Tools and Best Practices for Land Use Efficiency and Equity in Cities

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A Research Report from the National Center for Sustainable Transportation

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16. Abstract
Lowering vehicle miles traveled (VMT) to meet greenhouse gas reduction targets through land use and transportation planning and investments is a primary goal of planning organizations in California. This report provides information about the landscape of methods and tools available to regional and local governments to evaluate the land use efficiency and equity within their jurisdictions. This study draws on an evaluation of web-based tools for analyzing VMT generation, gentrification, and equity, and a stakeholder workshop to identify promising practices and opportunities for improvement with respect to planning tools to support land use efficiency. Most of the 11 tools analyzed were easy to use, providing ease of navigation and interactive, intuitive interfaces. Some were static with minimal or no documentation to help understand how to use them. None of the tools reviewed addressed all three issues of VMT generation, gentrification, and equity that were the focus of the study. However, the three tools addressed VMT and equity together were intuitive to use and provided multiple indicators for which to visualize outcomes relevant to VMT and equity. Stakeholders from metropolitan planning organizations (MPOs), city governments, and county governments discussed and gaps of existing land use efficiency tools and the potential need for a new tool development or improvements to existing tools. Participants saw the value of existing quantitative mapping tools supporting their evaluations of proposed planning projects as well as helping to facilitate conversations among staff about the impacts and potential VMT or greenhouse gas emissions reductions. Key gaps included transferability of data and analyses across scales and limited data available for rural areas. Participants saw the need for a new tool that could integrate localized data with statewide data. The findings can inform interagency collaboration around equity analysis and tool development.

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Disclaimer

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EXECUTIVE SUMMARY

Lowering vehicle miles traveled (VMT) to meet greenhouse gas reduction targets through land use and transportation planning and investments is a primary goal of planning organizations in California. This report provides information about the landscape of methods and tools available to regional and local governments—specifically small- to mid-sized cities across California—to evaluate land use efficiency and equity within their jurisdictions. This study began by drawing on literature from multiple sources related to existing tools and methods for analyzing sustainable land use, affordable housing, and gentrification. The research team then evaluated 11 web-based tools to identify their strengths and weaknesses in addressing VMT generation, gentrification, and equity. The team then conducted a workshop with 22 stakeholders to identify which tools would be most effective for their needs, gaps in those tools, and how they envisioned the development of future tools and methods. Multiple stakeholders included select local city and county governments across California and planning staff from Metropolitan Planning Organizations (MPOs) to understand their needs on how to measure land use efficiency, housing affordability, and potential risk of gentrification, and reduce VMT.

Most tools were easy to use, providing ease of navigation and interactive, intuitive interfaces. Some were static with minimal or no documentation to help understand how to use them. None of the tools reviewed addressed all three issues of VMT generation, gentrification, and equity that were the focus of the study. However, three tools addressed VMT and equity together: the Transportation Disparities Mapping Tool published by the UCLA Center for Neighborhood Knowledge, the Housing + Transportation Affordability Index published by the Center for Neighborhood Technology, and the Chicago Metropolitan Accessibility Explorer, published by the University of Illinois Chicago Travel Behavior & Urban Systems Research Group. Each of these tools provided multiple indicators for which to visualize outcomes relevant to VMT and equity, including household VMT, destination accessibility, housing and transportation affordability, and multiple socioeconomic characteristics. Each of the tools is intuitive to use and is designed for a variety of stakeholders. Two of the tools are limited in geographic scope, and there are few ways to disaggregate data by key equity variables.

The stakeholder workshops focused on the strengths and gaps of existing land use efficiency tools and the potential need for a new tool development or improvements to existing tools. When describing existing tools, participants saw the value of quantitative mapping tools supporting their evaluations of proposed planning projects as well as helping to facilitate conversations among staff about the impacts and potential VMT or GHG emissions reductions. A commonality among local government staff was that all use CalEnviroScreen—a tool not related to land use efficiency—to inform their planning decisions and project plans. MPO staff noted that the main strength of existing tools allows them to conduct more thorough macro-level analyses within the geographic jurisdictions. Local governments expressed that existing

tools save them time and funds by allowing them to easily retrieve data and visualizations without having to create their own. When looking at the gaps and limitations of existing tools, MPO and local government staff mentioned their concerns on the transferability of tools between agencies, between scales, and across jurisdictions. Moreover, local government staff were concerned about the lack of local knowledge and community input to the tools and the lack of representation of rural data.

When describing the need to develop a new tool, participants saw the need for a new tool to integrate localized data that can be coupled with statewide data. Forecasting ability was limited in public-facing tools, and a new tool should have the ability to show outputs across scenarios. Local government staff supported developing a tool that accounted for rural needs. Both groups also saw the need for additional data sources, like health metrics and historical redlining maps to provide context, and standardized methods for communicating equity needs. The tools were expected to facilitate interagency collaboration.

The findings can inform Caltrans, CARB, MPOs, and local governments on how to effectively conduct deeper analyses using the analytical tools discussed here as well as internal tools on integrating equity. The findings and recommendations demonstrated what can be pursued on both short-term and long-term timeframes. Key recommendations include prioritizing equity in tool development, integrating gentrification indicators in land use metrics, providing a state standardized tool or methodology, better forecasting methods, integration of local and statewide data, training for tool use, equity training, and better interagency collaboration around data sharing, planning, and tool development.

Introduction

California was the first state in the US to pass legislation to set greenhouse gas (GHG) reduction targets with the passage of the Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32). The bill gave the California Air Resources Board (CARB) the authority to regulate GHG emissions, roughly 40 percent of which come from the transportation sector. In 2008, the legislature passed the Sustainable Communities and Climate Protection Act (Senate Bill [SB] 375) to implement the needed changes region-by-region. The bill directed CARB to set regional targets for California's 18 Metropolitan Planning Organizations (MPOs) to meet GHG emissions reduction targets through the development of a Sustainable Communities Strategy in regional transportation plans. SB 375 intends to ensure that local government officials are involved in the development of these plans to reach emissions reduction targets. Regions can achieve these targets by decreasing the amount of driving through efficient development and the use of alternative transportation modes. Since local officials control land use decisions, local action is especially important to implement successful land use development strategies.

The generation of vehicle miles traveled (VMT) is influenced by the spatial patterns of the built environment; at least three decades of research underscore the relationship between compact development and less driving (*1*–*3*). Changes in land use designation, parcel size, denser development along major transit corridors, and access to alternate modes of transportation, for example, can help reduce VMT. However, this kind of development must be viewed with an equity lens; some evidence indicates that investments such as transit-oriented development (TOD) may lead potential risks of displacement and gentrification (*4*). To attain the GHG reduction targets, cities and regions—specifically small-to mid-sized cities with limited planning capacities—may benefit from access to tools and resources that assess the potential for and effects of VMT reductions while accounting for gentrification and equity concerns.

Prior research has either solely focused on measures of land use efficiency to reduce VMT or focused on measures of gentrification and housing affordability, but not both. For instance, a recent study on the development of metrics for assessing the impacts of the Sustainable Communities Strategy states that the limitation of their framework is that it does not cover issues of equity (*5*). This report begins to address this gap through the evaluation of existing tools that address both land use efficiency and equity to promote sustainability and equity of the built environment. The term "land use efficiency" refers to development strategies that enable more use of transit, walking, and cycling for daily travel needs, such as compact and dense development, transit-oriented development, mixed-use development, and parking reduction strategies.

This report provides information about the landscape of methods and tools available to regional and local governments to evaluate land use efficiency and equity within their jurisdictions. This study began by drawing on literature from multiple sources related to existing tools and methods for analyzing sustainable land use, affordable housing, and gentrification. The research team then conducted a workshop with key stakeholders to identify which tools would be most effective for their needs, gaps in those tools, and how they envision the development of future tools and methods. Multiple stakeholders include select local city and

county governments across California, as well as planning staff from Metropolitan Planning Organizations (MPOs), to understand their needs on how to measure land use efficiency, housing affordability, and potential risk of gentrification, and reduce VMT. Overall, the findings of this study identify the promising practices and missed opportunities of existing tools. Furthermore, the findings of this study will inform the potential development of a new tool or synthesis of improvements to existing tools.

Land Use and Transportation Efficiency in Planning and Modeling Tools

Tools and models have played a significant role within land use and transportation planning. Recent California state legislation has shifted conversations around the types of indicators and metrics that are used in those tools and models such as through SB 375 and SB 743. The intent of SB 375 is to create regional Sustainable Communities Strategies (SCS) that support the state's climate goals in reducing greenhouse gas emissions through collaborative coordination of land use, housing, and transportation planning (*6*). SB 743 requires planners to use VMT measures to evaluate transportation impacts within the California Environmental Quality Act (CEQA) in an effort to decrease GHG emissions (*7*). These policies have informed how models need to incorporate VMT and GHG indicators as well as other built environment and travel behavior indicators to support analyzing reductions from proposed and current planning projects. This literature review examines the value and use of tools in land use and transportation planning as well as key questions of integrating equity within both the tools, models, and planning processes.

Research has long established a relationship between the built environment and travel demand. A 2001 synthesis of the literature showed that VMT is lower in areas with more compact development as measured via density, higher land use mix, supportive design features, and regional accessibility (*1*). The elasticities associated with relationships were incorporated into an early smart-growth model developed by the US EPA (*1*). Other analyses conducted since that time using meta-analysis and regression analysis largely comport with the earlier findings: VMT is strongly associated with destination accessibility and other "D" variables like population and employment density, land use diversity, and intersection density (*2*, *8*). However, these local impacts are moderated by the overall urban spatial structure of a city—when more people live in denser areas, VMT reductions are even greater (*9*). These and related studies demonstrate the importance of accessibility and other related metrics for models related to climate action plans, health impact assessments, and other sustainability plans.

The findings have backed planning efforts to reduce VMT and GHG emissions through land use efficiency measures. As previously mentioned, one of the goals of SB 375 is to promote more effective coordination of land use, housing, and transportation planning to reduce VMT and GHG emissions (*5*, *6*). Researchers have developed a group of key indicators to track and monitor progress toward VMT and GHG emissions reduction goals in SB 375, which they refer to as the Statewide Monitoring System (*5*). The purpose of this system is to create a linked network of data with other tools, such as CalEnviroScreen, to support agencies with a more

comprehensive tool for planning, policy, and program evaluation. By measuring three indicators of changes in new housing units, subsidized affordable housing, and net changes in jobs, this system showed that land use development is largely inconsistent with SB 375 goals. A key reason for this may be inconsistent planning efforts and regulations across jurisdictions even within regions. Some scholars have suggested more intergovernmental coordination is needed for sustainable development (*9*). In parallel, a more unified data system may help promote a cooperative dynamic between MPOs and state and local governments; different regions have different tools, data sources, and units of analysis that makes it difficult to benchmark land use and transportation developments (*6*).

An emerging statewide framework in California is the analysis of VMT generation from development projects, mandated by SB 743 as a way to support SB 375 goals. As state and regional agencies work to develop methods to better integrate VMT calculations into their travel models, one pilot test situated in San Jose, CA showed that obstacles remain in terms of establishing reliable VMT calculation models (*7*). For example, measuring the effects of context and scale of a project's VMT outcomes is a challenge because limited data and methods are available. Additional research is needed to develop more effective indicators for SB 743 (*7*).

As VMT and GHG emissions reductions become more of a focal point for land use and transportation planning, further developments have been made to add metrics that evaluate the relationship between travel demand and the built environment. Sustainability, health, and livability are examples of additional domains that could incorporated into these land use and transportation tools and models (*10*–*12*). Land use changes can impact public health; the reduction of car dependency, greening of cities, and the need for citizen involvement and leadership are key to creating healthier and more sustainable cities (*12*). However, there is still uncertainty about what kinds of health metrics could be included in such tools and the socio-economic and geographical connections with health. Others have focused on smart growth and livability characteristics. The Smart Mobility Calculator, developed by San Diego State University for Caltrans, for example, integrates datasets that describe urban quality, destination accessibility, and livability (*11*). Equity is more explicitly addressed in the Smart Mobility Calculator, specifically as it relates to health, as it incorporates metrics related to housing affordability, income diversity, transportation affordability, and cardiovascular health.

