A Climate Change for Modeling

California's Innovative Legislation Heats Up a Frozen Practice

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Travel demand modeling is a key tool in transportation planning, but the practice of such modeling at metropolitan planning organizations has been widely criticized as resistant to innovation. This resistance is a major concern for transportation planners who would like to investigate policy options such as value pricing and smart growth, which are poorly considered with traditional methods. Advanced modeling methodologies are better suited for such policy analysis but, to date, attempts to systematically encourage such practices have not been successful. An emerging exception to this pattern is the experience of the state of California, whose pioneering climate change legislation has launched a multipronged challenge to the modeling status quo. This paper examines the enabling legislation, the subsequent guidance, and the implementation experience of the state's 18 metropolitan planning organizations to understand the combination of elements that are advancing modeling practice. The findings suggest that modeling can be advanced effectively when such innovations are seen as necessary for fulfilling a policy mandate. California identified travel demand modeling as essential for estimating greenhouse gas reductions of proposed land use and transportation policies. This recognition led to formal steps to overhaul and extend state modeling guidelines, dedicate funding for model development, daylight existing modeling practices, and establish a path toward implementing innovation. These steps have cultivated informal linkages among stakeholders that have proved critical to altering existing modeling practice. Although the California experiment remains ongoing, the early experience provides critical lessons for other regions seeking to use legislation to advance the practice of travel demand modeling.

Travel demand modeling continues to be a core tool of transportation planning, yet its practice is widely criticized for failing to adopt advances from research, in essence for being frozen in time (*1–4*). The 2007 TRB *Special Report 288: Metropolitan Travel Forecasting* concisely summarized this sentiment by concluding that the practice of metropolitan travel forecasting has been resistant to fundamental change (*3*). "Every 10 years or so there begins a cycle of research, innovation, resolve to put innovation into practice, and eventual failure to effect any appreciable change in how travel forecasting is practiced" (*3*).

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The state of California is breaking this cycle of stasis through its ambitious climate change legislation. The Golden State views travel demand modeling as essential to assessing whether planned land use and transportation policy interventions will achieve their greenhouse gas (GHG) reduction objectives. Therefore, California's climate change legislation explicitly aims to advance the modeling practiced at the state's 18 metropolitan planning organizations (MPOs). This paper examines the legislation and its early effect of raising the heat on the practice of travel demand modeling. Because California is leading the nation in climate change legislation, the structure of these laws and the nature of their implementation are likely to influence policy in other states, as well as in the nation as a whole. This analysis will inform efforts elsewhere to successfully advance the critical, but innovation-resistant, practice of travel demand modeling.

LITERATURE REVIEW

As noted above, expert assessment holds that the travel demand modeling practiced at planning agencies has shown a reluctance to innovate (*3*). A two-decade sampler of this position spans Pas (*2*), who noted in 1990 that "certainly, from the point of view of transportation planning practice, it is clear that travel forecasting models have seen little change in recent years" to Rodier (*4*), who in 2007 quoted experts who still "used words such as 'dismal,' 'primitive,' 'disappointing,' and 'deficient' to describe the state of the practice."

Despite these concerns, little has been written about effective strategies that might be implemented to advance the state of the practice. TRB Special Report 288 did provide some recommendations to overcoming the modeling stagnation (*3*). These include finding more state funding for advancing modeling practice, cost sharing and coordination among MPOs, partnerships between MPOs and universities, development of modeling user groups, and standardization of assumptions and input data. The report emphasized that the actions of individual states could be critical for fostering much of this coordination among MPOs, which accords with the early experience of California. However, although TRB Special Report 288 assumed that MPOs and state agencies would take the initiative, in California such advances are being triggered by legislation.

METHODOLOGY

This research is based on a review of the literature on modeling practices and innovations, an analysis of new state laws and their subsequent guidance and implementation, the written records of these actions and their perceptions by participants, and more than two

dozen interviews with modeling experts and practitioners at eight of California's 18 MPOs. Those interviews were conducted on the condition of confidentiality, with the result that quotations taken from those conversations are cited only generically in this paper. The work traces the effects of California's 2008 climate change legislation, Senate Bills (SB) 375 and 732, on the practice of travel demand modeling during the first 3 years of implementation.

