainable California waterscape

The Delta Blue Ribbon Task Force recently completed its Strategic Plan for the Delta's future. It calls for a comprehensive rethinking of California's water system and consumption habits, and urges a number of measures to reduce pressure and reliance on the Delta, starting immediately and continuing for the foreseeable future. These include aggressive improvements in water use efficiency throughout the state. While demand management for indoor use has been extensively implemented (metering formerly un-metered users, low-flow toilets, low-flow showers, etc.), there remain big potential gains from improved efficiencies outdoors (irrigated lawns and other landscaping). The efficiency recommendations have a wide base of political support among Delta stakeholders, and should be put into effect immediately.

Beginning with the last water plan update in 2005, the Department of Water Resources greatly expanded its emphasis on nonstructural supply development and demand reduction. Integrated Regional Water Management Plans are now being conducted throughout the state to coordinate different water planning measures, such as development of alternative supply, demand reduction, and groundwater management. Tiered pricing structures, public education campaigns, water recycling, stormwater harvesting, and desalinization are also among the tools in these integrated planning exercises. Not only are they a constructive approach to exploring the wide range of available water management tools, but—equally importantly—they serve to ensure that local water agencies continue to develop their expertise in the use of these tools. ➢

By far the largest water storage capacity available in California is in groundwater aquifers, so managing surface and groundwater resources together should be vigorously explored. Water storage will always be an essential task in California's Mediterranean climate. But with fewer practical and economical surface storage locations left in the state, and with climate change altering the precipitation patterns for the reservoirs we do have, California must devote more attention to aquifers. The San Joaquin Valley alone contains about 570 million acre-feet of groundwater storage capacity, far more than all its surface storage reservoirs combined. While not all of that capacity is usable, its sheer magnitude is much too large to ignore.

Conjunctive management of surface and underground water storage has a significant added benefit. The greatest groundwater storage opportunities are in the San Joaquin and Tulare Basins, which is also where the greatest agricultural demand for water is. Moreover, the San Joaquin basin is the source of serious flood risks that, as we witnessed in 1997, can do severe damage to life and property throughout the valley, and to the Delta. Creating a conjunctive management plan that reduces those flood risks, recharges aquifers throughout the farming areas, and thereby reduces dry-season export demand on the Delta, is a crucial task for the state. Conjunctive management

strategies could also restore controlled, environmentally beneficial flows to dewatered rivers (e.g. the San Joaquin) and dormant floodplains. Propositions 84 (on water quality and supply) and 1E (disaster preparedness and flood protection), both passed by voters in 2006, contain provisions and programs for such work.

Though the 2007 legislation requiring a 200-year level of flood protection for the urban areas of the Central Valley was an historic policy breakthrough, it leaves considerable residual risk of flooding to those who choose to live in floodplains, even before the effects of climate change are considered. The distribution of liability for such development decisions will remain a pivotal issue. Meanwhile the state should act vigorously to enhance flood control systems statewide to protect taxpayers from undue liability exposure. Flood bypasses and other set-asides of floodplain lands will be a key element of those efforts.

A sustainable waterscape thus has as much to do with land use and transportation as it does with water infrastructure itself. It is critical to recognize—and act upon—the fact that many of the water management challenges facing the state have a major planning and policy component. Groundwater recharge and floodplain restoration both require areas of undeveloped land. All flood management efforts should pay at least as much attention to keeping development out of floodplains as they do to keeping floods away from development. Creating new flood bypasses, especially along the lower San Joaquin River, is critical. Flood bypasses can, like the Yolo Bypass, be used for agriculture, recreation, and other uses that can tolerate inundation during winter months. Housing, commercial buildings, and transportation facilities should locate elsewhere. ◆

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Integrating Infrastructure Planning: The Role of Schools

BY DEBORAH MCKOY, JEFFREY M. VINCENT, AND CARRIE MAKAREWICZ

"The best cure for destructive sprawl is to build cities people don't want to abandon, places where they can live healthy, fulfilling lives in densities that don't devour our landscapes, pave our wilderness and pollute our watersheds, air, and wildlife. To achieve this, we need to invest in urban schools, transportation, parks, health care, police protection, and infrastructure that makes cities great magnets with gravity sufficient to draw back the creeping suburbs."

—Robert F. Kennedy, Jr.

California's golden opportunity

California sits at an historic moment. The state's policymakers and voters have aggressively ramped up their investment in public school buildings, providing more than $35 billion in state funds in the form of general obligation bonds to modernize existing schools and build new ones since 1998. Additionally, the *California Strategic Growth Plan* won voter approval and in 2006 state leaders began the first phase of a comprehensive twenty-year plan to upgrade critical infrastructure. The plan calls for spending $211 billion through 2016—with $42 billion in bonds already approved—on transportation, water systems, public safety, housing, the judiciary, and education facilities. By including public schools as one of six key pieces of critical infrastructure, state officials and voters recognized the importance of school facilities in shaping California's growth and prosperity. Ongoing school construction investment, coupled with the new, broader infrastructure investment, creates a strategic opportunity for California to improve the way it plans, funds, constructs, modernizes, and operates its schools, and to make school planning an integral part of community and regional development, rather than an isolated endeavor.