More recent work has begun to assessing metrics relevant to diversity and addressing racial equity within land use and transportation planning. Two related reports examine the conditions for assessing disparities. The first, *Mobility, Accessibility and Disadvantaged Neighborhoods: Assessing Diversity in Transportation-Related Needs and Opportunities*, focused on the similarities and differences among disadvantaged communities in mobility and access to opportunities (*13*). The authors found that disparities in disadvantaged communities are related to housing segregation, economic underinvestment, place stigma, and political disenfranchisement. They further concluded that addressing equity in land use and transportation tools is still novel and more research is needed on how to better incorporate equity metrics in these tools. Prioritizing impacts on disadvantaged communities and addressing equity needs to have more accessible data, other stakeholders such as community

members must have access, and accessibility needs to be addressed on a deeper level in transportation planning.

The second report, *Assessing the Incorporation of Racial Equity into Analytical and Modeling Practices in Transportation Planning*, examines the extent to which state transportation departments in four states, including California, incorporate race and equity into transportation planning technical analyses and modeling (*14*). The authors found that there is widespread acknowledgement within transportation agency staff of the existence of racial disparities in transportation and that there is a lack of standardization of how the models include impacts on low-income, minority, and disadvantaged communities. There is a lag between academic research on how to address racial disparities and incorporating the findings into regional transportation planning models—a finding that echoes other research (*15*). Furthermore, this work and the work of others identify a key challenge: technical staff have limited knowledge and training about racial equity and systemic racism, thus there are barriers to ensuring that staff prioritize equity as they revise and update models (*14*–*16*). Recommendations to better incorporate racial equity indicators include using legislative action and structural changes within planning agencies to ensure more interaction among separate units within an agency, more and better staff trained and orientation on racial equity, and encouraging collaboration with other agencies (especially non-transportation agencies that are active in establishing equity analyses) and researchers on racial equity.

The report also suggested types of indicators that should be included in land use and transportation tools and models for them to attempt to addressing racial equity (*14*). These characteristics include racially disaggregated demographic for major vulnerable populations, travel behavior by race (such as travel mode and distance traveled), the spatial structure of opportunities as experienced by race, the causes and consequences of racial disparities (e.g., discrimination and health outcomes), and racial dynamics and outcomes due to major changes in the transportation system (e.g., gentrification), among others. No singular tool currently incorporates all these characteristics, but the authors conclude that development of future tools should account for them.

Most studies recommend improved coordination among agencies and better meaningful public participation, roles that MPOs could facilitate as regional planning bodies. One study conducted a set of interviews with MPO staff about the achievements and challenges of implementing SB 375 (*17*). Key takeaways from those interviews showed that MPOs want to incorporate more equity such as affordable housing development with greenhouse gas reduction strategies as well as improved state government work on developing policies that acknowledge different economic and geographic contexts. Improved roles of MPOs and the state government must also be coupled with improved community engagement and outreach in order to address equity and impacts on disadvantaged communities. Because race and equity are not standardized in land use and transportation planning, many agencies rely on CalEnviroScreen to obtain their equity data (*14*). As shown later in the workshop summary, feedback from stakeholders confirm the need for a more standardized tool that incorporates equity and transportation aside from CalEnviroScreen. Reliance on one general equity tool for different

transportation projects can be challenging in addressing impacts on targeted communities with specific solutions (*14*).

This body of work supports the need for an evaluation of land use and transportation tools as there is clearly a gap of existing tools in addressing both land use efficiency and equity. The scope of our research study particularly aims to look at how these tools incorporate equity elements and indicators such those described above.

Land Use and Transportation Efficiency Tools Evaluation

The examination of existing tools related to land use efficiency, transportation, housing affordability, and gentrification provides an assessment to assist local governments and agencies to evaluate land use efficiency and equity. The main purpose is to identify promising practices and missed opportunities to address the gaps that could inform the potential development of new tools. One major gap is that current land use and transportation efficiency tools lack the integration of equity that are more present in tools that strictly focus on gentrification and housing affordability. Through this evaluation, we examined the extent to which tools described outcomes related to VMT, gentrification, and equity and the overlap among the three categories of metrics. The goal was to determine the extent to which any tools encompassed all three categories of VMT, gentrification, and equity. However, we did not find tools that overlapped perfectly; there were tools that encompassed at most two overlapping categories.

Methodology

The methodology used to identify, categorize, and assess existing tools related to land use efficiency, transportation, housing affordability, and gentrification began with a pre-selected list of six tools known by the research team as related to land use efficiency and equity. We identified additional tools that addressed the measurement of VMT, gentrification, and equity, included a national, statewide, regional, or large city scope, and could reasonably be used by a lay audience. We identified five additional tools to evaluate for a total of eleven. The tools evaluated as part of this study are shown in Table 1.

Table 1. Land use efficiency tools evaluated

Tool Name	Author	Purpose	Data year(s)
Access Across America	University of Minnesota Accessibility Observatory	Measures accessibility to jobs via various modes of transportation in major metropolitan areas across the United States. Analyzes transit, auto vehicles, biking, and walking.	Earliest: 2013 Latest: 2019
California Induced Travel Calculator	National Center for Sustainable Transportation	Allows users to estimate the VMT induced annually as a result of adding general-purpose lane miles, high-occupancy vehicle (HOV) lane miles, or high-occupancy toll (HOT) lane miles to publicly owned roadways, like those managed by the California Department of Transportation (Caltrans).	2019
Displacement Alert Project	Association for Neighborhood and Housing Development	Provides effective early warning information for residents facing harassment and displacement, for communities being destabilized, and for the community groups and policy makers trying to address the crisis. Designed for an audience of community groups, decision makers, and local residents.	2016
Gentrification Comparison Tool	Enterprise Community Partners	Maps neighborhoods in 93 U.S. cities over four decades by their gentrification status under three different definitions. The data used to make these classifications for each definition are visible within the maps, so users can evaluate why some tracts appear as gentrified and others do not.	2019
Housing and Transportation Affordability Index	Center for Neighborhood Technology	Measures the true affordability of housing by calculating the transportation costs associated with a home's location. Develops an index that expands the definition of housing affordability to include transportation costs at a home's location to better reflect the true cost of households' location choices.	2016 (updated in 2022)
Metropolitan Chicago Accessibility Explorer	University of Illinois at Chicago	Measures and display destination accessibility to a variety of activities in the Chicago Metropolitan area in a relatively simple, user friendly, online platform.	2016
Santa Clara Countywide VMT Evaluation Tool	Santa Clara Valley Transportation Authority	Helps users conduct a baseline VMT screening evaluation for small- to medium-sized residential, office, and industrial land use projects in Santa Clara County. The tool evaluates these land uses individually, in combination with each other, and with or without local-serving retail.	2020

Tool Name	Author	Purpose	Data year(s)
Seattle Displacement Risk Index	City of Seattle	Identifies areas of Seattle where displacement of marginalized populations may be more likely. It combines data about demographics, economic conditions, and the built environment into a composite index of displacement risk. It focuses on displacement that affects marginalized populations.	2016
Smart Location Database (SLD)	US Environmental Protection Agency	Summarizes several demographic, employment, and built environment variables for every census block group in the United States. The database includes indicators of the commonly cited "D" variables shown in the transportation research literature to be related to travel behavior. Can be used as inputs to travel demand models, baseline data for scenario planning studies, and combined into composite indicators characterizing the relative location efficiency of CBG within U.S. metropolitan regions.	Version 1.0 in 2011 Version 2.0 in 2013 Version 3.0 in 2021
Transportation Disparities Mapping Tool	UCLA Center for Neighborhood Knowledge	A project developed to better understand transportation disparities and built environment- related determinants of health in California. This tool focuses on four major categories of disparities: (i) private vehicle ownership, (ii) public transit, (iii) active transportation, and (vi) transportation networks. The mapping of these disparities supports agencies and organizations studying climate change and environmental justice.	2021
Urban Displacement Project: Displacement Typology	Urban Displacement Project	Aims to understand the nature of gentrification, and displacement, and exclusion in American cities through an interactive mapping tool designed to visually show the relationships between transit investment and neighborhood change. The outcome is to show neighborhood impacts according to identified levels of risk.	2011
Urban Displacement Project: Housing Precarity Risk Model	Urban Displacement Project	Estimates where households are at the highest risk of eviction, displacement, and long-term poverty as a result of the COVID-19 recession interacting with pre-existing precarity. The aim of this work is to better understand racial and economic disparities in housing and opportunities while providing state and local governments a tool to target needed resources to those that need it most.	2021

Once the tools were identified, we created a spreadsheet to record elements of each tool for description and evaluation. For each tool, we recorded the purpose, data sources, methodology, units of analysis, variables and outputs, scale, geographic area, and interface usability found within the application and manual guides. (See Data Summary.) After delineating each tool into the initial three categories, we found that tools ultimately addressed topics in one of four, non-mutually exclusive, categories: VMT, VMT & Equity, Gentrification, Gentrification & Equity. We then conducted an in-depth analysis on the tools within each of these new categories based on four evaluation questions. These questions asked how well the tools capture the relationships between travel behavior, land use, and VMT; how well these tools are applicable to policies around land use and VMT; how well these tools assess equity from different perspectives; how well these tools could be used for forecasting VMT reductions; and how easy the tools were to understand and be used by the public. From this assessment, we highlighted the limitations as well as developed emerging questions that informed the discussion for the virtual stakeholder workshop with metropolitan planning organizations (MPOs) and local government staff.

The tools were also evaluated qualitatively for accessibility, or ease of use for the general public. We graded each tool on a scale of 1-4 using the following criteria:

- 4: These tools were the easiest to access, provided clear and detailed instructions and user guides, and were the most user-friendly, especially for community members and the public.
- 3: These were easy to access; however, there were fewer instructions provided and tools were less user-friendly. For example, different variable layers and geographic locations may have been included on multiple webpages, requiring users to navigate back and forth between pages to access different layers and maps.
- 2: These were not as easily accessible and were less user-friendly as there were limited instructions and user guides provided for reference.
- 1: These were the least accessible and user-friendly. They lacked a reference or user guide that provides definitions and instructions and lacked interactivity.

Evaluation Results

The summary of the tool evaluation is shown in Figure 1. The first three tools on the list indicate the tools that we found to be closest to incorporating elements from all categories: Transportation Disparities Mapping Tool, Housing and Transportation Affordability Index, and Metropolitan Chicago Accessibility Explorer. Although there is not one tool that integrates indicators for all categories, these three incorporate VMT, equity, and a few land use elements which are critical to identifying equity components in land use and transportation tools.

Tools that received a checkmark for the VMT category means they included metrics and indicators such as VMT estimations or reductions as a result of selected land use and transportation inputs. Tools that include gentrification elements specifically address housing segregation, risks of eviction, and risks to gentrification and displacement in a neighborhood, and may include ancillary information such as redlining maps. Tools that include equity

components include demographic indicators such as race, ethnicity, income, and education, health metrics, and accessibility to jobs and services. Lastly, tools that address land use specifically include accessibility and the spatial distribution of land use types such as accessibility to parks, schools, grocery stores, as well as categories of land use types (residential, commercial, industrial, etc.).

Several tools focus on only one category. For example, tools that strictly focus on VMT include Access Across America, California Induced Travel Calculator, and the Smart Location Database. Similarly, there are tools that solely focus on gentrification, and they include the Displacement Alert Project and the Gentrification Comparison Tool. Tools that overlap in at least two categories include the Santa Clara Countywide VMT Evaluation tool (VMT and land use), Seattle Displacement Risk Index (gentrification and equity), and Urban Displacement Project: Displacement Typology (gentrification, equity, and land use). Not all tools included the same variables within each analysis category. For example, the Santa Clara Countywide VMT Evaluation tool only incorporates data about residential, industrial, and commercial land use types, but not others. The Transportation Disparities Mapping Tool on addressing land use only includes a limited number of land use indicators, such as accessibility to public parks.

The accessibility column in Figure 1 indicates the qualitative score for ease-of-use. The tools that were most accessible and user friendly included the Transportation Disparities Mapping Tool, Housing and Transportation Affordability Index, Metropolitan Chicago Accessibility Explorer, and Displacement Alert Project. These tools were easy to find online and provided a substantial amount of information on how to use them as well as explanations on what each indicator or metric means. Tools that were the least accessible, such as the Seattle Displacement Risk Index, were difficult to find online and were sometimes embedded in city government planning documents as static map outputs. Other less accessible tools, such as the Santa Clara Countywide VMT Evaluation Tool, are intended to be used by planners and developers to assess their projects. More accessible tools have fewer technical barriers to layperson use; they are designed in a way so that non-experts could employ and understand them for community analysis, feedback to public agencies, and other purposes.