LEGISLATIVE BACKGROUND

In 2006 California committed itself to significant reductions in GHG emissions through the passage of Assembly Bill 32: The Global Warming Solutions Act. Subsequent emission inventories and forecasts determined that transportation activities produce the largest share of GHGs and that policies to improve vehicular efficiency and reduce the carbon content of fuels were likely to fall short of the major long-run emissions reductions sought by the state. Consequently, on September 30, 2008, California enacted Senate Bill (SB) 375: The Sustainable Communities and Climate Protection Act.

SB375 established planning requirements to use urban development policy—specifically transportation and land use measures such as transit-oriented development and urban infill—to curb the vehicle miles traveled (VMT) by automobiles and light trucks and thereby reduce the GHG emissions from the transportation sector. SB375 mandated that the California Air Resources Board (ARB) set GHG reduction targets for each MPO, that the MPOs develop new approaches called sustainable community strategies (SCSs) as part of their Regional Transportation Plan (RTP) to achieve those reductions, and that ARB evaluate and approve the SCSs. Because improved travel demand models are necessary to better support each of these activities, SB375 also mandated that the California Transportation Commission (CTC) revise its modeling guidelines (Senate Bill 375, 2008).

SB732: Strategic Growth Council, a complementary law, was passed the same day to provide resources to assist MPOs in implementing SB375. SB732 created the Strategic Growth Council (SGC), a cabinet-level group, to "recommend policies and investment strategies and priorities to the governor, the legislature, and to appropriate state agencies to encourage the development of sustainable communities." SB732 further authorized the SGC to distribute $90 million for "planning grants and planning incentives . . . to encourage the development of regional and local land use plans" (Senate Bill 732, 2008). This provision paved the way for state grants to improve travel demand models.

Table 1 identifies four processes created by the new legislation that have directly or indirectly worked to advance modeling. These include revising modeling guidelines, granting funds for planning, setting GHG reduction targets, and preparing an SCS. This paper will address the first three processes, but omit the fourth, which is ongoing.

REVISING MODELING GUIDELINES

The revision of the CTC guidelines represents SB375's most explicit and direct attempt to advance metropolitan modeling practice. These guidelines determine acceptable models to be used in the development of RTPs and have been subject to periodic revision.

Legislation: SB375

SB375 emphasized expanding the policy sensitivities of the models. The law did not mandate a specific modeling approach, but rather presented a normative position on desired, but not required, model functionality:

> Current planning models and analytical techniques used for making transportation infrastructure decisions and for air quality planning *should* be able to assess the effects of policy choices, such as residential development patterns, expanded transit service and accessibility, the walkability of communities, and the use of economic incentives and disincentives. (Senate Bill 375, 2008) (Italics added)

This phrasing defines preferred model practice by the policies to be examined, not the type of model to be used. Similarly, the use of the auxiliary verb "should" rather than "shall" implies these objectives are recommended rather than required. By presenting the policies that models "should" address, SB375 established a clear functional goal, even if its fulfillment may be postponed to the future.

SB375 also set a minimum level of model functionality that the guidelines "shall" ensure, namely accounting for the effects of relationship between density and transit service on vehicle ownership and use, and the travel and land use effects induced by new transport infrastructure, mode splits, and transit service characteristics. The legislation thus delineated the baseline performance threshold of the revised guidelines. However, SB375 provided wiggle room by making these required only "to the extent practicable, taking into account such factors as the size and available resources of the metropolitan planning organization" (Senate Bill 375, 2008).

SB375's language could be read to suggest that the modeling guideline revision process was relatively weak with the law merely encouraging rather than exacting change; however, from another perspective, what seemed problematic was actually rather pragmatic. The MPOs in California vary greatly in regard to population and consequently in regard to planning challenges and resources. SB375 sought to foster change that was tailored to the realities of the state's different regions while maintaining a performance baseline.

TABLE 1 Four Legislated Processes That Affect Travel Demand Modeling

Impact	Process	Legal Structure	Oversight Agency	Law	Date Achieved
Direct	Revising modeling guidelines	California Transportation Commission	CTC	SB 375	April 7, 2010
	Granting funds for planning	Strategic Growth Council	Governor's office	SB 732	October 13, 2009
Indirect	Setting GHG reduction targets	Regional Targets Advisory Committee	ARB	SB 375	September 30, 2010
	Preparing an SCS	Sustainable community strategy	ARB	SB 375	Varies by MPO based on RTP schedule

Guidance: California Transportation Commission Guidelines

On July 1, 2009, the CTC created an Advisory Committee to prepare amended guidelines for RTP preparation to account for the new requirements of SB375. The committee met slightly more frequently than monthly and maintained an active discussion on a dedicated listserv and through electronic mail. The revised *2010 Regional Transportation Plan Guidelines* were adopted by the CTC on April 7, 2010. The revisions were focused particularly on the practice of travel demand modeling. To accord with the injunction to create a system that was appropriate for the needs and resources of each agency, the commission clustered transportation planning agencies into five groups labeled A through E, each with its own travel demand modeling requirements and recommendations. The A group was for non-MPO Regional Transportation Planning Agencies and is not considered in this research. The MPOs were placed in groups B through E (*5*).