California's public schools educate the largest and most diverse student population in the nation. Nearly 6.3 million students attend the state's 10,000 K–12 schools. By 2030, the number of school age children will increase dramatically, making up twenty percent of California's estimated fifty million residents. That's four million more students than today. Successfully accommodating this nearly two-thirds increase in enrollment needs to go beyond simply providing enough seats in classrooms. Planning public school infrastructure takes place within California's increasingly complex landscape. The all-too-common reality of "siloed" planning results in tremendous missed opportunities to make better land use and service decisions to better support students, families, and communities. New school planning must be inclusive, comprehensive, and integrated with community and regional planning. School planning must be coordinated with the housing, transportation, and work needs of the families and teachers of students as well as the communities that surround and support the schools.

The importance of public school infrastructure in shaping urban growth

It's well understood that the quality of California's schools has a significant influence on student achievement, and in turn on California's future economic competitiveness. But schools are also public infrastructure, and their location, design, and physical condition may well be one of the most important determinants of neighborhood quality, regional growth and change, and quality of life. As physical infrastructure, schools have significant impacts on transportation patterns and roadway service demands, residential choices, housing development and prices, as well as water and utility demands. The ➢

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planning of school infrastructure thus needs to be integrated with the planning of other infrastructure and development at local, regional, and state levels. The costs of continuing to *not* do so are too great.

Currently, however, there is no formal policy apparatus at local or state levels that requires or offers incentives for school districts and local governments to work together to plan school infrastructure as part of the larger urban development plan. Indeed, in California, as in most other states, school districts have a unique autonomy from other local government agencies, including the real estate and land use decisions school districts make. For example, when a California school district is looking for a location for a new school, it is not required to check with the local government planning agency to choose a site. Being exempt from local zoning laws, school districts can put a new school on a site the local agency planned to use for something else. Many school siting choices do not align with local land use and transportation plans, and some have caused a problem of "school sprawl," where school districts have been accused of choosing sites far from existing housing, which helps promotes more rapid, and often low-density, development of land. Remote school sites lead to increased vehicle miles traveled, because students must travel farther to reach these schools. If school bus services are not available, as is increasingly the case in California, then families may have to drive their children to school, which can greatly increase total vehicle miles traveled in the region and state. Parents getting to and from schools to drop off and pick up their children can also create traffic congestion during rush hours.

Indeed, because they are accessed by so many people each day, schools can be major contributors to traffic and emissions problems; some have estimated that school traffic accounts for as much as five to ten percent of morning peak travel. Despite that, and despite their significant use of energy and water, schools are currently exempt from AB32, the statewide initiative to reduce greenhouse gas emissions.

Separation of schools from urban planning processes

School district autonomy exists historically for many good reasons; it was intended to disentangle our schools from the strains of local politics, and to leave school planning to educational experts to ensure that educational needs drive decision making. However, decision autonomy has not insulated California school districts from severe financial pressures, and because schools are funded in part by property taxes and development exactions, they are never truly separate from urban development decisions. Instead, they both affect urban development and are affected by it. Formally, however, California school infrastructure planning is disconnected from other planning—governance, finance, and policymaking—in three important ways.

First, school district geographic boundaries rarely match the boundaries of other local planning entities. A school district might lie within several cities, for example, or encompass both incorporated and unincorporated areas. The map of the Sacramento region in Figure 1 shows the kind of disconnected, overlapping boundaries that make it difficult to coordinate school plans with city or county plans. In the Sacramento area shown on the map, there are five counties, fifteen unified school districts, nine secondary and twenty elementary school districts, 29 cities/towns, and 446 schools. Statewide,