Tool Evaluation Summary

TOOLS	VMT	GENTRIFICATION	EQUITY	LAND USE	TOOL ACCESSIBILITY
Transportation Disparities Mapping Tool	✓		✓	✓	
Housing + Transportation Affordability Index	✓		✓		
Metropolitan Chicago Accessibility Explorer	✓		✓	✓	
Access Across America	✓				
California Induced Travel Calculator	✓				
Displacement Alert Project		✓			
Gentrification Comparison Tool		✓			
Santa Clara Countywide VMT Evaluation Tool	✓			✓	
Seattle Displacement Risk Index		✓	✓		
Smart Location Database	✓				
Urban Displacement Project: Displacement Typology		✓	✓	✓	

Figure 1. Summary of tool evaluation. The green columns show the four categories (VMT, gentrification, equity, land use) that were assessed for whether these tools incorporate variables, metrics, or indicators related to those categories. The last column, "Tool Accessibility," indicates a qualitative assessment of how easily accessible it is to both planners and everyday commuters and how user-friendly the tool is on a scale of one (least accessible) to four (most accessible) bars.

Tool Categories

In this section, we describe each tool in more detail, categorized by the outcomes they address. We highlight the strengths and limitations of each and discuss potential use cases.

VMT

VMT tools provide the data for variables necessary to estimate vehicle miles traveled for land use projects, location efficiency, and accessibility to transit lines and jobs. By looking at a combination of the built environment, accessibility characteristics, and travel behavior, local jurisdictions, planners, and developers can calculate changes in travel associated with VMT-reducing measures and goals. Below are the four tools that have been identified under the VMT category. Note that not all tools calculate VMT directly, but all examine characteristics that are associated with VMT generation.

Smart Location Database. The Smart Location Database (SLD), published by the US Environmental Protection Agency, provides a consistent snapshot of the built environment and accessibility characteristics for neighborhoods across the U.S. The tool does not measure VMT directly, but it allows for VMT comparisons across neighborhoods by integrating variables related to location efficiency, accessibility to jobs, accessibility to transit, distribution of low-income populations, and zero car households—variables primarily related to the "D" characteristics (density, diversity, design, destination accessibility, and others) known to be associated with travel behavior (*2*, *18*). Data are provided for census block group geographies from a mix of open data sources and proprietary data and functions that identify points of interest and provide accessibility calculations. Coverage is available for all 50 states; many variables are also available for Puerto Rico and the Virgin Islands, and transit variables are provided where data are available. The database can be used to power offline analyses and custom-built visualization applications. The database is accompanied by an interactive map viewer that visualizes many of the SLD variables (Figure 1).

The primary strengths of the SLD are its comprehensive geographic coverage and extensive list of built environment variables. The tool is in its third update and has been used in numerous research and practice applications. However, it lacks analytical methods or outputs that explicitly link built environment characteristics to travel behavior and VMT generation. Furthermore, the SLD lacks indicators to assess equity; the only equity-related variables are the number and location of low-income workers. Population characteristics such as race, ethnicity, gender, and disability are not available. The forecasting ability of the SLD itself is limited; the tool may not be suitable for studies that require knowing the very latest conditions in a given neighborhood because of the long timeframe between updates, especially in areas that are experiencing rapid changes due to new construction, migration, or transit-service alterations.

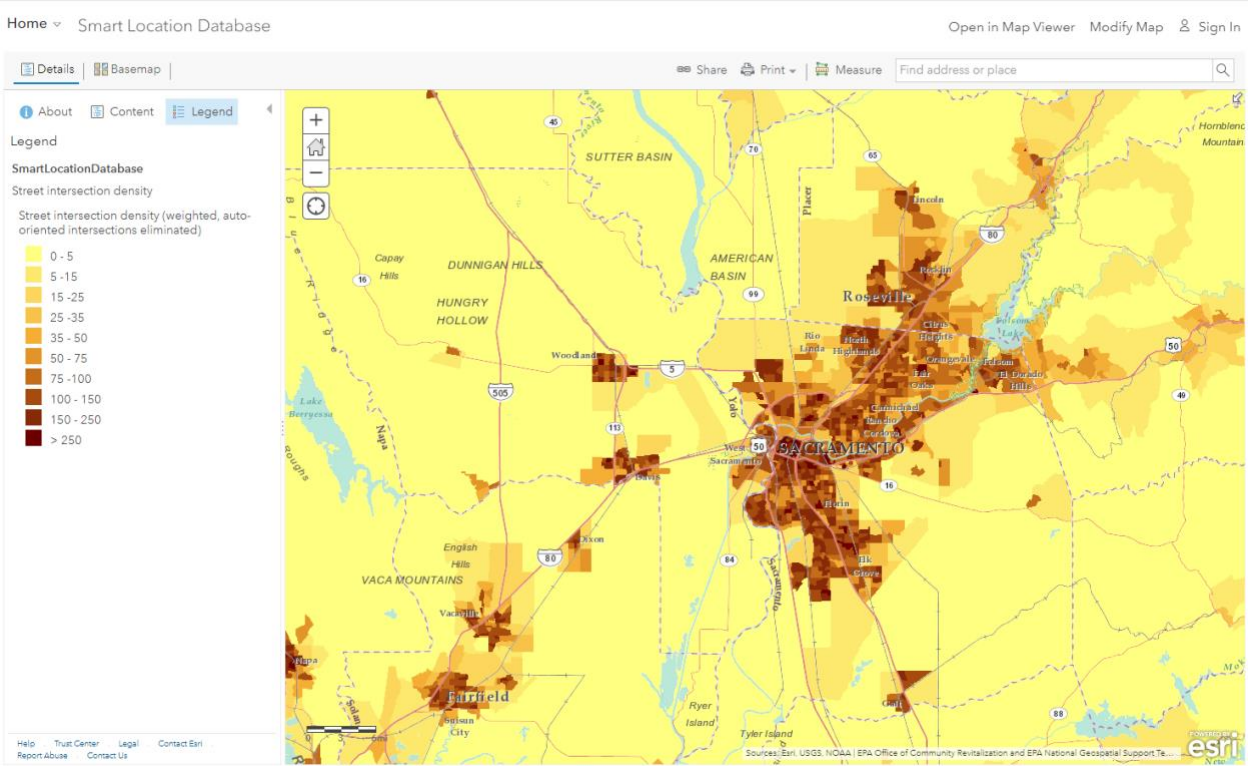

Figure 2. Smart Location Database Interactive Map Viewer

Santa Clara Countywide VMT Evaluation Tool. The Santa Clara Countywide VMT Evaluation Tool is specifically designed to meet SB 743 requirements by allowing planners and developers to assess VMT reduction estimates for their projects. The tool uses data from the Santa Clara Valley Transportation Authority and the City of San Jose travel demand models for baseline and forecast estimations to output VMT generation and reduction estimates at the parcel level.

Although this tool does not examine travel behavior directly, its capacity to analyze VMT mitigation for certain projects can help compare across land use projects within Santa Clara County, California. The tool is good for forecasting since it evaluates the outputs of a potential project and compares them with VMT targets (Figure 3). However, the tool does not include many equity components or include input variables such as residential affordability that could show the impacts of projects on existing residents. While the geographic scale of analysis at the parcel level is small, the geographic extent is limited to Santa Clara County only.

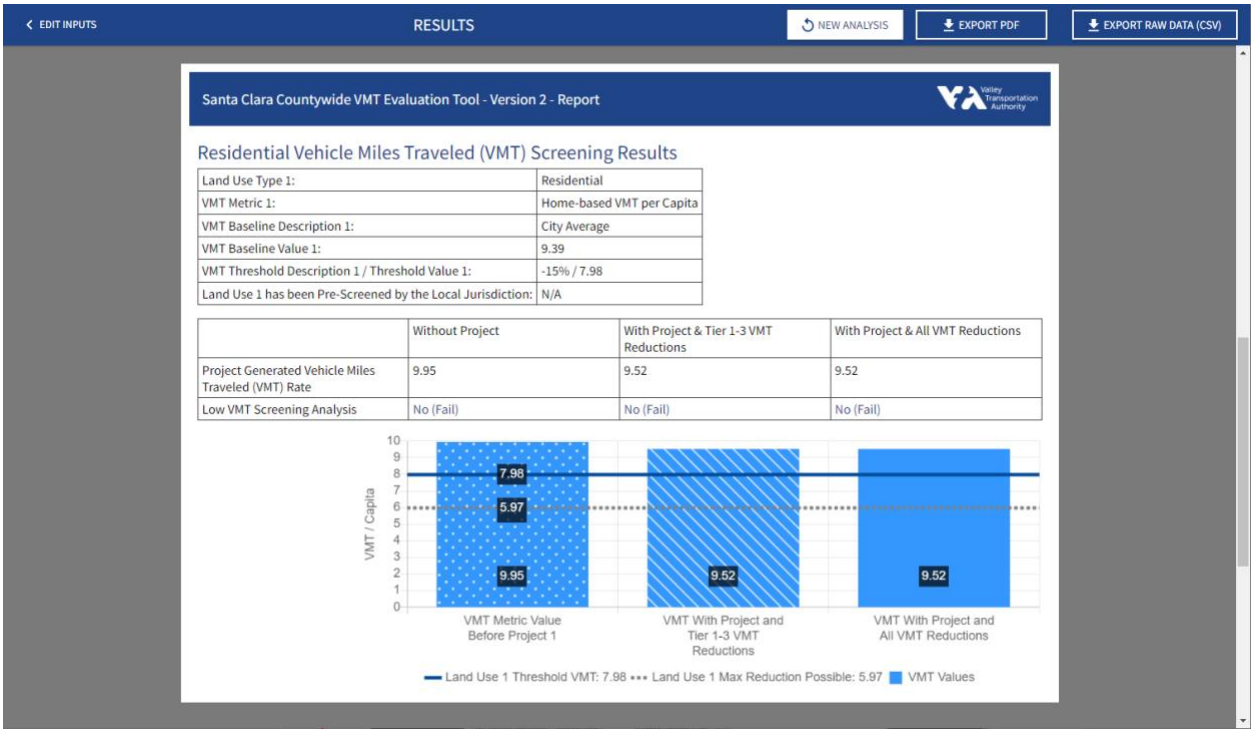

Figure 3. Sample Output from Santa Clara County VMT Evaluation Tool

Access Across America. Access Across America provides information on the destination accessibility to jobs in U.S. metropolitan areas by auto, transit, bicycle, and walking (Figure 4). The tool calculates access as a worker-weighted cumulative opportunities measure at the census block level, deriving the total number of jobs a worker can access within several travel time thresholds. These access measures are then used to rank metropolitan areas for their overall accessibility. The input data primarily come from open data sets except for travel time by auto, which is calculated based on roadway speeds from a proprietary dataset. Outputs are provided in multiple formats by metropolitan statistical area (MSA). The most feature-rich format is a geodatabase that identifies the total number of jobs that can be reached by each mode within five-minute increments (up to 60 minutes). Access to jobs by certain categories is also provided using the Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics (LODES) categories of age categories, earnings, two-digit NAICS codes, race, ethnicity, educational attainment, and sex. Outputs are also available as a set of zoomable web maps, in a series of reports as a set of static maps, and as ranked lists of metropolitan areas by overall access per mode.

The tools and datasets do not measure VMT directly, but instead provide information on levels of access that can be indirectly related to travel by car. The database outputs from different modes could be combined to develop indexes of relative access, such as a transit-to-auto access ratio, and ratios closer to one could indicate lower levels of VMT. However, this kind of information is available only to those who are versed in using GIS and statistical tools; the tool lacks an interactive map layer that incorporates land use types or other variables for comparison. Equity variables are limited to those available in the LODES job categorization, but

do not include any population- or transportation-level characteristics and are only available in the complete datasets.