The guidelines define the groups as follows:

> B. Regions with attainment AQ [air quality], slow to moderate growth, small population, and no urbanized area or transit having more than a minimal potential impact on VMT.
>
> C. Regions with moderate to rapid growth, non-attainment AQ, or the potential for transit to significantly reduce VMT.
>
> D. Regions that are nonattainment in ozone or CO [carbon monoxide], with a metropolitan planning area containing a population over 200,000.
>
> E. The largest MPOs with rapid growth, large population centers and established transit systems. (*5*)

Figure 1 presents a map of California MPOs and Table 2 clusters these by model group. The groups accord roughly with total regional population. The exception is the Association of Monterey Bay Area Governments, whose total population would suggest Group D; the agency remains in Group C because the coastal region lacks a single urbanized area with 200,000 people, the level at which an MPO becomes a transportation management area (TMA) under federal statutes.

The CTC guidelines require modeling only activities that are mandated by federal law. Therefore, Groups B and C share the same requirements and the TMA-designated Groups D and E share a stricter set of requirements. The real innovation of the revised CTC guidelines is therefore not its requirements, but its recommendations.

Table 3 summarizes the modeling guidelines. On the whole, the recommendations define a course of increasingly greater modeling complexity at an increasingly higher resolution. Along the way, the travel demand modeling becomes more nuanced and expands its purview to environmental and social equity concerns. The models increasingly gain feedback loops with the goal of having a fully integrated microeconomic-based land use model with an activity-based travel demand model that includes freight movements. To arrive at this endpoint, MPOs are to constantly upgrade their data resources, particularly the geographic information system (GIS) layers of the natural and built environment, and their travel survey methodologies. In other words, the recommendations lay out a clear and structured path for advancing modeling practice at MPOs.

Analysis

The effects of the CTC guideline revisions on modeling do not come from the basic requirements, which are very low and easily met, but from the recommendations, which for the first time in the state, outline an expected development path for MPO modeling practice. Because these expectations are embedded in the RTP framework for receiving federal funding, the MPOs are taking them very seriously. The recommendations have encouraged smaller MPOs to plan for upgrading to more advanced techniques and have accelerated the transition to such methods by the larger MPOs. While those larger MPOs had been developing activity-based models, the requirements furthered these efforts, particularly in the case of one large MPO whose modeling significantly lagged the other three major MPOs. One modeler noted that certainly the largest MPOs, those in modeling Group E, are viewing the CTC recommendations as required (Interview with MPO staff worker, June 30, 2010).

The graduated structure of the guidelines appears to also be very effective in advancing practice as agencies are facing discrete and incremental demands with clear and reasonable products. The expectations for each MPO are in line with its existing challenges and capacities. Smaller MPOs can now more easily anticipate future directions for their modeling efforts as it is assumed that, over time, the state expectations will grow so that, for example, Group B will be expected to fulfill what is currently expected of Group C. One modeler at a smaller MPO noted that with the revised guidelines in mind, he can more strategically monitor the experiences of his colleagues in higher modeling groups to "piggyback on the value" they generate (Interview with MPO staff worker, June 30, 2010). He added, "The big boys are building a toolkit from which the smaller MPOs will then be able to cherry-pick the tools that are most relevant for them." As a result, the benefits of the experience of the MPOs in the higher modeling groups can cascade over time to those in the lower modeling groups. Finally, the modeling group structure identifies peer MPOs across the state, at least for the purposes of travel demand modeling. Such identification facilitates cooperation, an often noted positive externality of the climate change legislation.

GRANTING FUNDS FOR PLANNING

SB732, by creating the SGC and vesting it with the ability to grant funds for planning, also established a process designed to directly affect the practice of travel demand modeling.