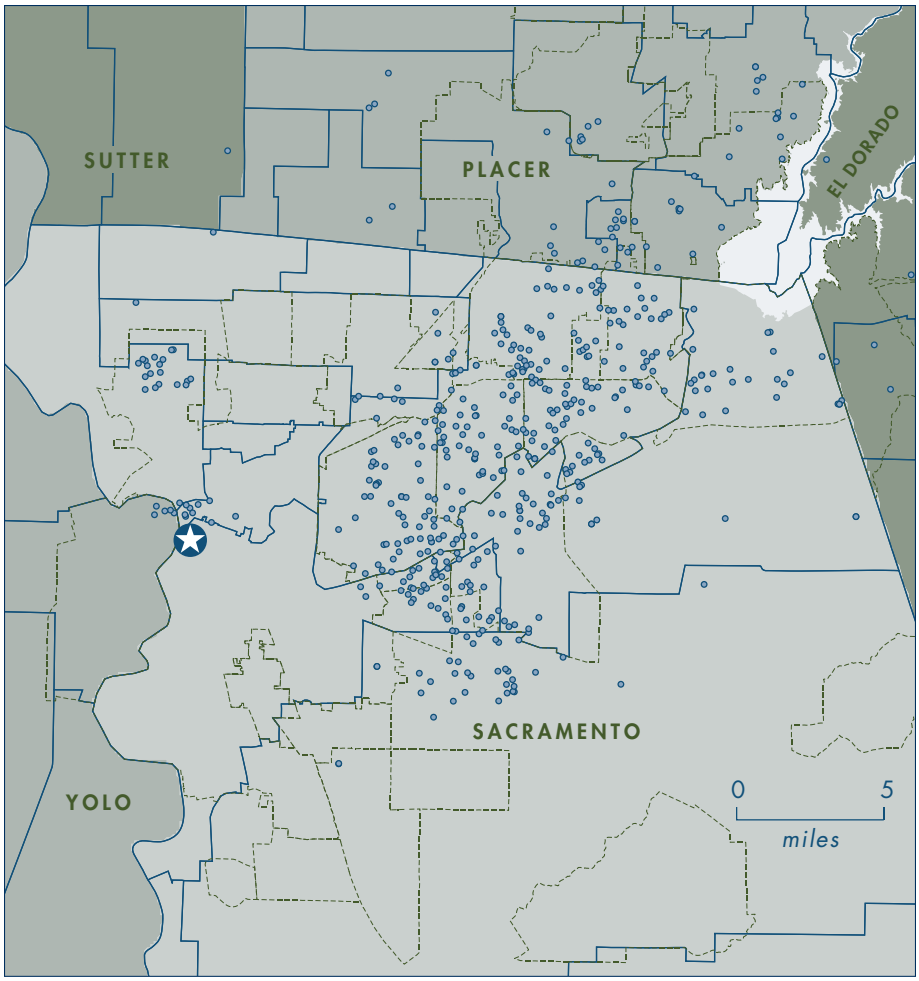


FIGURE 1

2004 jurisdictional boundaries in the Sacramento area

Counties

School

School district boundary

Place boundary (cities, towns and unincorporated areas)

Sacramento (city)

while there are only 58 counties and 478 incorporated cities, there are 1,052 school districts.

Second, the exigencies of school finance often result in school location and design decisions that are aligned with neither educational needs nor urban development needs, but instead are driven by land costs or developer exactions. Schools ultimately must base many facility design and location decisions on funding availability, and in many areas, the district must look outside of developed areas to find affordable land. In other cases, developers, not districts, choose new school sites. Developers' donations of land, which may be required as part of the development approval process, save schools the costs of securing new sites themselves, but these parcels may or may not be the most optimal for the school, the district, or the region, and may not support broader transportation, land use, or environmental goals, such as those outlined in AB32.

The third disconnect, noted earlier, is the lack of a state policy framework for school districts and local, regional, and/or state agencies to work together to integrate infrastructure decisions. In rare cases, local agencies have built relationships to plan together. Some progress at the state level has been made in connecting school planning and local planning. For example, the Office of Public School Construction (OPSC) has a program to fund the construction of joint-use school facilities through local agency partnerships. ➢

Nevertheless, most school infrastructure planning is still done largely in isolation, missing opportunities for efficiencies and coordinated investments. Most municipalities and school districts develop their general or operating plans separately from one another. Local conflicts often arise over how much traffic mitigation the school districts are responsible for when they site and build a new school. Even their time horizons are different: school districts usually create five- to ten-year capital plans, while cities' general plans tend to cover twenty years into the future.

How schools affect urban development and transportation

Excellence in public schools is one of the most important factors contributing to metropolitan vitality. Many stakeholders, recognizing these links, seek to define what makes a "good school" and a "quality education." The State of California, for example, measures and ranks every school based on test scores. Other educational organizations focus on different measures. What is often left out of nearly all definitions of a high-quality school, however, is the condition of school facilities—despite increasing evidence of its importance to teaching and learning, as well as the vitality of the community. Natural light, indoor air quality, temperature, cleanliness, acoustics, and classroom size can positively or negatively affect learning and productivity. Poor ventilation, dust, and mold in ceilings and walls—all factors found in many older urban school buildings and portables—can lead to respiratory infections, headaches, sleepiness, and absenteeism. Several studies have found that students attending school in newer facilities outperform similar pupils in ageing schools, even when controlling for socioeconomic differences. Studies are beginning to find that the *size* of schools also matters. Smaller schools (less

than 500 students) and small learning communities within larger schools have been associated with better student performance, less absenteeism, and increased student engagement. Research shows that teacher retention is higher when school facilities are in better shape.

School quality also affects housing demand and housing affordability, as parents of school age children bid up housing prices in communities with high public school rankings. In turn, this affects public finances. Higher housing prices mean more tax dollars, but financing their share of schools also may push local governments to compete for more commercial and retail development to increase the tax base, in part to support the schools.

School locations affect how children and staff get to school, which affects local traffic, congestion, and pollution. At least one fifth of the state's current population travels to and from a K–12 public or private school each weekday, nine months a year, so it matters how and when they travel. And school design can shape the types of educational programs the school can offer, and the opportunities for shared uses with the community or other government entities. In other words, location, land use, and community activities can all be greatly influenced by school siting and design.

New funding, new opportunities?