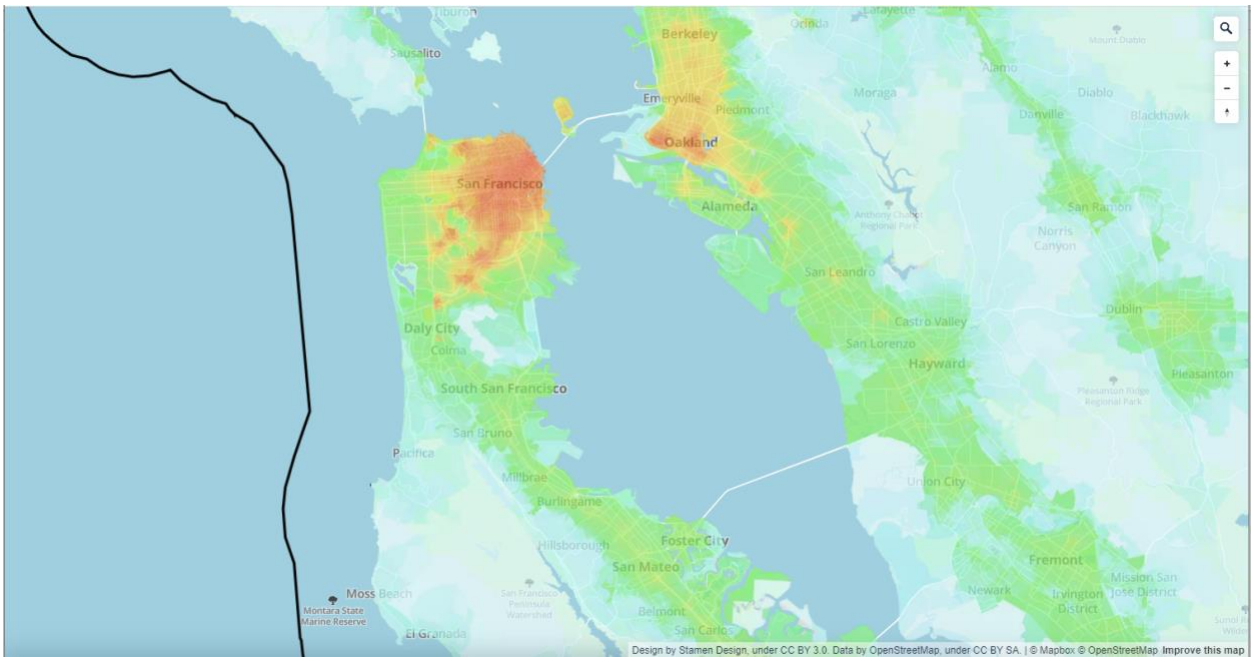

Figure 4. Access Across America Web Map Indicating Transit Accessibility

California Induced Travel Calculator. The California Induced Travel Calculator is another tool dedicated solely to estimating VMT (Figure 5). The calculator uses an elasticity metric to estimate the change in VMT that results from a change in lane miles associated with highway construction. The tool is simple, accounting for project length, county or MSA, functional classification of the roadway, and base year from which to forecast. This tool most likely is used by planning agencies and developers to gauge potential VMT estimations from highway lane projects. Due to this specific focus, it does not capture the relationships among VMT, land use, and travel behavior. Moreover, it is a minimal tool; it does not incorporate an equity lens that accounts for disparate community impacts. However, the simplicity of the tool makes it easy to combine with others that could account for VMT effects across demographic groups or land use types.

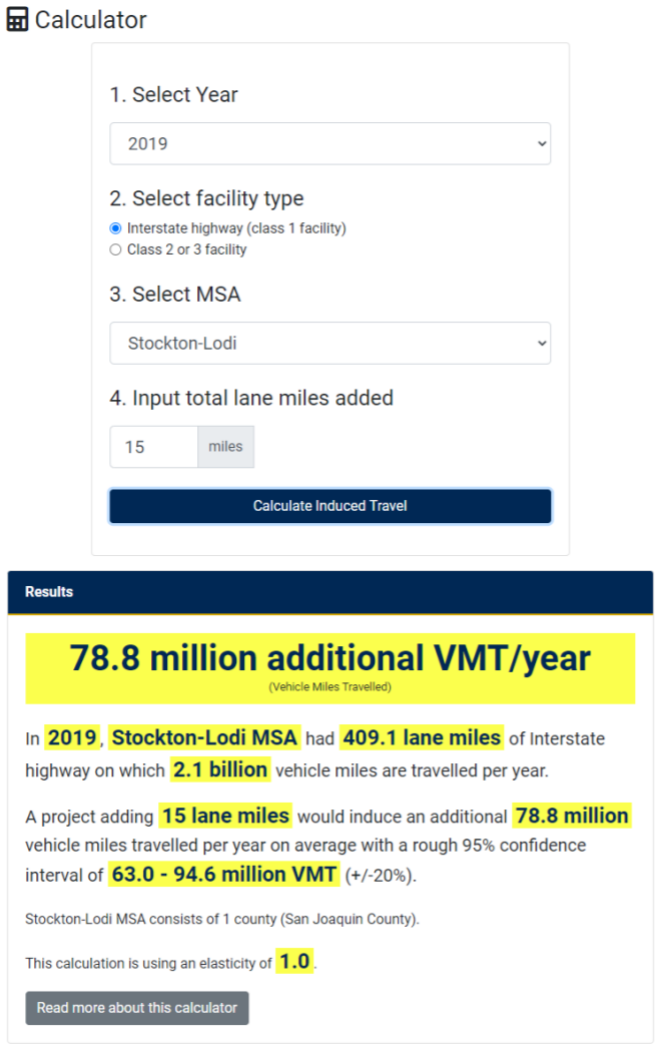

Figure 5. Induced Travel Calculator Sample Output

Gentrification

Tools in the gentrification category examine the existence and potential for gentrification, housing displacement, and residential exclusion specifically in metropolitan areas. These tools aim to help communities identify the pressures surrounding their neighborhoods to help address the impacts of gentrification. The two tools that fall under this category are described below.

Gentrification Comparison Tool. The Gentrification Comparison Tool, published by Enterprise Community Partners, focuses on gentrification trends in 93 U.S. cities by decade from the 1970s to the 2000s. For each city, the tool shows three maps to indicate census tracts that are not eligible to gentrify because the median household income is too high, eligible to gentrify using definitions from studies by Freeman, Ellen and O'Regan, and McKinnish and collaborators, and already gentrified using definitions from the same studies (Figure 6). The tool relies on data from the Geolytics Neighborhood Change Database to normalize variables and geographies

across the decades. Although the Gentrification Comparison Tool does not look at travel behavior, land use, or VMT, it can be used as a gentrification layer within other VMT tools. (Data can be downloaded in multiple formats, including the processed data and static maps.) A limitation is that this tool does not include other map layers related to gentrification risk, such as the spatial distribution of race and ethnicity. The tool is also somewhat out of date in that the latest data is from the first decade of the 2000s. However, because users can filter through different decades, the tool does provide some forecasting ability based on looking at decadal trends in the past 30 years.

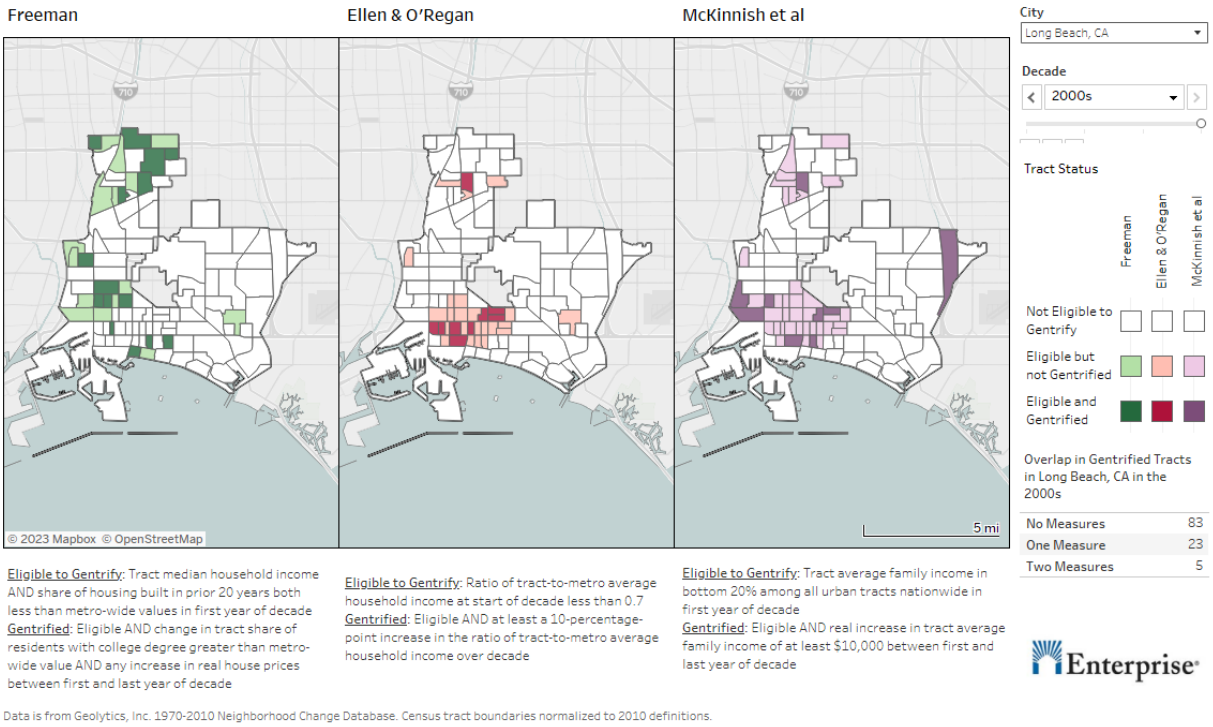

Figure 6. Gentrification Comparison Tool

Displacement Alert Project. The Displacement Alert Project (DAP) focuses on providing information about housing stability across New York City. The DAP consists of a suite of three information-rich tools about the risk for residential displacement at the housing-unit level: a data portal that shows properties by housing type (e.g., rent stabilized, subsidized, market rate) by address or within small-area geographies; a map that shows risk levels for housing deregulation, sales, construction, and eviction potential; and monthly reports by community board district. (See Figure 7 for the data map.) The tool is designed especially for residents to stay up to date on the displacement risk in their buildings and neighborhoods and to advocate and organize around stopping or mitigating displacement pressures.

While the suite of tools does not incorporate travel behavior, land use, or VMT, it does show the risks of displacement across multiple early-warning factors that could be used alongside other place-based tools. With a sole focus on displacement, the tools lack other contextual

information about neighborhood-level risks. Nevertheless, because of its focus on one city, the DAP blends a variety of government data sources to provide information at a scale that most other tools are not able to show. The map tends to be updated frequently with recent data to show the risks of existing conditions as they evolve over time.

Figure 7. Displacement Alert Project Data Map

Gentrification & Equity

Tools categorized as Gentrification & Equity contain similar information as the gentrification tools above, but incorporate additional elements such as race, ethnicity, income, and education level, as well as additional historical map layers. The two tools that fall under the Gentrification & Equity category are shown below.

Urban Displacement Project: Displacement Typology. The Urban Displacement Project includes several tools that help users understand the nature of gentrification, displacement, and exclusion across several U.S. and international cities. This analysis focuses on the Displacement Typology, which displays on maps the extent to which neighborhoods are vulnerable to gentrification and displacement (Figure 8). The displacement index combines data on demographics, transportation, housing, land use, and related policies to indicate neighborhoods on a scale from “Low-income/Susceptible to Displacement” to “Stable/Advanced Exclusive” with gradations in between. The maps include the ability to include other contextual information, including an index of residential segregation, historical redlining maps, opportunity zones, and transportation infrastructure. Data are shown at the census tract level for U.S. cities. International cities use a slightly different typology depending on data available and the particular gentrification and displacement dynamics.

Although this tool does not capture VMT, the variables used to create the gentrification and displacement typology incorporates layers that show land use types and access to public transit. Neighborhood vulnerability could be combined with information from other tools, such as VMT per household, mode of transportation to work, or travel time, to address the land use, travel behavior, and VMT relationships. The equity components of the tool address income differences between households and incorporates map layers of redlined and segregated neighborhood areas to show impacts on disadvantaged communities. Limitations of the tool include stale data—the latest data used is from 2017—and a limited number of cities for which the typology has been developed.