Legislation: SB732

The SGC, composed of the Director of State Planning and Research, four cabinet secretaries, and one member of the public, can offer grants from the $5.4 billion raised through Proposition 84 passed by voters in 2006. These grants are meant to fund planning that is not funded by federal monies, particularly the demands of SB375. The law provides that

> to support the planning and development of sustainable communities, the council shall manage and award financial assistance to a council of governments, metropolitan planning organization, regional transportation planning agency, city, county, or joint powers authority, to develop, adopt or implement a regional plan or other planning instrument consistent with a regional plan that improves air and water quality, improves natural resource protection, increases the availability of affordable housing, improves transportation, meets the goals of the California Global Warming Solutions Act of 2006, and encourages sustainable land use. (Senate Bill 732, 2008)

FIGURE 1 Map of California MPOs.

TABLE 2 California MPO Model Groupings (*5*, *6*)

Group	Metropolitan Planning Organization	2009 Population	SCS Due	CTC Requirements	CTC Recommendations
B	Butte County Association of Governments	220,748	Dec. 2012	B	B
	Kings County Association of Governments	154,743	July 2014		
	Madera County Transportation Commission	152,331	Dec. 2013		
	Merced County Association of Governments	256,450	July 2014		
	San Luis Obispo Council of Governments	270,429	Dec. 2013		
	Shasta County Regional Transportation Planning Agency	180,023	July 2015		
	Tahoe Metropolitan Planning Organization	55,232[a]	Aug. 2012		
C	Association of Monterey Bay Area Governments	758,545	Nov. 2013	B	B + C
	Santa Barbara County Association of Governments	431,312	June 2013		
	Tulare County Association of Governments	441,481	Dec. 2013		
D	Council of Fresno County Governments	942,298	Dec. 2013	B + D	B + C + D
	Kern Council of Governments	827,173	July 2014		
	San Joaquin Council of Governments	689,480	Dec. 2013		
	Stanislaus Council of Governments	526,383	Dec. 2013		
E	Metropolitan Transportation Commission	7,375,678	April 2013	B + D	B + C + D + E
	Sacramento Area Council of Governments	2,323,112	April 2012		
	San Diego Association of Governments	3,173,407	Oct. 2011		
	Southern California Association of Governments	18,761,139	April 2012		

[a]Population for the Tahoe Metropolitan Planning Organization is for 2005 (*7*). Not all of these residents live in California, as this region straddles Nevada.

TABLE 3 CTC Guidelines for MPO Modeling: Requirements and Recommendations (*5*)

Requirements B ("MPOs shall . . .")	Recommendations B ("MPOs should . . .")	Recommendations C ("MPOs should . . .")
1. Model a range of alternatives for RTP.	1. Run 3-step models to converge at equilibrium.	1. Follow all Recommendations B.
2. Forecast travel demand for 20 years ahead.	2. Model land use impacts on travel.	2. Develop 4-step model.
3. Model criteria pollutants for conformity.	3. Augment models with post-processing.	3. Run model to converge at equilibrium.
4. Quantify reduction in GHGs due to SCS.	4. Address changes in demographic patterns.	4. Use simple land use models in short term.
5. Validate data used in model.	5. Develop GIS towards simple land use models.	5. Develop market-based land use models.
6. Forecast travel for people and goods.	6. Enter natural resource data into GIS.	6. Develop parcel data and an existing layer.
	7. Develop parcel data and an existing layer.	7. Develop digital general plan layer.
	8. Augment model to measure impacts of SCS.	8. Develop and use simple freight model.
	9. Produce mode shares for all five main modes.	9. Use several employment types and trip purposes.
	10. Calibrate data used in model.	10. Model peak and off-peak periods.
	11. Have a model improvement program.	11. Ensure model yields reasonable road speeds.
	12. Forecast bike and ped trips (if model has modes).	12. Identify areas sensitive to land use impact.
	13. Input transit service characteristics to model.	
	14. Represent entire transit network in model.	
	15. Join California Inter-Agency Modeling Forum.	
	16. Secure funds to research advanced models.	
Requirements D[a] ("MPOs shall . . .")	**Recommendations D ("MPOs should . . .")**	**Recommendations E ("MPOs should . . .")**
1. Follow all Requirements B.	1. Follow all Recommendations B + C.	1. Follow all Recommendations B + C + D.
2. Meet all U.S. conformity regulations.	2. Have 4-step models with full feedback across steps as well as some sort of land use model.	2. Transition to activity-based travel models.
3. Validate outputs and check forecasts for reasonableness.	3. Add an auto-ownership step and make mode choice sensitive to land use variables.	3. Build formal microeconomic land use models (these should be integrated with travel model).
4. Document model assumptions.	4. Explicitly represent walk and bike modes.	4. Include freight movement in travel demand.
5. Make land use–transport scenarios consistent.	5. Model parking cost and quantity; use small TAZs around rail stations and BRT corridors.	5. Include commercial movements in a commodity flow model.
6. Use capacity sensitive assignment methods.	6. Include carpool and access-to-transit modes.	6. Coordinate freight data collection with state.
7. Use reasonable travel impedances.	7. Use feedback loops (mode choice, speed, etc).	7. Make travel surveys activity-based and accurately geo-coded; GPS sampling a plus.
8. Make models sensitive to travel costs.	8. Include simple land use models in next RTP.	8. Perform stated preference surveys as necessary for use in location choice models.
9. Estimate traffic speeds based on road volume.	9. Implement freight models in short term and commodity flow models within a few years.	9. Investigate microsimulation of households and firms—deploy if feasible.
10. Base VMT estimates on HPMS data.	10. Make simple environmental justice analyses.	
	11. Jointly model mode and destination choice.	
	12. Monitor larger MPO use of advanced models.	
	13. Include activities and tours in next travel survey.	
	14. Collect rent data for future land use model.	
	15. Use assigned travel times to model mode split.	