Until the late 1990s, there was a dearth in capital spending on schools in California. For the two decades prior, California school conditions deteriorated, and by 1995, a federal government study found them to be among the worst in the nation. Our recent research finds that in the decade following this finding California school districts spent much less per student on school construction and modernization than the national average, even though California leads the country in terms of total amount invested. Given the great need and the fact that construction work tends to be more expensive in California, this is a troubling statistic (see Figure 2). As a result, many schools are ➢

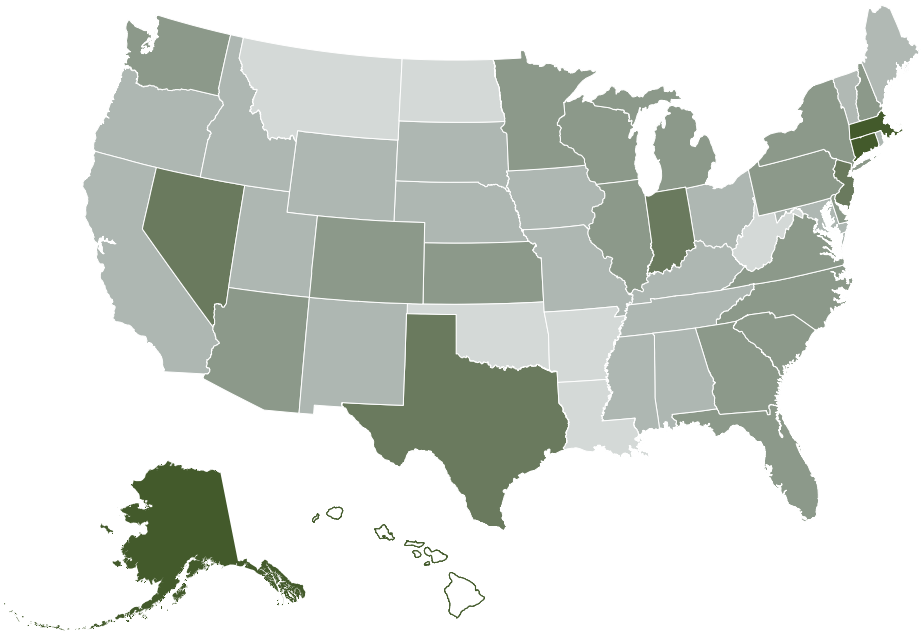


FIGURE 2

Construction expenditure per student

- Less than $4,000
- $4,000 – $5,999
- $6,000 – $7,999
- $8,000 – $9,999
- $10,000 and more

National average:
$6,519 per student

Source: Building Educational Success Together

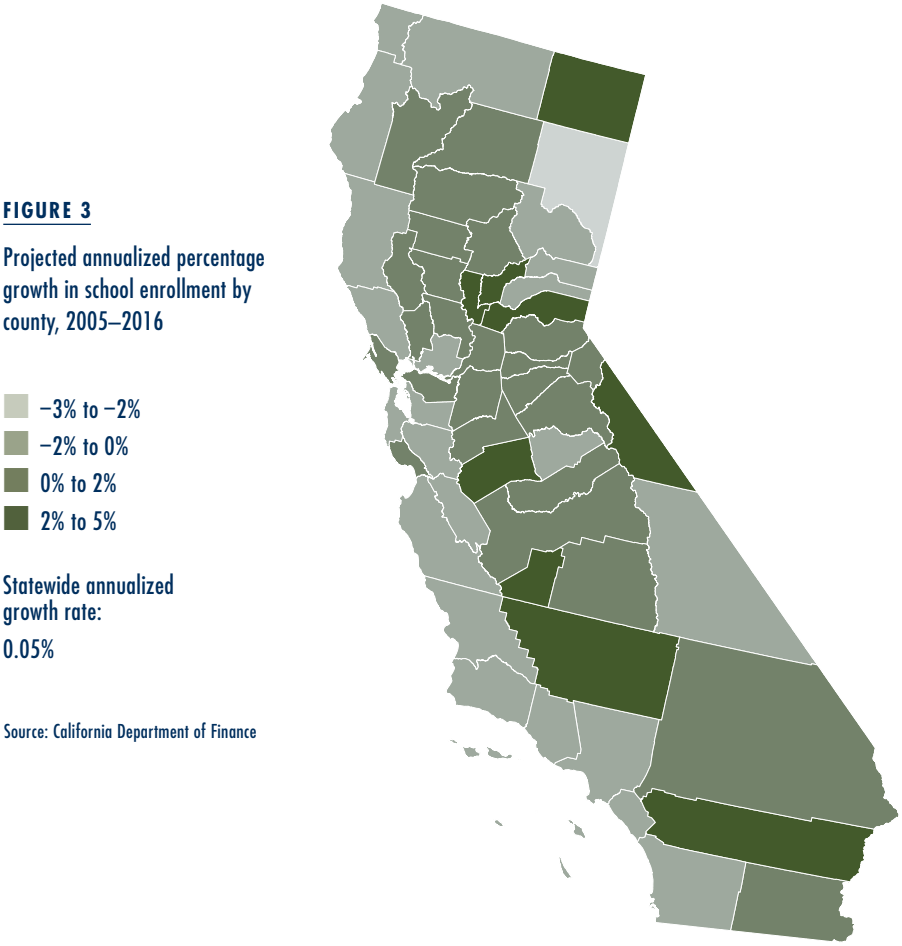
severely overcrowded and have to rely on portable classrooms (more than 85,000 statewide). Because there has been little money for school infrastructure, there was little pressure to coordinate school investment and planning with other infrastructure plans, and the issue did not often arise outside of new growth areas. Two fairly common exceptions have been shared playing fields and the use of public transportation and transit passes for school access, but even on these issues planning and coordination remain spotty.