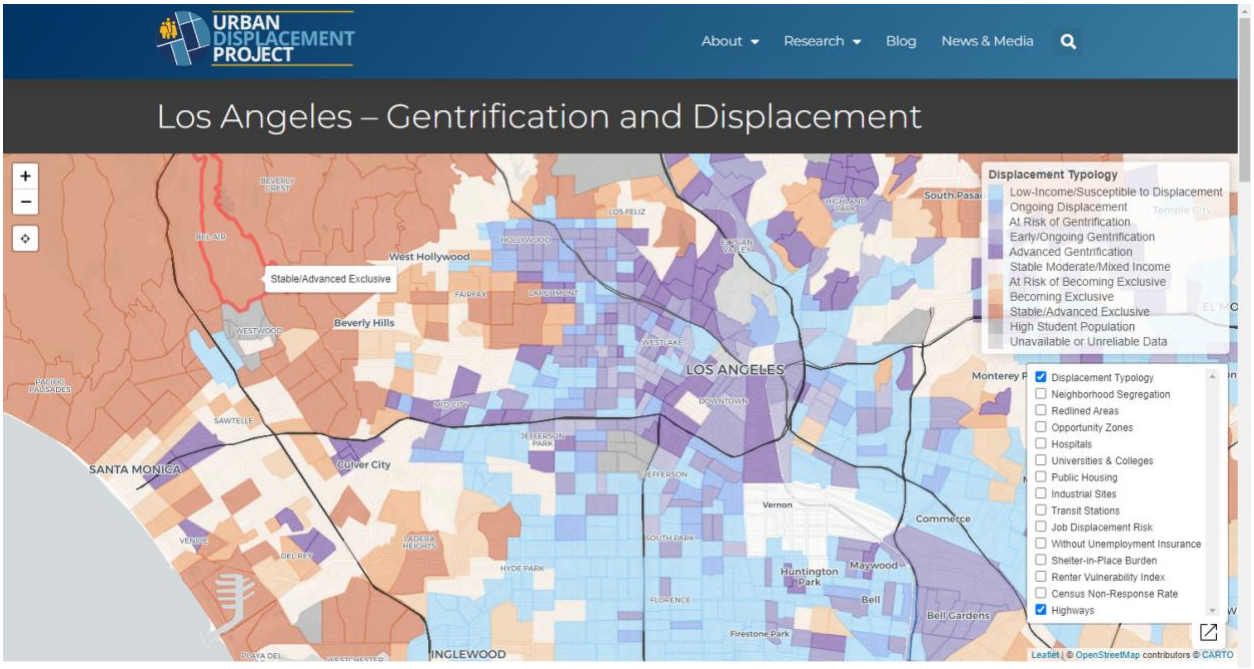

Figure 8. Urban Displacement Project, Displacement Typology

Seattle Displacement Risk Analysis. The Seattle Displacement Risk Analysis maps areas of Seattle where displacement of marginalized populations may be more likely to occur (Figure 9). The tool focuses on displacement risk that affects marginalized populations, defined in the Seattle 2035 Comprehensive Plan as people of color, low-income people, English-language learners, and people with disabilities. The displacement risk index uses 14 indicators from a mix of data sources on demographics, transportation service, land use, and development capacity, to map census blocks on a continuum from low to high risk. The tool uses an extensive set of equity-related metrics, including race and ethnicity, educational attainment, household income, and English-speaking ability, to develop the risk index. The tool reports only a snapshot of displacement risk as of 2016 and is a visual tool only; data are not available to be downloaded and the quantification of risk is not provided as an attribute table. Users must be familiar with the city of Seattle to adequately interpret the results.

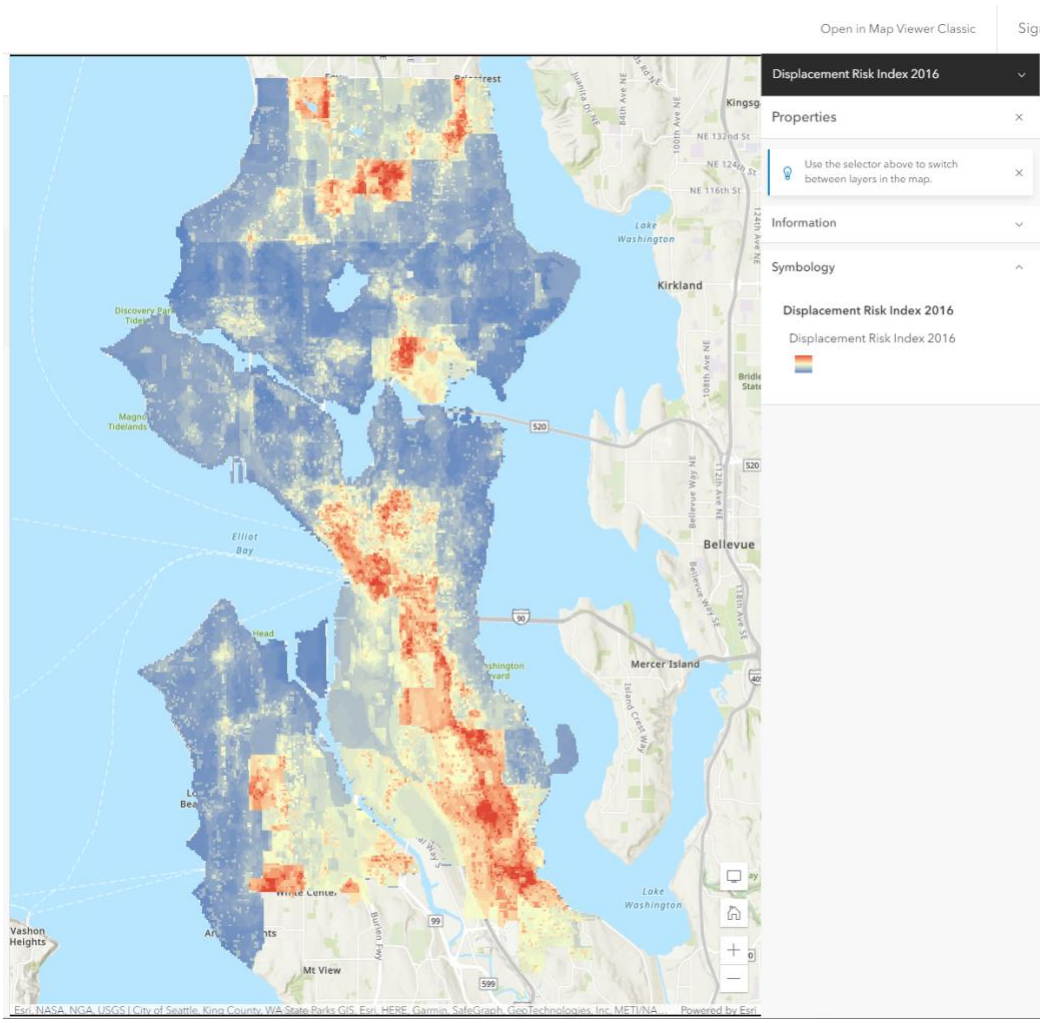

Figure 9. Seattle Displacement Risk Index Map

VMT & Equity

As previously mentioned, there is not one tool that incorporates elements from all three categories. However, the three tools discussed below are the best examples of tools that integrate VMT and equity and come closest to answering the core research questions of this study. Tools delineated as VMT & Equity go beyond incorporating the estimation and comparison of VMT between different land use projects and geographic scales by incorporating elements of equity characteristics, such as race, ethnicity, income, gender, and disability, and how they relate to certain demographics of different geographic distributions. Gentrification metrics are not included in these tools; however, the Transportation Disparities Mapping Tool incorporates housing indicators such as housing unit density and renter households. The three tools are described in more detail below.

Transportation Disparities Mapping Tool. Transportation Disparities Mapping Tool visualizes disparities in transportation, the built environment, and certain health indicators across California. The project's goal of mapping these disparities is to support local, regional, and state

agencies and organizations working on climate change and environmental justice. The tool provides five main categories of variables that users can select and explore at the neighborhood (census tract) level across the state of California (Figure 10): Transportation, Accessibility, Social-Economic-Demographic, Housing, and Health. In total, there are 40 indicators, which can be selected under these five categories. Neighborhoods are ranked within each indicator and displayed in separate maps. Data are from public sources and administrative government datasets.

We found that this tool provides the example that comes closest to incorporating a comprehensive assessment of travel behavior, land use, VMT, and equity indicators. The five categories the tool displays provided the most holistic and local level insights into the relationships with transportation disparities and access across the state of California. In terms of its applicability to policy, the data shown in this tool can aid with evaluating GHG emissions reductions, planning around land use types, housing demographics, and health inequities such as areas of higher asthma prevalence and cardiovascular disease. Additionally, the incorporation of socio-demographic layers such as race, ethnicity, household income, poverty, and job density, along with the health metrics, adds an important equity dimension to the tool.

A key strength of this tool is that it provides a comprehensive integration of the social-economic-demographic factors, which can aid in more holistic and inclusive forecasting of VMT. Because the tool was released only somewhat recently, there are unknowns with how frequently the data will be updated and how the visualization of the separate indicators can lead to a racial equity analysis of land use and transportation projects and policies. Although there are housing indicators that include the percentage of renter households and multi-family households, there are no displacement and gentrification indicators. Lastly, because there are so many indicators, there is some complexity in their display: they cannot be overlayed on each other, but the data can be used separately to inform existing conditions.

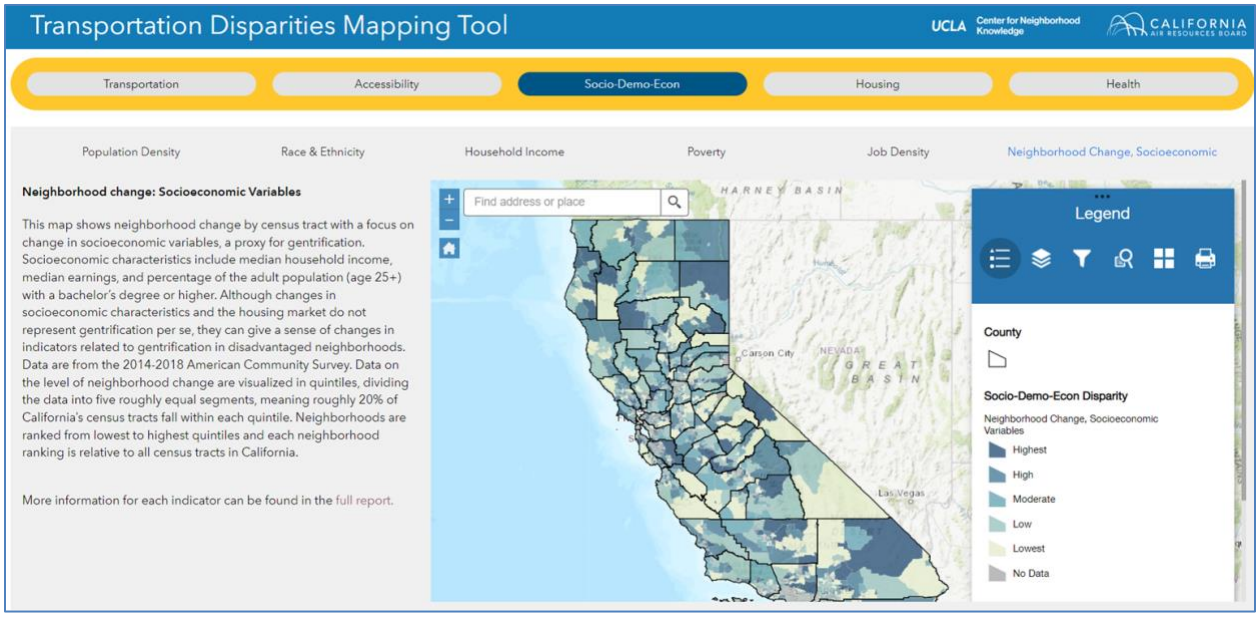

Figure 10. Transportation Disparities Mapping Tool homepage

Housing and Transportation Affordability Index. Developed by the Center for Neighborhood Technology (CNT) in 2016, the Housing and Transportation Affordability Index (H+T) provides a "comprehensive view of affordability the includes both the cost of housing and the cost of transportation at the neighborhood level." In order to better reflect the actual cost of households' location choices, the H+T Index builds upon the definition of housing affordability to include transportation costs at a home's location. By combining housing and transportation costs, the tool sets the benchmark for recommending affordability to be no more than 45% of the household income as compared to the traditional measure of no more than 30% of housing costs alone. The tool demonstrates that the combined housing and transportation costs are strongly correlated with urban environmental characteristics. The index values are modeled from several open data sources and administrative data, including odometer data from the Illinois Department of Motor Vehicles for a direct estimate of VMT, is based on peer-reviewed research, and is peer-reviewed itself (*19*). The tool was updated in October 2022 after the initial analysis for this report was complete.