NOTE: ped = pedestrian; HPMS = Highway Performance Monitoring System; GPS = Geographic Positioning System; TAZs = travel analysis zones; BRT = bus rapid transit.
[a]All of these requirements come directly out of the federal conformity regulations.

Guidance: SGC Modeling Incentives Program

In 2009 the state allocated $12 million of Proposition 84 funds to the newly formed SGC for modeling grants. The SGC established multiagency working groups to determine the evaluation criteria and possible distribution for these grants (*8*). The affected MPOs were actively involved with the working groups and made certain that the criteria reflected the modeling practice of all MPOs, not just the largest and most advanced, and also determined a need-based funding allocation scheme (*9*).

The SGC Modeling Incentive awards were designed "to expedite the development of regional transportation and land use modeling by supporting the data gathering and model development necessary to comply with SB375 and promote the objectives of the SGC." Those objectives explicitly included "a long-term view towards the development of fully functional regional integrated tour/activity-based models," but recognized the short-term needs to comply with SB375. Five-sixths of this money was designated for MPOs; the remaining sixth was for the statewide modeling efforts (*10*).

The funding criteria prioritized "accelerating and implementing improved modeling capability." The criteria, which preceded the revised CTC guidelines by half a year, also offered a graduated approach to advancing modeling. Specifically, the SGC presented three steps of acceptable models. The lowest rung was a trip-based model with postprocessing capabilities to consider smart growth. The middle rung was a tour-based model with a smart growth postprocessor. The highest rung was "an inter-regional/regional integrated tour/activity-based transportation model with land use and economic modeling components that support a healthy way of life." This highest step envisions applying models that do not yet exist in practice to a much broader array of policy questions. The SGC criteria also required models to be sensitive to a range of factors, with a particular emphasis on land use (*10*).

The SGC required applicants for grants to develop "a Model Improvement Plan (MIP) that describes the applicant's overall model enhancement approach, and/or data needs, to meet the goals of SB375 and promote the objectives of the SGC, including estimated milestones, costs, and timeframe for completion." This requirement forced MPOs to present a thoughtful and strategic vision of how they intended to advance their modeling practices (*10*). This idea was drawn from early drafts of the Regional Targets Advisory Committee (RTAC) report, which will be discussed in the next section.

Every California MPO submitted an application and received a grant according to the prearranged distribution. The grants were typically $400,000 although the Southern California Association of Governments and the Metropolitan Transportation Commission received at least double that amount (*11*). The eight MPOs of the San Joaquin Valley made a joint proposal, based on their history of modeling collaboration, to construct a tour-based model for the whole valley (*12*). Their application requested and received $2.5 million (*11*). Table 4 presents the modeling incentive grants received by MPOs and demonstrates how, on a per capita basis, the smaller MPOs received relatively larger benefits from the program. This outcome reflects the concern among the working group that allocations be based on need and not on population (*9*).