California's surge in school infrastructure funding since 1998 and the much-talked-about next statewide school construction bond likely in 2010 open up new opportunities for integrating school and metropolitan infrastructure planning to address schools' land use and transportation effects. Better coordination could help meet regional transportation planning goals and reduce the impact schools have on the environment.

The transportation opportunities are mutual: both schools and communities could greatly benefit from better coordination of transport services. California is one of three states that does not require school-funded transport, yet ninety percent of its districts report transport expenditures. The state's fastest-growing school enrollments are in the lowest-density areas where public transit options are sparse and where families live too far from schools for walking or bicycling—and absent a change in direction, this trend will continue (see Figure 3). Could smaller schools located closer to homes reduce the

FIGURE 3

Projected annualized percentage growth in school enrollment by county, 2005–2016



Statewide annualized growth rate:
0.05%

Source: California Department of Finance

need for school busing and parental driving, allowing more students to walk or bike to school? Similarly, could higher density neighborhoods planned with schools also decrease busing and driving to school? Could infill projects, urban revitalization, and school upgrades bring more of the student population back to communities that have lost students, further reducing school transport needs and opening up public transport options for older students? These are the sorts of questions that could be explored with new funding and new incentives for integrating planning.

Conclusion and policy recommendations

Three key recommendations could help align infrastructure planning and investment. These proposals stem from five years of work at the UC Berkeley Center for Cities and Schools in partnerships with local, regional, and statewide educational and civic leaders.

Create a statewide vision for California's ongoing major public investment in school facilities that is connected to broader goals of educational outcomes, community development, environmental protection, regional growth, and other infrastructure investments. Without vision, the current finance-driven model for school facility decisions is greatly influenced by projections of demographic shifts based on current housing markets, local housing restrictions, land cost and availability, and characteristics of proposed sites ➢

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(e.g., the need for environmental cleanup, topography, or acreage per student), rather than goals for smarter growth, creating schools as centers of community, or reducing greenhouse gas emissions. As a result, too many new schools are often simply "adequate," lacking the innovative siting and design ideas that could enhance teaching, learning, and community life.

Offer incentives to coordinate local and regional infrastructure planning. California will need legislative and policy changes to better inform, encourage, and provide guidance for the largely local practice of planning and siting new school facilities. Perhaps most important is the need for policy where none exists, such as ways to motivate interagency collaboration.

State policies should do more than just *encourage* local governments to include school facilities in their short- and long-range comprehensive plans, and school districts to incorporate local and regional plans into their master facility and capital improvement plans. State policies should establish incentives for these entities to strategically align their planning documents. The cost to build new schools in California has skyrocketed, and state and local education agencies are competing with the private market for land, labor, and materials. If local governments and schools coordinate their plans, opportunities arise for both to reduce costs by locating schools near existing infrastructure, by creating joint uses, by involving the community early and throughout the process, and by identifying opportunities to reinvest in urban assets. Including schools in plans for urban redevelopment, congestion reduction, and open space preservation offers new opportunities for meeting regional environmental goals.

Planned in collaboration with roads, housing, water, and other public infrastructure, schools can be made more accessible, allowing school users to walk and bike and thereby increasing physical activity and lessening road congestion. Schools also generate and attract economic activity for surrounding communities, and should be part of community and economic development plans. Joint use of school facilities creates opportunities for reduced operations costs and allows residents and students to pool resources. Coordination and community partnering is not only good for the environment and the community but may also contribute to school reform and should be common in school planning, not the exception.

Conduct research and provide education to guide integrated infrastructure planning. Research and training can address institutional inertia, state and federal legal requirements, fear of litigation, lack of knowledge of other agencies' processes, and other barriers that currently make working together across agencies a challenging process. Researchers need to analyze and measure the benefits and potential costs of more integrated infrastructure planning systems, of operating joint-use schools, and of the range of policies identified in this article. Longitudinal analysis of new schools built with innovative siting and design strategies would demonstrate the benefits and drawbacks of these strategies for schools and communities.