The tool interface allows users to select from seven major categories a total of 36 variables from the drop-down menu (Figure 11). These categories include affordability indices, household model outputs, greenhouse gas from household auto use, composite neighborhood scores, environmental characteristics, household characteristics, and housing costs. Users are also able to see the data at the census block group and census tract levels throughout all metropolitan and micropolitan areas in the U.S.

Our assessment finds that by incorporating both housing and transportation affordability, this tool allows for a more in-depth comprehensive analysis as opposed to only using traditional housing measures. The tool itself specifically analyzes the relationships between travel behavior, housing costs, and VMT. Policies that are applicable to the data presented are

legislations that would impact GHG emissions reductions from transportation, housing, and vehicle ownership. With respect to equity, the tool considers household income, but not other demographics such as race and ethnicity.

One strength of the tool includes the option of creating a summary factsheet after exploration of the map and selected variables. The factsheet shows location efficiency and a breakdown of household transportation model outputs and GHG emissions per household. Additionally, this tool has relatively good forecasting ability as the summary factsheet provides many output estimations centered on location efficiency that allows for the estimation of VMT and GHG emissions reductions. On the other hand, a limitation includes the static nature of the data (although the frequency of future updates may render this a minor limitation). Because the tool does not use land use types or equity demographics in the cost modeling, the index may not be fully robust to levels of racial residential segregation that may have impacts on affordability.

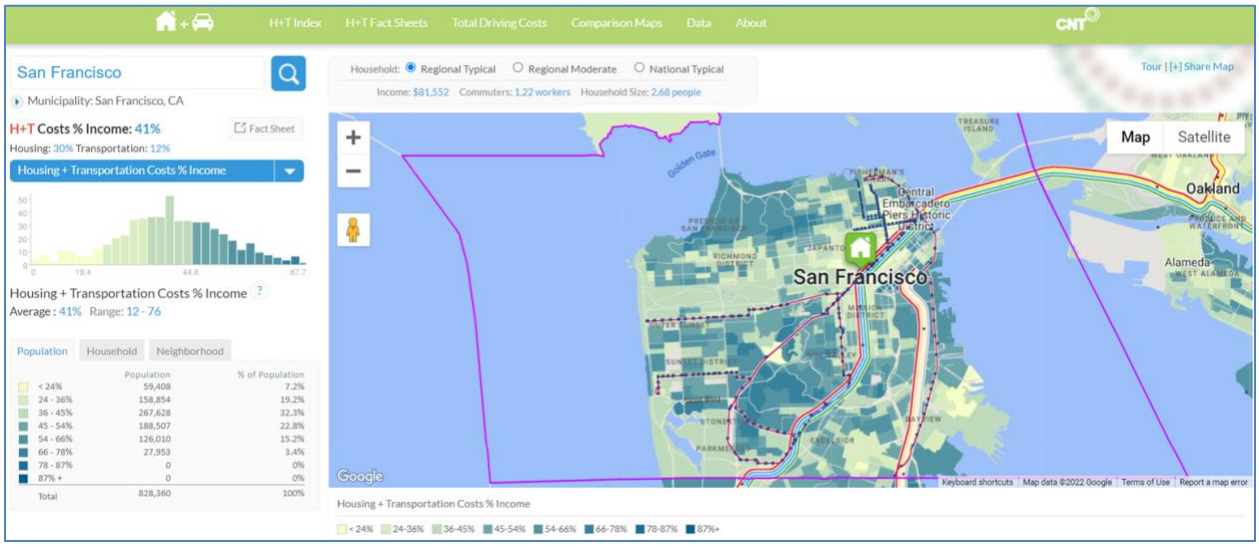

Figure 11. Housing and Transportation Affordability Index

Metropolitan Chicago Accessibility Explorer. The Metropolitan Chicago Accessibility Explorer measures and displays destination accessibility to several types of activities in the Chicago metropolitan area. The tool allows users to answer questions such as how certain urban amenities can be reached in specific neighborhoods at different time thresholds by various modes. Users can use the map help visualize the spatial distribution of access by census block group across Chicago and determine areas that are most accessible and areas that need improvements. Destination accessibility is modeled using a cumulative opportunities measure, which counts how many destinations can be reached within a given travel time, based on open data sources from the City of Chicago, OpenStreetMap, and the US Census.

The tool allows users to select from the five drop-down menus that include destination types, travel mode, departure time, travel time threshold, and, for employment destinations, a filter by job type across earnings, industry, and demographic factors like race, ethnicity, gender, and educational attainment (Figure 12). Users can also select the output display scale as a fixed

scale or natural breaks. The land use types that can be selected include access to jobs, parks, schools, grocery stores, hospitals, libraries, and fire stations. Users can select from auto, transit, bicycle, or walk as travel modes to compute accessibility and travel time. The tool then outputs a spatial distribution that shows the share and total number of destinations can be reached from each block group for a given departure type, mode, and travel time threshold. The tool also has an option to visualize travel time isochrones by block group for a given mode and departure time, and to visualize the accessibility and isochrone results side-by-side.

Overall, this tool allows users to compare land use types, VMT, transit mode, and certain kinds of travel behavior along with some demographic filters for job access that are relevant to equity. Although the tool is limited to analysis of the Chicago metro area, it provides insights into policies relevant to land use and transportation. Moreover, an important aspect of this tool is its incorporation of equity components. Not only does it provide accessibility metrics to land use types of jobs, parks, and other facilities, but it also includes equity filters by race, ethnicity, gender, and education level. Many of the other VMT tools lack these equity filters. The tool serves as a good model for expanding the analysis to other states and regions.

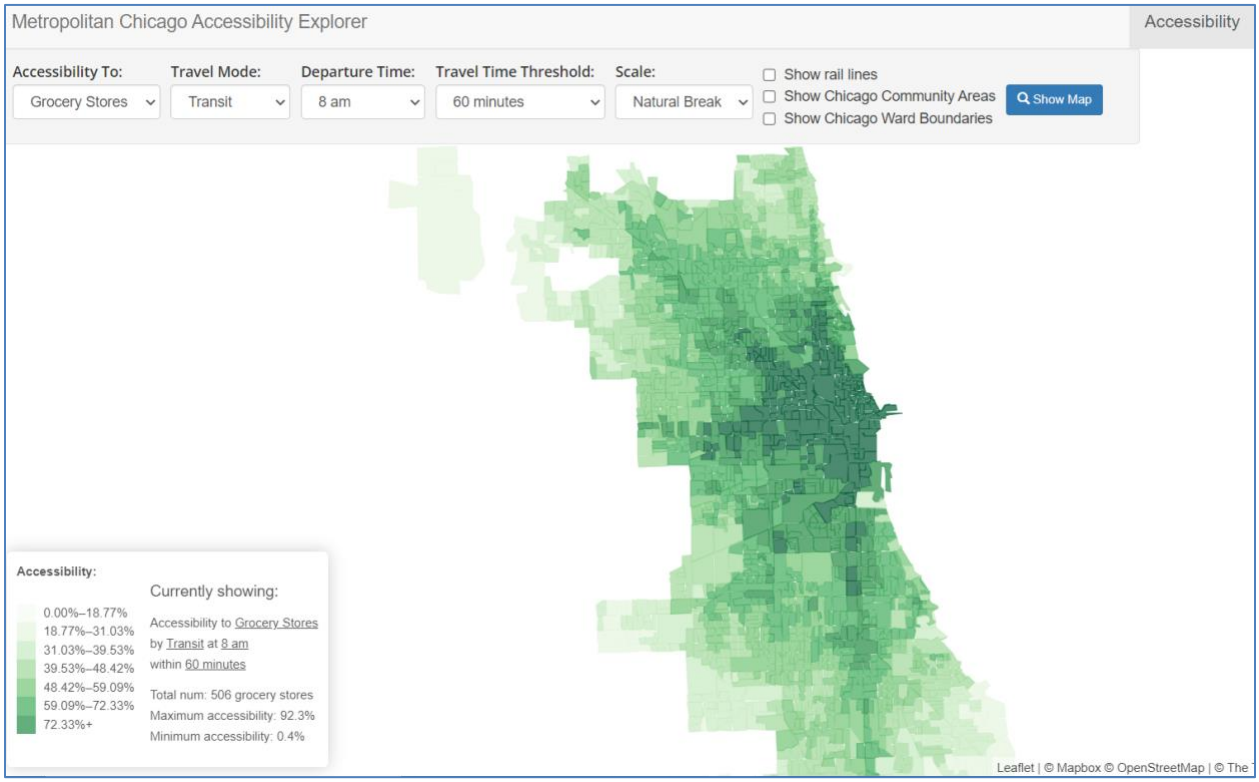

Figure 12. Metropolitan Chicago Accessibility Explorer

Summaries of key characteristics of the tools reviewed are shown in Tables 2, 3 and 4, below.

Table 2. Summary of key characteristics of tools analyzed (Part 1)

	Author			Data output				Forecasting	
Tool	Univ.	Govt.	Non-profit / CBO	Report	Database	Static map	Interactive map	Existing conditions	Forecasting
VMT									
Smart Location Database		●			●		●	●	
Santa Clara Countywide VMT Evaluation Tool		●		●	●				●
Access Across America	●			●	●		●	●	
California Induced Travel Calculator	●			●					●
Gentrification									
Gentrification Comparison Tool			●			●		●	
Displacement Alert Project			●	●			●	●	
Gentrification & Equity									
Urban Displacement Project	●						●	●	
Seattle Displacement Risk Index		●					●	●	
VMT & Equity									
Transportation Disparities Mapping Tool	●						●	●	
Housing and Transportation Affordability Index			●				●	●	
Metropolitan Chicago Accessibility Explorer	●						●	●	

Table 3. Summary of key characteristics of tools analyzed (Part 2)

	Data inputs						
Tool	**Housing**	**Land use**	**Transportation**	**Demographics**	**Employment**	**Travel behavior**	**Administrative**
VMT							
Smart Location Database		●	●	●	●		
Santa Clara Countywide VMT Evaluation Tool						●	
Access Across America		●	●		●		
California Induced Travel Calculator			●				
Gentrification							
Gentrification Comparison Tool				●			
Displacement Alert Project	●						●
Gentrification & Equity							
Urban Displacement Project		●		●			
Seattle Displacement Risk Index	●			●			
VMT & Equity							
Transportation Disparities Mapping Tool	●	●	●	●	●	●	●
Housing and Transportation Affordability Index	●		●	●	●	●	
Metropolitan Chicago Accessibility Explorer		●	●		●	●	

Table 4. Summary of key characteristics of tools analyzed (Part 3)

Tool	Analysis scale						Geographic coverage			
	Building or parcel	Block	Block group	Tract	MSA	Other	MSAs	Calif.	USA	Other cities
VMT										
Smart Location Database			●						●	
Santa Clara Countywide VMT Evaluation Tool	●									●
Access Across America		●					●			
California Induced Travel Calculator					●			●		
Gentrification										
Gentrification Comparison Tool				●			●			
Displacement Alert Project	●									●
Gentrification & Equity										
Urban Displacement Project				●						●
Seattle Displacement Risk Index		●								●
VMT & Equity										
Transportation Disparities Mapping Tool			●	●		●		●		
Housing and Transportation Affordability Index			●	●	●	●			●	
Metropolitan Chicago Accessibility Explorer			●							●

Limitations

As with any study, the analysis has several limitations. First, we were only able to review a limited number of tools in-depth because of time constraints. The research team began with the list of tools they were aware of followed by an extensive search for additional tools, but we discarded some from further analysis and may have missed some new ones in the search. It is possible that tools that cover all three categories we examined exist as internal tools or are otherwise not public facing. Nevertheless, the coverage consisted of tools from a variety of author types—academic, non-profit, and government agencies—and a variety of geographic areas and is representative of the available options.