Analysis

The SGC Modeling Incentive Program grants, which are distributed only to reimburse work completed, provide direct support to MPOs to advance their modeling practices. This support is critical particularly to the smaller MPOs whose preexisting modeling programs were less developed. Many of these MPOs sought SGC funds to add transit consideration and a 4-D postprocessor to their travel demand models. The broad participation of the MPOs in the Modeling Incentive Program created a process that was appropriate for the agencies involved. For example, early drafts of the criteria recognized only activity-based models, whose complexity is not entirely necessary for a smaller region. The MPO input altered the text to also value trip-based models, as long as they had a postprocessor that enabled smart growth analysis (*11*). Furthermore, by knowing what their allocation would be in advance, MPOs were able to propose very realistic work programs, rather than propose unrealistically ambitious programs in hopes of securing any funding.

The condition of setting a proposal within a broader Model Improvement Plan was also helpful for encouraging MPOs to think strategically about their model development. That condition forced

TABLE 4 SGC Modeling Incentive Grants by MPO and Population

Metropolitan Planning Organization	Group	SGC Grant ($)	$ per Capita
Tahoe Metropolitan Planning Organization	B	352,000	6.37
Shasta County Regional Transportation Planning Agency	B	400,000	2.22
Butte County Association of Governments	B	400,000	1.81
San Luis Obispo Council of Governments	B	400,000	1.48
Santa Barbara County Association of Governments	C	400,000	0.93
Association of Monterey Bay Area Governments	C	400,000	0.53
Sacramento Area Council of Governments	E	400,000	0.17
San Diego Association of Governments	E	400,000	0.13
Metropolitan Transportation Commission	E	800,000	0.11
Southern California Association of Governments	E	1,000,000	0.05
San Joaquin Valley MPOs[a]	B,C,D	2,500,000	0.63

SOURCE: California Transportation Commission (*5*) and Strategic Growth Council (*1*), with author calculations.
[a]Composed of Kings County Association of Governments, Madera County Transportation Commission, Merced County Association of Governments, Tulare County Association of Governments, Council of Fresno County Governments, Kern Council of Governments, San Joaquin Council of Governments, and Stanislaus Council of Governments.

the MPOs to critically assess their current needs and actively map out their approach for advancing modeling in their regions. Such planning appears not to be a consistent part of typical travel demand model management at MPOs.

Finally, the availability of funds was thought to encourage agencies to work together. The most overt example of such cooperation is the joint application of the San Joaquin Valley MPOs. The negotiation among MPOs on allocations demonstrated another example of integrated efforts.

SETTING GHG REDUCTION TARGETS

SB375 is ultimately aimed at achieving set levels of GHG reduction. The process put forward in the legislation to establish these levels proved to be a potent, albeit indirect, force for advancing travel demand modeling.

Legislation: SB375

SB375 called for the ARB to establish "greenhouse gas emission reduction targets for the automobile and light truck sector for 2020 and 2035, respectively" by September 30, 2010. The legislation also required that "no later than January 31, 2009, the state board shall appoint a Regional Targets Advisory Committee (RTAC) to recommend factors to be considered and methodologies to be used for setting greenhouse gas emission reduction targets for the affected regions" (Senate Bill 375, 2008). SB375 specified that the RTAC report consider a range of issues including

> data needs, modeling techniques, growth forecasts, the impact of regional jobs–housing balance on interregional travel and greenhouse gas emissions, economic and demographic trends, the magnitude of greenhouse gas reduction benefits from a variety of land use and transportation strategies, and appropriate methods to describe regional targets and to monitor performance in attaining those targets. (Senate Bill 375, 2008)

All of these elements (with the exception of modeling techniques, which are explicitly about models themselves) are either inputs to or outputs from travel demand modeling. Therefore, the practice of modeling at MPOs in California was central to the activities of the RTAC work. SB375 designed the RTAC to incorporate diverse stakeholders, which resulted in an expanded consideration of issues, particularly equity, to be supported by modeling. SB375 also required that the target setting process be consultative between the MPOs and the ARB, with the MPOs able to propose a preferred target. The ARB would issue draft targets on June 30, 2010, allowing for 3 months of further negotiation before the final targets would be set (Senate Bill 375, 2008).

Guidance: The Regional Target Advisory Committee Report

The RTAC was appointed at the end of January 2009, held its first meeting on February 3, 2009, and published its recommendations for structuring the target setting process in September 2009. The 21-member committee included MPO directors and former directors, elected officials who had also served on regional boards, air quality experts, transportation consultants, environmentalists, and an academic. The committee met 14 times during its tenure and invited many experts to testify before the group or to submit comments (*13*). The deliberations of the committee and the ensuing target setting process affected modeling innovation among California's MPOs.