California will continue to grow, and the state will continue to make important major investments in new public school facilities. Now is the time to craft a vision and strategic supporting policies to ensure educational, community, and regional growth and prosperity for generations to come. ◆

Transportation Infrastructure AND Sustainable Development

NEW PLANNING APPROACHES FOR URBAN GROWTH

BY MARLON G. BOARNET

As California's population expands to fifty million people over the next two decades, urban infrastructure will be under immense pressure. Partly in anticipation of growth, and partly to catch up after years of neglected investment, in 2006 California voters approved bond measures for transportation, affordable housing, education, disaster preparedness, flood prevention, and water projects. Most experts expect that even more funding will be needed to meet future needs. How can these funds best be spent to accommodate growth and avoid stressing California's environmental, fiscal, and social resources? In particular, how can we use the next round of transportation investment to help us plan for a more sustainable future? ➢

The first step in planning for sustainability is to step away from planning paradigms focused exclusively on specific land uses and single modes. For some time, transportation policy has split into advocates for and opponents of automobile travel. By focusing on modes, rather than on the needs of people and places, the debate has failed to take cognizance of a singular reality in most growing urban areas. Fast-growing metropolises need both expansions in infrastructure that supports automobile transportation *and* planning that supports alternatives to the automobile. It is not a matter of choosing one or the other, but rather of distinguishing appropriate locations and contexts for each.

The Two Faces of Urban Growth

The link between transportation and urban growth patterns presents two different issues. On the one hand, California's rapidly growing urban areas need to support higher densities, and one way to do so is with walking- or transit-oriented developments. On the other hand, car travel will remain the dominant mode of transportation for the foreseeable future, and California has a pressing need to manage congestion bottlenecks that threaten economic vitality and quality of life. Taken together, these two issues summarize concerns about growth in the core and growth at the fringe of metropolitan areas.

A sustainable regional investment program must consider both types of growth—development at the fringe and redevelopment in the core. The two are conceptually different and require different approaches to transport investment.

Growth at the fringe

For decades, scholars have debated whether and how transportation infrastructure investments—and highways in particular—influence urban growth patterns. Recent research provides some clarifying evidence.

Nathanial Baum-Snow, an economist at Brown University, analyzed the contribution of the interstate highway system to population decentralization in 139 US metropolitan areas from 1950 to 1990. He concluded that had the interstate highway system not been built, population in the central cities would have risen by eight percent between 1950 and 1990, rather than declining by 17 percent as actually occurred.

Tests of specific highway corridors give similar results. With colleagues at UC Irvine, I have examined the effect of the initial segments of the toll road network in Orange County, California on urban growth patterns. Using a model that controls for several possibly confounding influences, we found that the earliest portions of the Orange County toll road network were associated with increases in employment in nearby census tracts that ranged from 1,700 to 6,200 new jobs. Since the average census tract near the toll roads had about 1,900 jobs in 1990, the effect of the toll roads on employment was not just statistically significant; it was important in relation to the county's overall employment pattern. Saksith Chalermpong, in work funded by the UC Transportation Center, found similar results for employment growth near the Century Freeway (Interstate 105), which opened in Los Angeles County in 1993: employment was

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locating near the new highway capacity. When highways are built in outlying areas, metropolitan decentralization results.

Currently, because California freeway investment has not kept up with population and employment growth, the freeway networks in California metropolitan areas are among the most congested in the United States. The Texas Transportation Institute estimated that in 2005 the Los Angeles-Long Beach-Santa Ana and San Francisco-Oakland areas ranked first and second among US metro areas in hours of congestion delay per traveler. Congestion itself is costly, not only in terms of wasted time but also from an environmental perspective. Congestion causes more emissions, including greenhouse gas emissions, than smoothly flowing traffic, for example. Congestion relief would therefore reduce environmental as well as economic costs for the state, while

also relieving one of the stresses of daily life for many Californians. Yet building infrastructure may not, by itself, be a long-term cure for congestion. In growing areas, new investment in capacity can be "used up" in a few years; unless effective demand management and land use policies are in place, businesses and households will adjust locations and travel choices (destinations, trip frequencies, and modes) to take advantage of the new accessibility, and the added travel can lead to a return of congestion.

Taking all these findings into consideration produces a complex picture. Highway capacity influences metropolitan growth and can lead to decentralization. At the same time, highway investment can reduce congestion, providing social benefits including reduced travel times, lower emissions, and less energy used. However, unless coupled ➢

with effective travel demand management and land use policies, congestion relief may be short-lived. The question, then, is not whether to build new highways, but how to prioritize new highway investment so that the most important bottlenecks are targeted without causing unnecessary additional sprawl.

One strategy would be to focus on existing bottlenecks and to prioritize solutions for them. A decade ago, Eugene Jae Kim, Emily Parkany, and I built measures of peak-hour traffic volume as a fraction of highway capacity in California metropolitan areas. Caltrans continues to collect data that would allow similar highway segment congestion measures. With this data, we could map where the most congested segments are located, and we could then take action to relieve that congestion.

A vision of mixed-use activity centers that allow alternatives to car travel is at the heart of plans adopted by regional agencies throughout the state.

Switching the emphasis to congestion *measurement* would bring about a useful change by refocusing on congestion relief *now*—as opposed to current practice, which concerns itself with *future* travel demand and congestion. The shift in emphasis would highlight the importance of congestion-relieving projects over growth-serving projects. While most highway projects are some combination of both, tilting the tables toward the most currently congested arteries would give lower priority to fringe highways that might induce additional exurban growth.

Yet a focus on relieving highway congestion will only be useful if planners understand that highway building is only part of the answer. Planning for growth at the fringe can focus on questions of automobile travel to some degree but planning for growth in California's urban centers will require a broader focus.