Second, it was challenging to compare the utility of tools between different categories that have different metrics and characteristics, such a tool that focuses on VMT and access versus one that focuses on gentrification tool. To address this limitation, we adjusted our categories of analysis to included tools that overlapped across the singular dimensions we initially intended to review.

The analysis revealed a number of common limitations and gaps that applied to most of the tools. The questions that arose after identifying the gaps are described below.

- Do these tools become stale? If the tools are adopted to inform policy, how often do they need to be updated? The frequency with which the data are refreshed and the recently of input data impacts the forecast ability that planners and developers need to assess land use and transportation projects.
- Each of the tools used datasets from slightly different time periods. Does an inconsistency in the temporality of input data yield complications for analysis? Should datasets to analyze land use efficiency be standardized across locations?
- Can the tools that apply to specific geographic areas be transferable to other cities, regions, and states? What is lost in making such a tool? Should the tools be able to address multiple units of analysis, such as by neighborhood and city, or different land use types, such as rural and urban?
- What is needed for the tools to allow users to analyze equity in the outputs? How might the tools be used to inform equitable planning or policy processes in addition to equity across demographics or geography?

We used these questions to guide the structure the stakeholder workshop. We describe the methods and findings from this workshop in the next section.

Land Use and Transportation Efficiency Tools Stakeholder Workshop

As part of the tool evaluation, the research team hosted a two-hour virtual workshop through Zoom on August 9, 2022. This workshop brought together planning staff from Metropolitan Planning Organizations (MPOs) and local city and county governments who have been involved in land use and transportation planning. The purpose of this workshop was to share findings from the initial scan of tools and gather input on the strengths and gaps of those tools and others. A total of 22 participants were in attendance. The MPOs represented were San Luis Obispo Council of Governments (SLOCOG), Fresno Council of Governments (Fresno COG), Kern Council of Governments (Kern COG), Sacramento Area Council of Governments (SACOG), Southern California Association of Governments (SCAG), and Butte County Association of Governments (BCAG). Local governments included San Diego County, Alameda County, Kern County, Los Angeles County, City of Fresno, and City of Chico.

The format of the workshop began with introductions followed by a 15-minute presentation on the evaluation of existing tools and a brief question-and-answer period. The remaining stakeholder discussion was divided into two parts and in two breakout groups—one group for MPOs and one group for local governments. The first part focused on the strengths and gaps of existing tools, while the second part was focused the potential need for a new tool development or improvements to existing tools. Guiding themes for the workshop discussion included the value of tools in land use planning, tools currently used by agencies, the benefits of tools to agencies, the strengths and gaps of existing tools, possible development of a new tool or improvements to existing tools, and the ability of tools help integrate land use efficiency and equity.

The following sections summarize the discussions from the MPO and local stakeholders.

Discussion 1: Value, Strengths, and Gaps of Existing Tools

The first breakout group discussion focused the strengths and gaps of existing tools that MPOs and local governments have been using in their land use and transportation planning projects. A guiding theme for this conversation centered on the value of quantitative and mapping tools in land use planning and how agencies specifically use these tools for land use efficiency. The goal of this discussion was to gain feedback from government staff who work at different scales about how they engage with these tools and the gaps across areas of responsibility. This conversation provided the basis of the current landscape of tools today, which informed the conversation in the second breakout group discussions on future tool development.

The three sets of discussion questions that guided this first breakout group discussion were:

- What is the value of quantitative or mapping tools in land use planning?
- What are the strengths and gaps of the existing tools? How do agencies and local governments benefit from existing tools related to land use efficiency and equity?
- How does your agency use existing tools to best support the agency's planning goals and land use efficiency? What gaps do you see and what improvements are needed?

Value of Quantitative or Mapping Tools in Land Use Planning

Within the MPO breakout group, staff members saw the value of quantitative mapping tools supporting their evaluations of proposed planning projects as well as helping to facilitate conversations among staff about the impacts and potential VMT or GHG emissions reductions. Additionally, these tools help MPOs demonstrate compliance in meeting CARB targets such as the GHG emissions and VMT reduction targets under SB 375. Lastly, tools are often used to inform grant and funding applications such as meeting disadvantaged communities (DAC) investment targets under SB 535 as well as within California Transportation Commission's Active Transportation Program (ATP) grants to identify DACs.

Within the local government group, the main participating staff members primarily came from cities, and they stated that these tools aid in providing a more comprehensive view of urban development. These tools help to distinguish and compare between jurisdictions within the city and county levels. Specific to mapping tools, local governments appreciate the ability visualize data about neighborhoods and cities, which inform planning decisions and that can be referenced at local community meetings. A commonality among local government staff was that all use CalEnviroScreen to inform their planning decisions and project plans. Similar to MPOs, local governments stated that these tools help in informing their grant and funding applications, especially for applications geared towards DAC investment targets.

Strengths of Existing Tools

MPOs noted that the main strength of existing tools allows them to conduct more thorough macro-level analyses within the geographic jurisdictions. In terms of macro-level analyses, they also support MPOs in evaluating land use patterns, forecasting ability of long-range and long-term planning, and seeing how policies can impact their regions. Another strength is the ability of existing tools to integrate measures from other tools and allowing MPO staff to interface with data source owners. This is key as data sources are important to informing existing and future land use and transportation planning. MPOs were more likely to use propriety or in-house modeling tools in addition to visualization tools provided by others. For example, SACOG uses Envision Tomorrow, a scenario planning tool, to examine equity and VMT outputs in different growth scenarios. UrbanSim and PECAS (Production, Exchange, and Consumption Allocation System) are other example tools, which integrate land use and transportation models that factor in financial feasibility of projects in response to accessibility and regulatory factors.

Local governments expressed that existing tools save them time and funds by allowing them to easily retrieve data and visualizations without having to create their own. Several local governments stated that they use internal tools as well, however. Examples of internal tools include Alameda County Public Works using their own transportation tools and the City of Fresno using the Remix software. Cities, however, mainly use their own tools to inform General Plan updates. Additionally, existing tools allow local governments to compare geographic areas where land use and transportation projects are situated within their city or county jurisdictions. Lastly, referring to one of the values in the first question, many local governments use the tools

for grant applications, and this is key as these agencies are constantly applying during the funding cycles.

Gaps of Existing Tools

When looking at the gaps and limitations of existing tools, MPOs mentioned their concerns on the transferability of tools between agencies, between scales, and across jurisdictions. Staff stated an inconsistency in the scaling of statewide tools, which prompts the need for a more standardized process that can be used by all agencies across the state. They raised an important question: How can statewide tools be used at the local and regional levels, given how much the built environment and planning contexts differ across scales and regions? Lastly, a major concern is the lack of forecasting ability for existing tools. Information and data updates can be infrequent, which makes it difficult to predict and estimate the impacts of land use patterns as well as potential for more accurate VMT and GHG emissions reductions.

Local governments similarly expressed the inconsistencies and differences in geographic scale across existing tools. Because of the wide variation of tools as well as inconsistencies in the tools' units of measurements in addition to a limited general focus for certain tools, it is difficult to compare and transfer data and analyses. Moreover, local governments were concerned about the lack of local knowledge and community input to the tools, especially as these agencies work closely with local communities and neighborhoods. Participants raised another key issue: applications and representations of rural communities are insufficient as compared to urban communities. Many of these tools are more robust for urban metropolitan areas, thus there is usually an exclusion of rural and unincorporated areas. This is particularly evident in tools we reviewed, including Access Across America, Urban Displacement Project: Displacement Typology, and Gentrification Comparison Tool. The Transportation Disparities Mapping Tool does address some of those gaps in rural data, though participants thought more could be improved in integrating the accessibility, use, and application of that data.

Discussion 2: Future Tool Development

The second breakout group discussion expanded upon the conversations in the first group discussions by assessing whether a new tool needed to be developed knowing the strengths and gaps of existing tools. Participants were guided to discuss the specific features that would need to be included so that the tool would be useful to both local governments and MPOs. Participants also discussed how tool development or improvements to existing tools could best support land use efficiency and equity and how agencies might collaborate with each other. As different tools are being used at different agencies and scales, it is important that larger state agencies support the development of tools that can be standardized across scales and that all agencies can be on the same page when it comes to land use and transportation planning.

The three sets of questions that guided the second breakout group discussion were:

- Is there a need to develop a new tool?
    - If yes, what kinds of information, features, data sources, variables (and other variables related to equity), and interface applications would be needed to best support planning goals and address land use efficiency and equity?
    - If not, how can we use existing tools to better address land use efficiency and equity simultaneously?
- How can the development of a new tool or improvements to existing tools be made to best support planning goals as well as address land use efficiency and equity?
- How might agencies and local governments collaborate to address the development of a new tool and improvement of existing tools that address both land use efficiency and equity?

Development of New Tool or Improvements to Existing Tools

Most MPO staff supported the development of a new tool that would address the gaps and limitations of existing tools. A key point made for a new tool included needing to integrate localized data that can be coupled with statewide data. The participants saw a discrepancy between different scales of data and how they are integrated together. Additionally, in terms of addressing discrepancies between smaller MPOs as compared to larger MPOs, tools and their integrated data need to be easily accessible and transferrable between MPOs to foster more coordination. Specific indicators needed in a new tool included the opportunity to connect housing affordability, jobs and housing balance, and transportation together. Moreover, equity needs to be more effectively integrated as new tools must capture racial and ethnicity data.

Local governments were in support of developing a new tool as well as improving existing tools. For development of a new tool, staff recommended that they must include more robust data on rural communities and consider rural attributes in land use, a key distinction lacking in most tools. In terms of current tools, local governments suggest incorporating more equity and health attributes such as Area Median Income, local zoning, demographics, employment rates, illness rates, and health exposure to gain a more holistic picture on the impacts on disadvantaged communities. Participants also raised concerns about the accessibility of tools and outreach to potential users. Staff suggested having a common database of tools that agencies across the state can access anytime, which would further help in integrating community outreach with existing tools. Lastly, local governments recommend the need to provide training and orientation for agency staff to become literate on not only the tools but how to use them to assess equity. They suggested training should include how this kind of analysis could be integrated within the practice of the agency itself.

Tool Development in Supporting Planning Goals and Land Use Efficiency

Building upon the need for tool development, MPOs recognize that regions are different and that new tools must have the ability to integrate localized data along with statewide data to conduct both macro- and micro-level analyses. To best achieve land use efficiency, MPOs

recommended that tools must incorporate more land use data and health metrics and outcomes related to transportation. Specific suggestions to land use data include adding specific local zoning laws and ordinances as well as historical redlining maps and other environmental justice-oriented maps that focus on disadvantaged and vulnerable communities. Lastly, as iterated in both MPO and local government groups, participants recognized that there needs to be a more standardized methodology across regions in California that would help agencies with the ability to compare across regions and scales.

Local governments similarly echoed MPO suggestions of standardizing the methodology as well as a tool or model across the state to allow for better comparative analyses. There is a need to support interoperability and options for local agencies to add local data layers to tools so that comparisons between different data sets can be made. Local governments also emphasized the need for cross-sector and inter-scale communication. They suggest state-mandated communication and relationships between state agencies, MPOs, and local governments to improve collaboration as these land use and transportation planning issues stem across regions. Furthermore, local governments wanted more input from other stakeholders such as from community members, businesses, and academic researchers on land use and transportation planning.

Agency Collaboration to Address Land Use Efficiency and Equity

Agency collaboration is a critical point that was discussed more in the second half of breakout groups, but that needs more attention in addressing land use efficiency and equity. MPOs discussed an opportunity to integrate affordable housing with land use efficiency and ways that agencies can collaborate on this topic. SLOCOG raised an example of potential collaboration through the Regional Early Action Planning (REAP) grant where they were funded at the regional level to plan for affordable housing on the Central Coast. This grant was intended to help regional entities and governments facilitate local housing production for meeting Regional Housing Need Allocations (RHNA). MPO staff raised a challenge regarding how to navigate the issue of private property rights and new development projects when planning for land use efficiency. Another challenge in addressing collaboration is that state agencies often have different goals that might conflict; resolutions where agencies were more aligned with land use efficiency and planning goals were necessary.