Modeling, particularly the varied practice in the state, was immediately a major topic of discussion in the RTAC deliberations (*14*). The RTAC surveyed all California MPOs on their current modeling capabilities and areas that might need to be improved to implement SB375 (*15*). ARB staff developed and conducted the survey, which focused on two main questions: First, were models "reasonably sensitive to key factors and policy variables, which are potentially of great interest for target setting or implementation of SB375?" Second, is the level of that sensitivity consistent throughout the state (*16*)? The survey findings, presented to the RTAC in May 2009, included six different matrices that assessed MPO modeling capabilities across different attributes. These charts showed a wide range of modeling capabilities as well as a need for model improvements (*17*). The findings also provided, for the first time, a clear and comparative view of modeling practice at all of the state's MPOs. This awareness facilitated communication among the different MPOs on modeling practices and set the baseline for the model improvement plans required by the SGC (*10*).

The RTAC report detailed the process for setting GHG emission targets, of which all the key elements touched on modeling. The core of this process was the seven-step collaboration between each MPO and the ARB on proposed targets. Essentially, MPOs were to use their travel demand models to estimate future GHG emission levels under current and proposed policies. The ARB would then review these forecasts and ask for additional analysis until a reduction target could be mutually agreed on (*13*).

This approach recognized that travel demand models "are an essential, inextricable piece of the regional transportation planning process" and sought to build on that structure. At the same time, the committee recognized that the current state of modeling was lacking and improvements were needed:

> The use of travel demand models in conjunction with land use models provides the ability to estimate the aggregate impacts of implementing multiple land use and transportation policies and practices. Since the Committee assumes that these modeling systems will be used by all the MPOs throughout the SB375 implementation, regional and statewide model transparency, consistency, and plans for improvement are a critical component of the Committee recommendations. This report also includes recommendations for improving the functionality and consistency of these models for the purposes of predicting and measuring the greenhouse gas reductions attributable to actions pursuant to SB375. (*13*)

RTAC modeling recommendations explicitly called for the adoption among California MPOs of a model postprocessor capable of addressing land use interactions on travel. Such postprocessors are not common practice because GHG analysis is not a part of federal modeling regulations. The RTAC also called for an ongoing program of modeling self-assessment, documentation, and strategic planning. Assessments were to include key validation statistics, results of sensitivity tests for measures of travel such as VMT and trips by mode, and results of planning scenario tests that would demonstrate model sensitivity to a variety of conditions and policies. The documentation was to review this testing and identify where the model may lack sensitivity for analyzing certain policies. This documentation was to be easily intelligible by the public to conform with the SB375 language for increasing model transparency. MPOs were to build on their assessments to create a strategic model improvement plan. The RTAC suggested that these plans focus on the costs and phasing

of improvements for the initial target setting, the first SCS, and subsequent development (*13*).

Although these improvements were aimed at MPOs, the RTAC was also concerned about the ARB's capacity to effectively assess the forecasts from the MPOs and to exact appropriate reductions. The report recommended "that ARB consult with land use and transportation modeling experts during its review of the MPOs' analyses. The Committee believes this input is critical to supplement ARB's existing technical capabilities" (*13*). This provision ensured another high level review of modeling practices.

Analysis

The target setting process proved to be a significant arena for advancing modeling at California's MPOs. These impacts come from the activities of the RTAC as well as the actual target setting.

The RTAC survey of modeling practices shone a very bright light on existing modeling capabilities throughout the state. The findings provided a clear understanding of current practice and provided the baseline for structuring improvements through the RTAC (and SGC) recommendation of a model improvement plan. Equally important, the survey revealed the MPO's modeling practices to each other. This act of laying their cards on the table encouraged MPOs to assess themselves in relationship to their peers. The MPOs that appeared deficient were more motivated to address these issues by advancing their practices.

RTAC also provided a critical forum for MPOs to discuss modeling and analysis approaches. The committee meetings were designed to be highly accessible, with all the materials posted and the actual meetings broadcast online. Many MPO representatives and modelers, who were not officially on the committee, actively participated in the meetings as they wanted to understand and influence the target setting process, which they viewed as a dry run for the SCS planning process to follow.