Growth in the center

California's inner ring suburbs, developed in the two decades after World War II, are redeveloping at higher densities. California's four largest metropolitan planning organizations have all recently developed long-term growth plans that emphasize mixed-use activity centers as growth foci. Smart growth, whether mentioned by name or not, is an organizing theme for the planning dialogue throughout California. A vision of mixed-use activity centers that allow alternatives to car travel is at the heart of plans adopted by regional agencies throughout the state.

How can transportation investment best support alternatives to car travel, and more importantly, what would a sustainable transportation investment program look like in redeveloping urban areas? Research illuminates some important points.

The role of congestion in a developing center is different from the role of congestion in more outlying locations. Congestion relief is not the only goal, or even the most appropriate goal, in nascent or evolving activity centers. Traffic congestion makes rail transit, bus travel, walking, and carpooling more attractive. This does not mean that blunt attempts to increase congestion in the hopes of encouraging travel by modes other than the automobile are advisable. But a single-minded focus on traffic congestion relief at all costs and at all places and times is equally ill-advised. Urban centers with vibrant combinations of land uses and functional pedestrian environments are typically congested. The task in these centers is not to eliminate congestion but to combine careful land use planning, parking management, and alternative transportation to build vibrant locations that thrive on traffic rather than choke on the effects of congestion.

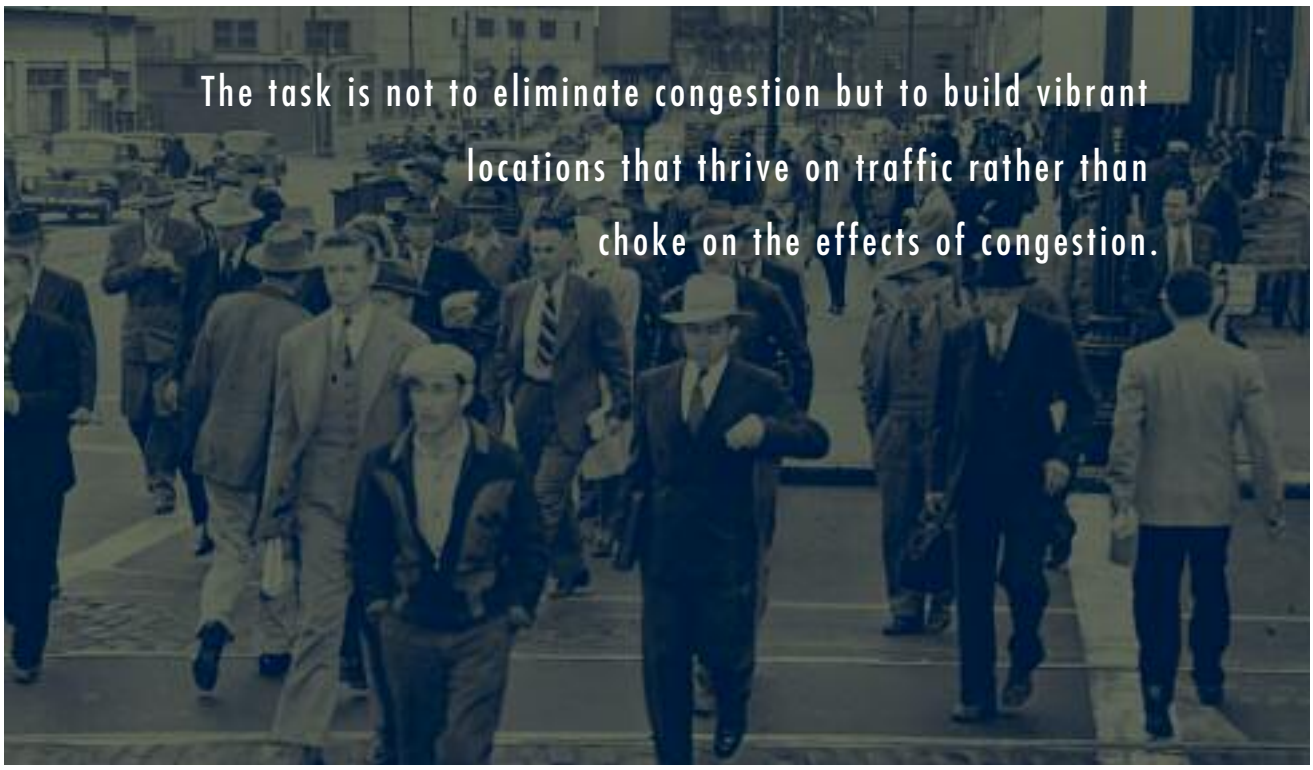
Many California cities have what planning commentator Bill Fulton has called "dysfunctional densities." These are densities high enough to swamp arterial streets with car traffic, but not high enough to sustain other transportation choices. In these cities, land use and transportation planning are not sufficiently coordinated to provide alternatives to car travel. Residents get the worst of both worlds: the disadvantages of density (traffic congestion) without the attendant advantages of activity centers where alternatives to car travel are viable.

In providing alternatives to car travel, walking is often the most important mode. Walking is the lynchpin of functional activity centers. As a practical matter, transit service in many of California's nascent activity centers is limited, but even when good transit is available, getting to and from it depends on walking. Design and development changes that encourage walking thus can also facilitate more transit travel.