At the local level, city and county government staff discussions were more centered on accessibility, normalizing interoperability across applications, and addressing interagency collaboration more specifically in working with MPOs. One major concern was that all agencies were not aware of these tools and that there needs to be increased awareness but a need for a unified repository of these tools, datasets, and applications that all agencies access to use for their own land use and transportation goals. Lastly, in order to achieve more inter-agency collaboration, local governments pointed to the need for the role of MPOs to be more active and possibly have standing items on their monthly meeting agendas regarding new resources and tools that local governments could be more aware of it and have access to.

Workshop Summary

The stakeholder workshop provided rich and meaningful conversations about the value of quantitative and mapping tools in addressing land use efficiency, equity, gentrification, and VMT. Having representatives from MPOs and local governments across the state of California representing both urban and rural regions facilitated discussion with diverse perspectives on how to address the gaps of existing tools that could inform the potential development of new tools. Both MPOs and local government stakeholders offered recommendations and promising practices on how to increase accessibility and applications of tools, as well as what needs to be done to standardize practices statewide to foster more interagency collaborations.

The main takeaways and key lessons to inform the value and need for tools that inform how and what agencies can do to achieve their planning goals while addressing land use efficiency and equity more effectively are described below.

- There is a need for a state standardized tool or methodology that incorporates transportation, land use, VMT, and equity. CalEnviroScreen functions as a statewide tool, as it is widely used by all state, regional, and local agencies because of funding mandates, but its focus is on environmental justice and environmental health issues rather than land use and transportation. Thus, a tool or methodology must be developed in a similar manner to how CalEnviroScreen is used and mandated for funding applications statewide.
- MPOs and local governments find the most beneficial use of tools to help inform their grant and funding applications. Tools must be better developed and updated to integrate localized and statewide data to help agencies conduct comparative analyses.
- One important aspect of the tools discussed is the ability to forecast patterns, impacts, and GHG reductions related to land use and transportation planning. Most existing tools do not have the ability to provide forecasts. Those that do tend to be internal-facing, complex, and computationally intensive. A main strength of the tools reviewed is in their ability to showcase existing conditions; however, they need to go beyond and provide more insight into potential impacts, especially for projects that impact disadvantaged communities.
- Interagency collaboration is a critical aspect raised by both MPOs and local governments. Local government representatives were particularly concerned with how to engage and collaborate with regional and state agencies more effectively. They raised questions related to how communication and collaboration between state agencies, as well as between state and local governments, be improved, and how the land use efficiency tools could be used to foster communication.
- Many of these tools lacked a major equity component. However, more recently developed tools such as the Transportation Disparities Mapping Tool integrates more social and demographic indicators. Equity needs to be better integrated into tools. Gentrification indicators are recommended if housing is also an analytical priority in the tool. The inclusion of land use types and historical redlining maps can help bring in

important context when examining VMT, travel behaviors, and accessibility to services and transit.

- There is a large discrepancy between urban and rural data and their applications within both tools and land use and transportation planning. Differences in the application or urban and rural data did not arise during the tool evaluation process as most of the tools urban centered. However, local governments raised an important point that many rural and unincorporated communities are not included in these tools and planning resources. Rural communities also need these tools; however, the lack of data and inclusion rendered them unusable for their needs. This data needs to be addressed when thinking about how to foster more regional and statewide collaborations.

Conclusions, Recommendations, and Future Research

In this report, we performed a review of literature that examined the value and use of tools in land use and transportation planning; an evaluation of 11 tools across categories of VMT, land use, gentrification, and equity; and a needs assessment workshop to gauge feedback from MPOs and local governments. As synthesized from the workshop summary, there remain gaps and limitations to existing tools within land use and transportation planning. However, the tool evaluation and workshop feedback showed that there are tangible solutions that could be pursued as well as positive signs of moving in the right direction with tools developed in recent years that have integrated more equity components. These potential solutions require a proactive engagement and systemic approach of all state, regional, and local agencies to be in collaborative discussions with each other. The findings of this report provide a foundation for developing a new tool that incorporates elements of land use efficiency and equity for to help meet statewide GHG and VMT reduction mandates.

This report also provides insights that Caltrans, CARB, MPOs, and local governments could use to better promote a deeper analysis into the analytical tools that they are using. A key finding is the need to better integrate equity and to have better training for staff to have an equity-focused vision facilitated by the use of land use efficiency tools. The following are recommendations and future research needs generated from the stakeholder workshop that can be pursued on both short-term and long-term timeframes.

- Integrating equity into land use efficiency tools is a key priority. Several of the tools evaluated in this project included equity demographic indicators such as race and ethnicity. However, most tools lacked a deeper integration. Equity needs to be prioritized by including marginalized and vulnerable populations and how they are impacted by planning for VMT reductions and transportation investment. Housing and gentrification tools tend to not include transportation components, but some, such as the H+T Index, incorporate both. However, some housing indicators still lack gentrification attributes, which are needed if equity and gentrification are to be integrated within these tools.
- A common gap is the forecasting ability of tools which depend on frequent updates to data. However, there are inconsistencies in terms of how often tools are updated and

where the data is sourced. This limits comparative analyses as well as forecasting abilities. Newer tools such as the Transportation Disparities Mapping Tool address some of those concerns by virtue of their recency; however, there needs to be an integration of a standardized tool or model that also standardizes the use and application of data sources.

- Concerns about cross-agency collaboration and communication were strongly emphasized in the workshop. New tool develop could provide a platform for additional opportunities where MPOs, local governments, and state agencies can be at the table together to discuss how to better integrate equity with land use efficiency in tool use as well as in planning goals.
- Agencies need support in using tools for land use efficiency and equity goals. There needs to be more training for agencies on equity and how to integrate the teams that solely work in the analytics and modeling departments with the planning and equity and diversity teams.
- With the need to prioritize equity, there also needs to be a mechanism to standardize definitions and practices with respect to centering disadvantaged populations and communities. For example, while SB 535 provides a common statewide definition for DACs, the definition leaves out many transportation-related characteristics, particularly related to destination accessibility. Some MPOs use other definitions for identifying equity-priority communities. A common definition or suite of definitions with explanations for when each is relevant could help tool users understand how to assess project needs and impacts.
- Further research into other state tools should be strongly considered. This research examined a mix of California-based, U.S., and other U.S. metropolitan area tools. However, it would have been more comprehensive to have a deeper dive into tools used in California and tools used in other states.

Lastly, state agencies, MPOs, and local governments should continue to collaborate with universities, academic researchers, and educators to better incorporate equity curriculum, training, and research into land use and transportation planning. While the research on the built environment and travel is long and well established and relatively well known, research on transportation equity, mobility justice, and intersections with land use are more nascent. Better training could improve tool development and use of tools to improve practice.

References

1. Ewing, R., and R. Cervero. Travel and the Built Environment: A Synthesis. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1780, 2001, pp. 87–114. https://doi.org/10.3141/1780-10.
2. Ewing, R., and R. Cervero. Travel and the Built Environment: A Meta-Analysis. *Journal of the American Planning Association*, Vol. 76, No. 3, 2010, pp. 265–294. https://doi.org/10.1080/01944361003766766.
3. Ewing, R., and R. Cervero. "Does Compact Development Make People Drive Less?" The Answer Is Yes. *Journal of the American Planning Association*, Vol. 83, No. 1, 2017, pp. 19–25. https://doi.org/10.1080/01944363.2016.1245112.
4. Padeiro, M., A. Louro, and N. M. da Costa. Transit-Oriented Development and Gentrification: A Systematic Review. *Transport Reviews*, Vol. 39, No. 6, 2019, pp. 733–754. https://doi.org/10.1080/01441647.2019.1649316.
5. Ong, P. M., C. Pech, A. Cheng, and S. R. González. *Developing Statewide Sustainable-Communities Strategies Monitoring System for Jobs, Housing, and Commutes*. UCLA Center for Neighborhood Knowledge, Los Angeles, 2018.
6. Ong, P., G.-C. Sciara, C. Pech, A. Cheng, S. R. González, T. Thomas, S. Strand, and A. Schouten. *Identifying, Evaluating, and Selecting Indicators and Data for Tracking Land Use and Transportation-Related Trends Related to SB 375 Goals*. UCLA, Los Angeles, 2018, p. 192.
7. Ferrell, C. E. *Measuring Incremental SB743 Progress: Accounting for Project Contributions Towards Reducing VMT Under California's Senate Bill 743*. Mineta Transportation Institute, San José, CA, 2019.
8. Ewing, R., G. Tian, J. Goates, M. Zhang, M. J. Greenwald, A. Joyce, J. Kircher, and W. Greene. Varying Influences of the Built Environment on Household Travel in 15 Diverse Regions of the United States. *Urban Studies*, Vol. 52, No. 13, 2015, pp. 2330–2348. https://doi.org/10.1177/0042098014560991.
9. Lee, S., and B. Lee. Comparing the Impacts of Local Land Use and Urban Spatial Structure on Household VMT and GHG Emissions. *Journal of Transport Geography*, Vol. 84, 2020, p. 102694. https://doi.org/10.1016/j.jtrangeo.2020.102694.
10. Moudon, A. V., and O. Stewart. *Tools for Estimating VMT Reductions from Built Environment Changes*. Washington State Department of Transportation, 2013, p. 36.
11. Appleyard, B., J. Stanton, and C. Allen. *Toward a Guide for Smart Mobility Corridors: Frameworks and Tools for Measuring, Understanding, and Realizing Transportation Land Use Coordination*. Mineta Transportation Institue, 2020.
12. Nieuwenhuijsen, M. J. Urban and Transport Planning Pathways to Carbon Neutral, Liveable and Healthy Cities; A Review of the Current Evidence. *Environment International*, Vol. 140, 2020, p. 105661. https://doi.org/10.1016/j.envint.2020.105661.

13. Ong, P., C. Pech, T. Green, and N. Rios. *Mobility, Accessibility and Disadvantaged Neighborhoods: Assessing Diversity in Transportation-Related Needs and Opportunities*. Pacific Southwest Region University Transportation Center, 2021.
14. Ong, P. M., C. Bryant, S. Gonzalez, J. Tadayon, C. Pech, and M. Garrett. Assessing the Incorporation of Racial Equity into Analytical and Modeling Practices in Transportation Planning. 2021. https://doi.org/10.7922/G2QJ7FMF.
15. Philbrick, S., L. Torres, and T. Reardon. *Demographic Forecasting by Race and Ethnicity: "Segregation Scenarios" and Environmental Justice Analysis*. Lincoln Institute of Land Policy, 2022.
16. Barajas, J. M., A. Natekal, and C. Abrams. *An Assessment of How State and Regional Transportation Agencies Advance Equity in Transportation Plans, Processes, and Implementation*. 2022.
17. Amini, J., C. Kerchof, L. Mathews, and M. Thompson. *Summary of Interviews with California Metropolitan Planning Organizations About Senate Bill 375 and the Sustainable Communities Strategies*. University of California Institute of Transportation Studies, 2021.
18. Cervero, R., and K. Kockelman. Travel Demand and the 3Ds: Density, Diversity, and Design. *Transportation Research Part D: Transport and Environment*, Vol. 2, No. 3, 1997, pp. 199–219. https://doi.org/10.1016/S1361-9209(97)00009-6.
19. Haas, P. M., C. Makarewicz, A. Benedict, and S. Bernstein. Estimating Transportation Costs by Characteristics of Neighborhood and Household. *Transportation Research Record*, Vol. 2077, No. 1, 2008, pp. 62–70. https://doi.org/10.3141/2077-09.

Data Summary

Products of Research

Links to 11 web-based tools on various aspects of land use, transportation, and equity were collected.

Data Format and Content

Data are available in an Excel spreadsheet. File contains links to each tool and analysis of the tools, including the following characteristics: Purpose, Year, Data Source, Methods, Units of Analysis, Variables, Outputs, Geographic Area, Scale, Stakeholders, Observation Notes, and Ease of Use.

Data Access and Sharing

The spreadsheet is available at the following URL: https://doi.org/10.25338/B8BP8H. The data are accompanied by a README file that contains additional description about the data.

Reuse and Redistribution

There are no restrictions on the dataset. The data should be cited as follows:

> Barajas, Jesus; Nguyen, Peter (2023), Analysis spreadsheet of land use efficiency and equity tools, Dryad, Dataset, https://doi.org/10.25338/B8BP8H