As people continued to come to the RTAC meetings, they began to form alliances with their counterparts from other MPOs to work together to influence the process and to get their individual targets set at levels they could live with. For example, the four largest MPOs submitted a joint report on their target setting activities (*18*). Those collaborations became institutionalized among the four largest MPOs and the San Joaquin Council of Governments, who now hold regular meetings at three different levels to figure out how they are going to comply with SB375. While there had always been interaction between the big MPOs, it has never been this formalized or been extended as deeply to the staff. Participants report this collaboration to be very useful for propagating new ideas and putting them into practice. These benefits extend to travel demand modeling. One expert described the new coordination as "SB375 seems to have alerted people to the idea that in modeling there are economies of scale with synergy opportunities." (Interview with modeling expert, October 25, 2010). Another noted, "It's the first time that so many MPOs and state agencies are talking in detail about how to do policy analysis." (Interview with modeling expert, October 25, 2010).

Although much of the attention in the model review tasks focused on improving four-step models and transitioning to more advanced tour- and activity-based approaches, simpler modeling approaches also played an important role in the target setting process. For example, the Metropolitan Transportation Commission, which was in the midst of a major transition from a trip-based to an activity-based model and did not want to rely on the old model, yet was not ready to apply the new one, used off-model, spreadsheet approaches to prepare its targets. In addition, many regions with trip-based models, such as those in the San Joaquin Valley, added smart growth postprocessors to adjust the model results to account for the effects of infill and transit-oriented projects. Over the longer run, these regions are likely to step up efforts to improve the models so that sketch planning methods and postprocessors will be supplements rather than the main tools used in GHG analyses.

Although the target setting process established the baseline and created an impetus for modeling improvements at many MPOs, some of the smaller MPOs felt that the target setting process actually hindered their efforts to improve. Many of these regions have been using models that focused only on automobile travel and were looking to an ambitious GHG reduction target to force them to develop the capacity to analyze transit, to consider parking policies, and to have more resolution (i.e., smaller travel analysis zone geometry). However, because the ARB has set small MPO emissions targets low, there is little impetus for significant policy changes or investments in modeling improvements. One MPO staffer noted with frustration that the ARB "has been walking on eggshells not wanting to offend local areas" and has essentially "given most small regions a pass" on air quality targets; yet "without a target, there is no real point" to SB375 compliance (Interview with MPO staff member, June 30, 2010).

DISCUSSION OF RESULTS

SB375 represents an opportunity to make significant advances in modeling and planning capacity. This leap forward is one that many MPOs, particularly outside the four major regions, have been putting off for some time. The director of one such MPO exclaimed "Thank goodness SB375 came along. Thank goodness Prop 84 [which funded model improvements] came along." (Interview with MPO director, July 6, 2010). In general, SB375 raised the expectations of planning and "gave more hope to modelers throughout the state to do more things." (Interview with modeling expert, October 25, 2010).

The California experience confirms the utility of all of the TRB Special Report 288 recommended strategies for advancing models and adds to them (*3*). The two key additions are instituting ongoing programs of model assessment and future planning and aiding in that future planning by providing a clear and graduated road map for expected advancement. However, the California experience also upends this framework to suggest that the critical precondition for model change is a legislative mandate to use models to achieve an ambitious planning agenda. Once the state committed to advancing modeling all these strategies naturally followed. It is not clear that without the renewed centrality of modeling, the proposed strategies, on their own, would make much difference. Therefore, it appears that the key ingredient for effecting modeling change is to pass policies that are predicated on advanced modeling features, otherwise there may not be sufficient incentive to innovate.

CONCLUSIONS

California's SB375, legislation mandating sustainable community strategies for GHG reduction, is changing the travel demand modeling practiced at the state's MPOs. Changes in modeling are coming about because the legislation mandates policy analyses that can be done only with advanced models or supplementary tools. As a result, state guidelines for modeling have had to change and so have MPO practices. Funding for model improvements of various sorts

has helped MPOs advance their practices. In addition, preliminary analyses and model reviews done as part of the GHG reduction target setting process have made the limitations of some of the MPOs' models highly visible to the agencies themselves and to a broader group of interests. This exposure has led to the lagging MPOs making new efforts to improve their modeling. Finally, collaborations among MPOs that arose as a result of the target setting process have led to agreements on the kinds of longer term model improvements that are needed. The process has accelerated change at the large and medium MPOs, but may have undermined faster change among the smallest MPOs, who are not expected to deliver major GHG reductions.

The ultimate test of whether this process of legislatively mandated change in modeling is effective is still to come. Will the enhanced models allow planners to develop more sophisticated and more accurate analyses of the new sustainable community strategies the law requires? What specific modeling approaches will prove most useful? Will advanced models help the public better understand the consequences of alternative development patterns and transportation investments? Monitoring the role of modeling in the planning process and the ability of advanced models to improve planning and forecasting performance will be an important future step.

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