A major question for California is how to transform moderately dense, centrally located, highly auto-oriented neighborhoods into mixed-use, pedestrian-oriented activity centers. Recent research in the South Bay area of Los Angeles County indicates that two elements are key. First, well-functioning, mixed-use activity centers concentrate retail outlets in small central locations, rather than spreading them more evenly along corridors. The sidewalk and street design in these activity centers also focuses attention and travel toward the center. Second, the mix of retailing appears to be important. A striking result from the South Bay study is the role of grocery stores both in anchoring other neighborhood retail associated with walking travel and in shifting trips, including grocery trips, from driving to walking. Not all trips are easily shifted from driving to walking, but trips to the grocery store, along with trips for personal services and trips to eat meals, are more likely to shift to walking than are other trips. ➢

These findings suggest that a way to promote alternatives to the automobile might start with identifying nascent activity centers where they can be successful. The following elements would be measured and evaluated: (1) Sidewalk infrastructure completeness and continuousness (or absence of gaps). (2) Retail mix that includes grocery stores, eating establishments, and neighborhood-serving businesses. (3) Street geometry that either focuses activity on the retail center or has the potential to do so, usually with pedestrian-friendly attributes such as street trees, benches, lighting, etc.

Measuring these data items would allow us to identify and invest in places that have the elements needed to become pedestrian-friendly (or could readily develop these elements with an infusion of planning and infrastructure funding.) This approach has been less tested, and therefore would be more experimental than the congestion measure discussed previously, but it is no less important. Inventories of sidewalk completeness and measures of the spatial distribution of retailing, when combined with assessments of the centeredness of the urban design as outlined above, can help planners understand which places are most ripe for transformation into walking-oriented neighborhoods. While metropolitan planning organizations in California have already identified candidate activity centers, that process was typically based on regional transportation and land use trends, and should be complemented with data that give insight into the potential for specific neighborhoods to accommodate alternatives to automobile travel. Once identified, such evolving activity centers should be the foci of planning efforts and policy innovation to provide not just more density, but more livable and sustainable transportation options.



Conclusion

Sustainable transportation investment requires distinct approaches in the growing outlying areas and in the redeveloping cores of California's metropolitan regions. Congestion relief and traditional highway investment, when carefully targeted, is a vital response to urban growth, but needs to be coupled with demand management (including pricing) and land use planning to produce lasting effects. Focusing on currently congested points should lead to more attention on existing highway bottlenecks and less on outward expansion. In existing or developing activity centers, possibilities will be available for promoting alternative modes—most importantly, walking. In both cases, simple measurement and data analysis approaches can help decision makers identify the best sites for investment.

In highway planning, tilting the tables toward congestion relief and away from growth-serving roads is appropriate, as is measuring and addressing current congestion rather than focusing on future congestion. Supporting alternatives to automobile planning will be increasingly important, and toward that end collecting consistent data on sidewalk coverage, retail mix, and street geometry can help highlight locations where transitions to nonmotorized or transit travel are likely or viable. When used in combination with existing tools, the planning approaches proposed here will allow a more sophisticated focus on both aspects of California's rapid metropolitan growth, and point the way toward coordinated investment and planning efforts that can foster congestion relief, sustainability, *and* neighborhood development. ◆

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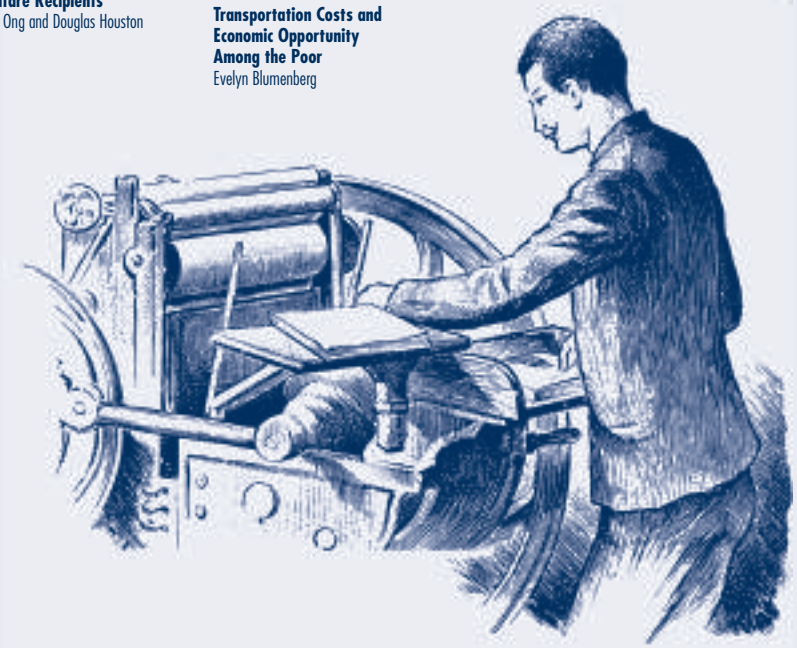

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